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Definitions and linkages between operational and strategic flexibilities

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Abstract

This paper aims at clarifying the concept of strategic flexibility, starting from that much more common of manufacturing flexibility (or operational one). After characterizing the dimensions of the latter, a classification of strategic flexibility is presented which distinguishes four categories. The measures of strategic flexibility are also investigated. Then two analogies are pointed out with the operational flexibility. The first, of the cause-effect type, is on two levels: at the business level, the operational flexibility estimates the variation of practices, while the strategic flexibility measures the effect obtained on performances; at the corporate level, the operational flexibility estimates the variation of competences, while the strategic flexibility evaluates the change in business. The second analogy, related to the classification variables, permits the main types of operational and strategic flexibilities to be placed in a single framework. So this study seeks to provide a framework—which has not been proposed in prior literature—for analyzing and evaluating the correlated concepts of operational and strategic flexibilities, to create a theoretical foundation for future research and empirical testing.

Keywords: Operational flexibility; Strategic flexibility; Strategic options; Competitive priorities

1. Introduction

Strategic flexibility is ever more discussed both in the academic and managerial fields as it has become one of the major critical success factors of a firm, while operational flexibility, in the sense of manufacturing flexibility, is still sufficiently well discussed by now, covering about 20 years of literature.

The concept of "operational flexibility" is broader than that of "manufacturing flexibility", taking in *all* the operations (design, purchasing, distribution, marketing, services, etc.), not only the manufacturing. However, in the literature the term "manufacturing flexibility" is often used to refer to *all* the operations that concur to manufacture a product.

The theme of strategic flexibility, though more recent than that of manufacturing flexibility, closely follows the variety and difficulties that marked the early years of discussion on manufacturing flexibility. As a consequence, "the confusion and ambiguity about a concept that often represents a critical competitive capability seriously inhibits its effective management" [1].

Not only it is still unclear, what is meant by the designation "strategic flexibility" and *how* this can be measured in real terms, but the links between strategic and operational flexibilities have not also been sufficiently clarified *within a coherent framework*, as also an explanation given of how

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strategic flexibility is achieved *through* operational (manufacturing) flexibility.

This article suggests a framework which, starting from the various definitions in the literature regarding both manufacturing and strategic flexibilities, collects the essential links.

So, first the definitions of flexibility—both general and concerning companies—are considered; in particular, regarding the business context, various approaches are treated: economic, organizational, operational, and strategic.

In view of the great attention that economic and organizational theories have already given to the subject of flexibility, only the last two approaches are considered in this paper: the definitions and consequent classifications of *manufacturing flexibility* (*operational approach*) and *strategic flexibility* (*strategic approach*) are studied in detail.

After having synthesized the various operational flexibilities in literature, a *classification of* the far less-treated *strategic flexibility* is compiled which contains four distinct categories: speed of variation of the competitive priorities, range of the strategic options, rapidity of movement from one business to another, and variety of the possible new businesses.

As a consequence, strategic flexibility considered both as the speed at which competitive priorities can be varied, and the speed of shifting from one business to another enables the *first link* between strategic flexibility and operational flexibility to be recognized; as will be shown, this link is of the *cause–effect type* and concerns practices and performances within a business, while it concerns competences and businesses at a corporate level.

The *second link* found between strategic and operational flexibility is of the *taxonomic type* and permits the two flexibilities and their relative dimensions to be placed within a common framework.

2. Definition of flexibility

There is not, in the literature, a definition of flexibility that is widely accepted: the problem of definition is felt to a significant extent; along with the difficulty of a conceptual unification of the terminology there is also the great variability, in the fields of application, of the concept of flexibility.

The definitions of flexibility found in literature were either derived from *a general definition*, originating in other disciplines and applicable also in other contexts (such as the biological-evolutionary one, the anthropological one, that of the theory of systems, etc.)—sub-par. 2.1—or *born directly in the managerial field* according to:

- an *economic* approach,
- an *organizational* approach,
- an *operational* approach,
- a *strategic* approach.

As for the definitions originating in the managerial field, a brief description of the economic and organizational approaches is given (sub-par. 2.2. and 2.3.). Because of the large space that the economic and organizational theories have already dedicated to the subject of flexibility, these two approaches will not be analysed in detail. The operational and strategic approaches are respectively treated in par. 3 and 4, where the dimensions of the manufacturing flexibility and the strategic flexibility are considered.

2.1. General definitions and their application to the firm's context

From a general point of view, flexibility can be understood:

- as *characteristic of the interface between a system and its external environment* [2]. In this case, flexibility acts as a filter, buffering the system from external perturbations. Flexibility thus functions as an absorber for uncertainty. The external perturbations are characterized by: (i) extent; (ii) frequency; (iii) novelty; (iv) certainty;
- as a *degree of homeostatic control and dynamic efficiency of a system* (according to an original definition by Boulding [3] taken up by Von Bertalanffy [4]). Reference is made to a cybernetic system, namely one which incorporates mechanisms of measurement, control, and regulation aimed at homeostasis, that is to say at the preservation of an existing state in the presence of exogeneous changes. Flexibility is thus mainly understood as a degree of cybernetic adaptation;
- as *capability of adaptation/change* (De Toni and Tonchia, [5]).

Flexibility, considered as a general ability to adapt/change was considered and extended to firms in rather similar terms both by Mandelbaum [6] and by Slack [7,8]. Mandelbaum [6] distinguishes between *state flexibility* and *action flexibility*. The former is the ability to work in spite of changes in the operative conditions (it allows the system to remain "stable"). The latter is the ability to take action in the face of a change, in a short period of time and with low costs.

Slack [7] assumes this concept, distinguishing between *range flexibility* and *response flexibility*. The former is an almost static aspect, typically measured over a long period, with time and cost as elements of friction. The latter is a dynamic aspect, involving the change from one state to another, and is typically measured over a short period and without notable changes in cost.

The two different types of flexibility—range and response—can be considered in the context of a company and placed together with the two main factors which induce the request for flexibility: the variety (of products and processes) and the uncertainty of demand. Volume flexibility (whether short- or long-termed, that is to say, of response and range) is the result of situations characterized by a high level of uncertainty and a low variety; on the other hand, product flexibility (typically long-termed or of range) is present when the variety offered is great and uncertainty

is low. Mix flexibility and delivery flexibility concern both situations of great uncertainty and low variety and those with great variety and not much uncertainty.

Slack [8] concludes that flexibility performance can be analysed as value range or number of states reachable: in absolute; within a certain time; within a limited cost; and within a certain limit of time and cost.

It follows that, though being the intrinsic dimension of flexibility, that of time (ability to move quickly from one state to another, in other words to "change in order to adapt"), flexibility is completely described by: the range of possible states; the time needed to move from one state to another; and the cost needed to change the state.

However, as there is a correlation between the cost and the time, so great that it often means a choice of "trade-off", only two dimensions may be considered: the range of the states and the time for change.

