

# Business-to-business External Sources of Technology (BEST) and Innovation: A Dynamic Portfolio Approach

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**Abstract** Especially in complex technological contexts, companies engage in external relationships and use Business-to-business External Sources of Technology (BEST) in order to innovate. The way this relationship has to be organized (should it be a merger or an alliance?) is a critical strategic choice. Despite the relevance of the above decision, the topic has not been often addressed by the literature and the existing guidelines provide little support to decision makers. Adopting a Dynamic Portfolio approach, the present papers designs a decision system where the governance modes is not conceived as a simple binary choice (either M&A or SA) but as their balance and integration within a dynamic portfolio. In doing so, the present works contributes to the literature releasing the limitations of previous studies and provide support to managerial practice.

**Key Words** dynamic portfolio, strategic alliances, mergers and acquisitions, decision system

## 1 Introduction

The number of strategic alliances, mergers and acquisitions has systematically increased in the last decades [1, 2]. Innovation has become one of the most cited motivations to enter in partnering activities, especially in high technology industries [3]. These facts seem to confirm that an “open innovation” [4] framework is prevailing, especially in industries characterized by rapid technology evolution. Companies are keen to use external sources to develop new technologies (BEST, Business-to-business External Sources of Technology) to foster innovation, embedding those technologies in new products and processes. Once a company has recognized the opportunity of an external technological relationship and identified a suitable partner, still the governance mode, the way this inter-firm relationship is going to be organized, has to be defined. The governance mode decision has been mainly framed as choice between Strategic Alliances (SA) and Mergers and Acquisitions (M&A). Despite the managerial relevance of the governance choice decision, the criteria to choose among different governance modes is a topic not often addressed by academic research [5]. Knowing in which situations an alliance or a merger is more suitable represents a critical strategic decision [6]. The failure rates of alliances and mergers can be imputed to the fact that managers, not knowing when to choose an M&A or a SA, simply do not compare the alternatives, “making a mess of both acquisitions and alliances”[7].

Wang and Zajac [8] identify two research lines in the literature: the first approaches SA and M&As as undifferentiated forms of governance, the second isolates one of the two alternatives and focuses on either SA or M&A. A third line of research proposes comparative criteria for selecting the governance mode that improves the technological innovativeness of companies (for example 9, 10, 5, 11, 12,13). Criteria suggested by the former research stream, however, 1) conceive the governance choice as a decision isolated from other existing governance modes in which the company is involved, 2) are useful if considered separately but often conflicting if taken in an integrated fashion to build a decision system, 3) hint only marginally the effect of time dynamics on the governance choice decision.

The main objective of the present work is to design a decision system for choosing BEST governance choices aimed at innovation that accounts for interactions among different governance choices and that adopts a dynamic, time dependent, perspective.

In order to answer these research questions, we consider that a portfolio approach is the most adequate and we motivate our choice with three main reasons. First, a rich body of literature has recognized the superiority of approaching external relationships from a portfolio perspective in order to enhance innovation [14, 15, 16, 17]. Second, the portfolio approach allows to face the complexity of multiple contemporaneous relationships (18, 19) providing a better understanding of the interrelationships and complementarities existing among different relationships (20, 21). Companies

have started to recognize that considering inter-firm links as “one-offs” – “independent relationships pursued separately” is perilous (22). A recent report from McKinsey (23) motivates the need for a portfolio approach arguing that, otherwise, companies collect over the years, a “random mix” of linkages whose contribution to corporate strategy is unclear. Finally, one of the main advantages of a portfolio approach is to comfortably deal with time dynamics [20, 24]. Although, portfolio approach has been mainly adopted for alliances, we enlarge the reasoning to M&As as well.

Building on financial Portfolio Theory [25,26], the present paper proposes to answer the research question adopting a Dynamic Portfolio (DP) approach as conceptual tool for supporting the governance choice. The main conclusion of the present work is that the decisions on governance modes are not to be conceived as a simple binary choice (either M&A or SA) but as their balance and integration within a dynamic portfolio.

The present paper is structured as follows. The next section provides an overview of the literature on criteria for governance choice. A discussion of the challenges left unsolved by previous studies follows and the motivation for a new theoretical approach is introduced. In the third section, the conceptual pillars from financial portfolio theory are presented and interpreted in a governance mode context. In section four, the Dynamic Portfolio approach to design a decision system is presented. Implications for research and managerial practice are discussed in the final remarks.

