

# Technology alliances and firm performance

Adão Carvalho\*

## ABSTRACT

This paper addresses the question of causality between technology alliances and firm performance and looks at the ability of firms to exploit the alliance outcomes. The study is based on the experience of 41 Portuguese manufacturing SMEs who participated in the EU-sponsored CRAFT (1994-98) programme. The findings provide considerable evidence to support the hypothesis that alliance success, measured here by the degree of firm's satisfaction, does not necessarily imply better firm performance. However, the latter normally requires at least the partial fulfilment of the alliance objectives. Firms have to have the capability to exploit the alliance outcomes and materialise the potential benefits generated together. The intermediate stage between the research period and the exploitation of results may involve a great deal of collaboration and require further actions not under the firm's control, thus involving a risk of failure. The results confirm the potential benefits firms can get with technology alliances, however more than 60% of all firms in the study did not have significant effect on performance.

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\* PhD research student, SPRU, University of Sussex, UK. ([a.a.n.carvalho@sussex.ac.uk](mailto:a.a.n.carvalho@sussex.ac.uk)) and Department of Economics, University of Évora, Portugal ([acarvalho@uevora.pt](mailto:acarvalho@uevora.pt)).

## **1. INTRODUCTION**

To what extent can firms turn technology alliances<sup>1</sup> into performance? The relatively recent profusion of technology alliances and the explicit interest of public policy-makers in promoting them, for instance the European Union (EU), are clear signs that cooperation must be a winning strategy. But, do such perceived competitive benefits for the economy and for the partner firms really materialise? The literature on alliances has benefited enormously from the contributions of an increasing number of interested researchers in the subject, yet the post-alliance phase is still very much an uncharted territory. Empirical research bridging technology alliances with firm performance, by focusing on the ability of firms to exploit the alliance outcomes, is scarce indeed.

The literature greatly emphasises the necessary conditions for the success of alliances<sup>2</sup> and satisfaction of partners, assuming that the attainment of both is the hardest obstacle for the successful exploitation of alliance outcomes. On the other hand, policy-makers believe that fomenting technology alliances and joining together firms, universities and research organisations is sufficient to strengthen the technological capability of firms and, consequently, enhance their performance. Apparently, neither of them takes into consideration or is fully aware of the risk of failure the post-alliance period involves. This paper addresses the causal relationship between technology alliances and firm performance and investigates to what extent the alliance success and partners' satisfaction are sufficient conditions for the successful exploitation of alliance outcomes.

## **2. PRIOR RESEARCH ON ALLIANCES AND FIRM PERFORMANCE**

Of the vast literature on inter-firm alliances, only a tiny fraction has analysed the consequences of alliances for the performance of the participating firms. An even smaller number of studies attempted to address the question of causality between the two. As a result, the perceived importance of alliances for firm performance is neither unequivocally supported by empirical studies given the different conclusions they have reached, nor is it

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<sup>1</sup> The notion of technology alliance follows the definitions of the Council on Competitiveness (1996) and Hagedoorn et al. (2000).

<sup>2</sup> However, the success of alliances is itself difficult to define (cf. Dodgson, 1993; Brockhoff and Teichert, 1995; Tidd et al., 1997; Dussauge and Garrette, 1999).

understood which factors are important for the unsuccessful exploitation of alliance outcomes. Probably the two hardest obstacles faced by researchers to assess the issue in greater detail are the logistical challenges of collecting the data (Gulati, 1998) and the accessibility of information, which is likely to be a critical constraint since few firms are available for an intense scrutiny of private and sensitive information. Table 1 is an attempt to categorise the different approaches taken by scholars to analyse the alliance-performance link<sup>3</sup>.

**Table 1** *Prior empirical studies on firm performance through alliances*

Category of studies	Examples of studies
Stock-market reaction to alliance formation announcement	McConnell and Nantell (1985); Woolridge and Snow (1990); Koh and Venkatraman (1991)
Likelihood of firm (business) survival	Singh and Mitchell (1996); Singh (1997); Tripsas (1997); De Meyer (1999)
Alliance intensity and firm performance	Berg, Duncan and Friedman (1982); Hagedoorn and Schakenraad (1994); Mowery, Oxley and Silverman (1996); Schmitz (1998); Benfratello and Sembenelli (2000); Stuart (2000)
Alliance outcome analysis	Beta (1993); BIE (1995); Rosenfeld (1996); Human and Provan (1997)

The first group of studies analysed the stock-market reaction to the announcement of joint ventures (JV) formation and found a positive impact on the stock market values of the parent firms around the time of the JV announcement. Despite the likely interest of such an association, one can hardly draw any strong conclusion about the relationship between alliances and firm performance, because all the studies examined the stock-market reaction to JV formation announcements instead of the outcomes of those corporate strategies, which would be more appropriate for that purpose. That these intended strategies may never become true or they may be modified during implementation (Woolridge and Snow, 1990) weakens any possible inference.

The second group of studies took firm (or business) survival as a proxy for firm performance and looked at the importance of firms' participation in alliances for the likelihood of their survival. Based on data of the U.S. hospital software industry, Singh and Mitchell (1996) analysed the risk of a firm becoming dependent when their partners shut

<sup>3</sup> See also Hagedoorn and Schakenraad (1994), Dussauge and Garrette (1995), Gulati (1998), Stuart (2000).

down or forming new partnerships, and Singh (1997) studied the impact of technological complexity on business survival and how alliances mediate this relationship. The former found that businesses become more likely to shut down following the dissolution of a partner if they do not add a new partner themselves or when their partners form collaborative relationships with new partners. The latter concluded that businesses with alliances had higher survival likelihood than businesses without alliances at each level of technological complexity. While Singh and Mitchell (1996: 112) found that “*the positive main effects of collaboration are consistent with the argument that collaboration provides substantial advantages*”, Singh's (1997: 360) results “*provide only partial support for the widely accepted proposition that collaboration improves the performance of the allied firms*”, leading Singh to believe that “*alliances are not necessarily valuable for all firms or in all circumstances. On the contrary, they may only be beneficial under relatively narrow circumstances.*” Tripsas (1997) examined the technological trajectories of three firms of the typesetter industry, aiming at understanding which factors make certain incumbents better than others at adopting radical technological change, and found that one of the relevant explanatory factors was the establishment of an external communication infrastructure to facilitate the transmission of external knowledge, including mechanisms such as strategic alliances and long-term supplier relationships. De Meyer (1999) analysed five small hi-tech companies and observed that “*in most cases these companies chose or were forced to engage in a technology partnership in order to develop or survive*”.

A third group of studies looked at the relationship between the alliance activity of firms and their economic performance (one or several performance indicators) often using statistical methods, but without establishing a clear cause-effect link between the two. Berg, Duncan and Friedman (1982)<sup>4</sup> found a negative relationship between joint venture incidence and firms' profitability in the chemical and mechanical engineering industries. They could not, however, establish the causal relationship between the two (Gulati, 1998: 309). Hagedoorn and Schakenraad (1994) investigated to what extent the intensity of firms' strategic technology partnering activities (i.e. the number of strategic links - dyads) affected their economic performance (i.e. net income to sales ratio or profit rate). They found no “*straightforward relations between strategic technology partnering and company*

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<sup>4</sup> Quoted in Hagedoorn and Schakenraad (1994) and Gulati (1998).

performance”, but “companies attracting technology through their alliances and companies concentrating on R&D cooperation have significantly higher rates of profit” (p. 300). For Brockhoff and Teichert (1995: 112), their results are not very convincing and they leave the question of causality unanswered. Schmitz (1998) looked at the relationship between firm performance and the intensity of cooperation in a footwear cluster industry. Using cooperation and performance indexes, Schmitz found a positive relation between the two and concluded that those firms that had improved cooperation had improved their performance more than those firms that did not. He stresses, however, that this is not evidence of a cause-effect relationship. Benfratello and Sembenelli (2000) tested whether participation in EU-sponsored research joint ventures (RJVs) had a positive impact on participating firms’ performance. They found that firms participating in EUREKA had a significant improvement in productivity and price cost margin, while firms participating in RJVs under the Framework Programmes did not show any significant change in performance.

