Journal of Technology Management & Innovation

Received May 15, 2007 / Accepted June 2, 2007

COLLABORATING TO COMPETE: A SEARCH INTO CAPABILITIES AND STRATEGIC ALLIANCES IN THE PHARMACEUTICAL INDUSTRY

Marisa Ohba
Praia de Botafogo, 501 – Bloco Corcovado – 1st floor
22250-000 Rio de Janeiro Brasil
E-mail: Marisa_ohba@hotmail.com

Corresponding author:
Paulo N. Figueiredo
EBAPE/FGV
Praia de Botafogo 190 sala 510
22250-900 Rio de Janeiro, Brasil
E-mail: pnf@fgv.br

Abstract

Athough there is a profusion of studies related to strategic alliances and technological capacities which evaluate the issues individually, there is a scarcity of studies with empirical evidence relative to the implications of strategic alliances at the technological capacity configuration. Drawing on a scrutiny of specialised databases (*Galé, Dialog*, and *Business & Industry*) covering the 1993-2003 period, this article examines the entry and exit composition of innovative capabilities of 25 pharmaceutical companies' capabilities involved in such alliances. They are organised in three groups: (i) large pharmaceutical companies ('big-pharma'); (ii) large bio-pharmaceutical companies ('bio-pharma'); and (iii) small and research-intensive companies. In terms of strategic alliance implications, a change was observed on the technological capacities' configuration. The evidence suggests that the criteria for partner choice and technological capacity depend on the objectives and needs of each different group of company. Such type of evidence is important to provide researchers, corporate managers, and policy-makers with a concrete notion of the extent to which such division of innovative labour occurs and the actual changes going on the structure and organisation of innovative activities in the pharmaceutical industry.

Keywords: capabilities; strategic alliances; pharmaceutical industry

1. Introduction

Over the past three decades the pharmaceutical industry has passed through profound changes. Such changes have led to a transformation of its knowledge basis, know-how, and new search procedures leading to changes in the organisation and distribution of innovative activities. Among the different business models adopted by the pharmaceutical industry along the decades, Fully Integrated Pharmaceutical Company (FIPCO) was the business model which has provided the big-sized companies a considerable growth and high revenues for a long period of time. Based

on the integrated activities, this model oriented the companies to focus on their own internal resources to perform their R&D. But the specificity of the technology involved in drug research and the time demanded required some adjustments on the integrated model by the big-sized pharmaceutical companies. James (2003) draws our attention to the necessity of the companies to complement their resources with external technological capacities. This complementation would be crucial for the competitiveness in the multinational pharmaceutical market. Besides this, the development of molecule research tools has caused a huge impact on the knowledge bases and on the course of pharmaceutical company (Leonard-Barton, 1995). Specialized technologies like combinatorial chemistry, analogue chemical compounds analysis made the search process more "guided" and path dependent (see Gambardela, 1995; Orsenigo et. al., 2001).

While some would argue that such changes are the result the molecular biology 'revolution' (Arora & Gambardella, 1994; Gambardella, 1995), others argue that change transition is a consequence of cumulative 'incremental' changes taking place within pharmaceutical industry (see Nightingale & Mahdi, 2004). Such cumulative incremental changes seem to have been drive by the gradual and steady emergence and development of competitive technologies and biological sciences, industrial molecular and cells biology, and in biochemistry protein search techniques, which, in turn, demand new kinds of highly specialised knowledge bases (Pavitt, 1990; Leonard-Barton, 1995).

Nevertheless, there is a consensus that such institutional and technical changes have led to fundamental modifications to structure of the pharmaceutical industry. These have involved, for instance, the emergence of biotech start-ups. In other words, such changes have triggered a new division of innovative labour between 'big-pharma' and dedicated biotech firms (specialised suppliers and small research-based firms): while small-sized biotech concentrate on upstream research the 'big-pharma' seeks to acquire from them initial drug compounds, to carry out costly clinical trials and commercialise such drugs worldwide (see Gambardella, 1995; Mazzucato & Dosi, 2006; Nightingale & Mahdi, 2004). Such 'division of innovative labour' implies, on the other hand, several kinds of knowledge complementarities (Pavitt, 1990) which, in turn, are operationalised on the basis of different management mechanisms, namely, strategic alliances (Forest & Martin, 1992; Rothaermel & Deeds, 2004).