## 2 Governance Choices Decisions: Theoretical Overview

### 2.1 The spectrum of BEST organizational modes

BEST organizational alternatives can take different forms that can be conceived as resting on a continuum, depicting various degrees of organizational integration [10]. Approximating the level of integration by the degree of equity participation, the spectrum is ranging from relatively simple contractual transactions to full equity integration in the form of M&As (see Table 1).

**Table 1 Spectrum of BEST organizational modes and associated characteristics.**  
Sources: adapted and modified from [6] and [10].

		Business-to-business External Sourcing of Technology (BEST) spectrum							
		Contractual transactions							
		Contract (Supply, Distribution, Manufacturing Outsourcing)		Strategic Alliances				M&A	
		Low High	Joint promotion / marketing	Licensing	Non equity alliance (joint R&D)	Equity alliance	Joint venture	Acquisition	Merger
Integration	Low	←							High
Control	Low	←							High
Integration	Low	←							High
Termination cost	High	←							Low
Transaction costs	Limited	←							Unlimited
Life spam	High	←							Low
Opportunistic behavior risk	Low	←							High
Formalization	Low	←							High
Capital intensity	Low	←							High

From a governance choice perspective, Strategic Alliances (SA) and Mergers and Acquisitions (M&A) constitute the main asset classes. Strategic Alliances refer to “cooperative efforts in which two or more separate organizations, while maintaining their own corporate identities, join forces to share reciprocal inputs” [5]. According to Dussage and Garette [27], an alliance can be qualified as strategic when “when it contributes significantly to the strategies pursued by the partner companies”. The term “strategic alliances” indicates many different partnering modalities including equity as well as non-equity linkages [28]. M&As refer to situations in which one company acquires the control over another corporate entity. In the case of a merger, the acquirer absorbs the other entity (that ceases to exist) while in the case of an acquisition the two identities keep on functioning as juridical entities. Mergers are relatively rare and many transactions called mergers constitute in fact acquisitions [29].

The characteristics of the governance choices change moving along the continuum. Highly integrated forms display lower levels of flexibility compared to SA [30, 10] and therefore the possibility

to adjust to changing conditions is constrained. More hierarchical forms of governance, like acquisitions, provide, however, higher levels of control and present reduced levels of opportunism [31]. The cost to terminate a partnership increases with the degree of integration [32], M&As representing also typically a larger investment compared to SAs [33]. Governance modes lying on the left side of the continuum, like alliances, are more concerned by worries about the appropriability of the results achieved by the joint activities. Especially when the scope of the alliances is broad, the possibility to control the partner is limited and the risk of opportunistic behavior is higher [34]. Therefore, SAs are typically concerned with the costs of managing and controlling the relationship. On the other side, governance forms with higher level of integration, like M&As, are typically associated with difficulties of integration that can hurt innovation performance in the post merger phase [35,36, 37]. With respect to the time dimension, moving along the continuum to higher integration forms implies that the life span of the relationship increases [30]. In M&As, the acquirer obtains immediate access and control over the resources needed [10] while, in SAs, partners are involved in joint activities to develop new technological knowledge [30]. Highly integrated forms, like M&A, however, need longer time span to affect innovation (around five years) while lower degrees of integration like alliances display their effects sooner (around three years or less) [3].

## **2.2 The criteria of governance choice in the literature**

Criteria for choosing a governance mode, given its peculiar characteristics, have been discussed principally within the conceptual framework of the Resource Based View (RBV), Transaction Costs Economics (TCE), Network Theory (NT) and Real Option Reasoning (ROR). The RBV states that the internal specific capacities of a firm (core competencies) constitute the fundamental factors that define the competitive advantage [38]. Knowledge is one of the most important resources that companies constantly try to develop [39]. Technological capabilities are the constituents of core competencies and two types of activities generate them: internal R&D and technology external linkages [40]. In a RBV perspective, the type and nature of the resources combinations involved in the relationship provide the criteria to identify the most suitable form of governance. RBV is linked to Transaction Cost Economics (TCE) because “combination of resources is influenced by transaction cost economizing” [41]. TCE (mainly framed by Coase [42], Williamson [43, 44] predicts that managers should prefer the governance mode that carries the lowest costs for coordination and control. TCE is more likely to determine the governance mode once uncertainty is low, large investments are undertaken and the need for control emerges. When uncertainty is high, flexible governance modes are preferred and a Real Option Reasoning is predominant [12, 45, 29]. In Real Options Reasoning, the main criterion for the governance choice is the level of uncertainty. Uncertainty can be exogenous (related to the phase of the technological development) or endogenous (related to the reliability of the partner in the relationship) (33). Both have an impact on the governance mode choice. A more recent body of literature has adopted the Network Theory approach [46, 47, 48]. Two qualifications of networks have been addressed by the literature [49, 46]: structural and relational. Relational aspects refer to the nature of the ties in the relationship. Companies can be linked by direct ties when they interact directly or by indirect ties when there is no direct contact and the relationship exists only through a third entity [ 50]. Structural aspects may refer to the redundancy in the network. Networks can be closed or dense if all the individual firms are interconnected with each others [48] or with structural holes or empty spaces if there are no full interconnections among the network members [47]. In a NT approach, the governance choice is influenced by the position of the company in its web (network) of relationships and by the nature of these links. An overview of the literature on the choice of M&A and SA with a summary of the suggested criteria and of their link with the supporting theories is presented in Table 2 (see Annex) .

