# Entrepreneurship and the anticipatory firm

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**Abstract:** Firms, in most cases, cannot be described adequately as if they were an individual person. And yet, they learn, anticipate, decide, and adapt in order to survive in an uncertain environment. To deal with such aspects of a firm, the theory of the anticipatory system is developed and applied to the specific case of the multiperson firm (one in which knowledge of the firm's environment and capabilities is distributed among the people in the firm) operating in a market environment in which product design and time-consuming production entail anticipation of an uncertain future and in which this very uncertainty means that adaptive responses will be required as experience accumulates. An important side-effect of this analysis is the recognition that "entrepreneurship" is not a single activity or capability—it is exhibited in different forms and in different places both within the firm and in the encompassing market.

**Keywords:** firms, entrepreneurship, capabilities, learning, anticipatory systems, adaptation

## I. INTRODUCTION

It is a given in modern business literature that a firm, to be successful, must have a good working knowledge of both its available capabilities and the environment in which it operates, such knowledge being the basis not only for successful production but also for anticipation of the reception of the products the firm may decide to supply to that market. The question arises, then, of how such knowledge is learned, how it is instantiated within the firm, how it is deployed in product planning, and how it is adapted with ongoing experience. For a firm (usually a small firm) controlled by a dominant individual, there is little mystery—it is this individual who learns by observation and experience, the knowledge is in his head, and his are the expectations and the product decisions and the reactions to market feedback. But when a firm grows beyond the direct control of an individual, the questions become more complicated and in a significant sense it is the firm itself which learns, which anticipates, which decides, and which adapts.

Current economic and sociological theories of entrepreneurship and the firm either do not address such epistemological questions or do not fully develop them into a model of the firm as a social arrangement capable of operating, learning, surviving, and maintaining itself within an uncertain environment. What is proposed here is a systemic

theory of the firm which neither assumes that a firm is simply a vehicle for enabling the actions of a single entrepreneurial individual nor anthropomorphises it as a super-individual but treats it as an adaptive system of mutually compatible processes within which learning and anticipation can emerge.

## II. THEORIES OF ENTREPRENEURSHIP AND THE FIRM

Although Adam Smith's description of the division of labor within a factory producing pins was neither original nor particularly accurate,[1] its recognition of the potential productivity of specialization and coordination has made it a fundamental starting point for economic theorizing about firms.[2] But division of labor in and of itself does not entail the organizational form we recognize as the firm, since productive coordination of specialists through market transactions is always possible, at least in principle, and so there have been proposed various economic theories of the firm, each emphasizing particular reasons why the consolidation of assets and the employer-employee relationships characteristic of firms should have an advantage over market contracting in many cases.[3] The great majority of this work models its postulated firm-like governance structures controlling the productive transactions as a closed system, takes the participants to be rational optimizers (sometimes boundedly so and sometimes lacking full information), and solves an optimization problem subject to an efficiency criterion.[4] While this work has been very useful in exploring the ramifications of particular governance and contractual structures and, to some extent, providing plausible reasons for the existence and scope of firms,[5] it abstracts away from what is surely a foundational issue in understanding firms: the inescapable need to organize production in the face of the uncertainty[6] of future market reception.

The recognition that business operates in an environment of uncertainty has a long history in economics, dating from well before Adam Smith, and in this literature the economic actor identified as the one shouldering the risk to pocket and reputation associated with business decision-making under uncertainty is the entrepreneur, to whom the residual profit from the operation is assigned.[7] Locating the response to uncertainty in the activity of a particular actor has led to a large body of work in economics, entrepreneurship theory, and business and management studies centered on defining the personal characteristics appropriate to such a role, explicating the functional requirements of the role, and examining the means and strategies available to such a person to organize assets and associates for profitable production.[8] Although the context for this work is, usually, the business firm, the emphasis is on the attributes and activity of the particular individuals designated as entrepreneurs, and the firm itself, as a working system, remains in the background, playing a supporting role to the lead actor. But to understand better the context of entrepreneurship, it is necessary to pay attention to the processes and transactions that may take place within the firm—not simply the firm's organization in the sense of chains of responsibility and command, but the ways in which the interactions taking place within the firm enable the generation within the firm of knowledge of itself and its environment and provide grounds for innovation appropriate to that environment.[9]

Offering the possibility for more of a systemic approach to the theory of the firm is work emphasizing firm capabilities[10] and organizational learning.[11] Since the focus of this work is on the characteristics of individual firms, it has opened avenues for understanding why some firms are more profitable than others, why some are more adaptable than others, and why some have more longevity than others. In capability theory, two types of capability are recognized: operational capabilities, which refer to the ability of people and procedures within the firm to make and market the firm's products, and dynamic capabilities, which refer to the ability to sense and react to environmental change, to recognize opportunities, and to reorganize product and procedures in the face of change.[12] Firms in a relatively static environment can survive and maybe prosper on the basis of their operational capabilities, but to cope with unpredictable environmental change requires the exercise of dynamic capabilities. And while some capabilities can be obtained by hiring or acquisition, others, especially those relevant to the firm's ability to learn about its environment and react to change, entangled as they are with the firm's culture and history, are not obtainable on the market and must be built up within the firm. Organizational learning theory, in which organizations are said to learn from

experience by implementing and adjusting the routines that guide the organization's internal behavior, is broadly compatible with capability theory.[13] These routines are the operational procedures, the rules and conventions, and the strategies that actors within the organization follow; they exist independently of the individuals as components of the organization's culture and mode of operation, and can be identified as the organization's capabilities, both operational and dynamic.

Capability theory (together with organizational learning theory) provides a basis from which to address issues of firm organization, learning, adaptability, and growth[14]—issues of considerably more salience to entrepreneurs and managers than are treated by the more formal efficiency-based treatments of transaction costs and agency problems.[15] It points to an understanding of the firm in which considerations of knowledge acquisition, transmission, and deployment assume primary importance. There is emphasis on the learning of skills, the development of tacit understandings of production processes, and the emergence of routines as shared rules of conduct. These operational capabilities are the firm's knowledge base.[16] But, by themselves, routines can lead to routinization and therefore a tendency for the knowledge base to become locked in, and hence the need for the dynamic capabilities of acquiring, innovating, or adjusting operational capabilities. However, by associating the deployment of dynamic capabilities with owners and managers acting as strategic planners in the face of uncertainty, the theory downplays the processes of learning and innovation that can take place within the firm not directly involving the top or even middle management.[17] In fact the firm appears more as a collection of roles and capabilities than as a knowledge-generating and knowledge-deploying system of mutually supportive processes involving people at all levels.[18] Developing that latter characterization, which follows naturally from the theory of anticipatory systems, is the object of this paper.