Indeed, over the past decade there have been robust and respected studies and analyses of the evolution of the pharmaceutical industry, from a capability-based perspective. However, there seems to be a scarcity of an empirical evidence relative to the implications of such 'division of innovative labour' in the pharmaceutical industry, especially based on strategic alliances, for the technological capabilities of companies involved in such arrangements. Such type of evidence is important to provide researchers, corporate managers, and policy-makers with a concrete notion of the extent to which such division of innovative occurs and the actual changes going on the structure and organisation of innovative activities in the pharmaceutical industry.

Thus this seeks to make a contribution in that direction. Drawing on systematic scrutiny of specialised databases such as *Galé, Dialog,* and *Business & Industry* covering the 1993-2003 period, this article examines the implications of strategic alliances for the configuration of companies' capabilities that participate in such alliances. Such search process was based on evidence of strategic alliances in a sample of 25 pharmaceutical companies. In this study, such sampled companies have been organised three different groups: (i) large pharmaceutical companies ('big-pharma'); (ii) large bio-pharmaceutical companies ('bio-pharma'); and (iii) small and research-intensive companies.

Following this introductory and background section, Section 2 presents the framework in the light of which our empirical evidence is examined. Issues related to the methods of study underpinning this paper are outlined in Section 3. The main findings are presented and discussed in Section 4. Finally, Section 5 discusses the paper conclusions and some recommendations.

2. Descriptive framework

Strategic alliances have been viewed as one of the major mechanisms to operationalise the knowledge complementarity and division of innovative labour in the contemporary pharmaceutical industry (Forrest & Martin, 1992). In order to sustain innovative and economic performance, the pharmaceutical industry needs to launch new drugs constantly. The process of obtaining new drugs depends, firstly, on the technological capabilities for the molecule research and drug development (P&D). The necessary investment for a new drug ranges between USD 800 million and USD 1 billion. Basically, the new drug discovery process involves molecule trials, preclinical and clinical trials in humans, as well drug development. Because clinical trials require high investments, many of the strategic alliances take place during these stages. Considering only the ten biggest studied "big-pharmas", the total annual revenue was USD 203 billion in 2003 (Tyebiee & Hardin, 2004).

Pharmaceutical companies complement their innovative resources in order to compete globally (James, 2003).

