

Complementarities among Capability, Transaction and Scale-Scope Considerations in Determining Organizational Boundaries¹

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ABSTRACT *The purpose of this paper is to discuss the conditions under which capability, transaction and scale considerations interact in determining organizational boundaries. It is argued that this interaction contributes to explaining the individual firm's performance and growth whenever cognitive competence is limited, radical uncertainty is present, some inputs and processes are indivisible and complementary, and some relevant knowledge is tacit, non-transmittable and characterized by set-up processes with high fixed costs. Under the above conditions, which are becoming increasingly important with the spread of the knowledge-based economy, the growth of the firm can be regarded as a consequence of managerial ability to set a strategy that exploits the mutually reinforcing advantages provided by the organizational coordination of capabilities, transactions and scale of processes, while limiting counteracting forces deriving from errors of strategy that are due to cognitive inertia and myopia, unclear allocation of rights and responsibilities, errors in identifying aims, imprecision in performance measuring, difficulty in focusing incentives, influence activities and problems of internal communication.*

Introduction

Developing capabilities, saving on transaction costs and balancing the different productive capacities of complementary inputs and processes are three main aspects of the organizational coordination of the firm. I will begin by briefly specifying what is implied here by each of these three aspects, after which I will discuss and evaluate the way in which they interact.

Firstly, developing capabilities means finding, interpreting and using knowledge in order to create and maintain a competitive advantage. Differential capabilities contribute to explaining the performance of firms and therefore their boundaries. Secondly, transaction costs affect the extension of organizational coordination within or among firms,

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and can be eliminated by the internalization of external processes. Thirdly, in designing the operational scale of each process the firm has to balance the productive capacities of different complementary inputs and intermediate stages in order to take advantage of economies of scale and economies of scope.²

For any given firm the advantages deriving from the development of capabilities, the arrangement of transactions and the design of the operational scale of different processes may have a different weight according to its particular characteristic, sector of activity and developmental stage. In certain cases and at certain times, one aspect may prevail over the other two, but very rarely do the advantages of organizational coordination derive exclusively from only one aspect. The actual weight of each single aspect and their possible interplay in influencing the boundaries and the growth of the firm is ultimately an empirical question that can be the object of applied analysis. However, the aim of this paper is not to provide evidence of the numerous interactions among capability, transaction and scale aspects³; rather, my purpose is to investigate the conditions that make the interplay of these three aspects of organizational coordination important in determining the boundaries and growth of the firm. For ease of presentation, among all numerous possible interactions linking these three aspects, I consider two simplified cases: (1) no interaction because only transaction costs have significant weight, while capability and scale consideration are insignificant; and (2) very significant weight of all three aspects of organizational coordination of the firm and very intense interaction among them.

The remainder of the paper is structured as follows. The following two sections examine respectively the two above possible cases: absent and very intense interaction. The final section concludes the paper with some remarks on internal strengths and weaknesses in the growth process of the firm.

No Interaction among the Three Aspects of the Organizational Coordination

Let us first examine the case in which transaction costs are significant but are not related to capability and scale aspects, which play no role. Transaction costs are significant while capability and scale considerations are unimportant when transactional information and knowledge is costly, technical information and knowledge is free and full,⁴ computing ability is complete, radical uncertainty is absent and production elements are divisible (see the first column of Table 1). This set of conditions is explicitly or implicitly present, even if with some notable exceptions, in most contributions on property rights, agency theories and transaction cost economics.⁵ In this literature, three possible causes of transaction costs associated with costly transactional information and knowledge are most frequently mentioned: (i) the coexistence of cognitive limits, opportunism and asset-specificity; (ii) enforcement difficulties; and (iii) measurement costs.

Coexistence of Cognitive Limits, Opportunism and Asset-Specificity

As in Oliver Williamson's transaction cost economics, transaction costs may be associated with imperfect contracts that are determined by the *combined effects* of cognitive limits, opportunism and asset specificity.⁶ Cognitive limits are assumed to be present in conjunction with farsightedness. As a result, individuals are not precluded from assessing the negative consequences of another party's potential opportunism and evaluating the pay-offs associated with possible outcomes. This means that parties do not face unanticipated

Table 1. Interaction among transaction, capability and scale-scope considerations

		Zero interaction	Very intense interaction
Weight of single aspects	Transaction	Significant	Very significant
	Capability	Insignificant	Very significant
	Scale-scope	Insignificant	Very significant
Conditions	Transact. I&K*	Costly	Cognitive limitations
	Technical. I&K	Full and free	Cognitive limitations
	Organis. I&K	Full and free	Cognitive limitations
	I&K Charact.	Not considered	Set-up process and low cost of reproduction
	Comput. abil.	Complete	Incomplete
	Input charact.	Divisibility and suitability	Indivisibilities and complementarities
	Contracts	Imperfect	Incomplete
	Uncertainty	Weak	Radical
	Rationality	Perfect (or bounded with farsightedness)	Cognitive rationality
	Boundaries of the firm	Tendency toward vertical integration through unified ownership of toward forms of collaborations among firms	Strong tendency toward the expansion of boundaries of organ. coordination within and among firms

*Information and knowledge.

consequences. ‘Transaction cost economics’, Williamson points out, ‘examines incomplete contracts in their entirety—hence the absence of surprise, victims and the like’. ‘Limited but intended rationality is translated into incomplete but farsighted contracting’.⁷ In this context, farsighted parties are able to spell out forward-looking contracts and identify the optimal governance structure.