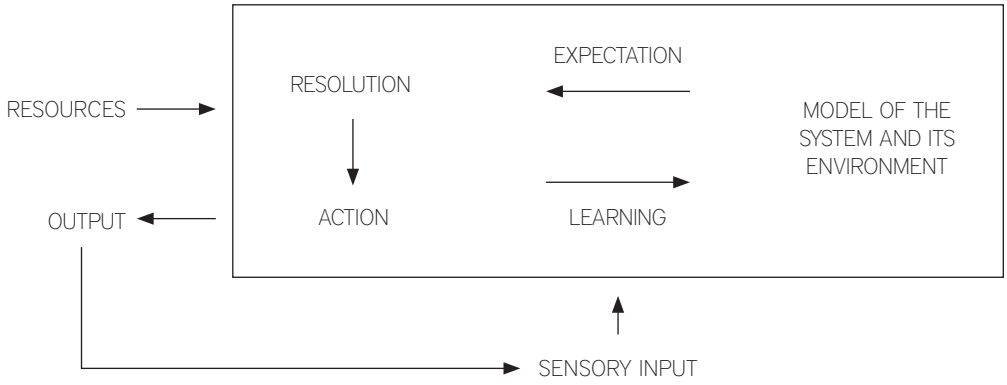
## III. ANTICIPATORY SYSTEMS[19]

Systems biologists, particularly Ludwig von Bertalanffy and Robert Rosen, have shown how biological systems can be modeled in terms of the organization of their internal processes.[20] This line of thought has a long history in biology, dating back at least to Immanuel Kant, who described biological organisms as self-organizing and self-maintaining systems with the characteristic that such a system is formed and maintained by the interaction of its parts, and the parts are formed and maintained by the system's processes. He contrasted such systems with mechanical arrangements which require external maintenance processes.[21] This mode of "systems thinking" gained major traction in the 1920s. Bertalanffy, in the course of arguing for biology's status as a science independent of physics, directed attention to the emergence of phenomena at the system level, phenomena that arose only as a result of the interactions of the system components and were not reducible to the characteristics of the components in isolation.[22] Such systems can be characterized as materially and energetically open systems with closed, self-maintaining organization, whose persistence is inherent in the mutually supporting functional processes within the system; the physical components, in contrast, are continuously being reconstituted with the help of inputs from the environment.

As systems open to their environment, self-maintaining biological systems are affected by environmental change, and may react to that change in various ways that maintain their structure and coherence, including the adoption of internal changes. Simple biological systems may adapt wholly as feedback homeostats that smooth out randomness in the environment, but in more complex systems there is the phenomenon of anticipation, where adaptation is informed by a prediction of possible future states of the environment. Rosen specified the essential requirement for anticipation as the ability for the system to maintain, within itself, an internal model of its environment.[23] A system is anticipatory if it contains a predictive model of its environment (and of itself in relation to the environment) which allows it to change state on account of the model's predictions as to a future situation. This ability to develop plans for possible futures, to form expectations of the future based on an internal model, allows for modification of the system's current state in the course of implementing these plans or predictions, and may result in output to the environment conditioned by that modification. And the system's input from the environment may be processed within

the system to confront, and perhaps modify, the model—for the model to be useful for anticipation, the system must be capable of learning, i.e., adjusting its model to reflect experience of reactions from the environment, especially in situations where prior expectations were not met.

To summarize, the systems described by Rosen as anticipatory possess the general attributes of material and energetic openness, process closure, and adaptation via the maintenance of a model of the environment which is conditioned by learning and capable of generating expectations as to relevant aspects of imagined future states and actions. The following is a schematic representation of the sort of system being described:




"Action" processes within the system construct items which may go directly to the environment but which may also undergo assessment processes conditioned by input from the environment to which the system is sensitive, including reactions to the system's output. Within the system there is a structure, the composition of which is modified by the output from the assessment processes. To the extent that the inputs from the environment are effective in the conditioning of the structure that emerges from the assessment processes, this constitutes a form of "learning", and is the means by which the system adapts to its environment. This emergent structure, therefore, can be regarded as the system's "model" of its environment. The "expectation" processes can, based in part on the existing model, generate dispositions for action which take into account possible future states. "Resolution" processes perform a selection operation on these dispositions, involving judgment as to which are to be acted on.

It is to be emphasized that this is a high-level picture of the functional organization of an anticipatory system, not of the movement of physical things within the system. It represents the processes as forming a materially open but self-maintaining whole, where the output from one type of process supplies at least some of the inputs to others in a closed causal cycle. It is an epistemic system, a system capable of building within it some relevant knowledge of its environment, and capable of employing that knowledge to anticipate environmental effects and thereby to attempt to adapt to them. It could usefully be described as a self-organizing and self-maintaining Popperian system[24] in that its adaptive apparatus consists of a process for developing conjectures based on existing knowledge, a process for implementing these conjectures so that they may be confronted by the environment, and a "refutation" or "error elimination" process through which failures and successes of this confrontation are learned from and the systemic knowledge updated.

