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COOPERATION AGREEMENTS IN BIOTECHNOLOGY COMPANIES: AN ADVANTAGE FOR THE ACQUISITION OF NEW CAPABILITIES AND GROWTH?

Tomas Gabriel Bas*
*Professor and Research, Business School, Innovation and Technology Management;
Center of Innovation & Technology University Adolfo Ibañez

Research of World Bank and United Nations
Santiago, Chile.
Phone: (56 2) 369 3533
Fax: (56 2) 369 3576
tomas.bas@uai.cl

Abstract

Cooperation agreements in biotechnology allow us to observe the complexity surrounding alliances. The market globalization, the exorbitant costs of R&D and the rapid changes in technology, are arguably amongst the principal reasons that push companies to establish cooperation agreements. Biotechnology companies use this instrument to develop external features in the search for resources and missing expertise. This paper sets out to identify if such cooperation agreements in biotechnology companies are an advantage in themselves, sufficient for the acquisition of new capabilities and if they help the growth of these companies. For this approach, a private database of companies in the two most advanced countries in this sector: United States and United Kingdom, will be used.

Introduction

The chemical industry, considered as the first to have had a scientific base, constitutes a very heterogeneous sector. Molecular biology is complemented by the chemical industry in its steps towards the conquest of the molecular world. We could even say that the marriage of these two sciences, which formed the young biotechnology sector, is indivisible. In addition, the birth of the large multinational companies that work today in biotechnology is the result of companies that developed since the 1920s. They were restructured while being interested in the always-promising sectors of pharmacy and agrochemicals. These two sectors form oligopoly structures in an environment of very high competition. In these industries, the R&D department is the primary component of importance, and the costs to complete an innovating product are often very high. For example, it will necessarily take from ten to twelve years and 500 to 800 million US dollars, on average, for a new drug to be made available on the market, included in these figures are the opportunity costs of development (Sachwald, 1994; Drew, 1999; DiMasi, 2001).

This article has a double profile. The first one implies the ambiguity in reason of a complex causal structural industrial cooperation (asymmetric differences), while the second profile involves a small number of studies made on the relationship between cooperation agreements, advantages and performance (taken in the broad sense: profitability, but also growth, stability, etc).

First, the methodology and hypothesis used in this work will be described. Secondly, a literature review regarding the theoretical aspects and forms of cooperation agreements will be presented. Thirdly, the way in which these alliances

contribute to the strategic aims of the partners and the way biotechnology firms cooperate will be decribed. Finally, the article finishes showing the results obtained through this research and conclusions are drawn suggesting that alliances by itself do not explain nor justify the pace of growth of emerging biotechnology companies . Within this scenario, the question that we will try to answer is: Why biotechnology managers choose collaborations instead of other possibilities? In addition, we want to know, what are the advantages and the disadvantages that the managers can encounter while engaging in this mode of agreements (does this practice really increase the company's knowledge, open the door to intellectual property, make easier access to venture capital and ensure growth?).?

We created a database of 900 biotechnology companies (from more than 3500 biotechnology companies in the world) with and without alliances in the United States and United Kingdom. We selected these countries because they are the leaders in this sector, not only by the number of companies, but also by their quality. We will analyze if the biotechnology companies with cooperation agreements develop an advantage in the acquisition of new capabilities, in relation to social capital, intellectual property, venture capital and finally, in which sector they are more active (human health, agriculture, environment, etc.).

Methodology

We used secondary information to create an original and exclusive database of biotechnology companies from the United States and the United Kingdom for the period 1996-2001. SPSS statistical software was used to analyze the data for regressions and correlations. Because several growth promoters are involved in the success or failure of biotechnology companies, we used different dependent and independent variables. The dependent variable was the fast growth of the companies, which was measured by the increase of 50% or more in the number of employees during the period 1996 to 2001. We use the number of employees because we work with private and public companies. We cannot use the income data from private companies, because for private companies that information is not publicly availabe. The independent variables were treated in a metric approach (for example the age of the companies) or dichotomy form by yes/no (supply/absence of alliances). The variables were: the age of the company (variable metric calculated over a number of years since the foundation), area of exploitation, such a human health or agro/bio (dichotomy yes/no), patents (yes/no), venture capital (yes/no) and finally, alliances (yes/no).