Slack's hypotheses are taken up by Upton [9], who considers flexibility as the result of various dimensions, each of which appears in different time intervals and has three typifying elements: range mobility (in relation to the "transition penalties for moving within the range"), and uniformity (of performances other than the cost—such as quality—within the range). Flexibility is therefore defined as "the ability to change or react with little penalty in time, effort, cost or performance".

Dixon et al. [10] consider flexibility as associated to:

- *quality*:
  - material flexibility (the ability to deal with variations in the purchased materials);
  - output flexibility (the ability to make products with different quality requirements);
- *product*:
  - new product flexibility (the ability to introduce new products rapidly and at relatively low costs);
  - modification flexibility (the ability to modify existing products);
- *service*:
  - delivery flexibility (the ability to change the content of the order or the delivery date);
  - volume flexibility (the ability to vary the quantity of the aggregate production);
  - mix flexibility (the ability to modify the variety of products in a given period of time with limited added costs);
- *cost*:
  - factor flexibility (the ability to change the mix of materials, labour, and capital used in the production process).

Particularly interesting is also the work by Bartezzaghi and Turco [11], who, after having pointed out four key performances (productivity, quality, flexibility and service) for each manufacturing system, study the relations between these performances. Furthermore, they remark the fact that "promptness" ("the ability to vary delivery dates and/or internal planning") and the various types of flexibility (product, volume, and mix flexibilities) may be in trade-off with each other.

2.2. Economic definitions

The notion of flexibility in the theory of the firm seems to have been first introduced by Stigler in [12]. Flexibility is discussed in terms of a cost curve. In comparison with the production volumes on the abscissa and the unitary costs on the ordinate, it is assumed that the unitary costs will have a U-shaped curve. In the area in which the curve is flat a variation in output around the minimum point implies low marginal costs and so the flexibility of the firm is high. On the contrary, a less flat curve is characterized by a greater amount of marginal costs and thus less flexibility.

In the perspective opened up by Stigler a theme of study is revealed which comprises a great part of the works carried out in the field of economic flexibility, a theme, which is limited to the consideration of flexibility as the ability to respond only to fluctuations in demand.

Mills and Schumann [13] formulated and tested the hypothesis that in the presence of fluctuation in demand a competitive equilibrium could exist among firms with different cost structures: the small firms in fact are able to compete successfully with the large "static-efficient" companies because they have more flexible technologies and a more flexible organization. The large firms produce at a lower cost thanks to economies of scale, while the smaller competitors have the advantage of their greater capacity to respond to casual or cyclic fluctuations in demand.

One of the first investigations on the characteristics of flexibility was carried out by Marschak and Nelson [14] who suggested three alternative definitions of flexibility understood as: entity of marginal costs (Stigler's approach); entity of the expected marginal profits (a plant is more flexible if it makes greater profits in new market positions); and amplitude of the set of choice (an initial position is more flexible if it permits a higher number of positions in the successive periods).

Klein [15], in regard to the dynamic theory of the firm, first distinguishes between static and dynamic efficiency, and then divides the latter into two classes of flexibility: one which deals with the risk and the other with the uncertainty. The author defines "*static efficiency*" as the firm's ability to combine the inputs in an optimal way, while "*dynamic efficiency*" refers to its ability to steer towards new and profitable situations. A firm that is efficient on the dynamic level is one that obtains competitive advantages over others by generating new initiatives and/or responding rapidly to new stimuli.

The two classes of flexibility proposed by Klein refer to risk and uncertainty according to the distinction proposed

by Knight [16]: the "*risk*" is associated with the repetitive events whose frequency can be measured, while the "*uncertainty*" is connected to events that cannot be assigned any numerical probability. According to Klein, the flexibility that copes with the risk contained in the production processes is capable of producing different products; over a short period of time a demand for variations in the mix can be satisfied, passing from the production of goods A to goods B at a low cost. On the other hand the flexibility that copes with uncertainty is connected with the ability of the firm to exploit new opportunities, acting or reacting rapidly to variations in the market, technological innovations, etc.

2.3. Organizational definitions

The organizational approach deals with models of organization that enable a firm to operate responsively in a rapidly changing environment, including labour flexibility as an individual (Atkinson [17]) or team (Meyer [18]) ability. To obtain flexibility, the nature of the firm's organization is essential as are the attitudes of people towards change and assumption of the risk (Carlsson [19]).

At the macro-organizational level, the contributions of Burns and Stalker [20], with the concept of the "organic" as opposed to the "mechanistic" structure) and Mintzberg [21], with the concept of "adhocracy") are of particular importance. Jennings and Seaman [22] demonstrate that organizations with a high-level of adaptation have an organic structure (instead of a mechanistic one) and adopt a prospector strategy (instead of a defender strategy). At the micro-organizational level, this theme is correlated with the job enrichment/enlargement concepts and compensation/incentive practices (Nemetz and Fry [23]).

Upton [24] argues that the flexibility of the plants depends much more on people than on any technical factor—equipment and computer integration. Suarez et al. [25] maintain that "flexibility has much more to do with non-technology factors than with technology itself". Schonberger [26], with the term "frugal automation", intended to stress that flexibility was not so much the ability to produce a high number of different codes as the ability to pass from an efficient type of production to another equally efficient one by making organizational-managerial choices which require lower investments in terms of fixed assets (thus the definition "frugal automation").

Furthermore, there are also studies which take into account the influence of the country-system where the firm operates, culture, education and training, relations with trade-unions, etc. (Gerwin and Tarondeau [27]). Hayes et al. [78] brilliantly synthesize the concept of flexibility in relation to learning processes in the title of their famous book: "Dynamic Manufacturing—Creating the Learning Organization". The organizational learning as the real source of firm's flexibility is now maintained by several authors (among which: Genus [28]).

3. The operational approach: definitions of manufacturing flexibility

Adopting an operational approach, one typically speaks about manufacturing flexibility. Zelenovich [29] defines manufacturing flexibility as the ability of a manufacturing system to adapt to changes in the environmental conditions and, in the process, requirements. This definition is important, since for the first time it takes into account both the exogenous and the endogenous nature of manufacturing flexibility: the former as a consequence of the market's demand, the latter as the exploitation of the opportunities offered by technological innovations.

Newman et al. [30] define manufacturing flexibility as a fundamental instrument for dealing with firm uncertainty. The counterbalancing action of flexibility towards uncertainty may be represented by the two plates of a balance, one of which represents flexibility, and the other uncertainty (both external—of the demand or the supply—and internal—failures, lack of materials, delays). Manufacturing flexibility may be defined:

- *for each machine* (therefore on technological grounds);
- *for each plant* (therefore on managerial grounds).

The fulcrum of the balance may be moved—with the obvious consequences on the balance—by acting on the "buffers" of the manufacturing system (inventory, reserve capacity, over-estimation of lead times); therefore, in the case of increased uncertainty, it is possible to counterbalance the latter either by increasing flexibility (for example, by means of a greater integration between the various departments and between production and the other functions of the company) or by "buffers", moving the fulcrum towards the plate representing uncertainty (for example, by operating with more inventories).