Asset specificity, with the possibility of opportunism, may cause transaction costs due to hold-up inefficiency. Thus, if it is impossible to draw up a complete contract and if market conditions change, the party that invests in relation-specific assets exposes itself to a hazard. Whenever a party—for example, a supplier—has to make a relation-specific investment that may be difficult to redeploy, ‘the supplier may be then unwilling to make specific investment’ or may expend resources in contractual safeguards consisting in rewarding specific assets and in setting penalties in case the contract should be breached before its expiry. ‘In either case, inefficiency results: either the market does not bring about optimal investment, or resources are expended on socially wasteful defensive measures’.⁸ In the presence of hold-up problems, residual rights of control foster specific investments, and unified property offers an alternative to contractual safeguards in protecting specific assets.⁹

Enforcement Difficulties

Transaction costs may derive from contract writing costs that result in the inability of a neutral outsider to verify and enforce the accomplishment of mutual obligations in the event of a contract dispute.¹⁰ That is to say, it may be hard to specify in advance, and unambiguously, all conditions regarding quantity, quality, price and possible external

factors.¹¹ Differences in cognitive structures and languages among contracting parties may lead to misinterpretations and misunderstandings. Furthermore, when the number of potential events is very high it may be extremely costly to spell out all conceivable circumstances in a contract, even if the contracting parties are perfectly rational and then are able to estimate the pay-off distribution of possible actions. In such circumstances, imperfect contracts leave out all the elements that are too costly to specify and enforce.

Measurement Costs

Transaction costs may simply be due to measurement costs that are the costs of obtaining information concerning quality and prices of products to be bought.¹²

In the latter two cases (enforcement difficulties and measurement costs), transaction costs may arise even in the absence of asset specificity and opportunism. For instance, in many spot markets that do not imply any specific investment, as in the case of the second-hand car market, informational asymmetries or measurement costs are sufficient to induce high transaction costs. Moreover, transaction costs are independent of opportunistic potential whenever there are different cognitive maps, possibilities of different interpretations among contracting parties or simple measurement costs.

In all three of the cases examined above (farsighted contracting in presence of cognitive limits, opportunism and asset specificity, enforcement difficulties and measurement costs), transaction costs derive from imperfect contracts which, nonetheless, do not prevent parties from computing the distribution of pay-offs, i.e. benefits and costs associated with all possible events deriving from their actions.¹³ On account of costly transactional information and knowledge, contracts are imperfect and significant transaction costs may ensue. Consequently, unified ownership of physical assets (and other critical resources, such as patents, brand names, software, etc.) may be profitable because it confers the rights of control and enforcement in relational agreements whenever a situation not covered by contracts arises.¹⁴

As far as capabilities are concerned, it should be pointed out that the continuous development of the firm's capabilities in order to create and maintain a competitive advantage is not necessary when relevant technical and productive information and knowledge consist of recipes for production like a blueprint of techniques available cost-free 'on the shelf' and comprehensible to everybody. In this case, the development of capabilities is irrelevant: if the potential adopters have the necessary knowledge and expertise to understand, use and take advantage of all production techniques, then *every firm can produce a particular good or service as well as another*. As argued by Harold Demsetz, 'although information is treated as being costly for transaction or management control purposes, it is implicitly presumed to be free for production purposes'.¹⁵ In other words, 'production costs are independent of the organizational framework—essentially because technologies are public goods'.¹⁶

With regard to scale considerations, their weight becomes insignificant when inputs and processes are perfectly divisible, radical uncertainty is absent and perfect competition prevails. With divisible inputs, it is not necessary to increase the size in order to balance the different processes in such a way as to reduce idle times of production elements. Furthermore, if radical uncertainty is absent there is no reason to accumulate reserve and to differentiate outputs.

In conclusion, under the above particular conditions, transaction costs are not related to the other two aspects of the organization because the advantages deriving from the development of the firm's capabilities and from the exploitation of the potential for economies of scale and scope do not arise.

Intense Interaction among the Three Aspects of the Organizational Coordination

In sharp contrast, strong interplay among capability, transactional and scale considerations is observed whenever cognitive limitations regard both transactional and productive information and knowledge, individuals operate under incomplete forecasting, i.e. radical uncertainty, some production elements are indivisible and complementary, and some relevant knowledge is tacit, non-transmittable and characterized by set-up processes with high fixed costs (see column 2 in Table 1). These conditions reflect the actual cognitive abilities of suppliers, members and customers of the firms, and the actual characteristics of inputs and information and knowledge used in economic processes.

Incomplete forecasting ability arises when individuals do not have complete theoretical knowledge of the list of future outcomes or lack sufficient information processing abilities to assess, classify, compute and compare states or events. Therefore, incomplete forecasting ability involves two different types of radical uncertainty: substantive uncertainty, which is linked to incomplete theoretical knowledge of future outcomes; and procedural uncertainty, which is attributable to incomplete information processing abilities.¹⁷ The former type of radical uncertainty, substantive uncertainty, is independent of personal abilities to process information and refers to a situation that may change in an unexpected manner, while the latter type, procedural uncertainty, arises when individual information processing abilities are insufficient to cope with a situation even if this situation is unchanging.¹⁸ In spite of this dissimilarity, both are *per se* a sufficient condition for radical uncertainty inasmuch as they both lead to incomplete forecasting.