These factors influence the behaviour of the companies at a point in time, such as now, and they show very different performances in an environment of similar characteristics. The literature shows that the companies do not have the same characteristics, nor the same competences or routines; the companies generate a variety of different capabilities, as if each one of them were equipped with limited rationality (Nelson and Winter, 1982). The companies do not have identical resources and they do not react in the same way either to same internal or external stimuli, which results in certain companies growing much more quickly than others (Azoulay and Weinstein, 2000). This complexity surrounding the various factors allowed us to construct our research assumptions.

The Hypothesis

Technological and commercial alliances between specialized biotechnology companies (SBC) and large companies (generally multinationals) are not sufficient to support the fast growth of the SBC. We assume that the cooperation by itself does not explain the fast growth or the acquisition of capabilities in biotechnology companies. Circumstances place the large companies and the SBC in a kind of constant interdependence in the search for expertise, resources and knowledge. This situation shows that cooperation is a route almost forced upon the SBC. Alliances can provide financial resources and complementary capabilities to the specialized companies in biotechnology (Hagedoorn and Schakenraad, 1994). These resources can be crystallized in activities like R&D, marketing, manufacture, distribution, protection and defence of the intellectual property as well as approval systems by national organizations (like the FDA in the United States). However, the SBC needs more than a simple cooperation agreement for growth. They need a virtuous circle with the interaction of all factors such as venture capital, intellectual property and knowledge.

The Theoretical Aspects

For several years, cooperation agreements between independent companies have not ceased to multiply, in order to start R&D programs, production scheduling or for the marketing of technological products (Lewis, 1990; Hagedoorn and Schakenraad, 1994; Combe, 1996; Gulati, 1998). The explanations, which we find in the literature, that justify the existence of such cooperation agreements, are numerous and sometimes ambiguous. Several authors simply say that economic globalization is partly responsible for the growth of cooperation between companies (Lewis, 1990; Hagedoorn, 1993; Policet and Noel, 1994; Yoshino and Rangan, 1995; Dussauge, and Garrette, 1995; 1999; Doz, 1996; Gulati, 1998; 1999). Also, this technological environment is in constant transformation and the speed of change is very fast (Pisano and Mang, 1993).

The term "cooperation", as Yoshino and Rangan (1995) and Ingham Mothe (2000) explain, generates very

heterogeneous realities. This concept is sometimes unclear, because it is employed to express all the contractual forms, such as joint ventures, consortia, licences, distribution and R&D agreements, etc. The definition of alliance and cooperation are relatively vague, but also rich and evolutionary (Bouayad, 1996). In fact, to define cooperation or alliance is a complex task. This is due to the ambiguity of the terms and the generic use made of these concepts that cover innumerable possibilities ("coalition", "partnership", "agreement", "cooperation between firms", "joint ventures", etc). Economic and management scholars have contributed partly to this confusion, from the great quantity of definitions and classifications that they have produced (Combe, 1995). In the same way, the concepts of cooperation or alliance are often ambivalent (Dussauge and Garrette, 1999). The expression "cooperation" relates to the relations established in a durable way to divide limited resources, without putting in jeopardy the autonomy of the partners. In addition, the duration of alliance, according to several authors, is more often of a strategic nature (Aliouat, 1996). Alliances are contractual, formal cooperation agreements, as opposed to the multiple informal forms of cooperation. The definitions that follow show the diversity of concepts. Combe (1995) defines alliance as an association of a formal or informal character, between two or several concurrent companies (or potentially competitors) or complementary, with or without financial participation. The allied companies try to rather develop, produce or market goods by sharing their competences rather than resorting to the commercial contract whose range is limited to the short term or total integration, marked by the disappearance of an entity. This concept coincides with that proposed by Jolly (1995). The author adds that the acquisition of unilateral grant of licenses, research under contract or total fusions are operations that escape to the alliance. For Gulati (1999) strategic alliances are voluntary cooperation agreements that imply exchanges, division or co-development and which can include contributions such as financing, technology or specific goods.

The growth of high technology companies, based on knowledge, plays a very important role in the development of the agreement. However, this role can be played in various ways. Either the companies choose internal development (independent), or they prefer external growth (hierarchical or cooperative). In this paper, we will focus on external growth, particularly the option of cooperation in high technology industry[1].

1Through the word "high technology", which is rather vague in its definition, we want to refer to biotechnology basically, but also to advanced materials and electronics. For more details to see OECD, codes CAB (http://www.oecd.org).