This may, however, create a vicious circle: by acting on the fulcrum, the complexity of the system may increase, and therefore also uncertainty (for example, longer lead times may cause congestion and uncertainty on source availability). Furthermore, internal uncertainty is not independent of external uncertainty; it is sufficient to mention supply and integration with the suppliers: the uncertainty of the supply (external) also has consequences on the uncertainty of operations within the firm (in terms of quantity and quality of the materials to be processed).

The different ways of defining and classifying manufacturing flexibility and the subsequent numerous dimensions found in literature appear to confirm the thesis of a vast and articulated concept (Hyun and Ahn [31]). "Flexibility is a complex, multi-dimensional, and hard-to-capture concept" (Sethi and Sethi [32]). It, therefore, becomes essential to find some variables for classification, that is to say, the different logics for interpreting the various dimensions of flexibility. Five different classification logics can be found in literature for flexibility (De Toni and Tonchia [33]).

3.1. Horizontal or by phases

Horizontal classification of flexibility is aimed at limiting the analysis (Harrison [34]). It makes reference to the single manufacturing stages, and, in a wider sense, to all the phases which constitute the "value chain" (Porter [35]), which also includes: upstream (design and purchasing); and downstream (distribution and customer service). More simply, it may be divided into internal flexibility (product/process design and production flexibility) and external flexibility (purchasing and distribution flexibility).

3.2. Vertical or hierarchical

The vertical (or hierarchical) classification of flexibility concerns the degree of detail of the analysed object: flexibility may be estimated in relation to the single resources of a system ("micro level") or to the whole system (aggregate flexibility or "macro level").

Buzacott [36] distinguishes between *resource flexibility* (machines and human resources) and *production system flexibility* as a whole (which varies according to the type of production and the managerial criteria). Swamidass [37] on the other hand makes a distinction between *machine-level* and *plant-level* flexibility: the former is exclusively technological, whereas the latter also takes into account the firm's skills, the procedures adopted, managerial systems, etc.

Gerwin [38] describes four levels at which flexibility may be analysed and measured:

- machine level;
- production function and work department level;
- product (or product line) level;
- global level of the firm (extending the concept to other functions, such as distribution, purchasing, design, maintenance, etc.).

Slack [8] introduces the concept of "flexibility hierarchy"; four categories of flexibility are described, concerning:

- manufacturing resources (flexibility of manufacturing resources may derive from: technology, human resources, and infrastructures);
- the aim of production (flexibility as a production aim coincides with product flexibility, mix flexibility, volume flexibility, and delivery flexibility);
- the production function (its flexibility increases the overall flexibility of the company, which also involves research and development, design, marketing, distribution, etc.);
- the whole company (this is the overall flexibility);

Narasimhan and Das [39] distinguish the level of: (1) operational flexibilities (machine and shop level); (2) tactical flexibilities (plant level); (3) strategic flexibilities (firm level), this latter in terms of ability to introduce new products and to adapt to or influence the market.

Koste and Malhotra [40], instead, consider five hierarchical levels, which comprise 10 flexibility dimensions in all: (1) individual resources; (2) shop floor; (3) plant; (4) functions; (5) business unit.

3.3. Temporal

Zelenovich [29] was the first to consider short-term or *adaptation flexibility* as well as medium-long term flexibility, which is typically related to *design adequacy*.

The first complete classification of flexibility on temporal bases was given by Merchant [41], who makes a distinction between:

- instantaneous flexibility (the ability to immediately select the most suitable work centre for carrying out the operation required by the work cycle of a certain part);
- very short-term flexibility (the ability to modify the sequence and mix of the parts produced);
- short-term flexibility (the ability to modify certain design specifications of the parts of the products);
- short to medium-term flexibility (the ability of the system to work at the maximal levels of productivity when production volumes are varied);
- medium-term flexibility (the possibility to add or eliminate parts from the mix of parts being produced);
- medium to long-term flexibility (the possibility to modify the manufacturing capacity by adding or eliminating work centres);
- long-term flexibility (the possibility to adapt the system to new types of products or mix of components);

Gustavsson [42] claims that flexibility has different aspects since it is required when problems occur, rising in different time horizons: (1) operational problems (machine failures, lack of materials), (2) tactical problems (such as those caused by changes in the plans or in the production levels), (3) strategic decisions (relative to investments in new plants and machinery due to an expansion in the production or the launch of a new product).

Carlsson [19] distinguishes between: (1) short-term flexibility, understood as the capability to work with small lots in any sequence; (2) medium-term flexibility, understood as the capability to work efficiently at different throughputs, produce a wide range of products, design in modular logic, use flexible machines, convert the plants to alternative uses when necessary; (3) long-term flexibility, understood as the capability to introduce new products and make technological innovations.

3.4. By object of the variation

The classification of flexibility by the object of the variation, for which flexibility is considered, is the most common one found in literature.

Gerwin was the first to mention various dimensions of flexibility in a specific manner and to relate them to the

different types of environmental uncertainties which caused them; Gerwin distinguishes various types of flexibility [38] and [43]:

- relative to the *materials*, which can be defined as the ability to deal with unexpected variations in the inputs;
- relative to the *volume*, which can be defined as the ability to deal with variations in the aggregate demand;
- relative to the *products* ("modification flexibility"), which can be defined as the ability to meet the demands of the market in terms of product specifications (these are small changes in the product, else reference is made to "change-over flexibility" which concerns product innovation);
- relative to the *mix*, which can be defined as the ability to meet the market's requirements in terms of variety of products supplied in a certain time;
- relative to the *change-over*, which takes into account the ability to vary in time the production mix, in relation to the life cycle of the single products ("while mix flexibility is the ability of a manufacturing process to produce a number of different products at the same point in time, change-over flexibility is the ability of a process to deal with additions or subtractions from the mix over time");
- relative to the *standard cycle* ("re-routeing flexibility"), measured by the number of possible routeing options.

A classification often cited in literature is that by Browne et al. [44] which, taking into account the Flexible manufacturing systems (FMS), considers eight different types or dimensions of flexibility:

- *machine flexibility*: "the ease of change to process a given set of part types";
- *product flexibility*: "the ability to change to process new part types";
- *process flexibility*: "the ability to produce a given set of part types" (Browne et al. consider process flexibility for each machine, while Buzacott [36] does not distinguish this type of flexibility, which the author also calls "job flexibility", for each machine or group of machines); for these first three dimensions of flexibility, the object of the variation is: *machine set-up*, the *product mix*, and the *part processed*, respectively;
- *operation flexibility*: "the ability to interchange ordering of operations on a part";
- *routeing flexibility*: "the ability to process a given set of parts on alternative machines";
- *volume flexibility*: "the ability to operate profitably at varying overall levels";
- *expansion flexibility*: "the ability to easily add capability and capacity";
- *production flexibility*: "the universe of part types that can be processed", i.e. the potential mix of the parts that can be produced.

On the basis of the Browne et al.'s classification, Sethi and Sethi [32] distinguish eleven types of flexibility, adding to the previous ones: *material handling flexibility* ("it is the ability to move different part types efficiently for proper positioning and processing through the manufacturing facility"), *program flexibility* ("it is the ability of a system to run virtually untended for a long enough period") and *market flexibility* ("it is the ease with which the manufacturing system can adapt to a changing market environment").