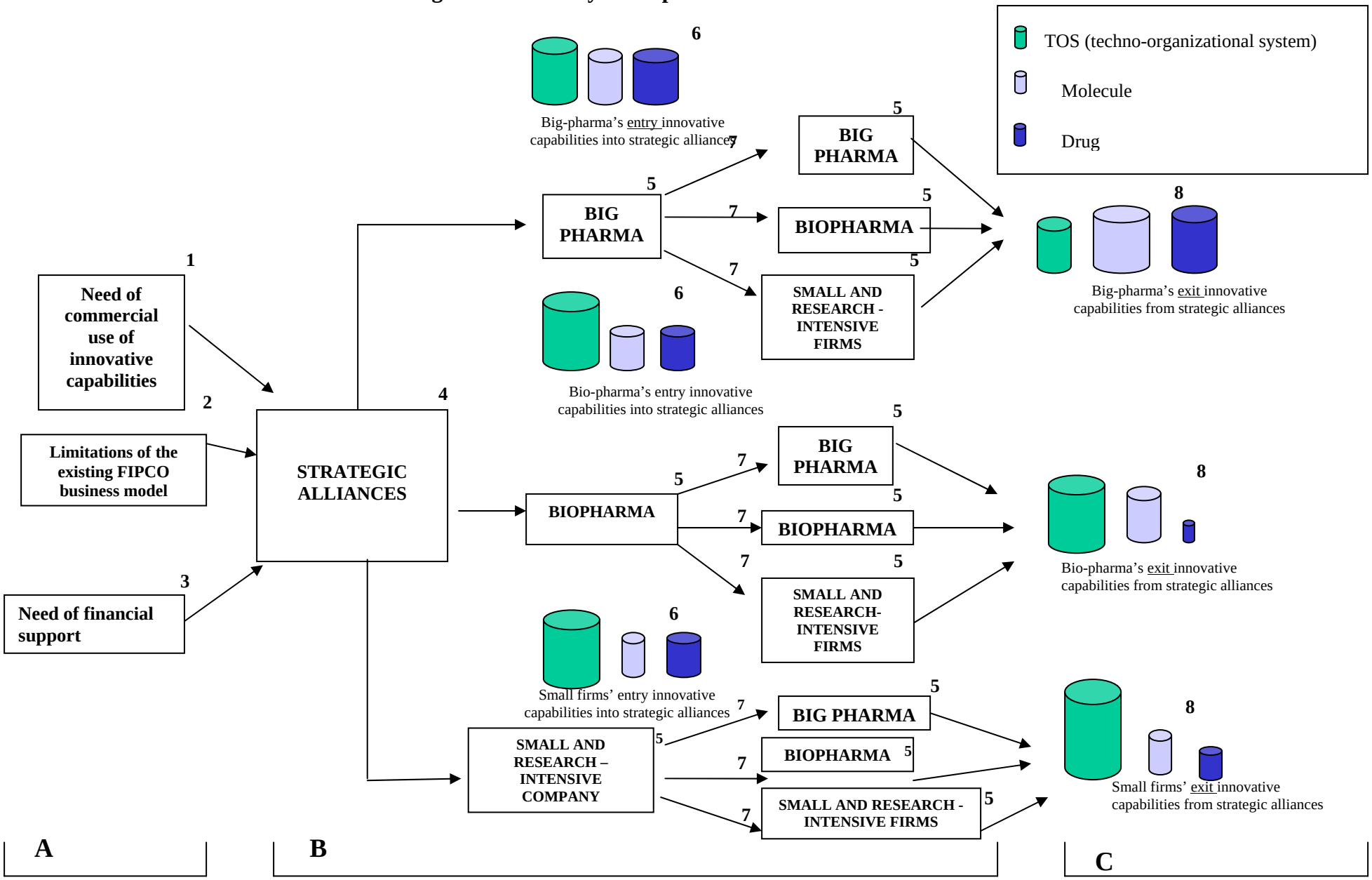
Indeed, Forrest & Martin (1992) found different reasons from large pharmaceutical companies and small research-intensive companies to look for strategic alliances: while the former seeks to update their knowledge bases and R&D structures in order to keep up their technological and leadership in the market with innovative drugs, the latter seek to take advantage of their innovative knowledge basis in order to capitalise themselves, to share the risks of their new investigations and to gain access to markets.

It should be noted that biotechnological companies have been responsible for the majority of strategic alliances. Between 1988 and 2002, 20,000 strategic alliances were registered involving biotechnological companies in the US representing. The exploration regime prevails on the biotechnological companies when compared with the collaboration regime between the companies (Koza & Lewin, 1988; Rothaermel & Deeds, 2004). Additionally, another reason for the establishment of strategic alliances is related to the fact that certain innovative capabilities can be under patent protection and under high difficulty of replication in the pharmaceutical field (Kotabe & Swan, 1995; Powell, 1996; Iyer, 2002; Rotharmel & Deeds, 2004).

As a result, Figure 1 presents the descriptive framework in the light of which the evidence on strategic alliances based on innovative capabilities in the pharmaceutical industry will be examined in the article. The framework involves three steps:

A ⇨ Factors influencing the establishment of strategic alliances;
B ⇨ Supply of innovative capabilities and other resources to enter to strategic alliances;
C ⇨ Acquisition of innovative capabilities through different types of strategic alliances.

Figure 1. The study descriptive framework



The changing scenario is represented by numbers 1, 2 and 3 in Figure 1: (1) need of commercial use of innovative capabilities, (2) limitations of the existing FIPCO business model, (3) need of financial support. Drawing on Pavitt (1990), Leonard-Barton (1995), Teece & Pisano (1994) and Tidd *et al*. (2001), this model is based on the concept that the companies gain and sustain their competitive advantage on the basis of their innovative capabilities and cognitive bases.

The three types of companies which participated on the studied strategic alliances are represented by Number 5 in Figure 1: 'big-pharma', 'bio-pharma' and small & reseach – intensive company. In this study, we adopt a broad perspective on technological capabilities involving in strategic alliances in the pharmaceutical industry: techno-organizational system (TOS), molecule and drug.