Mowery, Oxley and Silverman (1996) examined how collaboration changed the relationship between a firm’s technological portfolio and those of its alliance partner(s), using the citation patterns in a firm’s patent portfolio as the assessment variable. They concluded that “*there is no consistently positive pattern of interfirm learning*” (p. 87) in their overall alliance sample. The type of alliance has an influence on the transfer of technology, joint ventures being the most effective. International alliances produce less interfirm exchange of technological capabilities and larger firms appear to absorb fewer capabilities from their alliance partners. Stuart’s (2000) study offers evidence to confirm the assumption that strategic alliances can improve firm performance. By analysing the patent rate and the sales growth rate, Stuart concluded that more important than the number of alliances a firm is involved with for the alliance-performance link are the partners’ attributes. “*Technology alliances with large and innovative partners improved baseline innovators and growth rates, but collaborations with small and technologically unsophisticated partners had an immaterial effect on performance*” (Stuart, 2000: 808).

The last group of studies differs from the others because the studies attempt to identify and assess the benefits of alliances for the participating firms, normally based on opinions rendered by participants, rather than making associations between alliances and firm

performance. Beta (1993) is the only study, to my knowledge, that attempted to quantify the benefits achieved by firms in currency units. The direct and most of the indirect benefits (i.e. whether or not they were related to the research project objectives) were expressed in terms of added value generated by sales or cost reductions. This was only partially successful because one-third of all effects identified by firms could not be measured and some of the measurement assumptions are questionable. Further, since the purpose of the Beta study was "*to assess only the economic effects for the participant*", everything was quantified in currency units and, as a result, other important information has been lost or hidden in the course of the quantification process. The BIE's (1995) study assessed the impact on performance (employment levels, turnover, profits, productivity, exports) and on competitiveness (technology, quality, price, customer service) of respondent firms to a mail questionnaire. Firms were invited to indicate how the "key" arrangement (i.e. the one firms believed to be their most important) has affected (in per cent) those indicators over the three years prior to the study. It found that "*cooperative arrangements can and do play an important role in improving the performance and competitiveness of Australian manufactures*" (p. 169). In general, the key cooperative arrangement provided improvements for the bulk of firms, regardless of industry, size, age, product type and so on.

In Rosenfeld's (1996) assessment of two network initiatives, the participant firms were asked to report changes in their business performance and the extent to which those changes could be attributed to cooperation. Most firms reported having had performance improvements, namely improvements in the domestic sales, but they did not credit all the changes to inter-firm collaboration. Human and Provan's (1997) approach is different because their main aim was to categorise the network outcomes based on what the small firms have achieved from network participation. They have identified four main categories of outcomes: inter-organisational exchanges, organisational credibility, access to resources and financial performance. Based on the SMEs' answers to a list of potential firm outcomes, they then assessed the percentage of SMEs that achieved each type of the listed benefits, concluding that the "*involvement in an SME manufacturing network can be advantageous for firms*" (p. 397).

### 3. RESEARCH QUESTION AND IMPLICATIONS

Prior research has thus generated different conclusions about the impact of alliances on firm performance, and the different nature of the studies further complicates the interpretation of this issue. This study focuses on the following question: *Do (successful) technology alliances cause better firm performance?* It addresses the issue of causality between technology alliances and firm performance, aiming at understanding the relevant factors linking the two. The attainment of technical success, here measured by the degree to which the objectives set out at the beginning are achieved, is an important barrier the alliance partners should overcome in order to expect economic benefits. The attainment of poor technical results represents a fundamental obstacle for partner firms to receive any impact on performance, unless unplanned benefits not related with the alliance objectives occur. There can however be expected a positive impact on the performance of the participating firms if the alliance objectives are fully met or at least a substantial part of them is attained. In other words, when the alliance's technical outcomes are sufficient for any practical use, it is expected that the partner firms will exploit such outcomes.

The above question has a number of implications attached which help to understand the complexity of that seemingly straightforward relationship. Those implications lead to a set of new questions for which this study will attempt to provide an answer.

*Does satisfaction with the alliance imply better firm performance?* Despite its importance, this question remains unanswered. One may assume that individual satisfaction with the alliance implies better firm performance, because from a firm's point of view the notion of success generally goes beyond the achievement of technical success and includes commercial success as well (Carvalho, 1996). However, it is important to understand the extent to which the individual satisfaction with the performance of alliances is related to the attainment of the alliance objectives and if it necessarily leads to better firm performance.

*To what extent can firms turn technology alliances into performance? What are the factors behind the unsuccessful exploitation of alliance outcomes?* The achievement of technical success represents a landmark for the successful exploitation of the alliance outcomes but it

does not eliminate the risk of failure in doing so. The ability of firms to turn alliance outcomes into performance is crucial but it is equally important to understand to what extent they depend on third parties or other factors to accomplish that.

*To what extent do the initial conditions and the alliance implementation process affect the alliance outcomes?* This question looks at the structural factors and implementation circumstances that may affect the alliance outcomes and, consequently, the expected impact on the performance of firms.

## **4. SAMPLE AND METHODS**

### **4.1 Sample**

The sample of firms for this study was selected from those who participated in the EU-sponsored cooperative research programme CRAFT II (1994-98), sub-programme “Industrial and materials technologies”. This programme was designed to enable groups of SMEs with no or inadequate R&D means of their own to engage third parties - so-called RTD performers (i.e. universities, research organisations, industrial companies) - with adequate R&D means to carry out research on their behalf to solve common or similar technical problems (EC, 1994). Only the alliances with Portuguese participants (firms) were selected since only they were to be contacted. Thus, the total population is about 105 technology alliances and a total of 755 partner firms, 153 of them being Portuguese. Of those, 67 firms (i.e. those firms whose projects were terminated or about to terminate) were contacted for an interview and 41 accepted, corresponding to 43 different project-firm groupings and 30 alliances. These manufacturing SMEs are from 13 non-hi-tech industrial sectors. All alliances lasted two years except two that lasted only eighteen months.

### **4.2 Methods**

The empirical data have been collected through face-to-face interviews, using a questionnaire, consisting of a set of structured questions, both open-ended and scored (Likert-type) questions, whose main purpose was to be used for guiding the interviews. It also guaranteed that all interviewees were asked this fundamental set of questions which

were thought to be important for this research project. The questionnaire was structured to capture information on alliances in a longitudinal fashion, from inception to impact on firm performance. It comprises four main sections, namely the “initial importance of the projects”, “structural factors”, “determinants of performance” and “indicators of performance”, and has been designed to take advantage of the interview for an in-depth analysis of the research projects and simultaneously collect structured information for comparative purposes and aggregate analysis.

All the interviews took place at the firms’ premises with top management staff or technical directors, between February and May 2000. There were two interviewees in seven interviews and just one interviewee in all the rest. The longest interview took more than three hours while the shortest one took just 45 minutes, the average duration of the interviews being around one hour and fifty minutes long. It was decided from the outset not to tape-record the interviews in order to create an informal atmosphere; instead, notes were taken and the answers written up immediately after the interview took place, using as much as possible the interviewee’s own expressions. Subsequently, the answers were sent back to the contact person for validation and further comments.

At the beginning of each interview, the interviewee was given a full copy of the questionnaire. This was a very important approach because (s)he had the opportunity to follow each question being asked and re-read it when necessary. It was especially important when the terms used were not familiar to the interviewee or the question was too long and could not be fully assimilated at once. Having a copy of the questionnaire was essential to the intended interaction and active participation of the interviewee in filling in the scored questions. Furthermore, it greatly facilitated the researcher’s control of the interview, namely in keeping it focused on its intended course after any respondent’s diversion into particular issues, and especially after additional questions to clarify a particular point or justify a given answer had been asked. The interaction with the respondents, who after each scoring were requested to justify their answer, has been extremely successful to understand the reasons behind the answers they gave, namely those concerning the Likert-type questions. This systematic data gathering process has broadened the understanding about the alliances and proved to be very useful to understand many results and possible paradoxes that otherwise could hardly be explained. The compromise between the

interview and questionnaire methods greatly benefited from the advantages of both and ended up as an important methodological contribution.