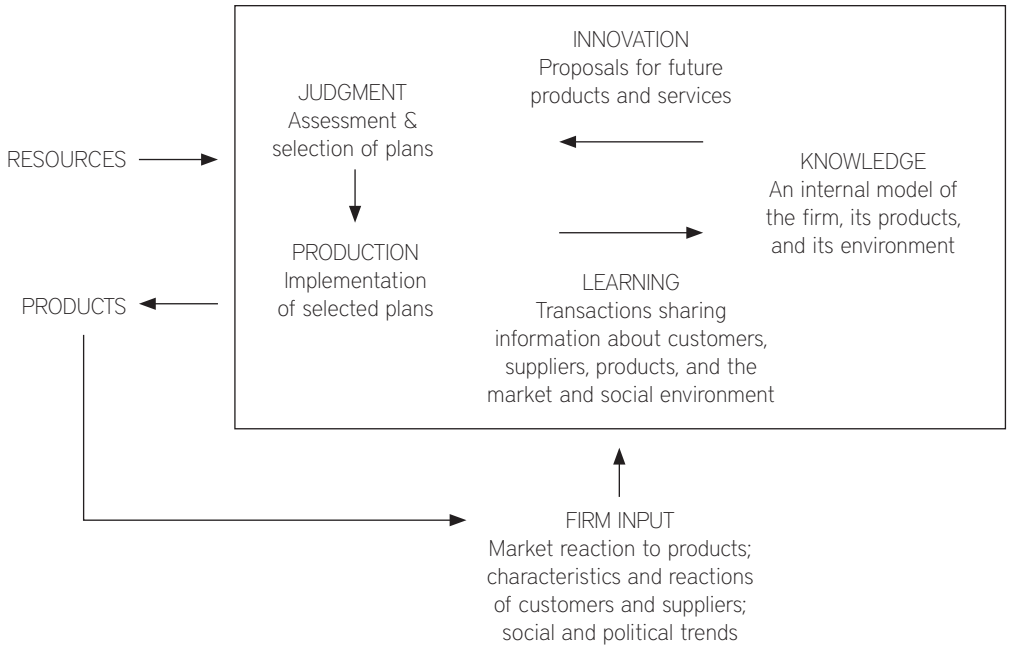
It is obvious that many biological systems (including us)[25] have such capabilities; the hypothesis developed here is that firms can be modeled as anticipatory systems[26]—very different of course from biological systems in material structure and in the motive forces which drive the internal processes, but analogous (at a very general level) in terms of the types of process they contain for generating anticipation and in the self-maintaining and self-supporting organization of such processes. The motive force animating the processes in a social system (such as a firm) is the purposeful agency of the participants, in the course of acting according to their subjective preferences and motivations ("pursuing happiness").[27] This is why the funda-

mental interactions in knowledge-generating social systems (such as markets and science) are both cooperative and competitive: the element of the potential for personal gain (where "gain" is a subjective appraisal) provides a strong incentive to engage in the requisite processes of cooperative interaction.

## IV. THE ANTICIPATORY FIRM

Any firm which has any chance of surviving and prospering in a changing and competitive environment must exhibit anticipation at least to some extent and, to that extent, must have internal processes which combine to generate such anticipation. For a small firm built around a dominant individual, the anticipatory processes are those of the individual—it is he who learns by observation and experience. The knowledge is in his head, and his are the expectations and the product decisions and the reactions to market feedback. But when a firm grows beyond the direct control of an individual, the knowledge-generating and knowledge-deploying processes are distributed (to varying extents in different firms) across the people acting within the firm, and it becomes reasonable to talk in terms of learning and expectation formation by the firm as a system rather than an individual.[28]

The following schematic, following the general model of an anticipatory system, shows the firm and its links to its environment, and portrays the firm in terms of a cycle of processes organized to effect learning, innovation, judgment, and production:




This organization of processes represents a firm as an anticipatory system incorporating and maintaining a working model of itself and its environment, a model which can be accessed internally within the system to project the anticipated effects of future actions taken by the system in the context of possible future environmental states. This model constitutes the firm's knowledge.[29] Reaction from the environment is taken into account in the processes which update the model, and this in turn provides an enhanced picture of the environment upon which innovative actors can base proposals which condition the propensities of the system to act on the environment. The processes of interest here are by no means the only processes taking place within the firm—under the heading of "production" are processes involving construction, sales, and deployment of the firm's current products and services, financial accounting, facility maintenance, and management of and training for such operations; these are examples of activity not under further consider-

ation. The processes of concern are those that have the emergent effect of endowing the firm with adaptability in the face of the changing state of the environment and its reactions to the firm's activity to which, for its own survival, it must be sensitive.

Actual multiperson firms vary greatly in the implementation of these epistemic processes and the internal model of the environment. This seemingly banal observation is actually quite interesting, for in some other forms of human interaction which exhibit the emergence of anticipation, the processes for generating the system's knowledge have become solidly entrenched customs. In modern markets, the exchange of property for money in a competitive environment is the customary transaction, and repeated execution of this transaction, involving many items of property and observable by other market participants, results in the emergence of what is known as "the price structure", which is, from the point of view of the market system, a mutable model of the market's environment of actual and potential resources and buyer and seller preferences. In science communities, publication and citation are the customary transactions, and their repeated execution results in the emergence of the mutable structure of scientific knowledge.[30] But no analogous customary transaction types have arisen (yet) in the case of firms.

As larger corporations replaced smaller family firms in the 19th and 20th centuries, the major form of business firm organization that emerged was the administrative hierarchy which, particularly (but not exclusively) in its instantiations in government departments, is called "bureaucracy". Max Weber, the preeminent theorist of bureaucracy, characterized it as a pyramidal arrangement of strictly defined levels, with each level managed by the one above it and responsible for executing specialized, well-defined and documented functions—a rule-based machine-like arrangement with a clear chain of management command and standardized division of labor. While Weber stressed bureaucracy's positive potential for technical efficiency and stability,[31] Robert Merton pointed to its darker side in which adherence to strict rules becomes an end rather than a means,[32] and since then there have been extensive discussions on bureaucracy's merits and shortcomings. But the point of interest here has to do with the potential for bureaucratic procedures within corporate hierarchies to generate actionable knowledge of the firm's environment. Any observations, insights, or ideas coming from by individuals at any level within the organization can only be communicated to the manager at the level above, from whence the information may or may not filter upwards, actionable only when, probably in attenuated and reinterpreted form, it reaches the manager with permission to act on it.[33] In terms of its ability to anticipate and adapt to change, the bureaucratic organization can be an improvement on an isolated individual, but only to the extent that the filter of level-by-level transmission retains the fidelity of the information. Of course, as is the case in all private firms, the measure of profitability can be an indicator of successful adaptation, but it is a lagging indicator.