The alliance strategy can be useful, as Niosi (1994, 2003) explains, for limiting (and controlling) the growing costs of internal development (R&D) of high technology. In addition, alliance can help the partners to rise in the market hierarchy (Hagedoorn, 1995; Aliouat, 1996). However, Jacquemin and Remiche (1988) illustrate the difficulty in classifying technological alliances, because they are intermediate forms of organization between the hierarchies and the markets.

Knowledge shearing has a crucial role in cooperations (Badaracco, 1991). In such situations, each partner contributes with a part of his resources and competencies (technology, equipment, financing, know-how, etc). In response to this contribution, the partners will seek to benefit from the results, which can be shared, or not, in the intellectual property or any other forms of advantage considered in the agreement (Niosi, 1994). The knowledge, is created during the alliance (Badaracco, 1991, Inkpen, 1996, Doz, 1996, Doz and Hamel, 1998, Ingham and Mothe, 2000) as a result of the collective learning generated by the partners during the cooperation agreement. The more the agreement is long-term, dynamic and interactive, the more the possibilities of learning and accumulation of knowledge will increase for the partners.

The Alliance Management

Before approaching the modes of alliance management, it is interesting to note a series of recommendations being used for the development and negotiation of what Gaudin (1988) calls, a "reciprocal charter of rights and obligations" in cooperation. This critical charter can be used as the base for better negotiating the agreement. The charter should include program objectives; agreement duration; the implement choice; clarification of mutual interest; instruments of direction, execution and control of the agreement; rules or principles of exploitation and how to protect results; and finally, the liquidation of the cooperation agreement.

In taking into account these elements and stipulating the measurements and objectives most simply and clearly, the cooperation management agreement should obviously be facilitated (Killing, 1988). Thus, the strategies of a manager will depend on the partner objectives, the time of the alliance, the type of technology to be exploited and the market to be used. It would also be necessary to consider the characteristics of each manager, because there are not two managers who will react in an identical way when facing the same constraint (Nelson, 1994; Williams, 1994; Carroll, 1994). In addition, it is important to consider environmental uncertainty in management. This contingency can be caused by a request of technology, by the preferences of the customer, the actions of the

competitors, the governmental policies, and the suppliers' capabilities, but also by the potential partners.

How partners are organized to work with each other, is one of the keys for successful cooperation, (Loranger and Roos, 1992). A manager that is a skilful alliance manager is able to face the problems and to overcome the difficulties more easily. We refer here to the difficulties of the social environment (language, culture), the other partners, and legal framework (Yoshino and Rangan, 1995). However, it is necessary that the objectives of the allies are as complementary and explicit as possible. It is essential also to establish a joint data carrier and that the process is as interactive as possible (Lorange and Roos, 1992). Thus, the alliance success will depend of the experience, quality, and the manager's talent (Woiceshyn and Hartel, 1996).

The alliance management is not an easy task given the multiplicity of the constraints that they produce. Managers must compose, within the existing legislation, the structures of the market in which the alliance evolves or with the existing capacities of communication (AECEC, 1992). The size of the partners (asymmetric influence) is another characteristic that should be considered because the input met by the multinational corporation in alliances should not be necessarily the same that of an SBC. In addition, the modes of alliance management will change according to whether they are national or international, high-tech or mature technology, formal or informal, as much as their goals, sometimes which present divergent characteristics (Niosi, 1994). In fact, the modes of alliance management should normally be specific to the culture of the companies that begin in the cooperation. Moreover, in any agreement, it will be necessary also to consider the management of the intellectual property that will result from this cooperation agreement (Lerner and Merges, 1997). Another important point is the degree of opportunism shown by one or both partners expressed during the cooperation agreement (Axelrod, 1984).

The cooperation agreement is a learning organization and represents a source of know-how advantage that depends on the basic intangible knowledge of its members (Moingeon and Ramanantsoa, 1995; Nonaka et al., 1996). Thus, learning is the only way to survive within cooperation, but also to obtain a differential growth. The organizational learning takes place in a process of social interaction through which an accumulation of knowledge occurs (organizational or not), which can contain knowledge or know-how (Ingham and Mothe, 2000). Knowledge is an abstract concept, which is built consciously or unconsciously by the interpretation of a group of information acquired through experience and meditation in the practice, which could give to its owner a mental and/or physical skill in its art (Albino et al., 1999). These authors argue that, from a structural point of view, knowledge is build by the information produced by the persons within the organizations. In their turn, the organizations are used as support or, they offer the context so that the process of knowledge founding takes place thanks to the interaction of the community. The creation of knowledge must thus be a construction in constant interaction (Nonaka et al., 1996). This opinion is divided by Inkpen (1996) who argues that the generation of new knowledge is based on the capabilities of transformation deployed by the managers. They are responsible for setting up the conditions of change necessary for the absorption or the assimilation of all new knowledge. This assimilation represents a process of learning accumulation of their individual skills, as well as the routines belonging to each organization are made profitable by the cooperative project (Albino et al., 1999).