These three different capability resources are identified by Number 6 and are part of the technological capabilities which were used to enter to strategic alliances. The different kinds of collaborations among **t**he three types of company and strategic alliance mechanisms are represented by Number 7. Number 8 refers to the technological capabilities that result from strategic alliances established by each type of pharmaceutical company (exit capabilities)

3. Study design and methods

3.1 Central question

The study underlying this paper has been structured to evaluate the following central issues: (i) the technological capacities which were made available at the strategic alliances by the three groups of pharmaceutical companies (big-pharma, bio-pharma and small-sized research-intensive company) and (ii) the main implications of strategic alliances for the different groups of company.. The strategic alliances studied involved different mechanisms: in/out licenses of technological capabilities; creation of techno-organizational systems; molecule research; drug development and marketing & sales development.
Technological capabilities are understood here as knowledge-based resources that are needed to generate and manage technological innovation. Such resources are embodied in techno-physical systems, people, and managerial and organisational systems (Bell & Pavitt, 1995; Leonard-Barton, 1995; Figueiredo, 2001). Thus, in this paper innovative capabilities involve different knowledge basis related to new drug development process: techno-organisational system (TOS); molecule, and drug. The TOS can be a tool for the molecule research equipment development; equipment for molecule research and equipment for drug development.

3.2 Sampling

We have scrutinised the strategic alliances implemented during the 1993-2003 period by three types of companies as shown in Table 1 below. The criterion to select big-pharmas and bio-pharmas was based on the revenue in 2003. For the five small & research-intensive companies, the criterion was the frequency on strategic alliances agreed with big-pharmas.

Table 1. Sample of the study

Types of companies	Companies
Large multinational pharmaceutical company ('big pharma'):	Pfizer; Glaxo SmithKline; Merck; Johnson & Johnson; Aventis; AstraZeneca; Novartis; Bristo-Myers Squibb; Roche, and Eli Lilly
Large multinational bio-pharmaceutical companies ('bio-pharmas'):	Amgen; Genentech; Serono; Biogen Idec; Genzyme; Chiron; MedImmune; Gilead; Millennium; and Intermune
Small and research-intensive rcompanies	Incyte; Icagen; Lexicon; Ligand and OSI Pharmaceuticals.

Our search of empirical evidence drew on three large databases: *Business & Industry*; *Dialog* and *Galé*. The homepages of each studied company and the specialized publications (e.g.: IMS, Pharma) were also examined. The survey of the empirical evidences considered the publications between 1993 and 2003. The used terms for the strategic alliances survey are related to: strategic alliance; molecule research and drug development (see Table 2).

Table 2. Terms used for searching the selected databases

Search (S1):	alliance or agreement or licenses or partnership or collaborative development
Search (S2):	molecule discovery or drug discovery or early discovery
Search (S3):	name of the company**
Search (S4):	S1 and S2 and S3 and PY = 1993:2003

** the names of the 25 companies (sample).

In order to simplify the assessment of the collected data, each technological capability (which was made available at the strategic alliance or which was acquired through strategic alliance) was considered as one strategic alliance. All qualitative information related to each strategic alliance was represented as one technological capability at the table of the corresponding company. The frequency of each technological capability generated a quantitative data. Such data were organized in tables and graphics in order for us to obtain a meaningful evaluation and discussion of evidence. Mergers, take-overs and joint-ventures were outside the scope of this study.