## **2.3 Challenges from existing literature**

Although the contribution from previous literature has been extensive, the application of the above mentioned criteria poses a number of challenges that encourages the quest for a new approach.

1) We observe that in order to serve as a tool for managerial decisions, the guidelines proposed by previous theories need to be presented in an integrated fashion. Even though previous literature focuses on features relevant in the governance decision, there are situations where suggestions from different theories diverge and it is not clear which theory, or which aspect within the same theory, should be predominant.

Table 2 summarizes which aspects are covered by each theory and which aspects are not fully considered. Note (see Table 2), for example, that, when dealing with mature technologies, RBV advises the use of alliances while a ROR suggests acquisitions [10, 51]. Without a proper framework, problems of coordination among suggestions from diverse contributions may arise. When different theories

suggest contrasting forms of partnering, there is no obvious reason to prefer one approach over the other. Observing that we do not dispose of a single conceptual framework, comprehensive enough, to deal simultaneously and consistently with the several facets of the governance choice, we formulate the following:

Constraint 1: Previous literature does not provide an integrated framework to support governance choice decisions.

2) Existing models tend to isolate the governance choice decision. As it can be noticed looking in Table 2, in the literature examined, the interactions between different governance modes are not central in the previous contributions. This may be due to the unit of analysis adopted by precedent literature. From a micro to a macro perspective, the governance choice decision can be alternatively analysed at the *transaction* level focusing on the specific nature of the relationship (as in TCE and ROR), or at the *company* level (as in RBV), or at the *network* level of external relationships (as in NT) [11]. In order to account for interactions among governance modes, a more suitable unit of analysis has to be identified. Therefore, we formulate the following:

Constraint 2: Previous literature do not account for interaction among different governance choices.

3) The governance choice criteria proposed by previous studies appear to be essentially static, considering only marginally the time perspective and its effects on the governance decision process. In a RBV framework, (see Table 2) for example, an acquisition is advisable if the resources involved are “core” to the company, at the moment of the governance decision. The contrary is valid for alliances [13]. How could decision makers account for key technology developments that could become the new core? As time-dynamic processes are, in the above RBV criteria, not explicitly accounted for, no immediate guideline is available. In a NT approach, (see Table 2) prior ties between two partners make advisable an acquisition [5]. Being the governance decision influenced by past relationships, the effect of time is indirectly considered. However, NT approach assumes that the other conditions (market/technology developments, or strategic intents and operational objectives of partners) remain unchanged. There is no explicit reference also to the changes in the network of each individual partner and to the associated effects on the governance decision. We, therefore, formulate the following:

Constraint 3: Previous literature considers only marginally the time dynamics of the governance choice decision.

In order to release the constraints faced by previous works, the present paper proposes to that the adoption of Dynamic Portfolio reasoning to governance choice decisions.

### 3 Governance Choices: a Dynamic Portfolio Approach

Adopting a portfolio approach, we propose to use as starting point Financial Portfolio Theory [25,26] already successfully applied to R&D investment selection (see for example 52). Investment selection is a term borrowed from financial literature and refers to the process that aims at determining in which asset, or class of assets, it is preferable to invest for a specific individual aiming at a defined goal (53). The reasoning that leads the choice of our theoretical framework is that when deciding which governance structure should be selected in order to achieve technological innovation, the company is, conceptually, facing an investment selection decision.

Financial Portfolio theory builds on three main pillars that, in the next sections, will be interpreted in the context of BEST governance decisions. Finally, we add a dynamic interpretation showing the time dependent links among the main building blocks. The resulting dynamic decision system is shown in Figure 3.