3.5. Mixed classification

Although classifications of flexibility according to one variable (phase, level of analysis, time horizon or the object of the variation) are the most common in literature, mixed logics are also adopted. The most common are those which consider both the object of the variation and time, or both the object of the variation and level of analysis (vertical logic).

For example, Barad and Sipper [45] consider nine classes of flexibility: eight of these are those proposed by Browne et al. [44], and the ninth is the so-called "transfer" flexibility (defined as the ability to process parts using different machines). The authors distinguish between flexibilities of short-medium term (such as machine, process or volume flexibility) and flexibilities of a long term (such as product or expansion flexibility).

Sethi and Sethi [32] classify their eleven flexibilities according to a vertical logic: (1) basic or component flexibilities (machine, material handling, operation); (2) system flexibilities (process, routeing, product, volume, expansion); (3) aggregate flexibilites (programme, production, market).

4. The strategic approach: definitions of strategic flexibility

If flexibility is considered as an instrument of competition and a priority to be pursued, the sphere of study is moved to a truly strategic level. "Increased competition means more volatile markets, shorter life cycles and more sophisticated buyers, which all contribute to flexibility's emergence as a new strategic imperative ... the real issue is being able to understand and manage flexibility strategically" (Suarez et al., [25]).

For Aaker and Mascarenhas [46] strategic flexibility derives from the firm's ability to adopt to large environmental changes, which have an important impact on the firm's performance. Such a flexibility can be achieved by: diversification of businesses; investment in under-utilized resources; reduction of undertakings in specialized sectors (all approaches which involve the different functions of the firm in varying ways—Research & Development, Production, Marketing, etc.).

Newman et al. [30] propose a "banking strategy", isolating the productive system, or part of it, using buffers which may be of three types: warehouses, productive over capacity, and over-estimated lead times. Slack [8] observes that, at times, it may be advantageous, instead of boosting the flex-

ibility itself, to scour other solutions: on the external downstream front trying to stabilize the demand as far as possible; on the external upstream front requesting flexibility from the subjects with whom the firm interacts (suppliers, sub-contractors, etc.); on the internal front using all those techniques (such as preventive maintenance) which increase the availability of capacity.

The definitions of strategic flexibility given in the literature are less numerous than those for manufacturing flexibility. Nevertheless their significance, as can be expected, is not unequivocal.

For Lau [47] "strategic flexibility refers to a firm's ability to respond to uncertainties by adjusting its objectives with the support of its superior knowledge and capabilities. The latter consist of people, processes, products, and integrated systems. Strategic flexibility allows a firm to support the development of future manufacturing strategies, and these enable it to react swiftly to the changing nature of internal and environmental conditions ... Not only, but world-class manufacturing firms also can influence market demand, creating uncertainties or customer expectations that competitors cannot deal with".

De Meyer et al. [48] and Nakane and Hall [49] treat flexibility as a competitive priority which must be pursued rather than a quantity simply to be measured (i.e. a performance), thus flexibility becomes a strategic fact. Flexibility is considered a competitive priority or key successful factor (KSF) because of the great turbulence in the demand, constant quest for better products/processes and competitors who have made their availability of flexible human and technological resources a source of competitive advantage.

Strategic flexibility provides an enterprise with the capability to modify strategies (Frazelle [50]; Evans [51]). Hayes and Pisano [52] define the strategic flexibility as the *capability to change the firm's strategy* with the competences selected, developed, and exploited according to the previous strategies. That is, the firm must be able to modify its competitive profile, adapting it rapidly to market trends, making a dynamic adjustment of the focus of its strategies. The authors stress the fact that strategic flexibility is obtained using the "Lean Production" practices (De Toni and Tonchia [53] and [54]) not only as systems for problem solving but also as a means of creating "capabilities" suitable for upholding their competitive position in the future. In addition they point out how "the "path dependencies" imply that the sequence of moves may affect where an organization ultimately ends up, and also act to limit its ability to make future changes in its competitive priorities". Thus, depending on the pathway the capability proves different and in the final analysis also the future opportunities. Therefore, the firm is conceived not only as a portfolio of products and activities but also as a portfolio of developing capabilities; consequently strategy must be understood as a plan for the development of capabilities.

Hayes and Pisano's definition of strategic flexibility as the capacity of a firm to successfully vary, in time, the mix of its competitive priorities is one of the most widely accepted definitions in the literature, also because it fits into the rich stream of studies on trade-off and compatibility between performances (see the "sand cone" model of Ferdows and De Meyer [55], who, retracing the original classification of Wheelwright [56] from the four competitive priorities, show the cumulative effect of competitive advantages starting from quality, then in order, passing through dependability, cost/efficiency and flexibility).

Corbett and Van Wassenhove [57] have represented strategic flexibility in a very effective way in a three dimensional space with axes of cost, time and quality; the firm is shown as a performance volume individuated by the values of the three types of performances. Strategic flexibility is thus visualized as the capacity to vary, in time, the volume of the cube by an increase in the values of the privileged performances.

Clark [58], instead, introduces the term of strategic flexibility into an examination of the *possible competitive configurations that the firm may assume*. The author observes that a firm placed, at a certain instance, in a competitive position is not limited in its strategic choices only by the traditional constraints of trade-off. In fact they take into account that the firm is characterized by an inheritance of knowledge, competence and specific capability, so it can sell in only some areas of the competitive space: those compatible with its own expertise. Strategic flexibility can then be measured by the number of possible strategic options (in the sense of a combination of competitive priorities) that at a certain moment the firm can assume. Thus, also Clark uses concepts that draw their inspiration from a vision of the firm in a "path dependency" evolutionary logic (Nelson and Winter [59]; Barnett and Burgelman [60]).

Stalk et al. [61] introduce five competitive dimensions: (1) "speed" ("the ability to respond quickly to customer or market demands and to incorporate new ideas and technologies quickly into products"); (2) "consistency" ("the ability to produce a product that unfailingly satisfies customers' expectations"); (3) "acuity" ("the ability to anticipate and respond to customers' evolving needs and wants"); (4) "agility" ("the ability to adapt simultaneously to many different business environments"); (5) "innovativeness" ("the ability to generate new ideas and to combine existing elements to create new sources of value").