The Alliances of Biotechnology companies

Biotechnology is a technological process founded on knowledge and can be defined as the application of science and engineering to the methods, processes and techniques (referred to as recombination of the DNA to, and/or within biological systems. This definition includes recombination of the DNA, cellular fusion and its related techniques, as well as the advanced techniques like the bioprocess engineering. All these techniques applied directly or indirectly to micro organisms, humans, animal or vegetable cells or parts of these, can facilitate the development and produce new molecules and cells, new organisms and procedures to improve in an innovative way those which already exist. In this context, university researchers (molecular biologists, medical doctors, as well as genetic and chemical engineers) dominate the general concepts surrounding molecular biology. However, these same scientists have neither the skills of management to organize companies, nor financing skill to market their products and this is why they are often constrained to search the partners for a cooperation agreement (Powell et al., 1996).

The approach between the specialized biotechnology companies and the large companies begin usually with a research contract, information exchange or simply consultation. Then, if the circumstances are favourable, the companies will be able to think of constituting partnerships that are much more formal. These alliances are often cemented, partly through to the support of governments. Being given the importance attached to biotechnology, the governments of the industrialized countries encourage universities and their researchers to patent and market the know-how of their products (OECD, 1987).

Alliances in biotechnology are different from alliances in other technologies. For example, biotechnology is unable to produce prototypes; it must, contrary to the other sectors, face the uncertainty of living organisms, with the ethics and the danger of environmental contamination. The product

development in biotechnology is generally longer, more complex, and with higher uncertainty, and in the case of products regarding human lealth, pre-clinical and clinical phases need to be taken into account. We can consider quasi-immediate outputs from others high-tech products like software, contrary to the biotechnology, whose return on the investments requires several years (Woiceshyn and Hartel, 1996). The legal aspect of biotechnology processes is expensive, complex and slow, contrary to technology information for example (Powell et al., 1996). Thus, uncertainty related to the market is omnipresent.

The objective of strategic alliances between the large companies (generally pharmaceutical) and the specialized biotechnology companies (SBC), is to obtain an advantage for the acquisition of new capabilities, which are very expensive or impossible to obtain inside, or which would take too much time to reproduce inside the company. There is a kind of information exchange (Botkin and Matthews, 1995) that is possible only if each company agrees to lose a certain degree of autonomy. Thus, the SBC will lose a few advantages, especially at the decisional level, in order to gain other advantages. These advantages can be represented in the SBC by the access to financing, laboratory equipments, large international markets, or by the admission to certain markets whose cultural barriers are difficult to cross, as can be the case of Japan or China (Barley et al., 1992).

Biotechnology Cooperation Agreements

The high costs of biotechnology R&D, the long duration of clinical trials, as well as the expenditure of marketing and product commercialization, exceed the financial possibilities of the small-specialized biotechnology companies. To fill this gap, these companies must sign agreements of cooperation with large companies. These alliances not only provide new sources of financing for the R&D, but they also make possible the participation of various team members to diversify and reduce uncertainties inherent to the development of new products.

In general, cooperation agreements between small and large companies materialize to combine complementary competences and resources. In this direction, the gaps of the small companies are related to industrial R&D, manufacturing, marketing, obtaining patents and accelerate the governmental approval of products (Baum et al., 2000; Statistics Canada, 2000; Bas and Niosi, 2006). The pharmaceutical companies research new innovating products to fill their pipeline. The sectors where the large companies take part in agreements with smaller companies are often the pharmaceutical, agro/bio, and chemical sector (Shan et al., 1994).

Generally, the SBC will establish alliances with:

- *Multinationals Pharmaceuticals Companies*: By the experience, the potential to increase the probability to patent and exportation, the financial capacity, the distribution networks, and the skill in R&D.
- *Universities*: By the intellectual capital and the equipment of laboratories.
- *Governmental laboratories*: By the high capabilities in R&D and financials contacts.