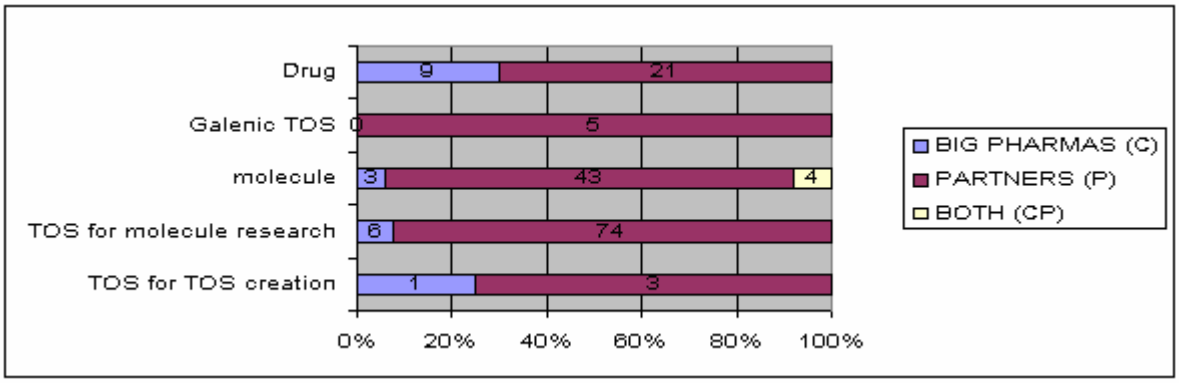
4. Main results and discussions

In this section we present the main results obtained from our empirical search. The results are presented in three Subsections in order to provide a better understanding of how different groups of company participated with their resources, as well how different interests generated a modification between the configuration of technological capabilities which were made available at the strategic alliances and the configuration of technological capabilities which were captured through the same strategic alliances.

4.1. Participation of companies' capabilities in the establishment of strategic alliances

Figures 2 to 4 illustrate the participation of each type of company with technological capabilities.

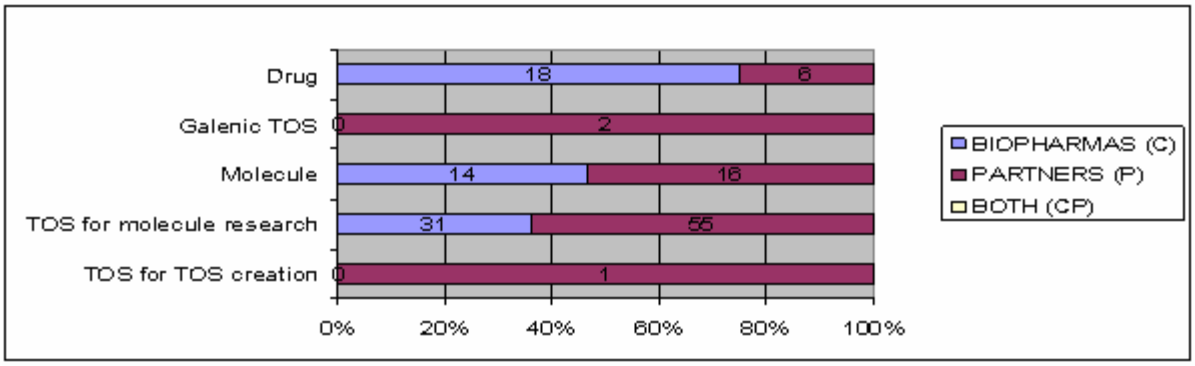
Figure 2. Innovative capabilities to enter strategic alliances: big pharmas 'C' *vs* partners 'P'



Notes/keys: C = innovative capabilities which were made available by the big pharma group;
P = innovative capabilities which were made available by partners (biopharma, big pharma and small and research-intensive company involved on the studied strategic alliances);
B = innovative capabilities which were made available by both companies (big pharma and the partner involved on the strategic alliance).

Figure 2 indicates a small participation of big-pharmas in examined strategic alliances in terms of innovative capabilities. From all strategic alliances agreed between big-pharmas and the correspondent partner, only 19 out of 169 capacities (11%) came from big-pharmas. The more relevant participation from this group was with drugs (30%).

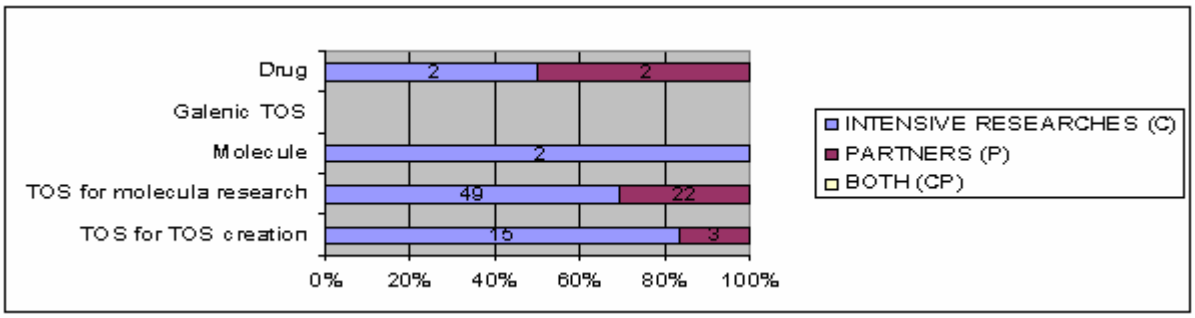
Figure 3. Innovative capabilities to enter strategic alliances: bio-pharmas 'C' *vs* partners 'P'