In a slowly changing environment, a limited capacity for learning, innovation, and adaptation may not be a big problem. But, especially since the 1970s, the business environment has become one of much more rapid change and increased competition, due especially to the emergence of computers and communication technology, to the trend toward globalization, to advances in transportation, and to increasing pressure from institutional investors.[34] In such an environment, the ability to anticipate and adapt becomes much more important for survival, so that the bureaucratic arrangement's deficiencies in this area have become apparent, and the business management literature is replete with studies of organizational experimentation as companies react to the new environmental realities.[35]

There are recurring themes that have emerged from this organizational experimentation. While these can be characterized as moves to dismantle the strict hierarchy to some extent, reducing the number of levels, enabling the formation of project teams from what were different areas of the firm and thus allowing for direct, sometimes *ad hoc*, interactions between people at various levels, and allowing these smaller units increased authority and responsibility, the significant underlying effects have been to foster increased communication within the firm,[36] especially with regard to understanding the firm's culture and capabilities, its customers, and its environment (market, social, political, and natural), and to inculcate a new tolerance for idiosyncratic ideas and suggestions, some of which may lead to innovations in product, service, and internal procedures.[37]

The model of the anticipatory firm provides a structure within which these developments can be related in a coherent manner. The firm's internal model of its environment and of itself is not a physical thing; it is the result of repeated interactions between people in the firm communicating observations, ideas, and opinions.[38] Like the price structure in a market system, it is neither one person's opinion nor the average of all, but it is emergent from transactions in which those opinions are exercised. To be effective for reliable knowledge generation, it is necessary that these transactions involve the possibilities of benefits and costs to the participants—most effectively in the forms of reputation and status, but in general providing a means by which the individuals involved pursue happiness as they see it in the context of the firm. The underlying openness and tolerance may have been policy initiated by the firm's founder and supported by subsequent management and therefore describable as idiosyncratic "company culture", but to stop the description there is to forestall understanding of the necessary transactions and the knowledge-generating possibilities that can emerge from them.

Individuals working within the firm have, depending on their particular roles, day-to-day contact with the firm's customers, its products and their production methods, and the firm's internal procedures. They also have their own experiences and observations from living in the greater society. They can bring to the firm their individual knowledge and ideas derived from their local experience.[39] This input may be idiosyncratic, incomplete, and even contradictory, but if it is communicated and assessed widely within the firm as a result of individuals repeatedly engaging in interactions from which there is a possibility of reputational or other gain (or loss), then what emerges as a common understanding will be the firm's knowledge, its model of itself and its environment.[40] One of management's roles is to enable and encourage transactions which have this emergent property.[41]

Based on this understanding (which, by the nature of its generation, is continually being updated), some entrepreneurial individuals (or teams) within the firm may come up with ideas for product, service, or internal procedure enhancement,[42] and again these may be communicated and analyzed in interactions in which personal gain might be the outcome. Determining which, if any, of the emerging proposals can be implemented, and where and when they should be implemented, calls for judgment, and again there will be interactions (probably among senior individuals) that implement this particular function. It is to be emphasized that these judgments, the end result of the anticipatory series of processes, are not necessarily direct predictions of the future; they will be, more likely, conditional anticipations of what to do depending on what shape the future takes. In this, they are like the anticipations every individual develops—a repertoire of hopefully appropriate responses to possible future situations.

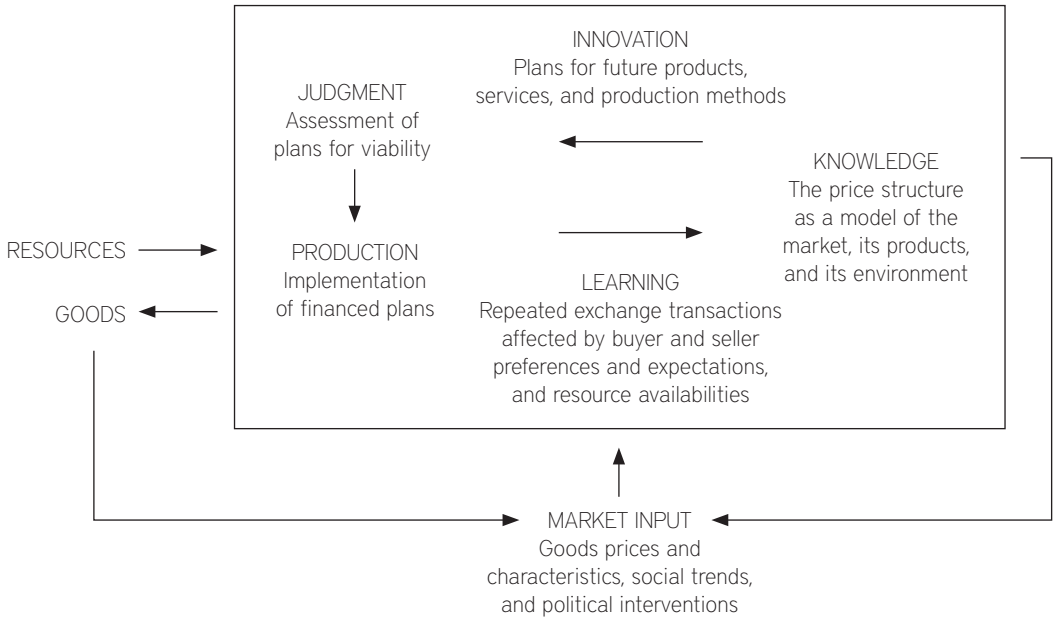
The theory of the anticipatory firm represents these epistemological activities of the firm as a linked cycle of processes implementing learning, innovation, and judgment in which the output from one is a necessary input to the next. The business experiments which are currently underway can be seen (from the vantage point of the theory) as attempts to implement processes of that kind—fostering communication, diffusing responsibility, ensuring contact between what used to be different departments, creating small project teams in which each member's contribution is known and can be assessed and appreciated, providing tools and time for imagining and discussing possible future scenarios, and rewarding innovative thinking. What specific arrangements and modes of interaction eventually emerge from this ongoing experimentation as best serving the purposes of firm survival and stable growth is not yet clear, nor is whether what does emerge will be widely applicable to all firms or will vary depending on firm size or industry type. What the theory of the anticipatory firm does predict, however, is that these arrangements, whatever their specific form, will involve widespread participation within the firm, and will involve cooperative interactions which are sufficiently competitive that there is incentive to participate and to put forward observations and ideas for consideration and assessment.