The cross-sectional analysis used in this study can be criticised in terms of its limitations to address an issue with implications over a period of time, but the design of the questionnaire, the interaction with the respondents and the systematic approach in collecting the data minimised considerably those limitations and greatly helped to capture change. This approach was chosen based on the balance of the existing trade-offs in applying the criteria of data accessibility, economy of resources, accuracy and relevance (Richardson, Dohrenwend and Klein, 1965). As a result, I am entirely confident of its adequacy to provide an answer for the matter under analysis, subject to the obvious limitations of the specificities of technology, space and time defined by the methodology.

### **4.3 Performance measurement**

In order to understand the alliance effect on firm performance, eight indicators of performance were selected, five of them conventional indicators (productivity, production costs, sales, profit and market share), and the remaining three non-financial indicators, which despite being increasingly more important to firms still lack any generalised measurement system (customer satisfaction, product/service quality and environment damage).<sup>5</sup> A ninth variable (overall) has been used to assess the general effect on firm performance as opposed to the assessment of the specific aspects given by the former indicators.

## **5. FINDINGS**

### **5.1 Overall assessment of alliance performance**

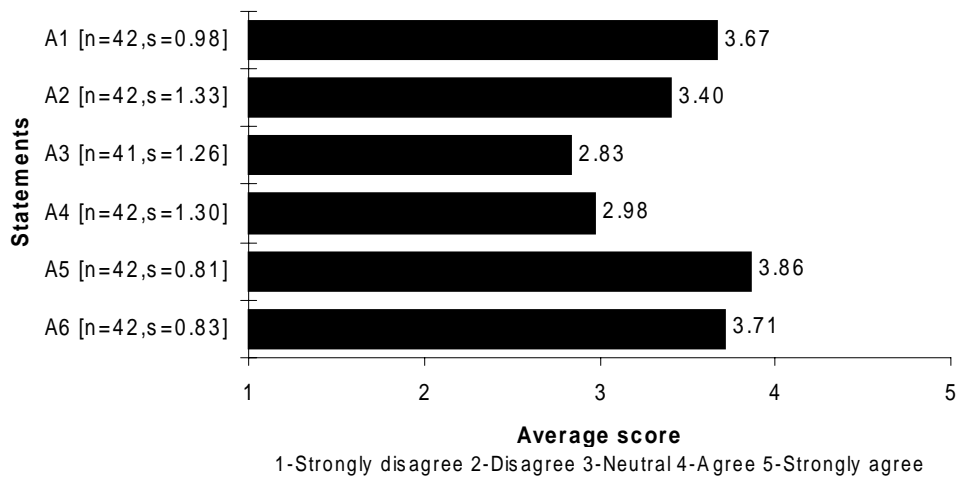
The executives were asked to assess six statements concerning the satisfaction with the alliance performance (A1, A2), the expected consequences for firms (A3, A4) and the intention in joining future alliances (A5, A6). The average scores are presented in Figure 1.

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<sup>5</sup> See for instance Eccles (1991) for a discussion of the performance indicators.

The results reflect a general satisfaction with the alliances, however some answers are conditional on the successful exploitation of alliance outcomes, which in many cases require the fulfilment of conditions not under the firm's control.

**Figure 1** Overall assessment of the performance of alliances



**Key:**

- A1 Overall we are satisfied with the performance of this alliance;
- A2 The alliance has realised the goals we set out to achieve;
- A3 Now we have a competitive advantage over our direct competitors;
- A4 This project has/will have a positive impact on the firm performance;
- The firm will certainly use interfirm cooperation on a more regular basis:
  - A5 if European Union funding is available;
  - A6 even without European Union funding;

**Notes:** (n) Number of observations. (s) Sample standard deviation.

**Source:** Interviews.

28 executives (67%) were satisfied or completely satisfied with the performance of the alliance (i.e. A1 = 4 or 5) and no one admitted to be totally unsatisfied with it. Only 23 executives (55%) agreed the alliance has achieved most or all the objectives set out initially (i.e. A2 = 4 or 5) and three others admitted that none of the objectives was achieved. Firm's satisfaction with the alliance normally requires the accomplishment of both technical and economic objectives. Executives would hardly classify as successful an alliance if the alliance outcomes could not be exploited. Interestingly, this "rule" was relaxed in three cases. Despite the achievement of technical success, three firms will not exploit the alliance outcomes due to changes in market conditions and loss of importance of the project in two cases, and a better technical solution was found meanwhile in the other case. These firms were nevertheless satisfied with the performance of the alliance.

There is a substantial and positive correlation between variables A1 and A2 ( $r = 0.782$ ), but there are other factors that explain the level of satisfaction with the alliance besides the fulfilment of its objectives. Apart from those firms that were not concerned about the common objectives, goal-achievement was the point of reference for the alliance performance assessment. Twelve executives rated higher their level of satisfaction with the alliance than the goals it achieved, and all the latter scores are equal to or lower than 3, meaning that the eleven alliances they represent did not achieve satisfactory results. This happened because the executives recognised the value of the know-how acquired and other direct benefits despite the low performance of the alliance. On the other hand, some indirect and unexpected benefits have been achieved. In favour is also the low cost of participation in the alliances, which was easily counter-balanced by the benefits in many cases.

As regards the consequences for firms, the relationship between the firm's level of satisfaction or the degree the objectives were attained and the expected impact on performance (A4) is not so strong;  $r = 0.531$  and  $r = 0.601$  respectively. Perhaps these results are not in harmony with what one would expect but some projects will not proceed to the following stages, others did not reach the objectives but partner firms got unexpected benefits, and some benefits are quite difficult to assess in terms of firm performance. There is however some kind of connection between these variables, given that only exceptionally was the expected impact on firm performance scored higher than the other two variables, suggesting that an expected impact on firm performance partially reflects the level of satisfaction with the performance of the alliance.

Not all projects were meant to generate a competitive advantage. Eleven executives said the projects were primarily aimed at resolving specific technical problems and any other advantage would be achieved only indirectly. In eight cases, the potential advantage would be temporary because imitation would be hardly possible to prevent, or there were plans to diffuse the new knowledge. Eventually five of those eleven firms mentioned above were able to strengthen their competitive position indeed; conversely, of those 24 firms expecting to get competitive benefits from the alliance, eleven were not able to do so.

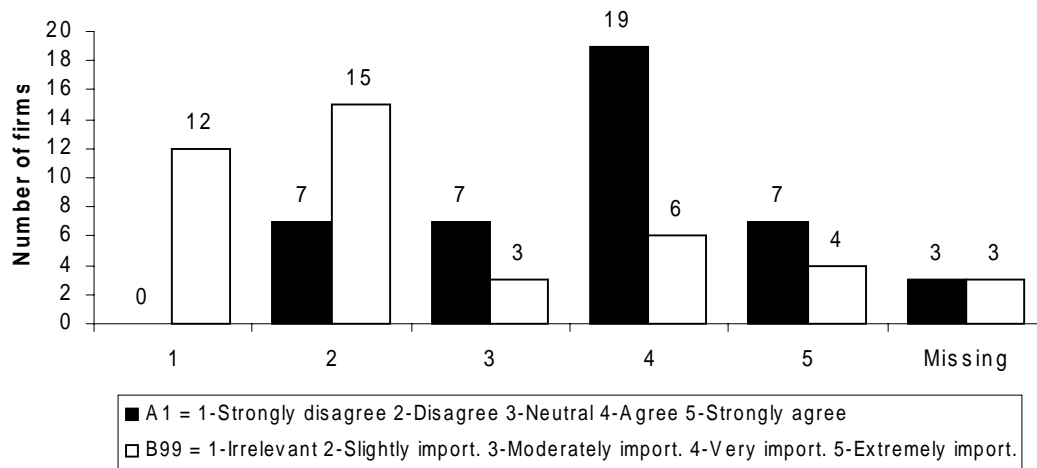
It is noticeable in Figure 1 there was a great deal of interest in participating in future

alliances. 34 executives (81%) affirmed their firms were interested in future alliances if EU funding is available and 29 others (69%) even without it. Despite the similarity of results (i.e. intention), these figures do not have a similar meaning because the latter has a number of restrictions attached. Generally, these are SMEs with scarce financial and research resources which constrain the size and sort of research projects they are able to carry out alone (or with RTD performers). To many executives the availability of EU funding is not a determinant condition to enter an alliance, the interest in the project being much more important. However the availability of funding substantially eases the decision-making process to enter an alliance and often reduces firms' demands on the quality of project and/or partners. Therefore, it is easy to understand the attractiveness of this kind of alliances because the potential benefits can easily exceed the costs. Without funding the interest in research alliances slightly decreases in general but the number and sort of restrictions to become a member increase considerably: the size and type of the project become more important and must be adjusted to the firm's availability of resources; the technical and financial aspects have to be carefully pondered; the quality of partners matters more.