Notes/keys: C = innovative capabilities which were made available by the biopharma group;
P = innovative capabilities which were made available by partners (bio-pharma, big pharma and small research-intensive companies involved in the strategic alliances);
B = innovative capabilities which were made available by both companies (bio-pharma and the partner involved on the strategic alliance).

On the other hand, Figure 3 shows a balanced participation of bio-pharmas in terms of technological capabilities in the strategic alliances. They contributed with 63 out of 143 capacities (44%). This group participated with more than 70% of the drugs and, numerically, on TOS for molecule research (31 from 86).

Figure 4. Innovative capabilities to enter strategic alliances: small and research-intensive 'C' *vs* partners 'P'



Note/keys: C = innovative capabilities which were made available by the small-sized intensive research company group;
P = technological capabilities which were made available by partners (biopharma, big pharma and small and research-intensive companies involved on the studied strategic alliances);
B = innovative capabilities which were made available by both companies (small and research-intensive companies and the partner involved on the strategic alliance).

The evidence in Figure 4 indicates a strong participation of small & research intensive companies in the strategic alliances with technological capabilities: 68 out of 95 capacities (72%). Within the examined strategic alliances they had impressive participation both in proportional terms (83% with TOS for TOS creation and 69% for TOS for molecule research) and absolute terms: 49 out of 71 TOS for molecule research.

The above empirical evidence suggests that there was a higher participation of small & intensive research companies in the strategic alliances in terms of innovative technological capabilities. Big-pharmas contributed mainly with financial support and marketing & sales structure. Bio-pharmas participated with technological capabilities and financial support, depending on the involved partner.

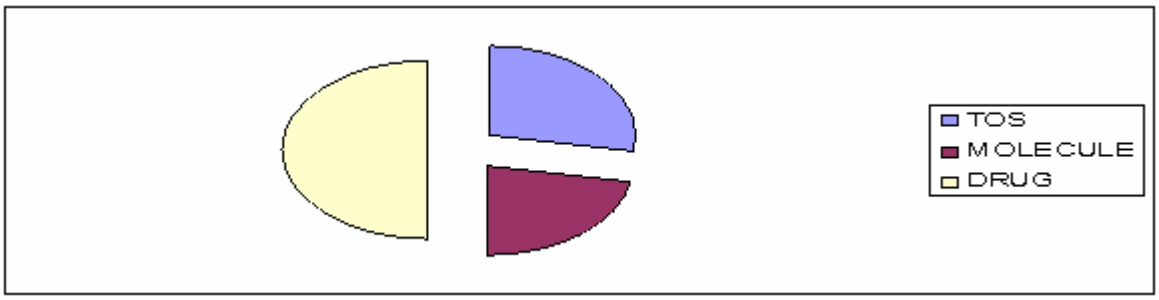
Indeed, big-pharmas adopted the strategic alliances as a way of acquiring new technological capabilities as a response to their internal limitations such as low productivity of their internal R&D structures, reduction of the profit from new drug's launch and external limitations like, on the one hand, the increased scientific sophistication of products and, on the other, the enlargement of the market for generic products (James, 2003). In relation to bio-pharmas, their engagement in strategic alliances was driven by the need to complemented technological capabilities in order to improve their financial structure and to obtain innovative drugs. Small and research-intensive companies adopted the strategic alliances for commercial application of their in-house innovative technological capabilities and to engage in new activities such as drug commercialization in the global pharmaceutical market, thus, in line with Forrest (1990).

4.2 Composition of innovative capabilities used by companies to enter strategic alliances

Figures 5 to 7 show the composition of innovative capabilities that made available by the three types of companies during the establishment of the examined strategic alliances.