The concept of "agility", in the sense of the *rapidity to move to different businesses* in a competitive environment characterized by "war of movement", fits the strategic flexibility definition, and is developed through the "capabilities predator" figure: "Such a company is able to come out of nowhere and move rapidly from nonparticipant to major player and even to industry leader. Capabilities-based companies grow by transferring their essential business processes first to new geographic areas and then to new businesses. But the ultimate form of growth in the capabilities-based company may not be cloning business processes so

Table 1
Types of strategic flexibility

	Object of the variation	
	Competitive priorities	Businesses
Scope of the variation	Strategic flexibility as the scope of the strategic options within a business (Clark [58])	Strategic flexibility as the variety of the possible new businesses (Upton [1])
Rapidity of the variation	Strategic flexibility as the speed of variation of the competitive priorities within a business (Hayes and Pisano [52])	Strategic flexibility as the rapidity of movement from one business to another (Stalk et al. [61])

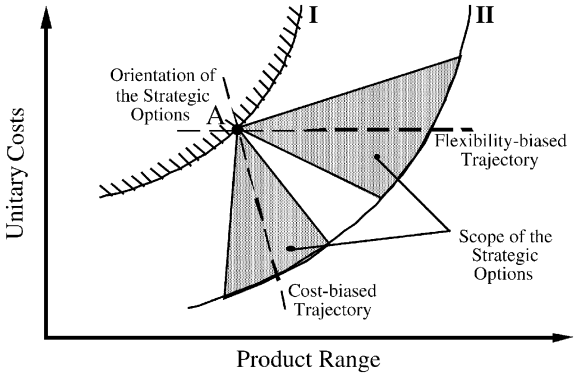

Fig. 1. Strategic orientations in terms of trajectories and strategic flexibility as the scope of the strategic options (elaborated from: Hayes and Pisano, 1996, and Clark, 1996).

much as creating processes so flexible and robust that the same set can serve many different businesses".

The concept of "agility" is translated by some people into "agile manufacturing", a new paradigm where the emphasis is put on the twin competitive priorities of flexibility and speed, which overlap and interact (Goldman and Nagel [62]; Youssef [63]).

The latest way of defining strategic flexibility is that of Upton [1], who considers it as the *number of businesses that a firm could potentially attack at a certain instance*: "firms able to move into new businesses which are very different from the existing business are seen as strategically flexible". However, Upton also considers the speed ("firms that can make strategic changes—e.g. acquisitions or joint ventures—very quickly") and the invariance of the performances in respect to the different businesses ("firms who perform well no matter which business they choose to operate in"). The idea of strategic flexibility as the number of businesses possible was first advanced by Harrigan [64] referring to the ability of firms "to reposition themselves in a market, change their game plans, or dismantle their current strategies when the customers they serve are no longer as attractive as they once were".

In conclusion, as far as the contents are concerned, strategic flexibility can be understood in the following ways (Table 1):

1. the speed at which the competitive priorities can be varied within a business (Hayes and Pisano [52]); it is directly related to the operational flexibility, understood as the capacity for variation of the practices in the time—the strategic level of reference is the business one;
2. amplitude and positioning of the strategic options at a certain instance within a business (Clark [58]); the amplitude is an index of the numerousness of the possible options, while the positioning is an index of their place in the multi-dimensional space of the strategic choices;
3. rapidity of movement from one business to another (Stalk et al. [61]); it is directly related to the operational flexibility, understood as the capacity for variation of the competences in the time—the strategic level of reference is the corporate one;
4. amplitude of the potential businesses that can be reached at a certain instance, a function of the available competences (Upton [1]).

5. The *cause–effect* link between operational and strategic flexibilities

A first link between strategic flexibility and operational flexibility of the *cause-effect* type will be proposed, following the four definitions of strategic flexibility reported in Table 1.

5.1. Strategic flexibility as the speed of variation of the competitive priorities

Fig. 1—elaborated from Hayes and Pisano [65] and Clark [58]—shows the curve of the "*competitive frontier*" of a given industry or business at a certain instance (curve I). The abscissa gives the product range (which the authors mean as flexibility to the range); the ordinate gives the unitary costs of the products obtained. The curve brings to mind the classic idea of trade-off between cost and variety: an increase in the mix is associated with an increase in the unitary costs.

The curve separates out two areas: that above the curve, the so-called one of possible options, and that below the curve, known as the area of impossibilities. The best feasible positions of the firm—in terms of combinations of technological, organizational and managerial choices—are those along the line of the curve. Above the curve can be found those firms that have not yet carried out interventions

that are potentially possible thanks to the introduction of new technologies, organizational re-engineering and the use of managerial practices such as Just-In-Time, Total Quality Management and Concurrent Engineering (Tonchia [66]).

When a firm moves beyond the curve it means that it has advanced and so has gained a competitive advantage in respect to the competitors (new frontier). So the curve is displaced in time (curve II) creating new competitive conditions. The trade-offs are thus superseded by the improvements that displace the competitive frontier: the trade-offs are not so much eliminated as displaced.

In the simple schematization of the frontier curve, the firms can compete staking on the low cost (and low prices) or qualifying on the basis of the wide range of products offered, within the Porter's classic framework that distinguishes between cost-leadership and differentiation (Porter [67]). As the frontier dynamically moves, the firms can follow different "trajectories", aiming for a greater product range (that is greater flexibility) or, vice-versa, for lower unitary costs.

Corresponding to the frontier curve of trade-offs between classes of performances, it is possible to individuate a curve of *practices–competitive priorities* (Fig. 2.1), which represents the totality of the best positions possible as a result of performances obtained and intensity of action on the organizational, managerial and technological practices. Like the preceding trade-off curve also the practices–competitive priorities curve has an area of impossibility (above the curve) and it is displaced upwards in time, as new synergy in the application of technical and managerial solutions for the running of the firm unfolded.

Imagine now that a firm operating on the frontier in position A decides to move along the curve to position B by carrying out an internal re-organization. For the sake of simplicity, let us assume that the firm decides to manufacture the various product lines not in a single productive system but according to the cellular manufacturing logic, in productive cells each of which is dedicated to a family of products. The overall result is that the unitary cost of the products is reduced thanks to the lower set-up costs, lower investments in work-in-progress and faster throughput times.

Thus, the performances of the firm improve (reduced unitary costs, shorter response times, etc.) in connection with a set of practices ("cellular manufacturing"). It can be hypothesized that starting from an instant t_0 the firm achieves these changes in a certain interval of time t_1–t_0. If the time taken had been greater, for example t_2–t_0, exactly the same results in terms of unitary costs would have been reached, but not in terms of temporal speed.

It is possible to analyse this difference in behaviour from two different points of view:

- *the point of view of effects*, that is of the performances, or *strategic*, in other words the speed at which unitary costs, response time to the customer, etc. are reduced, i.e. improved on the ordinate (Fig. 2.2); the path from point A towards point B_1 and B_2 is shown, representing the distance covered from instance t_0 to instances t_1 and t_2, respectively;
- *the point of view of causes*, that is of the practices, or *operational*, in other words, for example, the speed of lay-out modification, of the introduction of new managerial techniques, etc. (Fig. 2.3); now the amplitude of the changes regarding practices are on the ordinate and the time on the abscissa (the Cartesian quadrant has moved through 90°).

In the simplification of the proposed scheme at last it is possible to "operationalize" Hayes and Pisano's [52] definition of strategic flexibility, meant as the capacity to vary the competitive priorities in the time. In fact, we have (CP = competitive priorities, i.e. classes of performances, t = time, Δ = difference):

$$\text{strategic flexibility on the competitive priorities} = \frac{\Delta CP}{\Delta t}. \tag{1}$$

In a similar way it is possible to propose an "operationalized" definition of the operational flexibility on the practices, understood as the capacity of variation at the time of the practices themselves. In fact, we have (p = practices):

$$\text{operational flexibility on the practices} = \frac{\Delta p}{\Delta t}. \tag{2}$$

In Fig. 2.2 it can be seen that the quickest path AB_1 is that characterized by a greater strategic flexibility, equal to the tangent of the angle of the half-line. In the same way in Fig. 2.3 the path AB_1 corresponds to a greater operational flexibility, whose value is equal to the tangent of the angle of the half-line.