Forrest and Martin (1992) analyze also the principal reasons that lead the companies to establish cooperation agreements in biotechnology. According to these authors, the allies seek mainly:

- The possibility of fast technology exploitation;
- The medium-term incomes generation;
- The risk and uncertainties partition in the new products development;
- The access to the financing, otherwise very difficult;
- Credibility;
- Expertise in R&D, which the partner has.

The large companies often looking for agreement with SBC, when certain competences are dificult to obtain in the large corporations, and the goal is to increase the number of products in their pipeline (Forrest and Martin, 1992). In addition, many competences (in particular in biology, genetics, and proteomic) of the large companies do not exist in the small ones. The large companies thus prefer to join the small ones, rather than with other great multinationals (Martin and Forrest, 1994) in order to preserve their options on new technology.

For a few years, biotechnology has been one of the high-tech sectors having one of the fastest growth in the world. According to a study published in 2000 by Industry Canada, this expansion was four times more quickly than the average of the economy in general. The fast growth of the biotechnology companies has been very high, but on the other hand, it is limited to a very restricted number of companies (Niosi and Bas, 2001; Bas and Niosi, 2006). Small companies (80% of total) compose the biotechnology sector and usually they are very young (less of ten years) (Industry Canada, 2000). Moreover, the companies of this size are very innovating (Stephan and Everhart, 1998; Audretsch, 2001) and generally well equipped with intellectual resources. The theory of the resources of the company and the theory of the competences postulate that the internal capabilities have a direct effect on the growth of the companies (Penrose, 1959; Hamel and Prahalad, 1993; Foss, 1997; 2000).

Results

We evaluate the dimension and the dynamics of this technology and we have a good description of the stakes with the biotechnology companies are confronted in general. Table 1 and Table 2 present a brief summary of current biotechnology situation for the principal countries working in this sector. The first table shows how the United States dominates largely all plans. First, their prevalence appears by the number of biotechnology companies, bench at 1,457 companies, follow-up far by the United Kingdom with 395 companies and Canada with 391. Germany arrives in fourth place with 365 companies, but that is due to the youth and very small size of its companies. With regard to the public companies (quoted on the stock exchange), once again the United States is at the lead, with 339 companies; Canada occupies this time the second place with 89 companies and the United Kingdom is third with 48 companies. In addition the United States biotechnology companies dominate largely over the incomes plan, with 31,749 million US$, followed by far by the United Kingdom with 3,323 million US$ and Canada by 2,893 million US$. In addition, the reduced number of companies of other countries, the income achieve by there is more limited. This table clearly shows the uncontested leadership of the United States, follow-up by the United Kingdom and Canada. These three countries dominate jointly, with Germany that appears on the horizon like the fourth future world force.

Table 1: The State of the Biotechnology in the World in 2002 (the incomes are in millions US$)

	USA	UK	Canada	Germany	France	Japan
Incomes from Biotechnology	31,749	3,323	2,893	1,190	859	N/A
Number of Public companies	339	48	89	20	8	2
Number of Private companies	1,118	347	302	N/A	N/A	N/A
Total Number of companies	1,457	395	391	365	240	271

Source : Statistics Canada (2003)

Table 2 shows a particularity, because 70% of the Canadian SBC belongs to the human health sector, whereas this number is 56% in USA and 50% in UK. These statistics illustrate the human health like the more represented segment compares to another sector like agro/bio or environment. As explained previously, cooperation agreement between SBC and large pharmaceutical companies can play an important role for benefiting the human health in detriment of another biotechnology sectors. Also, the lack of ethical problems or public approval, as it is the case of agro/bio in Europe, plays an outstanding role. Another interesting element to emphasize is the numbers of revenues generated by the SBC, those that are dominated by the USA with 31,000 millions US$ followed by UK with 3,300 millions US$ and Canada with 2,800 millions US$. The expenses in R&D show the interest of these countries to this particular technology. The model shows the USA like a comfortable leader in R&D investment with 15,700 million US$, followed far behind by UK with 2,000 million US$ and Canada with 1,000 million US$. Another key factor when we considered the development of the biotechnology companies is the Venture Capital, whose investment is dominated once again by the USA with 1,330 million US$, followed by UK with 564 million US$ and Canada with 488 million US$.