#### 3.1 The risk-return profile

In a Portfolio theory framework, the main criteria to decide the asset to invest in, is based on its *risk-return* profile: preference is given to the asset that displays the highest expected return for a given level of risk (or vice versa), (28). Due to the conceptual similarity between investment selection and governance decision, we extend the Portfolio Theory criteria to the choice of BEST governance mode:

Conceptual Pillar 1: In Financial Portfolio Theory, *the two basic characteristics of an asset are expected returns and risk*. Similarly, in a BEST governance choice context we can affirm that *the most relevant characteristics of a governance mode can be defined by a specific profile of expected returns and associated risks*.

Figure 1 summarizes the dimensions used to conceptualize the risk and return concepts of a potential governance choice. The dotted line represents the risk-return profile of a hypothetical governance choice.



**Figure 1 The Risk-Return profile of a single governance choice**

In summary, using suggestions/prescriptions from RBV, TCE and ROR, we identify two dimensions for expected returns (exploration and exploitation) with four related modalities for achieving them (transaction costs, management costs, speed and timing) and two typologies of risks: endogenous and exogenous risk (see Fig.1, Phase 1). In the next paragraphs, the above dimensions are presented.

### 3.1.1 Expected Returns

In a governance choice perspective, expected returns can be considered as the benefits foreseen from engaging in a relationship. We define the nature of those expected benefits in the framework of innovative activities merging the insights gained from RBV, TCE and ROR. In the RBV framework, companies benefit from generating or acquiring technological knowledge and the value expected from partnerships derives from this knowledge exchange [54]. Depending if the companies aim at expanding existing knowledge or at expanding the use of the same knowledge over different applications, two broad technological scopes of inter-firm agreements can be identified based on the dichotomy proposed by March [55]: technology *exploration* (point A, in Figure 1) and technology *exploitation* (point B in Figure 1) [56, 57, 15]. Explorative partnering is aimed at “discovering new opportunities” while in exploitation inter-firm relationships are oriented to the maximization of the benefits deriving from “existing knowledge” (15). Radical innovations as those associated with “revolutionary changes in technology” and incremental innovations as “minor improvements in current technology” [58]. Exploration activities are associated with radical innovations while exploitation activities are mainly aimed at incremental innovations [59]. Consistently with the TCE approach, the expected returns are higher if the same objective can be reached at a lower cost. The rationale is that costs sharing with external partners can lead to the reduction of the overall costs of developing new technologies [60, 61,62]. Additionally, developing new products at lower cost increases the chance of acceptance in the market place [63]. The consideration of costs is at the essence of the TCE framework where the cost of the performing an activity determines the organizational governance of the activity - market, hierarchical or hybrid [64]. According to Calantone and Stanko [65], transaction costs (point D in the Figure 1) include three typologies of costs: adaptation, safeguarding and measurement costs. Adaptation costs are sustained when the contract has to be changed due to new circumstances (time-related changes in the relationship, in the corporate goals, strategic positioning, market and/or technology). Safeguarding costs are costs sustained to control opportunistic behavior from partners. Measurement costs are those related to control whether the goals of the relationship are met. In line with White and Lui [66], TCE can be complemented expanding the typology of costs to include those inherent to managing the relationship itself (*managing costs*) (point C in the Figure 1). Those costs can refer to activities related to alliance (cooperation costs) or to an acquisition (coordination costs) referring to the organizational expenses sustained for combining and integrating the resources provided by the entities involved in the relationship [66, 67]. All typologies of costs need to be considered as expenses associated with managing the external relationship can offset the initial benefits of cost sharing [68]. A recent work suggests, however, that cost considerations should be balanced versus time concerns [69]. Time considerations can be approached from two perspectives: a corporate and a market point of view. For the company, the urgency of the technological need determines the *speed* ( point F in the Figure 1) at which

exploitation and/or exploration needs to be reached. Companies that have a weak expertise in a technology that is expected to have a high competitive impact in the future may need to catch up [70]. Companies use, therefore, BEST forms to increase the speed of developing innovations [71] as being late can have costly consequences [72]. In technologically intensive sectors, an increasingly relevant form of competition is based on shortening the time to market in product development [73, 74]. From the market point of view, ROR approach suggests that, over time, new information becomes available about the potential benefits of new technologies or the feasibility of new applications and companies adjust their activities over time, at the rate this information becomes available [75, 76]. The timing (point E in the Figure 1) of exploitation/exploration depends, therefore, on adapting to changing situations, that is a typical behavior of flexible organizations [77].