The definitions above permit the value of the strategic flexibility to be related to that of the operational flexibility in the following way:

$$\frac{\text{strategic flexibility on the competitive priorities}}{\text{operational flexibility on the practices}} = \frac{\Delta CP}{\Delta p}. \tag{3}$$

It is a fact that, within the limits of the simplifying hypotheses implicitly adopted in the proposed scheme, the significance that can be extracted is interesting. Along curve AB in Fig. 2.1 *the tangent at every point of the curve identifies a line whose angular coefficient is the relation between strategic flexibility and operational flexibility*. This means that in the tract where the curve is very steep a slight action on the practices determines a strong impact on the performances (that is, a little operational flexibility determines a great strategic flexibility). Vice-versa in the tracts where the curve is almost flat a strong intervention is necessary to obtain significant results (that is, a notable operational flexibility determines only a modest strategic flexibility).

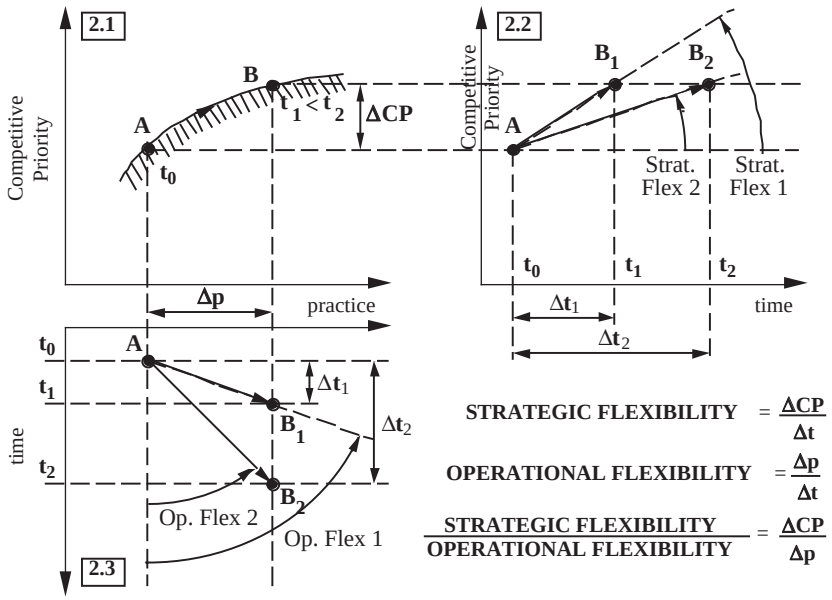

Fig. 2. The first link between strategic flexibility and operational flexibility (*CP* = performance result in the competitive priority; *p* = practice intensity).

5.2. Strategic flexibility as the range of the strategic options (within a business) and as the variety of the possible new businesses

The trade-off frontier curve of Fig. 1 represents the best competitive position in which theoretically a firm can place itself. Placing itself high up or low down along the curve, the firm pursues a cost-leadership strategy or a differentiation strategy, according to the standard perspectives of the Industrial Organization (Porter [67]).

If we think of the same firm using the interpretative key supplied by the Resource-based Theory (Wernerfelt [68]; Barney [69]; Grant [70]), it qualifies because of the growth in knowledge, competences and abilities over a period, beginning from the available resources, which permit it to reveal its competitive potentiality according to specific orientation and scope, and which depend on the competence itself. "Capabilities" refers to a firm's capacity to deploy "resources", usually in combination, using organizational processes, to effect a desired end" (Amit and Schoemaker [71]).

In Fig. 1, this concept is represented by the shadowed cones (Clark [58]), distinguishing:

- *a scope of the strategic options* (represented by the shadowed area), a function of the level of accumulated competences (compatible with the distance between curves I and II) and the variety of the developed competences (compatible with the amplitude of the shadowed area);
- *an orientation of the strategic options* (represented as the direction in which the shadowed surfaces are positioned), a function of the type of competence accrued.

So, essentially the firm's possible strategic options at a given time depend on the competences developed in the learning process, and these are characterized by three variables: (1) type of competency (technological, organizational, managerial); (2) variety of competences (numerousness); (3) level of development of the competences (degree of advancement).

In the plane of Fig. 1 the strategic option is considered as a point identified by the combination of the values of two assumed variables such as performances: unitary cost and product range ("process variety" as originally defined by Clark). In reality since there are many other performances (both in the ambit of costs/productivity and of quality and time) one must imagine that—in a multi-dimensional space—the strategic options are represented not by the "orientated surface of a circular sectors" but by the "orientated volume of a multi-dimensional solids" (a cone in the three-dimensional space). The volume is a measure of the amplitude of the possible strategic options and its orientation defines the relative positioning in the competitive space. The values assumed from the volume and the orientation of the solid are a dynamic function of the learning process of the firm.

Fig. 3 schematized how the developed competences and the consequent strategic options depend on the trajectory of learning accomplished ("path-dependency" approach). Two

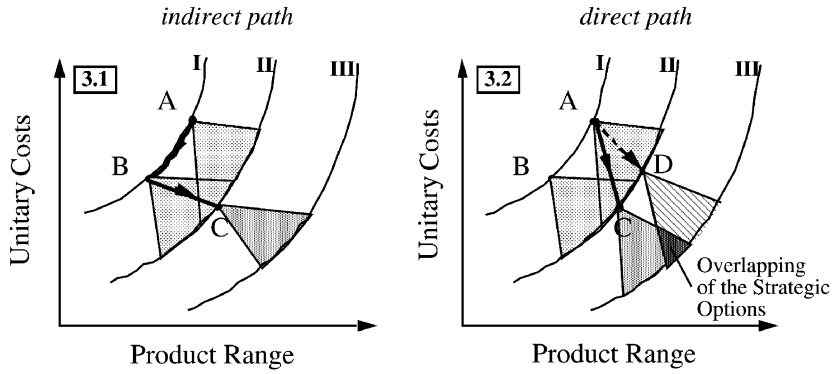

Fig. 3. Strategic flexibility as a function of the learning processes A-B-C (indirect path) and A-C (direct path).

alternative paths of a hypothetical firm which moves from A to position C are represented.

In Fig. 3.1 the firm decides on first restructuring, reaching situation B by means of—for example—redefinition of its layout and creating productive cells starting from the traditional job shop. Successively, the cells are automated by the introduction of flexible manufacturing systems (FMS) bringing about an improvement both from the point of cost reduction and an increase in the mix obtainable (final point C).

In Fig. 3.2 instead a straight path is shown from point A to C; still with reference to the above example the firm decides to bring out families of products directly starting from its job shop, producing them in newly acquired FMS and thus bypassing the restructuring typical of cellular manufacturing (which would have meant passing through B).