Table 2: The Specialized Biotechnology companies (SBC) in the USA, Canada and U-K in 2000-2001

	USA	Canada	UK
SBC in Human Health (%)	56%	70%	50%
SBC Total Revenues (mill. US$)	31,000 mill. US$	2,800 mill. US$	3,300 mill. US$
SBC Total R&D Expenditures	15,700 mill. US$	1,000 mill. US$	2,000 mill. US$
Venture Capital Invested in SBC	1,330 mill. US$	488 mill. US$	564 mill. US$

Sources: KPMG; BIO.org; Ernst &Young; British Information Services.

United States Correlation and Logistical Regression

Starting from data obtained of the random sample, we proceeded to make a linear correlation (Pearson) (Table 3). The correlations show multi co-linearity between particular variables like venture capital, patents, human health sector and alliances. This fact is simple to explain, because companies that establish alliances, obtained patent from their inventions, operate in human health sector, and obtained venture capital, are those that presented a fast growth. However, they are strongly correlated and we are in presence of multi co-linearity. This phenomenon appears in the correlations between the variables venture capital and patents, with a correlation of 0.363; the variables alliances and patents have a correlation of 0.363; alliances and human health present a correlation of 0.423 and finally, between the variables alliances and venture capital the correlation is 0.344. Considering this very strong co linearity, we must choose a variable that best explains both the fast growth of the companies and their stagnation. The venture capital showed the best estimate to explain the fast growth of the companies, with a correlation of 0.445, whereas the alliances shown the meagre estimation with 0.109 i.e. Americans companies which had access to the venture capital more often presented a stronger growth in comparison with those whose access to this type of financing was restricted or null. In addition, as presented in Table 3, most of the companies can see return in a kind of "growth virtuous circle". The companies belonging to this circle are: in human health sector, have patents in America , obtained venture capital, and have established long-term alliances with industrial partners.

Table 4 show the impact and the importance to be involved in others areas rather than human health, because other sectors were in stagnation or at best, had a very slow growth. Thus, our logistic regression cannot explain large growth and stagnation by only one variable, alliance (60.9%). To obtain better results is necessary to employ other independent variables (venture capital, patents and human health) in interrelation.

Table 3 United States Correlation

		VD Fast Growth	Patents	Human Health	Alliances	Venture Capital	Age
VD Fast Growth	Pearson Sig. (2-tails) N	1 . 137					
Patents	Pearson Sig. (2-tails) N	.168 .050 137	1 . 137				
Human Health	Pearson Sig. (2-tails) N	.330** .000 137	.242** .004 137	1 . 137			
Alliances	Pearson Sig. (2-tails) N	.109 .203 137	.363** .000 137	.423** .000 137	1 . 137		
Venture Capital	Pearson Sig. (2-tails) N	**.445**** .000 137	.363** .000 137	.242* .004 137	.344** .000 137	1 . 137	
Age	Pearson Sig. (2-tails) N	-.298** .000 137	-.164 .056 137	-.269** .001 137	-.087 .309 137	-.125 .145 137	1 . 137

**The correlation is significant at 0.01 and we have a multi co linearity with the variables.

*The correlation is significant at 0.05

Table 4 Logistical Regression of US companies with the independent variable: Alliance

Case in study = 137. Dependant Variable : **Fast Growth** (Yes/No)
Independent Variable : **Alliance** (Yes/No)

Omnibus test of model

	Chi-square	df	Sig.
Step 1	1.641	1	.200
Block	1.641	1	.200
Model	1.641	1	.200

Model Summary

Step	-2 Log likehood	Cox & Snell R-square	Nagelkerke R-square
1	188.274	.012	.016

Classification table

Observed		VD Fast Growth		Percentage Correct
		1 (No)	2 (Yes)	
Step 1 VD Growth	1 (No)	34	34	50.0
	2 (Yes)	27	42	**60.9**
Overall Percentage				55.5

Variables in the equation

	B	S.E.	Wald	Df	Sig	Exp. (b)
Alliance	.442	.346	1.631	1	.202	1.556
Constant	-.672	.565	1.417	1	.234	.511

United Kingdom Correlation and Logistical Regression

Starting from data obtained for United Kingdom random sample, we proceeded to make a linear correlation (Pearson), which is presented in Table 5. It shows the independent variables being able to influence the dependent variable (VD) (fast growth of the UK biotechnology companies). We used the same approach as in the case of the United States by correlating the independent variables, i.e. patents, human health, venture capital and alliances, between them and with the dependent variable (called VD growth) in order to control the co-linearity.