### 3.1.2 Risks

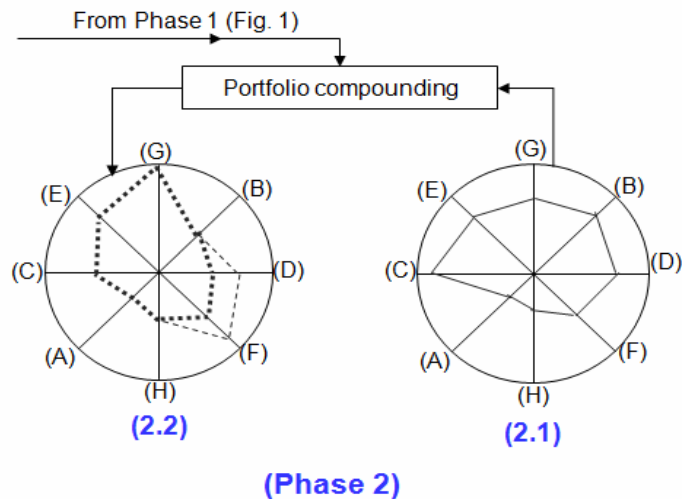
In financial portfolio theory, the precise quantification of an expected return is, however, not trivial. Expectations about returns can oscillate affected by a series of factors that influence the prospected outcome. How much an expected return can fluctuate depends on the level of the associated risk. The consideration that uncertainty affects investment decisions and governance choices is essentially a ROR approach [76]. From a governance choice point of view, the returns expected from partnering activities can fluctuate due to two types of uncertainties: *endogenous* and *exogenous* (33, 29), (see Figure 1 - Phase 1, points G and H). Endogenous uncertainty refers to the possibility of failure of the relationship. Exogenous uncertainty refers to the unknown evolution of technologies and of markets conditions. It increases proportionally to the level of technological newness and the novelty of the potential applications in the market. Both exploration and exploitation are affected by exogenous uncertainty. MacMillan and McGrath [78] have adopted a ROR perspective to categorize, in terms of market and technological uncertainty, the innovation options available to the companies. Technological options that preserve the position of the company in a technological area that is still unclear display high level of technological uncertainty but low or medium level of market uncertainty. When technological opportunities refer to unknown applications of a not yet developed technology they display high levels of technological and market uncertainty. The two above categories can be associated with the characteristics of exploration activities. Options that are aimed at expanding market opportunities, that have a more exploitative nature, display high levels of market uncertainty but lower levels of technological uncertainty as the technology is already known. The above considerations about the level of risk of exploration and exploitation are consistent with the literature on product and technology life cycle and diffusion [79, 80, 81, 82, 83, 84] where uncertainty is higher in exploration activities and in early stages of technological development, when both the technology and the potential application are still not well understood. Compared to the results of exploration activities, the outcome of exploitation is less insecure, temporally more close to the actions taken and more influenced by the experiences gained by the company [55].

### 3.2 The Portfolio perspective on BEST governance choices.

In a Portfolio Theory approach, the definition of the risk-return profile can not be performed in isolation.

Conceptual Pillar 2: In Financial Portfolio Theory, *the returns and risk of each single asset are influenced by the risk-return profile of all the other assets*. In a BEST governance choice context: *The risk-return profile of each governance mode is connected with, and depends on, the risk-return profile of all the other governance choices*.

The Figure 2 shows the risk-return profile of the existing portfolio without considering the new potential governance choice under valuation (2.1) and the new risk-return profile of the hypothetical governance choice altered by the interactions with other governance choices of the portfolio (the bold dotted line in 2.2).