Apart from the fact that the paths A-B-C and A-C may require different resources and times, the fact of having reached the same point C following two different trajectories (one indirect and the other direct) implies, anyhow, two strategic options distinct in scope (proportional to the number and level of learnt competences) and orientation (a function of whichever competences have been accrued). The fact of having, for example, gone through the experience of cellular manufacturing may have developed the capacity of the work force to work efficiently with a wide mix; on the contrary the experience of flexible automation may have developed ability to squeeze not yet fully exploited costs.

The fact that the scope of the strategic options are determined not only by the positioning but also the trajectory accomplished introduces another point fundamental to decision-making: that of the *degree of reversibility of the choice*.

This phenomenon can be represented as in Fig. 3.2. The amplitude of the darker surface represents a measure of the degree of reversibility of the choice made by the firm, if one must decide between the two different decisions/directions AC or AD. It is evident that the greater the overlapping the greater is the degree of reversibility of the choice made in A. The play between the scope and the orientation of the areas of strategic options determines the amount of overlapping and in the final analysis establishes the degree of reversibility–irreversibility in the choice made.

Similar to what was done before at the *single-business level* (evaluation of the range of the possible strategic options), also at the *corporate level* a strategic flexibility can be defined, evaluated as the variety of businesses that can potentially be added by a firm starting from a set of available capabilities (Upton [1]).

5.3. Strategic flexibility as the rapidity of movement between businesses

It has been seen how the competences play a determinant role in the strategic positioning of the firm at the business level as they determine the dimension (“scope”) and localization (“orientation”) of the areas of strategic options.

For every strategic option (understood as a combination of values assumed from the competitive priority) there is a corresponding strategic choice of intervention practices, both as nature (which practice to apply) and as intensity of use (how much to apply). On the other hand the definition of a strategy requires that it be combined both with the competitive priority and with the choice of practices.

Since the competences represent the presupposition of a possible and efficient use of the practices themselves, it is evident that stock and nature of the available competences condition the choice in the hypothetical space of the practices to be set in action (Dierickx and Cool [72]). The application of the practices in turn strengthens the competences present, makes new ones, tries out the mixing of different competences, according to complex schemes of knowledge creation (Nonaka [73]).

But the competences have another role in respect to that described on the part of practices and performances. In fact their growth does not only permit the increase of the strategic options at the business level, but also the insertion into other businesses.

In this case also, as before, it is possible to formulate an "operationalization" of the definition of strategic flexibility now given by Stalk et al. [61], understood as the capacity of the firm to transfer from one business to another in time. Expressly:

$$\text{strategic flexibility on the businesses} = \frac{\Delta b}{\Delta t}. \quad (4)$$

Similarly as was done before for the practices, we can define an operational flexibility on the competences, understood as the capacity to keep, develop, combine, and acquire competences in time. As a formula:

$$\text{operational flexibility on the competences} = \frac{\Delta c}{\Delta t}. \quad (5)$$

If at the corporate level strategic flexibility is measured as the capacity in time to successfully transfer to other businesses, the condition for obtaining strategic flexibility is to have operational flexibility available on the competences in the sense above mentioned. Similarly as defined on a *business level*, one can say at the *corporate level*:

$$\frac{\text{strategic flexibility on the businesses}}{\text{operational flexibility on the competences}} = \frac{\Delta b}{\Delta c}. \quad (6)$$

Thus, it is possible to distinguish, also in this case, between effect (strategic flexibility on the businesses $\Delta b/\Delta t$) and cause (operational flexibility on the competences $\Delta c/\Delta t$).

The "capability predator" firm as meant by Stalk et al. [61] is precisely that firm which, adapting its "business processes" to new sectors, is able to prey on them.

In conclusion, the relationship between strategic and operational flexibilities can be analysed on two levels: *on the business level* as a variation of performances by means of changes of practices; *on the corporate level* (i.e. multibusiness) as a variation of businesses by means of changes of competences.

6. The *taxonomic link* between operational and strategic flexibilities

It is possible to individuate a second link of the taxonomic type (that is classifying) between the above-mentioned classes of strategic flexibility and the principal types of operational (manufacturing) flexibility described in the first part of this paper.

The link is possible if one considers, for all types of flexibility, in addition to the *object of the variation*, also the *characteristics of the variation*, in other words:

- the *state conditions*;
- the *type of transition*, that is the degree of reversibility or irreversibility of the variation.

This distinction between the state conditions and transition type is to be placed in the ambit of specific study approaches to manufacturing flexibility based on the Petri net. Such nets are graphic structures with "states" (conditions) and "transitions" (events); every transition (for example the start of the work) has input states (machines available, waiting work) and output states (working machine): in this scheme the flexibility is a function of the time of reaching the states (Barad and Sipper [45]).

The use of the two variables (state conditions and type of transition) enables us to reach the link, reported in Table 2, between the different types of strategic and operational flexibilities.

It can be seen how the use of the variable "state conditions" permits to consider simultaneous, as descriptive characteristics of the situation in the firm at a given instance, the following variables:

- *productive capacity*;
- *range of products*;
- *scope of the strategic options*;
- *variety of businesses* in which the firm is present.

They are related, respectively, to the following "objects of variation":

- quantity of output (that is, the productive volume);
- composition of the output (that is, the production mix);
- competitive priorities (understood as classes of performances);
- businesses.

If it is assumed that flexibility is a *capacity for variation in the time of a certain "object"* (productive volume, mix, competitive priority, business), then it is possible to assert that it is not formally correct to attribute any significance of flexibility to the four descriptive variables of the state. The values of the descriptive variables of the state represent "snapshots" of the firm and cannot be linked to the concept of flexibility (this instead is considered in respect to the passage of time). However, other authors (such as Mandelbaum [6]) consider our "state conditions" as "state flexibility" and our "transitions" as "action flexibility".

As regard to the variable "type of transition" (reversible or irreversible) it enables us to differentiate *volume flexibility* (generally evaluated over a short period because of fluctuating and reversionary variations in the demand and therefore in the production quantity) from *expansion flexibility* (evaluated over long periods, because of irreversible variations in the quantity to be produced, connected for instance with a plant capacity increase). In the same way *mix flexibility* is considered over a short period in relation to reversible fluctuations in the output composition, while *product flexibility* is evaluated for variations in the output composition over long periods (for instance new products are introduced).

It follows that if one acts on the operational practices that determine irreversible transitions (for example those of

Table 2
The second link between strategic flexibility and operational flexibility: a unitary classification of the main types of strategic and operational flexibilities

Characteristics of the variation		Object of variation			
		Operational level		Strategic level	
		Quantity of output	Composition of output	Competitive priorities	Businesses
State conditions		Productive capacity	Product range	Scope of the strategic options	Variety of Businesses
Transition	Reversible	Volume flexibility	Mix flexibility	Speed of variation of the competitive priorities	Rapidity of movement between businesses
	Irreversible	Expansion flexibility	Product flexibility		

expansion of the productive capacity and introduction of new products) one obtains the effect of "travelling" from a "departure condition" characterized by certain productive capacity and product range to "arrival conditions" characterized by new and different productive capacity and product range.