## V. ENTREPRENEURSHIP

The question of what, exactly, is "entrepreneurship" has been addressed many times in economics, sociology, entrepreneurship studies, and business and management literature, and, as already noted, quite a long list of definitions and characterizations have been proposed. Peter Klein has classified the extant perspectives on entrepreneurship[43] as either occupational (dealing with the characteristics of "entrepreneurial" individuals), structural (dealing with the characteristics of "entrepreneurial" firms), or functional (dealing with the characteristics of "entrepreneurial" processes). The functional category is more general in terms of the locus of entrepreneurship,[44] but within this category the entrepreneurial process has been characterized in various ways: as alertness, as judgment, as innovation, as coordination. Reasonable arguments can be made for all of these, and there is a large literature making, discussing, and comparing the particular cases. One is tempted to invoke the parable of the blind men and the elephant[45] here, but a more interesting resolution, suggested by the theory of the anticipatory firm, is that there is not just a single elephant to consider.

Let us define an entrepreneurial process as any of the processes leading from knowledge to decision under uncertainty in an anticipatory system. There are a number of processes which take place within an economy that can be labeled as entrepreneurial under this definition. And these can operate at the level of the individual, the level of the firm, and the level of the market. For individuals, these processes are normal brain functions, and it can legitimately be said that individual entrepreneurial behavior, i.e., behavior resulting from entrepreneurial processes, is ubiquitous.[46] But that is hardly helpful, and it makes more sense to single out for attention a subset of individual entrepreneurial behavior as that which constitutes the driving force, the efficient cause, of entrepreneurial processes in a social system. In the model of the anticipatory firm, those processes are labeled as "innovation" and "judgment", and so behavior contributing to the innovation process (innovative behavior) and behavior contributing to the judgment process (exercising judgment) are both entrepreneurial behavior, albeit in different contexts within the firm.[47]

Entrepreneurship can also be discussed in terms of the market in which firms are embedded. A market system can itself be modeled as an anticipatory system, as follows:[48]




From the perspective of the market system, the entrepreneurial processes are those of market-level innovation and judgment which may, but do not necessarily, take place within firms, and entrepreneurial be-

havior is the activity of individuals whose actions constitute the efficient causes of these processes. It is at the market level that innovative ideas judged to be viable may result in the creation of new firms.

In general, entrepreneurship is behavior furthering any social process which bridges existing knowledge and forward-looking decision in an environment of uncertainty. It is clearly manifested within firms, but it is also obviously manifest at the market level, not least in the creation of firms. It is observed at both the firm level and the market level, and it appears in innovation-type processes and in judgment-type processes. This multiplicity of perspectives and contexts has made it impossible to convincingly pin it to particular characteristics of individuals or firms, or to uniquely describe it as a particular process.

## VI. SUMMING UP

Economic theories of the firm, beginning with that of Ronald Coase, have provided many plausible explanations for the existence (and the boundaries) of the firm. Given, then, that firms exist, given that the purpose of any firm is to survive and prosper, and given that the environment in which it operates is characterized by a certain amount of real uncertainty, one may look for understanding of how that purpose might be best achieved. Any firm pursuing that purpose in that sort of environment must, of necessity, engage in anticipation of what is to be done in imagined future situations. It may do this by relying on the anticipatory abilities of one or a select number of individuals or, increasing its potential for knowledge acquisition, it may draw on input from a wide range of individuals within the firm. In the latter case, the theory of the anticipatory firm proposes a structure for the necessary epistemic processes within the firm.

The focal element in this structure is the firm's knowledge of itself and its environment, a conception shared in various degrees by the individuals within the firm, emergent from interactions between those individuals. This knowledge, whatever its fidelity to actual conditions, is the basis for proposals and plans for new or updated products and methods and initiatives which envisage future situations to which the firm might react. Whether or not these plans and proposals are implemented in production depends on judgment exercised by those individuals with a decision-making role. The processes of learning, innovation, judgment, and production form a continuously operating closed cycle in which the output from each in turn is a critical input for the next. The learning process is of particular interest because in order to effectively generate reliable knowledge of the firm and its environment, the transactions which implement it must provide real incentives for individuals to communicate and discuss—at risk of their reputation and standing—their observations and ideas. What form these transactions should take is an area of current experimentation within firms.

Thinking in terms of anticipatory systems offers a possible way of reorienting the ongoing discussion as to what is the nature of entrepreneurship and how to usefully define it. If any process in the path from knowledge to decision within an anticipatory social system is defined as an entrepreneurial process, then entrepreneurial behavior is the activity of the individuals who participate as the driving force of those processes. Thus, entrepreneurship can be exhibited both within the firm and in the market, and it can take different forms, appearing, for example, as innovation in one context and judgment in another.[49]

## NOTES

1 See Smith (1776, pp. 13-15). Adam Ferguson (1767, p. 326), asserting rather effusively that by "the separation of arts and professions, the sources of wealth are laid open; every species of material is wrought up to the greatest perfection, and every commodity is produced in the greatest abundance", anticipated Smith in the recognition of the productivity of the division of labor although, according to Hamowy (1968), the economic usefulness of specialization and coordination was known at the time, having been addressed by both Mandeville and Hume. Ferguson (1792, p. 424) also invoked the case of a pin factory, but Hamowy posits that both got the example from the somewhat fanciful description in Diderot's *Encyclopédie*, and Kay (2019) notes that Smith's notion of 18 separate operations each performed by a specialist does not accord with actual accounts of the pin factories of the

time, which had only about 3 or 4 specialist operations. Nevertheless, the exaggeration does not diminish the relevance of the insight.

2 The neoclassical model of the firm, found in introductory economics textbooks, is a production function from which, given input prices, an optimal output can be calculated. As such, it says nothing about the internal organization of the firm or of the transactions that take place within it, and so it does not qualify as a "theory of the firm" in the sense relevant here.