**Figure 2 The Risk-Return profile of a governance choice with portfolio compounding**

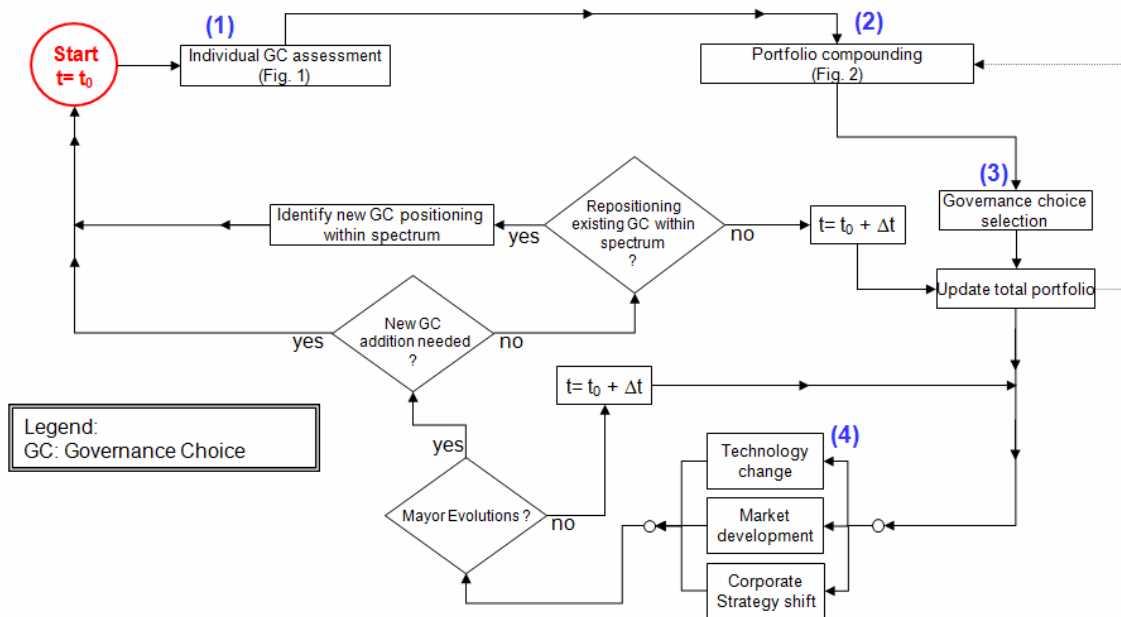
Despite the little attention attracted among scholars, the interactions of multiple relationships, their complementarities and synergistic effects are essential to understand innovation results [21]. In line with prescriptions from financial portfolio theory, those effects need, therefore, to be considered when deciding the governance mode.

The relationships, in which the company has engaged along the years, constituting the web of links, the portfolio, that interact and alter the risk-return profile of the governance decision. The consideration that the governance choice cannot be taken independently of the web of the firm's relationships is derived from the Network approach. In a network approach, firms interact with each other through one or several alliances [85]. Consistently with our continuum approach, we extend the reasoning also to include integrated forms of BEST, like M&As. Moreover, we focus on the interaction among the relationships with the same degree (among alliances, for example) and/or with different degrees of integration (among alliances and mergers).

In the context of the present work, these interactions can either reduce risk and/or increase returns. In a portfolio framework, risks and returns are altered by means of two mechanisms: diversification or synergy [19]. Adapting the definition of Wilcox Chang and Grover [86], diversification is obtained if a firm enters in diverse and unrelated relationships. Diversification has an effect mainly on spreading exogenous technology and market risks over different partnerships [19]. Mahnke and Overby [19] reported that between 1998 and 2003, Motorola entered in alliances supporting two different technological developments to reduce the risk of betting on the wrong one. Similarly, from 1999 until 2002, NTT DoCoMo entered in partnerships with different software vendors to spread the risk of low market acceptance for their new applications. Synergies are typically generated by links among firm's activities [87] and by the combination of complementary assets [88]. Previous alliances between Compaq, HP and Disney paved the way in 2000 for the infrastructure, marketing and distribution alliance between the Disney Internet Group and Compaq [19]. Similarly, the uncertainty surrounding an acquisition can be lowered by the existence of previous alliances with the same partner and by reciprocal knowledge reducing the overall risk of the governance choice. A recent study confirms that previous alliances with a target company increase the performance and the learning effect of the M&A [89]. Additionally, the benefit expected from an M&A can be higher because of synergies and complementarities generated by and with other existing alliances. In the acquisition of KLM by Air France, for example, the complementarities of the routes has played a significant role, KLM having a partnership with Northwest Airlines and Air France with Delta Airlines that allowed to cover the principal hubs of the North America market.

### **3.3 A Dynamic Portfolio approach and the governance choice: a decision system**

The overall decision system applying the portfolio theory into a dynamic process that leads to the governance decision is illustrated in Figure 3.