Substantive uncertainty can spring from indeterminacy of outcomes linked to interdependence, subjective reaction and creative learning. An endogenous creation of a novelty causes incomplete forecasting knowledge because a party may be surprised by unexpected actions of other agents. In fact, which action is optimal for one individual depends on the behaviour of the individual's opposite party, but under heterogeneous knowledge it is impossible to predict the behaviour of the opposite party, whose reactions are unavoidably based on subjective interpretation of private information. Moreover, creative learning implies the production of an unexpected novelty and the consequent impossibility of assessing the probability distributions of an unknown event. As forcefully argued by Nathan Rosenberg, genuine innovations are characterized by a high degree of uncertainty because of 'the inability to anticipate the future impact of successful innovations, even after their technical feasibility has been established'.¹⁹

Radical uncertainty may also be brought about by an insufficient level of information processing ability in relation to the degree of complexity of the situation at hand (procedural uncertainty). This type of uncertainty is due to misperception, to difficulties in acquiring potentially available knowledge in a context of asymmetric knowledge, an inability to take into account some event or possible outcomes that are nevertheless known, or incapacity to compute, order or assess phenomena. Since the early 1970s, experimental psychology has provided a considerable body of evidence on human information processing ability. Laboratory studies have confirmed that man's information

gathering and processing abilities vary enormously from one human being to another and generally are very limited. Furthermore, experimental findings suggest that the number of cognitive anomalies in perception of information and in the process of choice is very high.²⁰

Under radical uncertainty, flexibility is ensured by the assets of the firm, which represent reserves in case of unanticipated events, as well as by learning processes, division of knowledge, and long-term employment relationships. Ownership of the assets gives the employer residual rights of control that allow the work content to be modified if circumstances change. In this respect, the firm plays a role analogous to money, which is a purchasing power that 'can be deployed at will' and permits the choice to be postponed to 'a later and better-informed time'.²¹

Developing new capabilities within the firm may be essential in order to mitigate the effects of both substantive and procedural radical uncertainty. Whenever technical, productive and transactional knowledge is not full and free, the development of capabilities makes it possible to acquire the necessary transactional knowledge and absorptive ability, which constitute elements of competitive strength.

Self-interested individuals with different aims and cognitive maps may react in an unexpected way to changes in environmental conditions that are not forecast and not spelled out by the contract. These reactions springing from the identification of new interests may conflict with the opposite party's interests and lead to a costly negotiation, generating deep disagreement and causing losses to one or both parties even if the two sides behave in a loyal, non-opportunistic, lawful and honest way.²² In this context, transaction costs do not necessarily require, or imply, opportunism.²³ The development of knowledge and capabilities through organizational coordination appears to be an appropriate response to the existence of transaction costs that result from multiple interpretations and misunderstandings among contracting parties. In presence of transaction costs due to 'misinterpretation, misunderstanding or disagreement', the role of management in developing information and knowledge among parties may be crucial.²⁴

The incompleteness of contracts, which derives from radical uncertainty, favours substitution of the firm's market relations by managerial coordination, resulting in a strong tendency toward expansion of the boundaries of organizational coordination within and between firms. A scenario of this kind in turn implies economies of scale and scope²⁵ that are attributable not only to the specific characteristics of information, knowledge and production elements (such as indivisibility, complementarity, the presence of set-up processes, low cost of replication of information and knowledge), but also to the decrease in the cost of keeping reserves, as well as the reduction in the negative economic consequences of the failure of one activity stemming from unforeseeable circumstances.

Under the above conditions, these three aspects of the organizational coordination of the firm have a significant weight and are inextricably interwoven. Let us address some of the main links and crossed-linked effects among them.

Capabilities-learning and Scale-scope

First, consider the relationship between capabilities-learning and scale-scope. Productive knowledge is linked closely to the dimension of scale of production processes that results from a given organizational setting. Economies of scale imply the firm's capabilities and learned competencies necessary to exploit the properties of indivisible and complementary

production elements and processes. These capabilities have 'resulted from solving problems of scaling up the processes of production'.²⁶ Put differently, for each given dimension of scale achieved and technique that can be chosen by the production unit, there are different stages of the development of abilities facilitating the use of specific machines and equipment.

Cognitive and operational division of labour is limited by the scale of the production process. Increasing scale implies further division of labour that entails a qualitative modification not only in some of the equipment, but also in the abilities and skills of some members of the firm, according to the new tasks linked to the changed organizational structure. In brief, increasing division of labour is a form of organizational innovation that involves different individual abilities and calls for new learning processes.²⁷ Moreover, a rise in dimension of scale allows an increase in the division of knowledge that brings about managerial economies of scale.

In producing specific goods, firms may develop capabilities that turn out to be useful for supplying new commodities in complementary technology. Re-utilization of the same capabilities across time and space implies an opportunity to overcome the trade-off between economies of scale and economies of scope.

It thus becomes clear that there is a two-way relationship between capability and scale-scope considerations. On the one hand, the actual operational scale depends on technical and organizational knowledge that makes it possible to take advantage of the particular properties of production elements and processes. On the other, the increasing dimension of the scale of a firm's operations favours new organizational settings that involve a new division of knowledge and the development of new capabilities. These crossed-linked effects show the strong relationship between organization, knowledge and efficiency: different organizational modes associated with specific technical knowledge bring about dissimilar levels of efficiency.

Capabilities-learning and Transactions-internalization

Capability and transaction considerations turn out to be complementary if we recognize that both production and transaction processes involve an essential knowledge dimension.²⁸ A specific function of the entrepreneur-manager is to ascertain which distinctive abilities and competencies should be developed within the firm and which should instead be developed outside. This is linked to decisions about which activities to conduct internally and which to contract out. These decisions are then fundamentally human resource decisions.²⁹

Internalising technologically separable processes through vertical integration involves in-house learning processes aimed at developing the productive and technical knowledge necessary to perform the internalized processes.