3 These theories follow on from Coase's (1937) insight that there are transactions costs inherent in the use of market mechanisms and that firms exist to internalize these costs. Coase pointed to the problems of discovering relevant market prices and executing the necessary contracts, citing the reduction of such costs made possible by incorporating trading partners as employees and thus explaining the boundaries of firms in terms of the point at which the internalization is no longer cost-effective. Follow-on work addresses both the scope of firms and their internal organization, emphasizing particular types of cost: costs of overcoming the incentive problems arising from asymmetric information and moral hazard by Alchian and Demsetz (1972); costs of contract enforcement in the face of possible hold-up associated with specialized capital by Williamson (1975), costs of monitoring performance in principal-agent situations by Ross (1973) and Holmström and Milgrom (1991), costs of processing information by Marschak and Radner (1972), costs of dealing with "market failure" or missing markets by Arrow (1974), costs of property rights enforcement and the necessity to deal with incomplete contracts by Grossman and Hart (1986), contracting costs in the context of firms modeled as a nexus of contracts by Jensen and Meckling (1976) and Klein et al. (1978), and cost savings due to the efficiency of authority by Simon (1951). For good summaries of these and the proliferation of later work in this vein, see Hart (1989), Roberts (2004), and Foss and Klein (2012). Loasby (1976) is an interesting outlier in this literature—he regards the inevitable incompleteness of contracts as a benefit rather than a cost to the extent that it provides space for learning and adaptation within the firm.

4 As Foss and Klein (2012, p. 157) comment: "the modern economics of organization has the same deterministic and 'closed' feel as the neoclassical theory of the firm: although notions of uncertainty, ignorance, and surprise are occasionally invoked, these serve mainly as rhetorical devices to justify the assumption of contractual incompleteness". Simon (1991, p. 40) states flatly that "The difficulty economics has had in giving a good account of organizations and their predominance is traceable in no small part to the fascination of economists with systems in equilibrium."

5 For example, the theory of incomplete contracts, which elaborates (adding formality) to Williamson's (1975) work on asset specificity and the consequences of the inevitable inability to write contracts which take account of all eventualities, models the decision as to whether to contract for an asset or to bring its ownership in-house, and so addresses the question of the boundaries of the firm. See Grossman and Hart (1986).

6 According to Knight (1921, p. 199), "If we are to understand the workings of the economic system, we must examine the meaning and significance of uncertainty". "Uncertainty" is to be understood (1921, pp. 214-227), not as a state for which probabilities (whether in the sense used in describing games of chance or in statistical assessments based on known distributions) can be deduced, but as one in which there is "inherent unknowability in the factors" and so no calculable basis for estimates, and anticipation or expectation based on judgment is the only recourse. Keynes (1937, p. 214), not adding anything to Knight's insight, but putting it in memorable form, explained: "The sense in which I am using the term [uncertainty] is that in which the prospect of a European war is uncertain, or the price of copper and the rate of interest twenty years hence, or the obsolescence of a new invention".

7 Cantillon (1755) developed the first systematic theory of the economy, identifying three classes of economic agents: landlords, entrepreneurs, and employees, and characterizing the entrepreneur as the driving force of the economy. He described many different types of entrepreneur, from farmers to middlemen to shopkeepers, all having in common that they have to deal with the uncertainty of future prices for their goods. See Hébert and Link (2009, pp. 7-13) and Brown and Thornton (2013).

8 For example, Cantillon (1755) pointed to risk tolerance and the exercise of judgment, Knight (1921) to judgment under uncertainty, Mises (1920) also to judgment under uncertainty but particularly in the form of "econom-

ic calculation", Marshall (1920) to business acumen and management ability, Schumpeter (1926) to innovativeness, Kirzner (1985) to alertness, Casson (1995) to self-confidence, Harper (1996) to drive for achievement, and Langlois (1998) to ability to communicate a vision. Shane (2003), defining entrepreneurship (p. 4) as "an activity that involves the discovery, evaluation and exploitation of opportunities to introduce new goods and services, ways of organizing markets, processes, and raw materials through organizing efforts that previously had not existed", lists (pp. 61-177) a range of personal attributes for which there is empirical evidence that individuals engaged in activity fitting that description may possess, and (pp. 194-249) discusses strategies available to such individuals for developing and exploiting new opportunities in the face of uncertainty and information asymmetry. See also Alvarez and Barney (2007).

9 Simon (1962, p. 468) makes a similar point: "In fact, even in human organizations, the formal hierarchy exists only on paper; the real flesh-and-blood organization has many inter-part relations other than the lines of formal authority."

10 Capability theories of the firm have their origin in the work of Penrose (1959), whose inquiry into how firms grow focused on the firm's internal resources, or "capabilities", which for her included the knowledge of how to do things inherent in the skills of the participants (particularly the firm's management) and in the routines they have learned to follow. She held that the growth of a firm of any size is driven (and limited) by the availability for further use of productive services created through experience in the ongoing operation of the firm. Richardson (1972, p. 888), citing Penrose, defined capabilities as "the knowledge, experience, and skills" of the firm. Another early exponent of capability theory was Teece (1982), who addressed the fungible and tacit character of organizational knowledge.

11 Organizational learning theory arose from behavioral studies of organizations, especially that of Cyert and March (1963), and the idea that organizational learning was instantiated in the organization's internal routines was developed further by Nelson and Winter (1982). The routines are conditioned by experience and adjusted as operational results diverge from management goals and expectations.

12 See Teece et al. (1997), Langlois and Robertson (1995), Winter (2003), Zahra et al. (2006), and Teece (2017) for definitions and descriptions of dynamic capabilities. It bears noting that the possession of a dynamic capability does not guarantee that the exercise of this capability in any instance will have a successful outcome—there is always the possibility of mistakes. On this point see Zahra et al. (2006, p. 921).

13 For a good overview of organizational learning theory, see Levitt and March (1988).

14 Zahra et al. (2006) document and discuss a wide range of studies, both empirical and conceptual, dealing with learning and the development of capabilities of various sorts within firms.

15 The salience of considerations of learning and adaptability for business practitioners is obvious from a perusal of more popular case-based studies in the business literature, such as Toffler (1985), Collins and Porras (1994), de Geus (1997), Fulmer (2000), and Roberts (2004).

16 Myers (1996, p. 2) defines organizational knowledge as "processed information embedded in routines and processes which enable action".

17 According to Teece (2017, p. 10): "Dynamic capabilities reside, in part, with individual managers and especially the top management team, who are required to take an entrepreneurial role in detecting and exploiting opportunities." Again (p. 15): "Because the market for information/knowledge about new opportunities isn't well developed, entrepreneurs and managers must also build organizational capabilities for knowledge creation, typically generating a distinctive competence by doing so … the absence of a market for capabilities means that benefits can flow from entrepreneurial and managerial activity that builds and hones value-creating capabilities." And again (p. 20): "In the dynamic capabilities framework, … the distinctive role of the (entrepreneurial) manager is this 'orchestration' of cospecialized assets and of business activity to achieve value-creating and value-capturing alignment." However, there is growing recognition that knowledge within firms is not simply an individual phenomenon. Myers (1996, p. 2), while still properly recognizing management's important role, observes: "For knowledge to provide a company with sustainable competitive advantage, such knowledge must be independent from any given individual. For this reason, we can identify—and then manage—organizational knowledge only to the extent it has been captured by an organization's systems, processes, products, rules, and culture."