In the case of reversible transitions we move, instead, within productive capacity and product range given, with the conditions of the arrival state hardly differing from those of the departure.

The different temporal horizons which, in general, characterize both reversible and irreversible variations also explain why flexibility to volumes and mix (reversible) are evaluated, above all, in relation to costs (the interval of the variation is brief in respect to the times at stake). On the contrary the irreversible transitions, as they come at significantly longer intervals (think of the introduction of a new product that could require a number of years), are evaluated both in terms of costs and time.

As far as strategic flexibility is concerned, it is reaffirmed that scope of the strategic options and variety of potentially accessible businesses are state conditions and thus are not truly flexibilities, though at times they are treated as such in the literature.

According to our scheme, then, strategic flexibility is the capacity to successfully modify the competitive priorities and to move to new businesses. It should be noted that these "transitions" can be either reversible or irreversible (Table 2). However, on an in-depth analysis they seem to be prevalently *irreversible* in character. In fact, strategic flexibility of priorities is evaluated on tendentiously long temporal horizons, a characteristic typical of irreversibility; besides, according to a cumulative approach of improvement of performances in "sand cone" logic, the trajectory is often one-way. Likewise flexibility of businesses most often shows characteristics of irreversibility in view of the long temporal horizons involved.

7. Conclusions and future work

We have tried to clarify the concept of strategic flexibility and its linkages with the operational flexibility (or manufacturing flexibility, which is a term more diffused in the literature and generally refers not only to manufacturing in a strict sense, but also to all the *operations* that concur to manufacture a product: design, purchasing, distribution, marketing, services, etc.).

The concept of strategic flexibility is in fact more recent and still vague in respect to that of operational/manufacturing flexibility. Furthermore, for too long time a sort of strategic flexibility was considered *inside* the operational ambit: i. simply as a long-term flexibility ("the distinction between manufacturing and strategic flexibility concerns two different temporal dimensions"—Eppink [74]); or ii. as an upper-level flexibility ("a meta-level of flexibility known as "strategic adaptability" ... in order to quickly adjust company objectives to meet new conditions and readily change the types, ranges and times of the various dimensions of flexibility"—Gerwin [43]).

Few works have considered flexibility in real strategic terms, clearly defining it and/or linking to other (operational) flexibilities. For example, Evans [51] considered two distinguishable dimensions of the concept of strategic flexibility: temporal and intentional. "The temporal dimension comprises an "ex ante" mode (preparing in advance for some future transformation) and an "ex post" mode (after-the-fact adjustments undertaken once a triggering episode has occurred). The intentional dimension comprises an offensive mode (creating and seizing an initiative) and a defensive mode (guarding against predatory moves or correcting past mistakes)".

With this work, after resuming the dimensions of the manufacturing flexibility, a definition/classification of strategic flexibility is presented (summarized in Table 1) which distinguishes four categories, considering the competitive priorities and businesses as *objects of variation*

and the amplitude and the speed as *characteristics of the variation*.

The strategic flexibilities individuated thus regard: (1) the scope of the strategic options; (2) the variety of the possible new businesses; (3) the speed of the variation of the competitive priorities; (4) the rapidity of movement from one business to another.

The above-mentioned definitions of strategic flexibility use concepts developed within the theory of the firm. For example the "trade-off" curve used by Clark [58] can be set in the industrial organization, characterized by the sequence "structure - strategy - performance"; the Porterian strategies of leadership of cost and differentiation are used to explain the different choices regarding privileged performances. The "business processes" of Stalk et al. [61] can be linked to the Resource-based Theory, characterized by the sequence "resources - competences - competitive advantages". The paths taken by the firms and their accumulation of competences ("path-dependency") proposed by Hayes and Pisano [52] can be interpreted within the framework of the Evolutionary Theory.

Furthermore, the work carried out has enabled two links between strategic flexibility and operational/manufacturing flexibility to be determined, evaluated and measured.

The *first link* individuated permits the operational flexibility and the strategic flexibility to be placed in formal relation in a cause-effect logic. After assuming a unitary definition of flexibility (the capacity of variation in the time of a determinate object), a link of the cause–effect type between the two flexibilities, both at the level of single business and corporate (that is, multi-business), was pointed out.

- At a business level, the link of the cause–effect type regards "practices and performances"; the operational flexibility measures the variation of the practices to set in motion, while the strategic flexibility measures the effect obtained on the performances (or competitive priorities); the tangent to the curve at a certain point is a measure of the relationship between the two flexibilities, in other words the ratio between strategic flexibility and operational flexibility is given by the change in the competitive priorities as a result of the change in the operations practices (Fig. 2).
- At a corporate level, the cause–effect type link regards "competences and businesses": in the proposed logic, the ratio between strategic flexibility and operational flexibility is given by the business change as a result of the change in the firm's competences.

The *second link* is represented by the unitary scheme of classification of the various types of strategic and operational flexibilities (Table 2). Thanks to the individualization of the variables "state conditions" and "type of transition", the various flexibilities presented have been placed in a common scheme, in which only the object under consideration changes (the production volume and mix for operational flexibility, the competitive priority and the business for strategic flexibility).

In regard to strategic flexibility, some streams of research are still open to development. It could be useful and interesting:

- a vertical analysis, distinguishing, for example, besides strategic flexibility at corporate and business levels, also *strategic flexibility at a functional level*, as shown by the studies carried out by Sanchez [75] in the ambit of product development;
- a horizontal analysis, *along the supply chain*, moving the focus of attention to the upstream-downstream interaction, trying to put the various flexibilities (strategic and operational) of one firm in relation to those of the other firms of the chain;
- an analysis of the object the variation, which no longer belongs to a single firm but to an integrated network of firms or *Extended Enterprise* (Tonchia and Tramontano [76]), moving the focus of investigation to the centre-periphery interaction and considering the flexibility links between the nodes of the network;
- a temporal analysis, distinguishing, for example, between "*core competences*" and "*capabilities*", with the former, on a technological base, developed over longer temporal horizons, while the latter, on an organizational-managerial base, over shorter horizons (De Toni and Tonchia [77]).

This distinction of the future streams of research, based on the same logic used to interpret the various manufacturing flexibilities (horizontal, vertical, temporal, by objects—par. 3), would seem to suggest a *third link*, between strategic and operational flexibilities, that remains to be explored.

This link, starting from the above four logics used for manufacturing flexibility, enables managers to plan and implement their strategies, respectively: (a) gaining company's flexibility from the flexibilities of various company's functions; (b) and/or from the flexibilities of the upstream (suppliers) and downstream (distributors/customers); (c) managing a network of owned companies and their supply chains and aiming at an Extended Enterprise's flexibility; (d) considering the leverage on technological "core" competences rather than on more soft "capabilities" (people's behaviour-based).

In conclusion, this study has tried to provide a framework—which has not been proposed in prior literature—for analysing and evaluating the correlated concepts of manufacturing and strategic flexibilities, to create a theoretical foundation for future research and empirical testing.

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