## **5.2 Satisfaction with the alliance and impact on firm performance**

Does the firm's satisfaction with the alliance performance (A1) imply better overall firm performance (B99)? Figure 2 compares the answers to both variables. It shows these variables do not match and even suggests there is some contradiction between the two. While about two-thirds of all executives positively assessed the performance of alliances (i.e. A1 = 4 or 5) and none of them was completely unsatisfied with it, one gets quite the opposite picture reading the overall impact on firm performance, as two-thirds of the answers indicate that such impact is irrelevant or slightly important (i.e. B99 = 1 or 2). Only seven executives were not satisfied with the alliance but many more were expecting a small or no impact on performance. As we will see below, all the executives expecting a slightly important effect on performance were not able to convert it to a per cent variation.

**Figure 2** Alliance performance assessment vs. overall impact on firm performance



**Note:** Only (A1;B99) pairings were included in the analysis. If one of the variables is missing, both are considered as missing.

**Source:** Interviews.

In explaining the results, one may not rule out some inconsistency<sup>6</sup> between the answers since the two questions were asked in different contexts, but its explanatory power is likely to be minimal. There are several other explanatory factors in support of the hypothesis that alliance success, measured here by the degree of firm's satisfaction, does not necessarily imply better firm performance. Based on the answers of one-third of the executives who were satisfied with the alliance performance (A1 = 4 or 5) but reported no or small impact on firm performance (B99 = 1 or 2), four main factors support the above hypothesis:

Dependence on external factors. Alliances may have achieved technical success but the subsequent economic success depends on external conditions not under the firm's control; for instance, when the performance (or the use) of an improved component/system relies on the performance of the equipment where it is to be fitted. If the existing equipment is not able to take full advantage of the improved component or if the firms (customers) do not update their equipment, the commercial success of that improved component is unlikely to happen.

Dependence on internal factors. Firms lack the minimum size required to benefit fully from technically successful projects due to the economies of scale they involve.

<sup>6</sup> Indeed, there appears to exist some inconsistency because twelve executives affirmed that the overall impact on firm performance is irrelevant but fifteen others disagreed with the statement concerning a possible positive impact on firm performance.

Limited use. When alliances do not achieve technical success or only do so partially, some firms may nevertheless be satisfied with the progress achieved and the new knowledge acquired, even if it is insufficient to make changes on the production process or the results have a very limited application on products/production processes. The impact on firm performance is sometimes insignificant or just slightly important because the scope of some research projects is very small indeed and, therefore, the potential to induce change is rather limited. In both cases firms may get additional satisfaction with the alliances in the light of other benefits not directly connected with the objectives of the alliances.

Different objectives. Firms tend to be satisfied if their own objectives, normally different from those of the alliance, are attained. For instance, some firms used alliances as a means to confirm results of research carried out internally, to establish international contacts, to get experience in inter-firm cooperation, or just to participate in joint projects that include partners of their business area.

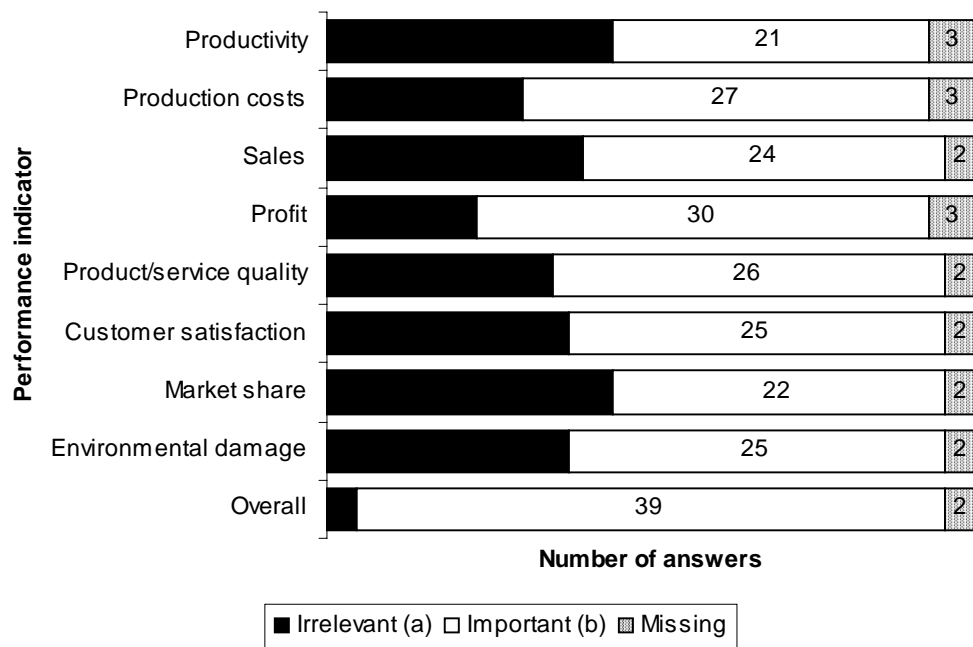
In assessing the success of a technology alliance through taking a partner firm's perspective, it is not just the collective technical achievements and the economic benefits directly arising from the use of the new knowledge that matter. The fulfilment of individual objectives and the attainment of unplanned (or indirect) benefits are important as well. The relative weight each success element has in the assessment equation differs from firm to firm, as does the reason for individual satisfaction. Being satisfied with the alliance outcomes does not necessarily mean that firms expect a positive impact on performance.

### **5.3 Expected vs. real impact on the performance indicators**

As expected, not all performance indicators in the list were pertinent to every research alliance or every firm at the beginning or at the end of the project; the performance indicators were relevant to each firm in specific combinations. The nature of projects is indicative of the type of performance indicators most likely to be affected but this is far from linear, and firms' specific characteristics and interests are certainly important factors to take into account as well. Figure 3 shows a straightforward classification for the expected impact on the performance indicators as initially perceived by the executives.

Two of them were not expecting any impact on the firm performance at all since the interest in the alliance's objectives was marginal.

**Figure 3** *Expected impact on the performance indicators*



**Notes:** Number of answers: (a) of category "1-Irrelevant"; (b) of categories "2-Slightly important", "3-Moderately important", "4-Very important" and "5-Extremely important".