**Figure 3 Decision System on governance choice in a Dynamic Portfolio approach**

In Phase 1, the risk-return profile of a governance decision is defined. In Phase 2, the risk-return profile is approached from a portfolio perspective and altered by the interactions with the other BEST in the portfolio (2.2). By explicitly considering interactions and synergies among proposed governance choices and existing web of relationships, current governance decisions are a direct function of past governance choice decisions, and of the unique present corporate identity (technology and market positioning). The argument that the governance decision has to be integrated to the specific company's context is grounded on the concept of governance "inseparability" that suggests that past governance choices affect the nature and the typology of future governance decisions [90]. In a financial portfolio approach, once the risk return profile of a potential asset is defined, considering the potential interactions with other securities, the final choice about which investment to prefer can be taken. Building a parallel with the BEST governance choice context, we formulate the following:

Conceptual pillar 3: In Financial Portfolio Theory *the investors choose to invest in the asset that that, once introduced in the portfolio, provides the highest return for a given level of risk, to the overall portfolio*. Similarly, in a BEST governance choice context we can say that *the governance choice decision is aimed at portfolio optimization (that is, to select the governance mode that, interacting with other BEST choices, providing the highest return for a given level of risk and maximizes the risk-return profile of the entire portfolio)*.

The governance choice is selected (in Phase 3) balancing different risk-return profiles to select the governance choice that, when added to the portfolio, optimizes the risk return profile of the overall portfolio and that serves better the strategic orientation of the company (that is the ultimate interest that the portfolio serves).

In the words of Koza and Lewin [57] the corporate relationships co-evolve with the firm's strategy. Strategy can be defined as "the scope and direction of an organization over the long run" and deals with making choices for the future [91]. In this context, the current choice of a governance mode cannot be considered independently of the previous choices, the past evolution of those choices as well as of the strategic prospective orientation embraced by the company.

The approach presented in Figure 3 is dynamic as it unifies three time dimensions in the decision process, considering jointly the future-oriented corporate strategic orientation (Phase 4), the past decisions that led to the present portfolio (Phase 2.1) and the current characteristics of the company (Phase 1 and 2.2). The proposed approach is dynamic because it also recognizes the need for rebalances over time (Phase 4 in Figure 3) to account for the dynamic evolution in which the governance decision takes place. As indicated in Phase 4, after the governance decision is taken, the external conditions evolve over time simultaneously in terms of technology change, competitive and market conditions, corporate profile and strategic orientation. The need of a more dynamic approach arises from the consideration that the framework in which the governance decision takes place is fluid and dynamic as it



is constantly changing, affected by the evolution of the markets and technologies, by the development of the company's profile, competitive position and web of relationships. A rich body of literature from different disciplines confirms that technologies [92], innovation patterns [79,80,81], markets and competitive situation [93, 94], companies' capabilities [95, 96], and networks [97] change and evolve over time. Also the portfolio is evolving. By the passing of time, for example, some of the SAs will reach their termination altering the profile of the portfolio and calling for a rebalance through new governance decisions. Consequence of the time dynamics, the same company facing a new governance decision can opt for completely different decisions in two points in time. The process starts again entering in a circular loop that is continuously repeated.

#### **4 Discussion and Conclusions**

The present paper proposes to adopt a Dynamic Portfolio approach as a conceptual tool to support Business-to-business External Sources of Technology (BEST) governance decisions. In doing so the present paper contributes to both the literature and the managerial practice.

From the literature perspective, the three main constraints identified in previous works have been released. First, the lack of an integrated framework has been filled translating conceptual pillars into decision steps and designing a decision system for governance decision. Second, the interactions among governance decision, that did not attract the attention in previous works, have been accounted for considering how the mechanisms of synergy and diversification alter the risk-return profile of a governance choice. Third, in the proposed decision system, the governance decision is interpreted considering simultaneously different time dimensions and the effects of their evolution. Therefore, time dynamics have been put central.

The present work provides also a contribution to managerial practice. Firms can adopt the proposed decision system in order to face the decision of governance. In order to be able to assess the interactions among the new governance decision and the existing portfolio of BEST, a preliminary exercise has to be performed: companies have to classify the existing ensemble of BEST according to the dimensions of expected returns and risks. The result is a mapping of the firms' relationships that helps companies to look at their relationships in an integrated fashion. The decision system can be used then to support the firm to make the governance decision accounting for past, present and expected time effects. Moreover, by exploiting the dynamic nature of the model, the decision system can also be used by companies, after the initial choice, to rebalance their portfolio of BEST over time. It is worth noting that, in the proposed approach, the focus is not on identifying a governance choice with superior absolute qualities but on selecting the governance choice that contributes better to the portfolio over time. The governance decision should not be conceived as alternative choice but as an element in the dynamic balance of the portfolio.