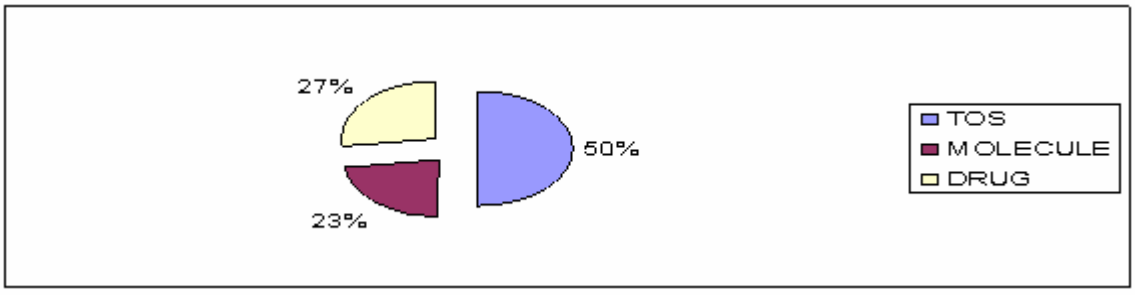
Of the 19 technological capabilities which were made available by big-pharmas, the great majority of them referred to drugs (47%). The empirical evidence suggests that the majority of these drugs were on the verge of losing their patent protection or having already lost it. Big-pharmas also participated considerably with techno-organizational system for molecule research (see Figure 5)

Figure 5. Big-pharmas' innovative capabilities entering to strategic alliances



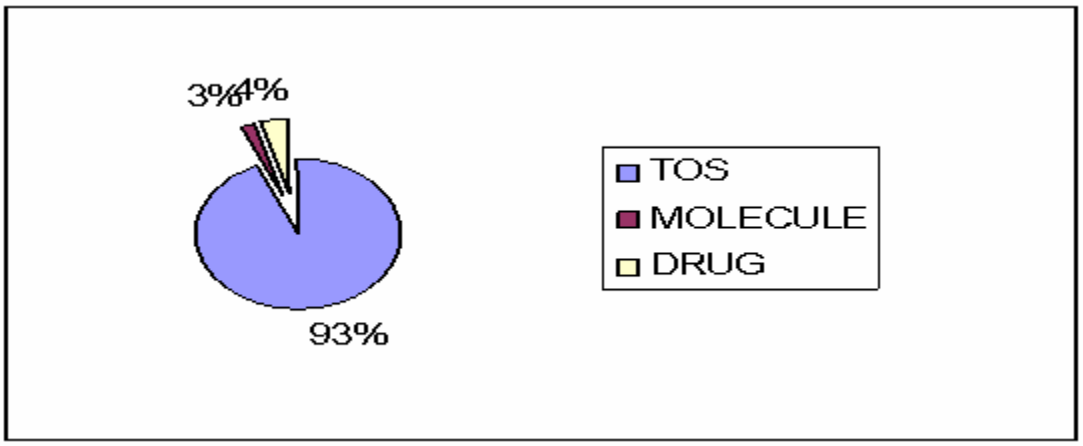
Of the 63 technological capabilities which were made available by bio-pharmas at the studied strategic alliances, it was observed that great part was techno-organizational system (TOS) for molecule research (49%). The empirical evidence indicates that most part of these TOS was made available to big-pharmas. This, in turn, suggests that bio-pharmas participated considerably with molecules and drugs (see Figure 6).

Figure 6. Bio-pharma's innovative capabilities entering to strategic alliances



Of the 68 technological capabilities which were made available by the small & research-intensive companies, it was observed that the great majority of them being based on TOS for molecule research (93%). The great part of these TOS was made available to big-pharmas. Additionally, we can observe a contribution with TOS for molecule research (see Figure 7).

Figure 7. Small research-intensive firms' innovative capabilities entering to strategic alliances