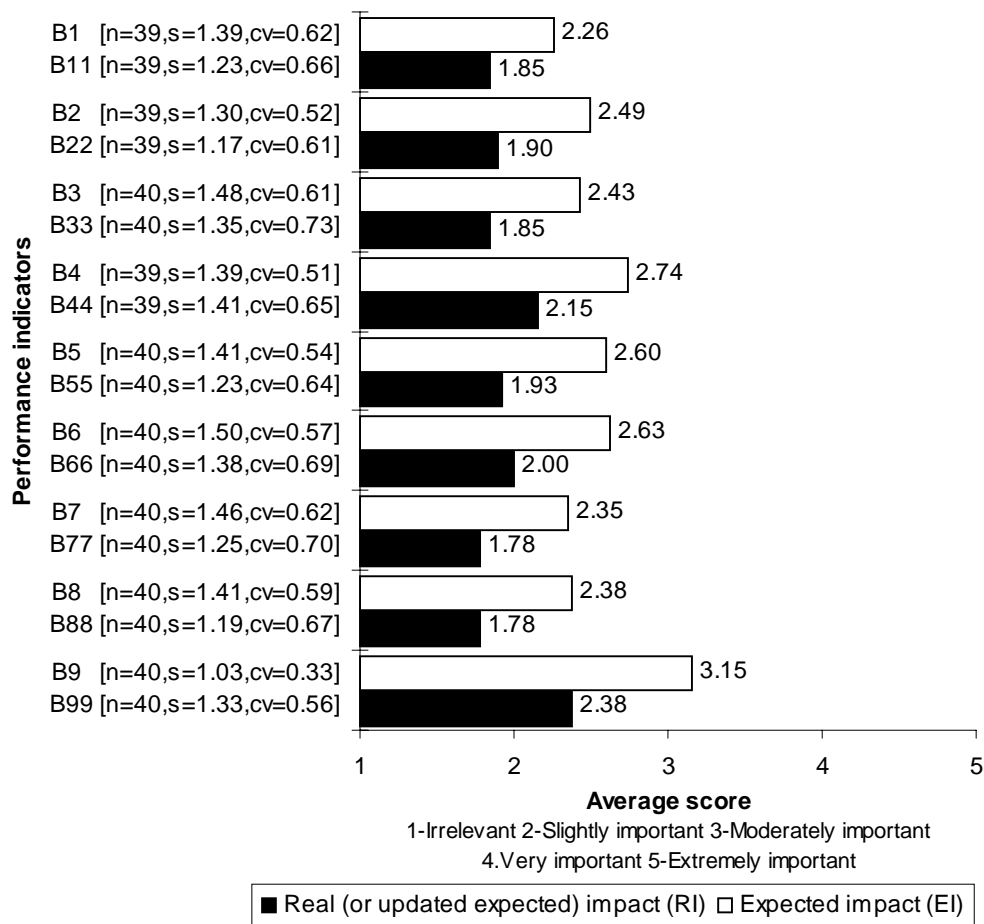
**Source:** Author.

Obtaining profit was the most common goal but in many cases it was the consequence of some expected impact on other indicator(s), such as an increase in productivity or reduction in the production costs. Generally, when the production costs and/or productivity were the intended goals, usually involving an innovation to the production process, firms were not much concerned about the indicators of “product quality” or “customer satisfaction”. If the latter was the case, namely when the project involved the development of new product, the former indicators of performance tended to be less important or not important at all. With the exception of those projects that aimed at reducing the environmental damage, typically to deal with environmental waste resulting from the production process, often this performance indicator has not been considered a goal in itself but something the project *also* has a positive impact on<sup>7</sup>.

<sup>7</sup> The results of a hierarchical cluster analysis indicate four clusters for the expected impact (EI) values: 1- sales, profit; 2- customer satisfaction, market share, product quality; 3- productivity, production costs; 4- environmental damage. For the real impact (RI) values, the results point to three clusters, with clusters 1 and 2 blended into a single cluster.

Figure 4 compares the average scores of variables “expected impact” (EI) and “real impact” (RI), which represent the executives’ expectation about the impact on the indicators of performance at the beginning and the end of the alliance<sup>8</sup>, respectively. The EI average values are relatively small mainly as the result of the high number of “irrelevant” observations as shown in Figure 3. The RI values are relatively more dispersed than those of the EI. For variables “overall” and ”profit”, the observations are effectively more dispersed than they were at the beginning of the alliances.

**Figure 4** *Impact on the performance indicators*



**Key:**

- |  |   |
|--|---|
| B1 [B11] Productivity (increase)           | B6 [B66] Customer satisfaction (improve)  |
| B2 [B22] Production costs (decrease)       | B7 [B77] Market share (increase)          |
| B3 [B33] Sales (increase)                  | B8 [B88] Environmental damage (reduction) |
| B4 [B44] Profit (increase)                 | B9 [B99] Overall (improve)                |
| B5 [B55] Product/Service quality (improve) |   |

<sup>8</sup> In several cases, the data on the "real impact" could not be collected at the time of the interview because the alliance outcomes were not being exploited yet. Thus, in such cases the collected information refers to the "updated expected impact" and not the "real impact" on the performance indicators as initially sought.

**Notes:** (n) Number of observations - only (EI,RI) groupings. (s) Sample standard deviation. (cv) Coefficient of variation (=s/mean).  
**Source:** Author.

Figure 4 clearly shows a substantial decrease in the average scores from the first period to the second period across the whole range of the performance indicators. Most important, it shows that the executives were able to distinguish both periods and assess the change in their expectations. Generally, the expectation of firms about the impact of the alliance on the performance indicators did not happen. As can be seen in Table 2, which presents the variation in the number of answers per category and per indicator between the two periods, every single category higher than two of every performance indicator registered a smaller number of answers in the latter period, denoting a downward adjustment in the executives' expectation. Conversely and consequently, the figures in column two represent the additional number of firms expecting an irrelevant impact on the performance indicators at the end of the alliances.

**Table 2** Net difference between the RI and EI number of answers

	1-Irrelevant	2-Slightly important	3-Moderately important	4-Very important	5-Extremely important	n
Productivity	5	1	-2	-3	-1	39
Production costs	9	-2	-1	-5	-1	39
Sales	8	1	-4	-4	-1	40
Profit	9	-1	-3	-4	-1	39
Product/service quality	8	2	-3	-5	-2	40
Customer satisfaction	7	3	-3	-6	-1	40
Market share	7	2	-3	-5	-1	40
Environmental damage	9	-1	-4	-1	-3	40
Overall	10	7	-13	-4	0	40

**Notes:** (n) Number of observations - only (EI,RI) groupings. For each performance indicator and each answer category, the net difference is the result of RI-EI.

**Source:** Author.

We shall now focus the attention on the overall impact on the performance of firms. According to Table 3, twenty Portuguese firms achieved a smaller impact on performance than that initially expected; these firms were partners in sixteen different projects, more than half of the research partnerships under analysis<sup>9</sup>. Fifteen executives reported that the

<sup>9</sup> In Table 3, the sum of the second row, 36, is higher than the number of alliances under analysis, which is 30. This is evidence that alliance outcomes do not have a similar importance to all the partner firms of a particular alliance. Indeed, there are several factors influencing the ability of firms to identify potential advantages and have access to them. As firms are naturally different from each other and with different sets of objectives, their ability to perceive and appropriate the alliance outcomes tend to be different as well.

results achieved basically correspond to what was previously foreseen, and only five admitted a positive variation in the amount of benefits expected.

**Table 3** Overall impact on the performance of firms: real vs. expected impact

	RI < EI	RI = EI	RI > EI	Missing
No. of firms satisfying the condition	20 (46.5%)	15 (34.9%)	5 (11.6%)	3 (7.0%)
No. of alliances these firms are from	16	13	4	3

Notes: (RI) Real impact. (EI) Expected impact.

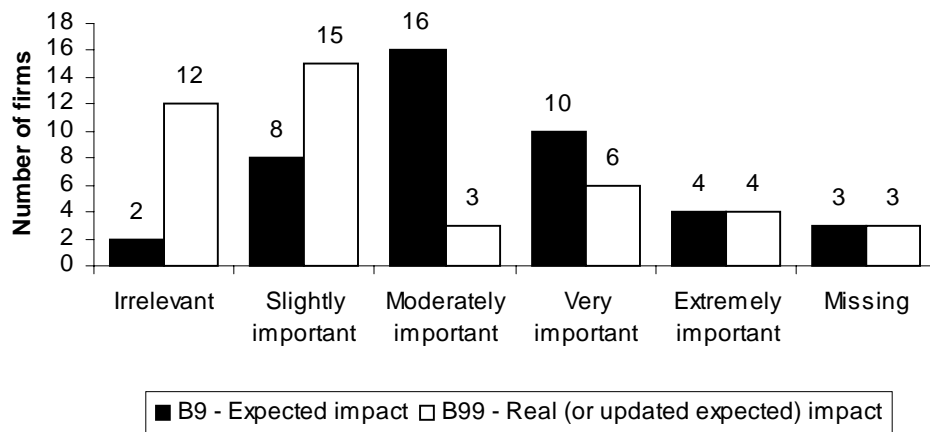
Source: Author.

Such a downward movement has a variety of causes. Several alliances ended up with poor technical results that do not permit any economic application of the new knowledge acquired; other alliances achieved interesting and useful technical results, however smaller than expected due to problems faced during the research activities or just because the technology under development reached its physical limit. Technology-related causes are common to about 60% of those 20 cases where  $RI < EI$ . In two other cases, despite the alliances' technical success, the small size of the firms impedes them from fully taking advantage of the potential benefits generated by the alliance. The dependence on external factors not under the firms' control, such as market conditions or the customers' decision on whether to get technologically updated, is a great obstacle to the ability of four firms to derive benefits from their alliances. Finally, one firm lost interest in the project in the course of its execution, and the EU cancelled another project.