In the presence of dispersed, heterogeneous and tacit knowledge, collaboration and co-specialization among complementary producers entails costs that derive from expensive productive and transactional knowledge. On the other hand, collaboration needs the co-development of capabilities to reduce possible misunderstandings. Out-sourcing requires specific learning processes. In particular, out-sourcing involves the development of:

- (a) internal capabilities in order to bargain, design suitable contracts, control quality and enforce contracts

- (b) external capabilities in order to educate suppliers, potential licensees and franchisees.³⁰

In multitechnology firms that rely on outsourcing, internal capabilities stretch beyond the boundaries of the firms' in-house production so that staff can relate to suppliers of equipment, knowledge and components.³¹ Evidence from applied studies on franchise systems and durable interfirm collaboration among Japanese automakers, firms that produce aircraft engines and firms in electronics, food and biotechnology industries has shown the significant level of investments in specific human assets. Such investments are designed partly with the aim of enhancing the learning processes needed to master the different technologies adopted in specialized sub-units of the firms, but also for the purpose of training the staff members who have to arrange external relationships and have to command multiple technologies adopted by partners who produce various components or supply services.³²

The consideration of cognitive matters offers an insight into the different reasons underlying vertical integration or safeguards in complementary relationships among partners. For instance, co-specialization represents an idiosyncratic investment exposed to possible moral hazards or more simply the transfer of knowledge possessed by some partners toward various competitors. In order to capture all the benefits that accrue from the development of productive knowledge and keep relevant information inside the firm, it may be in the firm's interest to hire individuals 'on a more permanent basis rather than secure the use of their services through a contract'.³³ Alternatively, in other circumstances, vertical integration and the abandonment of contracts mediated by the market may instead be motivated by the difficulty of developing suppliers' knowledge. For example, when Ford adopted the moving assembly line, in accordance with Tayloristic labour organization, the main problem, according to a cognitive perspective, 'was . . . the difficulty of changing the suppliers' conception of their own business, and persuading them of the obsolescence of many of their existing capabilities'.³⁴ The characteristics of capabilities possessed by firms operating in different intermediate phases of the productive *filière* (or cluster) influence the effects of transaction costs on the level of integration. As argued by Robert Grant, 'if markets . . . transfer knowledge inefficiently . . . vertically adjacent stages of production A and B will be integrated within the same firm if production at stage B requires access to the knowledge utilized in stage A'.³⁵ If capabilities are highly correlated along the productive *filière*, then a reduction of transaction costs will not lead to substantial dis-integration. In contrast, if capabilities are weakly correlated along the value chain, a reduction of transaction costs will lead to substantial dis-integration.³⁶

On the other hand, transaction costs mould the trajectories of capability development.³⁷ Low transaction costs may favour external specialization in single activities and social division of labour, while high transaction costs may induce the development of capabilities within the firm. However, high transaction costs do not always imply a unified ownership. In some circumstances, organizational coordination of learning processes under forms of collaboration among firms may be more suitable than vertical integration. For instance, even in the presence of high transaction costs, the attempt to integrate complementary activities that are not truly similar—inasmuch as they are based on distinct technologies and may require 'different styles of management'—'is likely to produce lower quality or higher costs, or both'.³⁸ In this case, a possible response to high transaction costs might be forms of collaboration among firms rather than unified ownership.

If specialization brings significant advantages and complementarities among different processes are highly specific, a successful response to uncertainty may be represented by organizational coordination within hybrid forms.

Organizational coordination not only makes it possible to avoid transaction costs and therefore 'avoid a negative', but it also provides the advantage over market relationships of enhancing the generation of new capabilities and can thus 'create a positive'. Whenever learning works better in a unified organization than in two autonomous firms and whenever this is also essential for the development of capabilities on which the firm's competitive advantage is grounded, then a strong incentive for integration arises. Conversely, whenever learning works worse in a unified organization than in two autonomous firms, there is incentive toward keeping the firms autonomous. In other words, organizational coordination or disintegration may prevail according to the governance structure that fosters learning and the creation of capabilities.

In conclusion, when asymmetric information and heterogeneous knowledge concerns not only transactions, but also production activities, then, on the one hand, technology cannot be considered constant across organizational modes and, on the other, transaction costs and capability considerations can be seen as largely complementary.

Transactions-internalization and Scale-scope

Finally, consider the crossed-linked effects between transactions and scale.³⁹ Transaction-internalization and scale-scope considerations are related in many ways.

Firstly, when high transaction costs trigger the integration of technologically separable processes through unified ownership, they lead to a reorganization of production that usually involves economies of scale and scope in other intermediate processes at different operational levels. For instance, an integration of manufacturing processes may lead to economies of scale and scope in managerial and administrative processes that are characterized by increasing returns due to the specific attributes of information and knowledge.

Secondly, transaction costs imply indivisibilities because they are linked to information problems and are therefore largely independent of the volume of goods and services exchanged. Fixed lump-sum transaction costs give rise to economies of scale and scope, and foster increasing dimension.