18 This notion of a firm as a systemic whole and not simply the aggregate result of contractually-linked individuals is not new: Davis (1897, p. 294) describes the firm as an "autonomous, self-sufficient, self-renewing body", and Brown (1905, p. 379) claims that it is "an organic whole … which cannot be analyzed into the mere sum of its parts". Much more recently, Gindis (2007, p. 266) characterizes it as "a real integrated entity and a dynamic causal system" and (p. 281) as an emergent "whole which can no longer be viewed as reducible to any of its constituent parts or members". Adelstein (2010), citing these sources, demurs, conceptualizing a firm in abstract terms as a network of relational contracts among individuals (i.e., contracts subject to ongoing renegotiation as circumstances change) which adjusts as necessary to align capabilities with opportunities. While he is insistent, for reasons of strict methodological individualism, that firms not be seen as organic wholes, everything he says about relational contracts and capabilities is not incompatible with this view. Recognizing that firms, at one level, can usefully be seen as systems with repositories of knowledge does not negate the fact that, at a lower level, they are composed of interacting individuals, for it is from those interactions that the systemic characteristics are emergent.

19 Parts of this section are taken from a longer and more detailed discussion in McQuade (2019).

20 See Bertalanffy (1928, 1968) and Rosen (1975, 1985, 1991).

21 Kant (1790) described biological organisms as purposeful systems in which the parts "so combine in the unity of a whole that they are reciprocally cause and effect of each other's form". In contrast, in a mechanical arrangement such as clockwork, "one part is for the sake of the others, but it does not exist by their means. In this case the producing cause of the parts and of their form is not contained in the nature (of the material), but is external to it".

22 When Bertalanffy talked about the organization of a biological system he emphasized the organization of the internal processes rather than the organization of the physical matter—in fact, he held that the former determined the latter. In Bertalanffy's (1968, p. 27) own words: "In the last resort, structure (i.e., order of parts) and function (order of processes) may be the very same thing: in the physical world matter dissolves into a play of energies, and in the biological world structures are the expression of a flow of processes." Rosen's (1991, pp. 119-120) short statement of his approach to understanding biological systems was "throw away the matter and keep the underlying organization … The organization of a natural system … is at least as much a part of its material reality as the specific particles that constitute it at a given time, perhaps indeed more so."

23 Rosen (1975) defined "anticipatory modes of behaviour of organisms … [as those] in which an organism's present behaviour is determined by: (a) sensory information about the present state of the environment; and (b) an 'internal model' of the world, which makes predictions about future states on the basis of the present data and the organism's possible reactions to it."

24 See Popper (1963) and Harper (1996, p. 282).

25 The human brain is a good example of a biological anticipatory system, and its high-level functional organization can be represented by such a system diagram, with "output" understood to include actions manipulating aspects of the environment and the mutable model of the environment instantiated in memory structures. Interestingly, the economist Hayek (1952) was one of the first to describe the functional aspects of the brain in these terms, showing how a model of the environment could be maintained and updated within a complex neuronal structure and used to create dispositions for action in particular circumstances based in part on past experience which are resolved prior to action. Hayek's model of the mind as a "sensory order" is fundamentally a process (rather than a substance) model. Hayek (1967, p. 74) also alluded to the possibility that an adaptive social order could maintain an anticipatory model, although he did not develop the idea. For a review of more modern work on the acquisition of tacit knowledge acquired unconsciously by "implicit learning", see Litman and Reber (2005).

26 Rosen himself explicitly entertained the analogy, discussing at length how understandings of adaptiveness in complex biological systems might be usefully applied to complex economic systems. See Rosen (1975). Also, in his introduction to his major treatise on anticipatory systems, Rosen (1985, pp. 4-5) noted the possibility for biological metaphors to be applied in social theory: "It is plain, on the face of it, that many tantalizing parallels exist between the processes characteristic of biological organisms and those manifested by social structures or societies." One upside he cited for the employment of such parallels was that since "it is hard for us to conceive what an external observer of our society as a whole would be like … [but] by exploiting biological experience, obtained from

a standpoint of an external observer, we could … develop entirely new insights into the properties of our social systems."

27 This is a major difference between biological systems and social systems—in social systems, the efficient causes (the forces driving the processes) all have as their basis the purposeful action of the participants in the system, whereas in biological systems the elements that act as efficient causes must be generated within the system by other processes.

28 According to Roberts (2004, p. 283), "in a firm of any size, the knowledge of how things really work, how customers really behave, how choices really interact, is highly dispersed." While this is true in general, there is no assumption that the knowledge is dispersed uniformly, and different firms will vary in this respect. There are, indeed, very well-known (but rare) instances of large firms in which the behavior of the firm is dominated by an entrepreneurial individual—Apple, in the Steve Jobs era, being an example.

29 Foss and Klein (2014) properly dismiss the idea that a systemic description implies some sort of a group mind: "Thus, the notions that firms or whole economies are distributed knowledge systems mean that the set of agents comprising these entities somehow can be said to collectively possess knowledge that no single agent possesses. This does not amount to asserting the existence of mysterious supra-individual 'collective minds'. Knowledge still ultimately resides in the heads of individuals; however, when this knowledge is somehow combined, it means that considered as a system, the agents possess knowledge that they do not possess if separated. However, nobody possesses all this knowledge in its totality." This totality, this individual knowledge "somehow combined" by interactions comprising the processes within the firm, is what is regarded here as the firm's knowledge.

30 For a fuller treatment of market and science systems as anticipatory systems, see McQuade (2019).

31 Weber (1922, p. 214), having described bureaucracy as an "ideal type", and aware that implementations of it can fall short of the ideal, stressed its superiority to alternate administrative structures, claiming that fully developed bureaucracy compares with them "exactly as does the machine with the non-mechanical modes of production. Precision, speed, unambiguity, knowledge of the files, continuity, discretion, unity, strict subordination, reduction of friction and of material and personal costs—these are raised to the optimum in the strictly bureaucratic administration".