In general, when the alliances achieved results comparable to the initial expectations, the executives scored variables RI and EI identically, but at least four out of these fifteen executives affirmed the alliance achieved only partially the goals set out at the beginning. Unplanned benefits in the course of the relationship or the fulfilment of particular objectives, sometimes the ones the firms were really concerned about, compensated for the not-so-good technical results achieved, leading these four firms to keep the same score, on different grounds though. Only five firms reported the real benefits surpassing the initial expectations, and two of them believe the impact on performance will be extremely important. This is the result of positive effects on some performance indicators that were not expected to change (e.g. productivity), better commercial benefits than expected, or achievement of indirect unplanned benefits.

Figure 5 looks at the category level variations between variables EI and RI. An important fact is the shift of about two-thirds of the observations from categories “very important” and “moderately important” to categories “slightly important” and “irrelevant”. The category “moderately important” lost thirteen observations, falling from the top to the bottom in terms of its relative importance. The overall real impact on performance is much smaller than what most of the firms expected it would be. For twelve of them that impact is expected to be irrelevant and for another fifteen is only slightly important. As demonstrated elsewhere, such small or no impact on firm performance does not necessarily mean alliance failure or dissatisfaction with the alliance outcome. Puzzling and perhaps inconsistent is the fact that those 12 executives who reported the real impact on performance as irrelevant also claimed having had some direct and indirect benefits<sup>10</sup> and expressed their belief that such benefits would have a positive effect on performance.

**Figure 5** *Expected and real impact on firm performance - breakdown of the answers by degree of importance*



Source: Interviews.

One possible explanation for that can be found by analysing the "method" used by several executives to score the overall impact on firm performance. They estimated the answer to the overall impact on the firm performance as a kind of an "average score" of the answers given to the previous performance indicators. Since the questions about the alliance's benefits and about the performance indicators were asked in different contexts it might have hindered the link that should have been established between the two. Presumably,

<sup>10</sup> Direct benefits are those benefits directly related with the project goals. Indirect benefits are those benefits that go beyond the project goals.

those twelve interviewees answered questions B9 and B99 without establishing such a link. However, the most likely explanation, as we will see below, lies in the difficulty felt by many executives to identify and quantify small intangible benefits.

#### 5.4 Impact on the performance indicators in percentage terms

Almost all executives were able to assess the impact on the performance indicators on a five-point importance scale. Would they be able to “translate” those scores into a more objective and comparable measure, for instance in percentages? Table 4 shows the results. The exercise has been only partially successful but the findings are meaningful. Of those executives expecting an overall positive impact on firm performance ( $B99 > 1$ ), only some of them were capable of giving an adequate answer and just one executive provided a full answer. The executives felt much less comfortable in providing answers for smaller expected impacts (i.e. when  $B99 = 2$  or  $3$ ), resulting in an unbalanced answer distribution. The nature of the alliances appears not to be an important factor to justify their inability in answering this question because the projects were very problem-solving orientated and the outcomes were to be exploited straight after the research phase. On the one hand, the executives did not provide data because the expected variation is rather small and the cause-effect link is very difficult to establish, thus impeding any attempt at accurately quantifying it. On the other hand, some of them admitted they simply did not know how important will be that effect, although in some cases not all elements were available for calculating it.

**Table 4** *Variation of the performance indicators in percentage*

Project No.	B99 scores	Performance indicators								
		C1	C2	C3	C4	C5	C6	C7	C8	C9
1	5	20	20	15	5	?	?	?		?
6	5			?	?	?	?	?	70	15
11	5	10	?	?	?	?	?	?	?	?
15	5	?	?	35	15	?	?	10	?	20
7	4	20	5	15	?	10	20	10		25
8	4	20	5	15	?	10	20	10		25
12	4	30	15	25	7.5	10	10	20	5	10
19	4	50	15	40	15	50	?	70		40
31	4			?	?	?	?	?		?
41	4	0	25		0.1	?			20	20
13	3	25	18	20	?	15				15
18	3		15		5	?	?	?	?	?

26	3									?
2	2		?		?				?	?
9	2			1	?		?		?	?
14	2		?						?	?
17	2			?						?
21	2	?	?		?	?	?		?	?
23	2	?	?		?				?	?
24	2	5	4	6	?	2	60	2	?	?
28	2					?	?		?	?
29	2									?
32	2	0.1	0.1	0.1	0.1	?	?	10	?	?
33	2		?		?					?
34	2									?
35	2	?				?	?	?		?
39	2	?	?							?
43	2	?	?	?	?	?	?	?	?	?
% of no responses		37.5	47.4	33.3	65.0	66.7	76.5	50.0	80.0	71.4

**Key:**

C1 Productivity

C4 Profit

C7 Market share

C2 Production costs

C5 Product/Service quality

C8 Environmental damage

C3 Sales

C6 Customer satisfaction

C9 Overall

**Notes:** The table includes only those observations for B99>1. (?) Answer not provided. (Blank cell) Answer not expected (because RI = 1).

**Source:** Interviews.

As regards the relative answer rate per performance indicator (bottom row in Table 4), the variables "environmental damage" and "customer satisfaction" got the lowest percentage of answers, both less than 25%, while the variables "productivity" and "sales" got the highest percentages, 66.3% and 62.5% respectively. These figures suggest that the assessment of the impact on the conventional performance indicators tends to be less complicated, perhaps because the non-financial indicators still lack an adequate and reliable measurement technique or these performance indicators are not systematically assessed yet.

The available data are perhaps insufficient for strong statistical inferences, but are sufficiently significant to realise the potential benefits firms can get by participating in a research alliance of the kind under analysis, if technically successful and the outcomes exploited. All the projects for which the executives were able to provide data on the overall impact on the firm performance (C9) involve important innovations, some of them about to be patented, which firms had no in-house expertise (and other resources) to carry them out alone. These firms achieved a competitive advantage with significant impact on their performance as the figures available indicate (in three cases the numbers are based on real achievements, not (updated) expectations). Unlike the research costs, the investment

necessary to exploit the alliance outcomes is often considerable.

## **5.5 Measurability of the performance variation**

Measuring the impact on firm performance is not always feasible or even possible. It depends on the type and amount of variation of the determinants of performance<sup>11</sup>. While there are some “inputs”, e.g. a new production equipment, that may have a relatively straight measurable impact on the performance indicators, other types of “inputs”, e.g. new knowledge about competitors, are not that simple to establish a cause-effect link with performance. The executives were able to identify a number of direct and indirect benefits achieved with the alliance and assess their impact on performance on a five-point importance scale but only a few of them were able to provide a more objective assessment, i.e. the variation of the performance indicators in percentages. All benefits are important to the performance of firms but it appears that the causes of the variations in performance cannot always be tracked down, given the difficulties in isolating cause-effect relations.

Many of the benefits achieved by the firms had a very small influence on the performance indicators and any attempt of measuring that impact was strongly discouraged by the opportunity costs involved. For instance, obtaining ideas from partner firms was one of the most common indirect benefits which many executives were prepared to detail, but only a few of them could assess this in terms of performance. There were small changes in the production process that could hardly be quantified. This is likely to be the main reason why all the executives reporting an overall impact on performance lower than “moderately important” were unable to quantify that variation in percentage terms. It looks as if there is a threshold in the variation of performance for which the quantification becomes relevant. All the figures provided by the executives for the overall impact on performance are no lower than 10%.

Another aspect concerning the measurement of performance is the relative difficulty of assessing different types of benefits. In general, the executives’ perception about the impact on performance of tangible inputs, such as equipment, facilities or products, is more

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<sup>11</sup> Determinants of performance are the direct and indirect benefits achieved by firms. They are inputs that are expected to produce an effect on the performance indicators (see also Anderson, 1990).

accurate than that of intangible inputs, such as improved image, enhanced visibility or experience on cooperation. Within the latter type of inputs, those directly related with the firm's production activity (e.g. new technology) tend to be better assessed than those of a more general nature (e.g. improving knowledge about competitors). The small expected consequences on performance and the difficulty of assessing intangible benefits are probably the explanation for the fact that 12 executives reported no expected impact on the firm performance but affirmed having had some direct and indirect benefits.