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**Appendix Table 2 Criteria for governance mode and associated theories**

	<b>Resource based view</b>	<b>Transaction cost economics</b>	<b>Real options approach</b>	<b>Networking</b>
<b>Basic context</b>	Rare, valuable, imperfectly imitable and not substitutable resources (like technological knowledge) ensure competitive advantage. Companies need to balance the exploitation of existing resources and the development of new ones in order to assure firm's growth.	Individuals are boundedly rational (they act as rationally as possible according to the information they dispose) and opportunistic (they act to maximize their own profit). Information asymmetry affects decisions.	An option gives to the owner the right, but not the obligation, to take an action at a certain point in time in the future for a certain price/cost. As the decision to exercise the right can be postponed when more information is available or when risk is reduced, options guarantee the flexibility to adapt to changes in the business.	Companies should not be considered as independent actors but as a constituents/components of a larger and more complex structure, the network
<b>Main conditions for selecting technology sourcing governance modes</b>	<p><b>Acquisitions</b></p> <ul style="list-style-type: none"> <li>-If resources are core for the company</li> <li>-If synergies come from hard resources (like manufacturing plants).</li> <li>-If high levels of integration is required among the partners' activities (i.e. in case reciprocal synergies are needed, when resources necessitate to be generated by integrated activities of the two companies).</li> <li>-If technologies are initial phases of the life cycle (fluid or transitional)</li> <li>-If the content of the collaboration is very familiar to the company</li> <li>-If content of the collaboration can be clearly defined</li> </ul> <p><b>Alliances</b></p> <ul style="list-style-type: none"> <li>-If resources refer to mature technologies</li> <li>-If synergies come from soft resources (as human resources)</li> <li>-If low level of integration in partners' activities is required (i.e. in the case of modular synergies where resources are independently managed and then combined)</li> <li>-If content of the collaboration cannot be clearly defined</li> <li>-If the content of the collaboration is not familiar to the company</li> </ul> <p><b>Joint ventures</b></p> <ul style="list-style-type: none"> <li>-If desired resources are linked to undesired resources leading to problems of digestibility</li> <li>-If sequential synergies are needed (one firm completes its task and the partner continues with its task)</li> </ul>	<p><b>Acquisitions</b></p> <ul style="list-style-type: none"> <li>-If high time pressure</li> <li>-If low degree of cultural distance among partners</li> <li>-If high level of relative power/size of one partner over the other</li> <li>-If low appropriability regimes</li> <li>-If high levels of specificity of assets</li> <li>-In sectors with high needs of control (low-tech)</li> </ul> <p><b>Alliances</b></p> <ul style="list-style-type: none"> <li>-If low time pressure</li> <li>-If high degree of cultural distance among partners</li> <li>-If low level of relative power/size of one partner over the other</li> <li>-If high appropriability regimes</li> <li>-If low levels of specificity of assets</li> <li>-If high costs of integration with the target firm</li> <li>-In sectors with low needs of control (high-tech)</li> </ul>	<p><b>Acquisitions</b></p> <ul style="list-style-type: none"> <li>-If low level of endogenous uncertainty</li> <li>-If exogenous uncertainty is low/medium (mature technologies)</li> <li>-If learning about the value of the uncertain investment is endogenous (obtained within the governance)</li> </ul> <p><b>Alliances</b></p> <ul style="list-style-type: none"> <li>-If high need for flexibility</li> <li>-If high level of endogenous uncertainty</li> <li>-If high level of exogenous uncertainty (in the early phases of the technological development).</li> <li>-If learning about the value of the uncertain investment is exogenous (depend on factors external to the governance)</li> <li>-If longer project duration (higher uncertainty about the potential developments)</li> </ul>	<p><b>Acquisitions</b></p> <ul style="list-style-type: none"> <li>-If prior direct ties exist</li> <li>-If companies were previously positioned at the center of a network</li> <li>-If the relationship is intra-industry</li> </ul> <p><b>Alliances</b></p> <ul style="list-style-type: none"> <li>-If prior indirect ties exist</li> <li>-If relationship is inter-industry</li> <li>-If networks are vertical (relationships with suppliers and/or customers)</li> </ul>
<b>Unit of analysis</b>	The company	The transaction	The Transaction	The network
<b>Missing elements</b>	Risk, time as dynamic variable, synergies among relationships, nature of the transaction	Risk, time as dynamic variable, corporate identity, synergies	Time as dynamic variable, corporate resources involved, synergies	Risk, time as dynamic variable, corporate resources involved, synergies, nature of the transaction
<b>Main References</b> [10, 11, 102, 98 7, 29, 99, 51, 45, 5, 100, 76, 101 12, 13]				