We can observe in Table 5 that the companies in the United Kingdom have very strong co-linearity between ranges of variables. This situation is independent of the phenomenon of multi co-linearity and easily observable in the correlations between alliances and venture capital with 0.600; human health and venture capital, 0.413; human health and alliances with a correlation of 0.564; patents and venture capital 0.531; patents and alliances 0.529 and finally, patents and human health with a correlation of 0.617. As in the case of the matrix correlation of the United States, we confronted the same decision as for the variable explaining the differential growth of the UK companies. The correlation shows that the independent variable "Patent" explains best the fast growth of the companies because it is most strongly dependent with a correlation of 0.398. The British companies with American patents had a stronger growth than those which do not have. The correlation between the independent variable alliance with the dependent variable Growth showed a score of 0.285. However, more important still, we can look that the alliances by itself cannot explain the growth of the biotechnology companies. To explain that we need the virtuous circle with the other variables (venture capital, alliances, human health) to take an active part in the process. These data confirm the assumptions predicting the importance to work in interaction with a virtuous circle and their factors.

We chose to regress the dependent variable with alliance – the variable that yielded the best estimate. 79.2% of companies that growth established a cooperation agreement (Table 6). The other independent variables – venture capital or patents – yielded somewhat similar decisive results.

Table 5 United Kingdom Correlation

		VD Growth	Patents	H. Health	Alliances	Venture capital	Age
VD Growth	Pearson corr. Sig. (2-tails) N	1 . 49					
Patents	Pearson corr. Sig. (2-tails) N	.398** .005 49	1 . 49				
H. Health	Pearson corr. Sig. (2-tails) N	.361* .011 49	.617** .000 49	1 . 49			
Alliances	Pearson corr. Sig. (2-tails) N	.285* .047 49	.529** .000 49	.564** .000 49	1 . 49		
Venture capital	Pearson corr. Sig. (2-tails) N	.306* .033 49	.531** .000 49	.413** .003 49	.600** .000 49	1 . 49	
Age	Pearson corr. Sig. (2-tails) N	-.146 .318 49	-.281 .051 49	-.298* .038 49	-.223 .123 49	-.262 .069 49	1 . 49

Table 6 Logistical Regression of UK companies with the independent variable: Alliance

Cases in study = 49. Dependent Variable : **Fast Growth** (Yes/No)
Independent Variable : **Alliance** (Yes/No)

Omnibus Test of model

	Chi Square	df	Sig.
Step 1	4.081	1	.043
Block	4.081	1	.043
Model	4.081	1	.043

Model Summary

Step	-2 Log likehood	Cox & Snell R-square	Nagelkerke R-square
1	63.827	.080	.107

Classification Table

Observed		Predicted VD Fast Growth		Percentage Correct
		1 (No)	2 (Yes)	
Step 1 VD Fast Growth	1 (No)	12	13	48.0
	2 (Yes)	5	19	**79.2**
Overall Percentage				63.3

Variables in the equation

	B	S.E.	Wald	DF	Sig	Exp. (b)
Alliance	1.255	.643	3.814	1	.051	3.508
Constant	-2.130	1.124	3.594	1	.058	.119

Conclusion

The extensive work done from 1980 in biotechnology companies management and particularly on the alliances, have tried to present these like the central axis of the growth of biotechnology companies. Although the cooperation agreements are extremely important in the search of missing competencies and resources (access to capital, distribution chains, asymmetrical reduction, greater and better protection of the intellectual property, etc.), we could also say that the alliances by itself do not explain and nor justify the fast growth of many biotechnology companies. The alliances are very important for the acquisition of capabilities, knowledge and resources, but this is only one player in a portrait that we could describe as "typical" in biotechnology, which is observable in the virtuous circle growth of the companies. The companies that make experimental research in human health, usually protect their inventions by patents, can attract venture capital or any other form of financing, will growth more quickly and better than others. This strategy may open the doors to potential cooperation agreements. A good patent (for example obtained in the United States) also grants prestige for the company. This can draw the attention of the large pharmaceutical companies in search of competences of the SBC and seem for establishes alliances. The power of all these factors under the umbrella of the "virtuous circle" will be positioning favourably the SBC to a fast growth.

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