## **5.6 Ability of firms to exploit the alliance outcomes**

The ending of a technology alliance is not the end of the process it implies. At the end of the research period, partner firms normally have new knowledge and prototypes but they still need to have the capability to exploit the alliance outcomes and, de facto, materialise the potential benefits generated together. This intermediate stage between the research and the exploitation of results is very important, even crucial in some cases, and cannot be taken for granted because it involves the risk of failure. Such risk was not taken into account at the beginning of the relationships, and even at the end some firms seemed not to be fully aware of it. Depending on the specific characteristics of projects, this intermediate stage may involve a great deal of collaboration of part or all of the former partners. Some projects end naturally at the end of the research period, others require further actions such as building adequate facilities, scaling up prototypes, meeting market requirements, technical assistance in setting up the new capability and financial resources. Not all of these factors are under the firm's control.

There are a variety of factors influencing the ability of firms to exploit the alliance outcomes. These factors have been divided into three categories, each having a different prospect of turning the alliance outcomes into economic benefits:

“None”-type factors. To those firms included in this category, the possibility of achieving economic benefits is extremely low. This comprises 35% to 42% of all firms, depending on whether or not some of the firms falling into the other categories who expressed the intention of not exploring the alliance outcomes are excluded. The most important factor in this category is the poor technical results achieved by the alliance that do not permit an

immediate economic use of the new knowledge acquired. Also in this category are those firms who entered the alliance for other reasons than the project itself, and those who realised over its execution that the expected outcomes did not suit their interests. The EU cancelled one project and one firm participated in the alliance basically to confirm its own research findings, i.e. confirm the limitations of a specific production technology.

“Limited”-type factors. These factors somewhat impede firms from fully taking advantage of the alliance outcomes, or the technical results achieved are far behind the initial expectations, though they are positive and useful. 16% to 19% of all firms fall within this category (one firm decided not to exploit the alliance outcomes for now). It happens when firms' small size (in terms of production capacity) is an obstacle to the entire exploitation of the new technology, which may lead firms not to exploit it at all. In such circumstances there is a minimum size required for the new technology to be cost-effective. This category also includes those cases where the new technology only applies to a fraction of the firm's range of products or processes, and those cases the alliance outcomes were positive but lower than initially expected due to the technological complexity of the project or limitations of the technology. Two firms regarded this last aspect not necessarily as a bad thing because they are now technically prepared to explain to their customers the limits of the technology and suggest the best solutions available.

“Conditional”-type factors. To the firms included in this category, the attainment of economic benefits is normally postponed because it is dependent upon further actions to be taken either by the firm itself or by a third party or by both of them. It sometimes depends also on the evolution of the economic context in which firms do business. This category comprises 30% to 35% of all firms, with varying degrees of dependence and risk of failure. The range of factors in this category is very diversified, including: firms that have no sufficient means to acquire the novel equipment immediately; the decision to acquire the novel equipment depends on its cost-effectiveness (cost not known in some cases); the new (industrial) equipment, production system or product has yet to be produced and marketed by a third party, frequently a partner firm; a new specific plant has yet to be built or the firm's production facilities layout has to be modified; there are important logistic problems of collecting the raw material; the market conditions are different from expected in terms of raw material prices, production price, market size, etc; and firms need technical

assistance from the RTD performers or further research needs to be carried out. In many situations, the potential economic benefits and the time for having access to them are dependent on circumstances that basically escape the firm's control, hence increasing the risk of not achieving the intended objectives. The risk is not negligible, and frequently the firms in this category were not in a position to guarantee the successful exploitation of the alliance outcomes although they were optimistic.

The remaining group of firms, about 12%, successfully went through the intermediate stage and are now exploiting the alliance outcomes.

### **5.7 Firm performance and alliance conditions**

To understand the consequences of the research alliances on the performance of participating firms it is convenient to take into consideration the circumstances in which the research alliances were formed and implemented. There is no way of assuring the "best possible results" even when alliance partners follow religiously all the literature's "prescriptions" to avoid the many pitfalls of alliances, but failing to observe them increases the prospect of attaining worse results than expected. Retrospectively, one can identify several critical factors in the cooperation process that weakened the potential for achieving greater benefits, first jointly and then individually. These factors are presented below according to three dimensions: actors, alliance structure, and framework programme.

Actors. Most firms did not take full advantage of what was on offer, i.e. the possibility of having access to research resources at a low cost to set up a project to suit their interests. Instead, they accepted participating in projects structured by somebody else with little contribution on their part. This strategy has advantages because firms have access to structured projects they probably would not have enough knowledge or competence to structure by themselves, but its drawbacks may be quite substantial as well since firms cannot customise the research projects to entirely suit their needs and choose the partners (firms and RTD performers) to work with. By setting up their own projects, firms would likely to be much more committed and have more realistic expectations about the outcomes and the ability of exploiting them. This explains why only 12 firms considered the project

both urgent and very important, while 18 firms admitted the project was neither urgent nor much important.

The Portuguese firms would benefit from a more energetic participation in the alliance, however the lack of resources (know-how, personnel, financial) and experience in similar projects are possible explanations for them to accept smaller roles. That means they also accepted a smaller influence on the alliance. By accepting participating in someone else's projects, firms are normally accepting to work with unknown partners. Considering that only in a small number of cases were there preparatory meetings with all partners for the sake of discussing the project and getting to know each other, this is a risky game which some executives regretted.

The RTD performers were an important part of the whole process of cooperation, because the technical success of most projects chiefly relied on what they were capable of doing. The poor commitment and professional attitude of some of them eventually jeopardised the alliance outcomes and the ability of firms to achieve better benefits.

Alliance structure. The alliance structure is likely to have had influence on the alliance performance. Firms and RTD performers complement each other and getting them together for a research project is, in principle, advantageous. When there is a clear divide between technology users and technology producers, as happened in several alliances, the power within the alliance becomes very unbalanced and the interaction among partners quite poor. This is not immediately or necessarily a bad thing in itself if the objectives set out at the beginning are achieved, but when the control over the alliance is too unbalanced the risk of misbehaviour is high. Some firms felt powerless to deal with unexpected situations of RTD performers' misconduct. Poor interaction among alliance partners means the specific nature of alliances is being adulterated and the potential contribution of partners is not being maximised. As a result, the alliance outcomes may not reflect the joint capability.

In general, the research alliances had a relatively high number of partners, which is not necessarily a bad factor, namely when each partner contributes with something unique to the common undertaking, but it requires a better coordination effort and it is likely to increase substantially the transaction costs, especially when it involves partners from

several different countries. Despite one-third of all alliances under analysis having more than twelve partners, the number of partners has not been considered a major problem because the partners had very defined roles (some of them of marginal importance), and most projects were structured in a way that did not require intense interaction among the partners (Killing, 1988). Even so, some executives mentioned the logistic problems faced to arrange meetings suitable to everyone.

CRAFT programme. This research is primarily focused on firms and then on alliances, however, these are EU-sponsored technology alliances whose characteristics have influence on their structure, implementation conditions and the ability of firms to exploit the outcomes. Two important structural aspects come out. First, the CRAFT programme has characteristics resembling the old linear model of development and diffusion of technology. The implicit model, i.e. the model in which the alliances actually take place, provide evidence that points to the linear model, such as the divide between different types of partners, the stream of knowledge that is mainly (sometimes totally) unidirectional from technology producers to technology users, and the lack of de facto (genuine) interaction between all the alliance partners. Second, unlike the research investment, which is subsidised, the post-alliance investment necessary to reap the benefits is important and often represents a significant constraint for the participating firms. The low cost of participation in an international research project attracts SMEs and often relaxes their demands, but it may also represent a pitfall because they may not have adequate financial capability to exploit the alliance outcomes.