Conclusions

Potential advantages deriving from the crossed-linked effects between development of capabilities, arrangement of transactions and design of the operational scale may be cancelled out by several counteracting forces, due to unfavourable environmental conditions and internal weaknesses which limit the firm's growth or, in more extreme cases, lead to its bankruptcy. In this concluding section, let us focus on internal counteracting forces.⁴⁰ In setting the firm's strategy, firms are subject to errors in identifying aims and imprecision in performance measuring that may lead to unnecessary changes or preclude timely response to problems.⁴¹ The management may make erroneous decisions because of various forms of cognitive myopia and inertia, leading to difficulties in finding the right balance between exploitation of available knowledge, abilities and skills (i.e. the pursuit of higher efficiency), and exploration of new possibilities and alternatives.⁴²

Rising organizational costs may have different causes. Firstly, unclear allocation of rights and responsibilities makes decision-making mechanisms inefficient. Secondly, the firm's growth can imply that top management may lose touch with events affecting the decisions. This causes problems in vertical communication within organizations, resulting in decreased efficiency and efficacy. Thirdly, difficulty in establishing rewards and focusing incentives may entail the possibility of shirking, high cost of coordination, monitoring and control, agency problems, influence activities, collusion, subverted inspections, parochial interests and unimplemented decisions. Finally, the firm's growth involves transformation in the organizational set-up and in the power structure, and such a phenomenon may meet with resistance on the part of some members of the firm who are unwilling to accept or strongly oppose any modification in the existing equilibria.

These cases of rising organizational costs, which can limit the firm's growth, derive partly from the management's inability to avoid errors of strategy, but partly also from the failure to create the necessary knowledge for exploiting advantages provided by the crossed-linked effects of development of capabilities, arrangement of transactions and design of operational scale. This conclusion introduces an unavoidable subjective element as regards the way in which the firm's management succeeds in grasping opportunities and is able to oppose counteracting forces. Subjective and discretionary choices by management are influenced by the specific manner in which the different stakeholders' interests are weighed in decisions and also by the various environmental conditions. Moreover, the aforementioned conclusion shows that the boundaries of the firm cannot be attributed solely to one single cause, but are instead the result of the interplay between negative factors, which are represented by the counteracting forces listed above, and opportunities for growth that derive from the interaction of the three aspects of the firm's organizational coordination. The fundamental implication of these considerations is that the firm's efficiency and efficacy, and thus its revealed performance, size and boundaries must be regarded as 'time and path-dependent' phenomena subject to the constantly evolving influence of the different internal decision-making mechanisms and multifaceted environmental conditions.

Notes and References

1. Paper presented at the Shifting Boundaries: Governance, Competence and Economic Organization in the Knowledge Economy Conference, Bristol Business School, 2–3 September 2004, Burwalls House, Bristol.
2. Capability, transaction and scale-scope definitions are extensively discussed in M. Morroni, *Knowledge, Scale and Transactions in the Theory of the Firm* (Cambridge, Cambridge University Press, 2006), chapter 3.
3. Ample evidence on this interaction has been provided by Alfred Chandler's historical investigation and meticulous case studies on industrial enterprises. See, for instance, A. Chandler Jr., *Strategy and Structure: Chapters in the History of the Industrial Enterprise* (Cambridge, MA, The MIT Press, 1962, 3rd edn 1966); *The Visible Hand: The Managerial Revolution in American Business* (Cambridge, MA, Belknap/Harvard University Press, 1977); *Scale and Scope: The Dynamics of Industrial Capitalism* (Cambridge, MA, Belknap/Harvard University Press, 1990); see also A. Bonaccorsi & P. Giuri, Increasing returns and network structure in the evolutionary dynamics of industries, in: P. P. Saviotti (Ed.), *Applied Evolutionary Economics* (Cheltenham, Elgar, 2003), p. 79, p. 84.
4. Information is an organized set of data. Information is not self-interpreting; rather, its interpretation is mediated by individual knowledge that derives from the ability to search, select, memorise, store, retrieve, structure, embody and use bits of information within a cognitive system. For a discussion and bibliographical references on the characteristics of information and knowledge, see the collection