32 Merton (1940, p. 565): "If the bureaucracy is to operate successfully, it must attain a high degree of reliability of behavior, an unusual degree of conformity with prescribed patterns of action. Hence, the fundamental importance of discipline … Discipline, readily interpreted as conformance with regulations, whatever the situation, is seen not as a measure designed for specific purposes but becomes an immediate value in the life-organization of the bureaucrat. This emphasis, resulting from the displacement of the original goals, develops into rigidities and an inability to adjust readily. Formalism, even ritualism, ensues with an unchallenged insistence upon punctilious adherence to formalized procedures. This may be exaggerated to the point where primary concern with conformity to the rules interferes with the achievement of the purposes of the organization, in which case we have the familiar phenomenon of the technicism or red tape of the official."

33 Tullock (1965, pp. 148-152) uses the game of "whispering down the lane" to illustrate the distortions in information transfer in a hierarchy in either direction.

34 According to Roberts (2004, p. 2): "Falling barriers to international trade and investment, the rise of information technology (especially the Internet), and improved transportation mean that a firm's competitors are not just the old local rivals, but may be from anywhere. With more competition, the need to improve performance increases. These same developments also open new opportunities to do business far from home, and the new organizational designs support taking advantage of these opportunities. Capital markets, too, are increasing the performance pressures on firms. Especially in the United States, but increasingly elsewhere as well, the increased power of institutional investors and their increased willingness to use this power are pushing companies to do better." Another factor often cited—for example, by Drucker (1970), Pinchot and Pinchot (1993), and de Geus (1997)—is the emerging importance of "knowledge workers" who chafe under the rigid bureaucratic strictures and whose productivity is enhanced if given more freedom to use their imaginations.

35 See the case studies detailed in Bahrami (1992), de Geus (1997), Fulmer (2000), Roberts (2004), Ruigrok et al. (1999), Whittington et al. (1999), and Pettigrew et al. (2001). The latter is the introduction to a full journal issue on

studies of organizational experimentation. The thrust in this research project is to get beyond platitudes and investigate the implementations of "new forms of organization". As Ruigrok et al. (1999, p. 41) put the challenge they are addressing: "According to one persistent argument, we are currently witnessing a major break from the multidivisional form of organisation seen in the past. Emerging organisational forms … would be characterised in particular by less horizontal and vertical differentiation, and by more ad hoc internal linkages. However, beyond certain well-known examples …, the incidence and international diffusion of these new organisational forms or new modes of organising have yet to be established."

36 Peter Drucker was an early exponent of hierarchy dismantling, and he emphasized the virtues of, and necessity for, communication throughout an organization. Drucker (1970, p. 19) asserts that "Communications in organization demands that the masses, whether they be employees or students, share in the responsibility of decisions to the fullest possible amount." And (p. 22): "Communications in organization … are not a means of organization. They are a *mode* of organization."

37 Roberts (2004, pp. 1-2) gives a good overview of the types of organizational rearrangements that are being tried: "They have eliminated layers of management and associated staff positions, redefined the units into which they divide themselves internally, dispersed functional experts to the business units, and increased the authority and accountability of line managers. By these measures, coupled with improved information and measurement systems and redesigned performance management systems, they have sought to increase the speed of decision-making and to tap the knowledge and energy of their employees in ways that have not been tried before. To facilitate coordination and learning, they have experimented with linking people in different parts of their organizations directly, so that communications are more horizontal and not just up and down the hierarchy. Many have also tried to redefine the nature of the relationship they have with their employees while redesigning jobs and the very nature of work."

38 Obviously, the various individuals within a firm will possess tacit knowledge and skills which cannot be explicitly communicated. But who they communicate with, and what they communicate about, and how they communicate it will be influenced by this knowledge, and so it will indirectly contribute to the knowledge-generating process.

39 Grant (1996) provides a good overview of considerations of transferability and appropriability of the explicit and tacit knowledge of individuals within a firm. He develops a "knowledge-based" theory of the firm in which the emphasis is on how individual specialized knowledge is integrated and applied in the firm's production processes.

40 There is an obvious parallel here with Hayek's (1945) picture of the market process which enables the significance of "the particular circumstances of time and place", which are only known individually to "the man on the spot", to be made available, in the form of the price system, to market participants in general.

41 Foss et al. (2019, p. 53) describe this sort of management activity as "designing incentive schemes, monitoring systems, means of resolving disputes, and other mechanisms", contrasting it with management by command.

42 Kollmann et al. (2020) show that what they call "entrepreneurial orientation" can be present in firms in management teams below the top management levels. It emerges, as the theory in this paper would predict, where there is a shared "transactive memory"—a knowledge base that combines what the individuals know themselves with the knowledge of who knows what, which arises through communication and interaction with other individuals in the firm.

43 See Klein (2008) and Foss et al. (2019).

44 Klein (2008, p. 177) makes the point as follows: "The entrepreneurial function can be manifested in large and small firms, in old and new firms, by individuals or teams, across a variety of occupational categories, and so on. By focusing too narrowly on self-employment and start-up companies, the contemporary literature [dealing with occupational and structural concepts of entrepreneurship] may be understating the role of entrepreneurship in the economy and business organizations."

45 See https://en.wikipedia.org/wiki/Blind_men_and_an_elephant.

46 "Alertness to (subjectively perceived) opportunities" is simply a way of describing a characteristic of this ubiquitous behavior.

47 There are other contexts within the firm in which entrepreneurial behavior can be recognized. The model of the firm presented here assumes the firm's existence and specifies the processes within the firm necessary to support

anticipation. It does not address the formation of the firm, the creation and adjustment of the forms of interaction supported within the firm, the coordination of production, or the acceptance of individuals into, and ejection of individuals from, the firm. These all involve processes leading from knowledge to decision under uncertainty and thus qualify as entrepreneurial.

48 This is an elaboration of the model discussed in McQuade (2019, pp. 5-8). The market's anticipations, the result of entrepreneurial processes driven by individuals, play out in the adjustments to the price system (conceived broadly to include the reputations of goods and their organization in the capital structure) stemming from interaction with the market's environment. The market system itself is entrepreneurial only in the sense that it is a system containing entrepreneurial processes.

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