## **6. CONCLUSION AND POLICY IMPLICATIONS**

The paper discusses the importance of technology alliances for the participating firms' performance and uncovers the difficulties faced by firms to turn alliances into performance. The successful cases, though quite few, illustrate the potential benefits SMEs can achieve with the CRAFT model of partnering. If well adjusted to firms' needs and well implemented, these cooperative research projects can provide substantial benefits for the participating firms, provided the conditions to exploit the alliance outcomes can also be met.

There is considerable evidence to affirm that alliance success, measured here by the degree of firm's satisfaction, does not necessarily imply better firm performance. However, better firm performance normally requires at least the partial fulfilment of the alliance objectives. In general, the real impact of the alliance outcomes on the firms' performance indicators fell far behind the initial expectations, and for more than 60% of all firms the real impact is expected to be irrelevant or only slightly important. However, that does not necessarily mean alliance failure or dissatisfaction with the alliance outcomes. Of the firms reporting an overall impact on performance lower than “very important”, only one executive was able to “translate” that impact into a percentage variation, suggesting the effect on firm performance is hardly quantifiable below a certain level.

The ending of a technology alliance is not the end of the process it normally implies. After the research period, partners firms still have to have the capability to exploit the alliance outcomes and, de facto, materialise the potential benefits generated together. Depending on the specific characteristics of projects, this intermediate stage between the research period and the exploitation of results may involve a great deal of collaboration of former partners and may require further actions not under the firm's control. It involves the risk of failure. Such risk was not taken into account at the beginning of the relationships, and even at the end some firms seemed not to be fully aware of it, even knowing they were not in a position of guaranteeing the successful exploitation of the alliance outcomes. There are several factors with varying degrees of influence on the time and ability of firms for turning the research results into economic benefits, including poor technical results, indifference about the common purpose, small size of firms, cost-effectiveness of the new technology, unsuitable market conditions, and the new (industrial) equipment, production system or product has to be produced by a third party.

A number of structural factors explain a great deal of the low performance of many of the research alliances. Many firms were not demanding enough at two crucial periods of the cooperation process, namely the negotiation and project implementation stages. They accepted playing a minor role without any significant contribution, not only in structuring the project but in many cases also at the implementation stage, and did not seek a strong interaction among all the partners. Some RTD performers did not commit themselves professionally to the projects and others took advantage of their dominant position. The

CRAFT programme's implicit model allows a clear divide between technology producers and technology users and does not stimulate convincingly the interaction among all the partners. It contains characteristics resembling the linear model of development and transference of technology.

The results of this study are insufficient to claim their broad generalisation to all technology alliances but they shed light on an important issue deserving greater attention by scholars, policy-makers and alliance partners.

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## REFERENCES

- Anderson, Erin (1990), Two firms, one frontier: on assessing joint venture performance, *Sloan Management Review*, Winter, Vol. 31, No. 2, pp. 19-30.
- Benfratello, Luigi and Alessandro Sembenelli (2000), *Research joint ventures and firm performance*. Nota di Lavoro 13.2000. Milano: Fondazione Eni Enrico Mattei.
- Berg, S. V., J. Duncan and P. Friedman (1982), *Joint venture strategies and corporate innovation*. Cambridge, MA: Oelgeschlager, Gunn & Hain.
- Beta (Bureau d'Economie Theorique et Appliquée) (1993), *Economic evaluation of the effects of the Brite-Euram programmes on the European industry*, Final report for the Commission of the European Community DG XII. Strasbourg: Université Louis Pasteur.
- BIE (Bureau of Industry Economics) (1995), *Beyond the Firm: an assessment of business linkages and networks in Australia*, Research Report 67. Canberra: AGPS. (<http://www.pc.gov.au/icpubs/biepubs/research/rr67/>, 28.03.2001)
- Brockhoff, Klaus and Thorsten Teichert (1995), Cooperative R&D and partners' measures of success, *International Journal of Technology Management – Special issue on The Management of Technological Flows Across Industrial Boundaries*, Vol. 10, No. 1, pp. 111-123.
- Carvalho, Adão (1996), *Cooperação tecnológica entre empresas: motivações e factores de sucesso. Estudo de casos.*, Unpublished Master's Thesis. Lisboa: ISEG-UTL.
- Council on Competitiveness (1996), *Endless frontier, limited resources: U.S R&D policy for competitiveness*. Washington: Council on Competitiveness.
- Dodgson, Mark (1993), *Technological collaboration in industry: strategy, policy and internationalization in innovation*. London: Routledge.
- Dussauge, Pierre, and Bernard Garrette (1995), Determinants of success in international strategic alliances: evidence from the global aerospace industry, *Journal of International Business Studies*, Vol. 26, No. 3, pp. 505-530.
- Dussauge, Pierre, and Bernard Garrette (1999), *Cooperative strategies: competing successfully through strategic alliances*. Chichester: John Wiley.
- Eccles, Robert G. (1991), The performance manifesto, *Harvard Business Review*, Jan-Feb, pp. 131-137.

- European Commission (1994), *Technology stimulation measures for SMEs. Part II: cooperative research - CRAFT. Information Package*. Luxembourg: Office for Official Publications of the European Communities.
- Gulati, Ranjay (1998), Alliances and networks, *Strategic Management Journal*, Vol. 19, pp. 293-317.
- Hagedoorn, John and Jos Schakenraad (1994), The effect of strategic technology alliances on company performance, *Strategic Management Journal*, Vol. 15, pp. 291-309.
- Hagedoorn, John, Albert N. Link and Nicholas S. Vonortas (2000), Research partnerships, *Research Policy*, Vol. 29, pp. 567-586.
- Harrigan, Kathryn R. (1988), Strategic alliances and partner asymmetries, in Farok J. Contractor and Peter Lorange (eds.) *Cooperative strategies in international business*, pp. 205-226. New York: Lexington Books.
- Human, Sherrie E. and Keith G. Provan (1997), An emergent theory of structure and outcomes in small-firm strategic manufacturing networks, *Academy of Management Journal*, Vol. 40, No. 2, pp. 368-403.
- Killing, J. Peter (1988), Understanding alliances: the role of task and organizational complexity, in Farok J. Contractor and Peter Lorange (eds.) *Cooperative strategies in international business*, pp. 55-67. New York: Lexington Books.
- Koh, H. and N. Venkatraman (1991), Joint-venture formation and stock market reaction: an assessment in the information technology sector, *Academy of Management Journal*, Vol. 34, No. 4, pp. 869-892.
- Mowery, David C., Joanne E. Oxley and Brian S. Silverman (1996), Strategic alliances and interfirm knowledge transfer, *Strategic Management Journal*, Vol. 17 (Special issue), pp. 77-91.
- Richardson, Stephen A., Barbara S. Dohrenwend and David Klein (1965), *Interviewing. Its forms and functions*. London: Basic Books.
- Rosenfeld, Stuart A. (1996), Does cooperation enhance competitiveness? Assessing the impacts of inter-firm collaboration, *Research Policy*, Vol. 25, pp. 247-263.
- Schmitz, Herbert (1998), *Responding to global competitive pressure: local co-operation and upgrading in the Sinos Valley, Brazil*, Institute of Development Studies, Working Paper No. 82, University of Sussex, UK.

- Singh, Kulwant (1997), The impact of technological complexity and interfirm cooperation on business survival, *Academy of Management Journal*, Special issue on Special Research Forum on Alliances and Networks, Vol. 40, No. 2, pp. 339-367.
- Singh, Kulwant and Will Mitchell (1996), Precarious collaboration: business survival after partners shut down or form new partnerships, *Strategic Management Journal*, Vol. 17, pp. 99-115.
- Stuart, Toby E. (2000), Interorganizational alliances and the performance of firms: a study of growth and innovation rates in a high-technology industry, *Strategic Management Journal*, Vol. 21, pp. 791-811.
- Tidd, Joe, John Bessant and Keith Pavitt (1997), *Managing Innovation: integrating technological, market and organizational change*, Ch. 8; pp. 37-40; 362-363. Chichester: John Wiley.
- Tripsas, Mary (1997), Surviving radical technological change through dynamic capability: evidence from the typesetter industry, *Industrial and Corporate Change*, Vol. 6, No. 2, pp. 341-377.
- Woolridge, J. Randall and Charles C. Snow (1990), Stock market reaction to strategic investment decisions, *Strategic Management Journal*, Vol. 11, pp. 353-363.