- of essays in N. Lazaric & E. Lorenz (Eds), *Knowledge, Learning and Routines*, 2 vols (Cheltenham, Elgar, 2003), vol. I, part I.
5. For a survey on these models and applications, see R. Gibbons, Team theory, garbage cans and real organizations: some history and prospects of economic research on decision-making in organizations, *Industrial and Corporate Change*, 12(4), 2003, p. 755ff. It is necessary to stress that some models of this vast literature provide a richer and more complex picture than this rather simplified version would appear to suggest. For instance, Oliver Hart assumes complementary assets. Accordingly, vertical integration is connected to economies of scale, O. Hart, *Firms, Contracts, and Financial Structure* (Oxford, Clarendon Press, 1995, reprinted 1997), pp. 50–51. A further exception can be found in some recent contributions belonging to transaction cost economics that are increasingly paying attention to cognitive matters; see, for example, O. E. Williamson, Strategy research: governance and competence perspectives, *Strategy Management Journal*, 20(12), 1999, p. 1087; and C. Ménard, The economics of hybrid organizations, *Journal of Institutional and Theoretical Economics*, 160(3), 2004, pp. 345–360. Finally, Harold Demsetz jointly considers specialized knowledge, and economies of scale in direction and knowledge acquisition, H. Demsetz, *The Economics of the Business Firm. Seven Critical Comments* (Cambridge, Cambridge University Press, 1995, reprinted 1997), pp. 11, 31–32.
 6. O. E. Williamson, *The Economic Institutions of Capitalism* (New York, Free Press, 1985, reprinted 1987).
 7. O. E. Williamson, *The Mechanisms of Governance* (New York and Oxford, Oxford University Press, 1996), p. 9. Brian Loasby has highlighted the contradiction of assuming that although individuals do not know, ‘they know the effects of not knowing’, B. J. Loasby, *Knowledge, Institutions and Evolution in Economics* (London, Routledge, 1999) p. 80. On the contradiction between bounded rationality and farsightedness, see also the interesting discussion in G. Slater & D. A. Spencer, The uncertain foundations of transaction costs economics, *Journal of Economic Issues*, XXXIV(1), March 2000, p. 68; G. Dosi & L. Marengo, On the tangled discourse between transaction cost economics and competence-based views of the firm, in: N. Foss & V. Mahnke (Eds), *Competence, Governance, and Entrepreneurship. Advances in Economic Strategy Research* (Oxford, Oxford University Press, 2000), p. 87.
 8. B. R. Holmström & J. Roberts, The boundaries of the firm revisited, *Journal of Economic Perspectives*, 12(4), 1998, p. 74.
 9. *Ibid.*, p. 128, p. 137, p. 599, *passim*.
 10. *Op. cit.* Hart ref. 5, p. 23, p. 81 *passim*.
 11. On ambiguity in spelling out contracts, see Hart, *op. cit.* ref. 5, p. 24.
 12. Y. Barzel, A theory of organizations to supersede the theory of the firm, preliminary version, <http://www.econ.washington.edu/>, September 2001, pp. 31–32.
 13. These contracts, which I call imperfect, are usually defined as ‘incomplete contracts’. However, I prefer to reserve the adjective ‘incomplete’ for those contracts designed under incomplete knowledge or incomplete computing ability.
 14. On the role of critical resources, see K. B. Kumar, R. G. Rajan & L. Zingales, What determines firm size?, *NBER Working Papers*, no. w7208, July, <http://gsbwww.uchicago.edu/fac/luigi.zingales/research/Pspapres/size.pdf>, 1999, p. 7ff.
 15. H. Demsetz, The theory of the firm revisited, *Journal of Law, Economics, and Organization*, 1988, pp. 141–161; reprinted in R. N. Langlois, T. F.-L. Yu & P. Robertson (Eds), *Alternative Theories of the Firm*, vols 3 (Cheltenham, Elgar, 2002), vol. I, p. 287.
 16. B. J. Loasby, Organizational capabilities and interfirm relations, *Metroeconomica*, 45, 1994, p. 248, reprinted in N. J. Foss (Ed.), *The Theory of the Firm. Critical Perspectives on Business and Management*, vols 4, (London, Routledge, 2000, vol. II), p. 298; *op. cit.* Loasby ref. 7, p. 84; B. J. Loasby, Economics after Simon, in: M. Augier & J. G. March (Eds), *Models of Man: Essays in Memory of Herbert A. Simon* (Cambridge, MA, MIT Press, 2004), p. 249.
 17. On the distinction between substantive and procedural uncertainty see G. Dosi & M. Egidi, Substantive and procedural uncertainty: an exploration of economic behaviour in changing environments, *Journal of Evolutionary Economics*, 1(2), April, p. 165.
 18. As observed by Stephen Dunn, the different nature of these two types of radical uncertainty relates to Paul Davidson’s distinction between transmutable (nonergodic) systems and immutable (ergodic) systems, which may be regarded as similar to Tony Lawson’s distinction between open and closed systems. See S. P. Dunn, Bounded rationality is not fundamental uncertainty: a Post Keynesian perspective, *Journal of Post Keynesian Economics*, 23(4), 2001, p. 572, p. 575; P. Davidson, Reality and

- economic theory, *Journal of Post Keynesian Economics*, 18(4), 1996, p. 479; T. Lawson, *Economics and Reality* (London, Routledge, 1997). On the analytical consequences of the transmutable and unknowable nature of the future, see also Slater & Spencer, *op. cit.* ref. 7, p. 61ff. and Loasby *op. cit.* ref. 16, pp. 255–266.
19. N. Rosenberg, Uncertainty and technological change, in: R. Landau, T. Taylor & G. Wright (Eds), *The Mosaic of Economic Growth* (Stanford, CA, Stanford University Press, 1996), p. 334.
 20. The pioneering works featuring experiments on cognitive anomalies in perception and in the process of choice that prevent full rationality and optimization were carried out jointly by Daniel Kahneman and Amos Tversky. Among these two authors' recent papers, see, for instance, D. Kahneman & A. Tversky, On the reality of cognitive illusions, *Psychological Review*, 103(3), 1996, p. 582ff. For extensive bibliographic references on experimental evidence, see Morroni *op. cit.* ref. 2, chapter 1, Section 1.5.
 21. *Op. cit.* Loasby ref. 7, p. 90, p. 118; cf. G. L. S. Shackle, *Epistemics and Economics. A Critique of Economic Doctrines* (Cambridge, Cambridge University Press, 1972), p. 160; *op. cit.* Davidson ref. 18, p. 482, pp. 492–493. Early important contributions on the role of power and coordination in the employment relationship come from R. H. Coase, The nature of the firm, *Economica*, November 1937, p. 386 and H. A. Simon, A formal theory of the employment relationship, *Econometrica*, 19, 1951, p. 293. Links and differences between Ronald Coase's original conceptualization and recent developments are discussed, for instance, in Williamson *op. cit.* ref. 6, p. 78; N. M. Kay, Markets, false hierarchies and the role of asset specificity, *Journal of Economic Behaviour and Organization*, 17, 1992, p. 315, reprinted in N.M. Kay (Ed.), *The Boundaries of the Firm. Critiques, Strategies and Policies* (London, Macmillan, 1992), p. 73ff.; *op. cit.* Slater & Spencer ref. 7, p. 61ff.; and P. Mariti, The BC and Ac economics of the firm, Collana di E-papers del Dipartimento di Scienze Economiche, Università di Pisa, Discussion Paper no. 4, www-dse.ec.unipi.it/discussion-papers/discussion-papers.htm, 2003, p. 1ff.
 22. Radical uncertainty constitutes a sufficient condition for the existence of positive transaction costs. On uncertainty and transaction costs, see, for instance, R. N. Langlois, Internal organization in a dynamic context: some theoretical considerations, in M. Jussawalla & H. Ebenfield (Eds), *Communication and Information Economics. New Perspective* (Amsterdam, North-Holland, 1984) p. 28ff.; M. Dietrich, *Transaction Cost Economics and Beyond: Towards a New Economics of the Firm* (London, Routledge, 1994), p. 26; and K. R. Conner & C. K. Prahalad, A resource-based theory of the firm: Knowledge versus opportunism, *Organization Science*, 7(5), 1996, p. 488.
 23. This does not mean, of course, that opportunism is an unimportant factor in increasing transaction costs. It is undeniable that both organizations and markets are subject to cheating, fraud, influence activities and lobbying, even if, as Williamson recognizes, 'most economic agents are engaged in business-as-usual, with little or no thought to opportunism, most of the time' (O. E. Williamson, Opportunism and its critics, *Managerial and Decision Economics*, 14, 1993, p. 98).
 24. G. M. Hodgson, Opportunism is not the only reason why firms exists: why an explanatory emphasis on opportunism may mislead management strategy, *Industrial and Corporate Change*, 13(2), 2004, pp. 411–414, *passim*.
 25. Economies of scale consist in a reduction of average costs as the dimension of scale increases, the latter being expressed by the maximum number of processes carried out per unit of time. On the other hand, economies of scope arise if it is less costly to combine the productions of two or more commodities than to produce them separately. This occurs whenever it is possible to economize on some shareable component, material, equipment, knowledge and labour service by saturating their production capacities.
 26. A. D. Chandler Jr., Organizational capabilities and the economic history of the industrial enterprise, *Journal of Economic Perspectives*, 6(3), 1992, p. 81, p. 84, p. 99. On complementarities between capabilities and scale, see also E. Penrose, *The Theory of the Growth of the Firm* (Oxford, Blackwell, 1959, 3rd edn 1997), p. xiii, p. 55; N. Georgescu-Roegen, Man and production, in: M. Baranzini & R. Scazzieri (Eds), *Foundations of Economics* (Oxford, Blackwell, 1986), p. 261; M. Morroni, *Production Process and Technical Change* (Cambridge, Cambridge University Press), 1992, pp. 32–36, pp. 44–47; M. Morroni, Production and time: a flow-fund analysis, in: K. Mayumi & J. M. Gowdy (Eds), *Bioeconomics and Sustainability. Essays in Honor of Nicholas Georgescu-Roegen*, (Cheltenham, Elgar, 1999), pp. 195–196; *op. cit.* Demsetz ref. 5, p. 11, pp. 31–32.
 27. M. Turvani, Reading Edith Penrose's *The Theory of the Growth of the Firm* forty years on (1959–1999), in: P. Garrouste, & S. Ioannides (Eds), *Evolution and Path Dependence in Economic Ideas* (Cheltenham, Elgar, 2001), p. 150. On the link between the expansion of the firm, qualitative transformations of inputs

- and knowledge processes, see Penrose *op. cit.* ref. 26, p. xiii, p. 55; S. Winter, Toward a neo-Schumpeterian theory of the firm, Santa Monica, The RAND Corporation, draft, 1968, p. 11, forthcoming *Industrial and Corporate Change*, 15, 2006, pp. 125–141; N. Georgescu-Roegen, *The Entropy Law and the Economic Process* (Cambridge, MA, Harvard University Press, 1971), p. 244; *op. cit.* Georgescu-Roegen ref. 26, p. 261; G. C. Harcourt & P. Kenyon, Pricing and the investment decision, *Kyklos*, 29(3), 1976, p. 449ff.; J. Robinson, The time in economic theory, *Kyklos*, 33(2), 1980, pp. 220–221; *op. cit.* Chandler ref. 26, p. 81, p. 99; *op. cit.* Morroni 1992 ref. 26, pp. 32–36, pp. 44–47; and *op. cit.* Morroni 1999 ref. 26, pp. 195–196.
28. Complementarities between the capabilities and transaction considerations are also indicated, for example, in Chandler *op. cit.* ref. 26, pp. 88–89; *op. cit.* Loasby ref. 16, p. 248; G. Dosi, Boundaries of the firm, in G. M. Hodgson, W. Samuels & M. Tool (Eds), *The Elgar Companion to Institutional and Evolutionary Economics* (Aldershot, Elgar, 1994) p. 231; N. S. Argyres, Evidence on the role of capabilities in vertical integration decisions, *Strategic Management Journal*, 17(2), 1996, p. 129ff.; P. T. Spiller & B. A. Zelner, Product complementarities, capabilities and governance: a dynamic transaction cost perspective, *Industrial and Corporate Change*, 6(3), 1997, p. 561ff.; G. Dosi & D. J. Teece, Organizational competences and the boundaries of the firm, in R. Arena & C. Longhi (Eds), *Markets and Organization* (Berlin, Springer, 1998), p. 281ff.; J. N. Baron & D. M. Kreps, *Strategic Human Resources. Frameworks for General Managers* (New York, J. Wiley & Sons, 1999), p. 9; R. N. Langlois & N. J. Foss, Capabilities and governance: the rebirth of production in the theory of economic organization, *Kyklos*, 53(2), 1999, p. 201; *op. cit.* Williamson ref. 5, p. 1087; G. Dosi, M. Faillo & L. Marengo, Organizational capabilities, patterns of knowledge accumulation and governance structures in business firms. An Introduction, Pisa, Italy, February 2003, p. 2ff.; G. M. Hodgson & T. Knudsen, Firm-specific learning and the nature of the firm: why transaction cost theory may provide an incomplete explanation, University of Hertfordshire, Hertfordshire (GB), June, 2003, p. 1ff.; *op. cit.* Ménard ref. 5, p. 354; B. Nooteboom, Governance and competence: how can they be combined?, Rotterdam School of Management, Erasmus University, Rotterdam, June 2003, p. 3ff.; C. Antonelli, The economics of governance: the role of localized knowledge in the interdependence among transaction, coordination and production, in: K. Green, M. Miozzo & P. Dewick (Eds), *Implications for Firm, Strategy and Industrial Change* (Cheltenham, Elgar, 2005), draft, p. 4ff.; J. H. Love & S. Roper, ‘Economists’ perceptions versus managers’ decisions: an experiment in transaction-cost analysis, *Cambridge Journal of Economics*, 29, 2005, pp. 3–34. In a recent paper, M. G. Jacobides & S. G. Winter persuasively argue that the co-evolution of transaction costs and capabilities is essential in shaping vertical scope over time (The co-evolution of capabilities and transaction costs: Explaining the institutional structure of production, *Strategic Management Journal*, 26(5), 2005, pp. 395–413).
 29. *Op. cit.* Chandler ref. 26, pp. 88–89 and *op. cit.* Loasby ref. 16, p. 301 have highlighted the primary role of immaterial resources, such as human assets, in explaining the boundaries of the firm.
 30. *Op. cit.* Loasby ref. 16, p. 301; *op. cit.* Baron & Kreps ref. 28, p. 9; and N. J. Foss, Edith Penrose: economics and strategic management, in: C. Pitelis (Ed.), *The Growth of the Firm. The Legacy of Edith Penrose* (Oxford, Blackwell, 2002), pp. 160–161.
 31. S. Brusoni, A. Prencipe & K. Pavitt, Knowledge specialization, organizational coupling, and the boundaries of the firm: Why do firms know more than they make?, *Administrative Science Quarterly*, 46, 2001, p. 598.
 32. *Op. cit.* Ménard ref. 5, p. 356.
 33. N. B. Niman, The evolutionary firm and Cournot’s Dilemma, *Cambridge Journal of Economics*, 28(2), 2004, p. 278. See also B. Heiman & J. A. Nickerson (Towards reconciling transactions cost economics and the knowledge-based view of the firm: the context of interfirm collaboration, *International Journal of the Economics of Business*, 9(1), 2002, p. 97ff.) on contracting hazards involved in transfers of tacit and complex knowledge.
 34. *Op. cit.* Loasby 1999 ref. 7, p. 97.
 35. R. Grant, Toward a knowledge-based theory of the firm, *Strategic Management Journal*, 17, Winter Special Issue, 1996, pp. 119–120. See also Demsetz *op. cit.* ref. 15, p. 295ff.
 36. *Op. cit.* Jacobides & Winter ref. 28, p. 410.
 37. *Ibid.*
 38. *Op. cit.* Loasby ref. 16, p. 299.
 39. See, for instance, Nooteboom *op. cit.* ref. 28, p. 5, *op. cit.* Hart ref. 5, pp. 50–51; B. R. Lyons, Specific investment, economies of scale, and make-or-buy decision: A test of transaction cost theory, *Journal of*

Economic Behavior and Organization, 26, 1995, p. 431ff.; *op. cit.* Antonelli ref. 28, p. 6; *op. cit.* Bonaccorsi & Giuri ref. 3, pp. 70–79, pp. 84–87; P. Bertolini & E. Giovannetti, The internationalisation of an agri-food district, preliminary version (Dipartimento di Economia Politica, Università degli Studi di Modena e Reggio Emilia, Modena, Italy, 2003), p. 1ff.; A. Lindbeck & D. Snower, The firm as a pool of factor complementarities, Discussion Paper Series, no. 4242, Center for Economic Policy Research, in www.cepr.org/pubs/dps/DP4242.asp.

40. Space constraints do not permit me to consider external factors, i.e. how and to what extent the size of the firm is affected by basic conditions, such as institutional and market conditions, competitive pressure and structural change. On this see, Morroni *op. cit.* ref. 2, chapter 1.
41. H. R. Greve, *Organizational Learning from Performance Feedback. A Behavioral Perspective on Innovation and Change* (Cambridge, Cambridge University Press, 2003), pp. 65–66, p. 152.
42. On the other various forms of cognitive myopia and inertia, see J. March, Exploration and exploitation in organizational learning, *Organizational Science*, 2, 1991, p. 71ff.; and D. Levinthal & J. March, The myopia of learning, *Strategic Management Journal*, 14, 1993, p. 95ff.