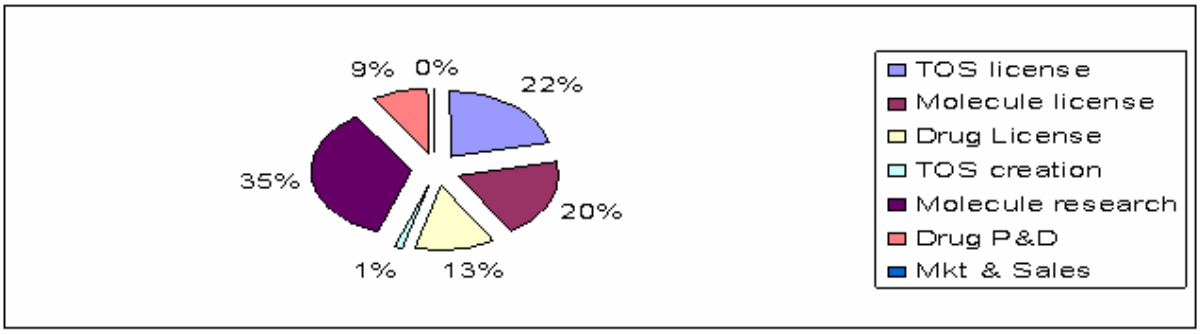


The evidence in Figures5 to 7 allows us to observe an unbalanced composition of capabilities offered by big-pharmas in contrast to small & research-intensive companies to enter to their strategic alliances. While the participation of the former was mainly with drugs (47%), the latter contributed heavily with TOS (93%). Besides the fact that the participation of bio-pharmas was much more balanced, this company profile presented a considerable contribution with TOS (50%).

4.3 Composition of innovative capabilities resulted from strategic alliances

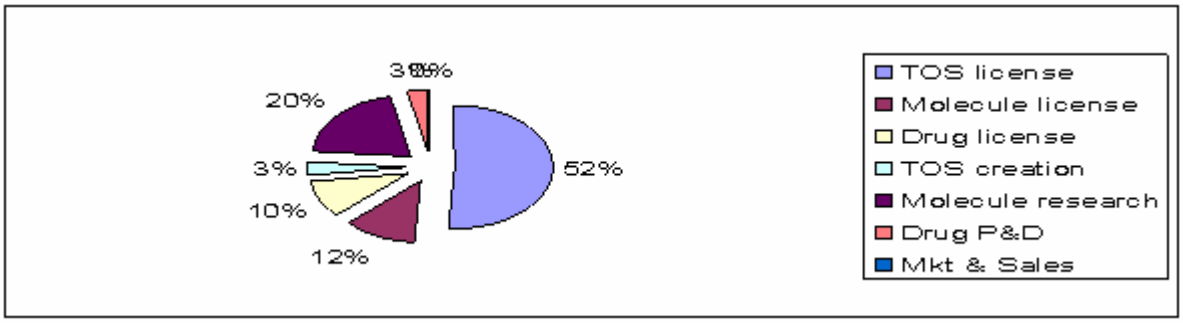
Figures 8 to 10 illustrate the composition of the technological capabilities during the exit of companies from the examined strategic alliances.

Figure 8. Big-pharmas' innovative capabilities exiting from strategic alliances



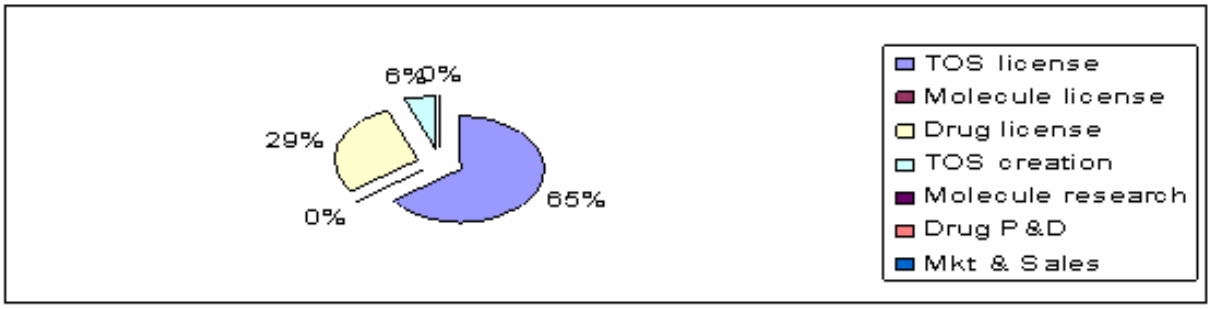
Of the 206 technological capabilities resulting from the big-pharmas studied strategic alliances, 143 (69%) were retained by big-pharmas (55% of them were related to molecules). This type of company also acquired a considerable number of TOS for molecule research, reinforcing the idea that the main interest of this type of company is in molecules.

Figure 9. Bio-pharmas' innovative capabilities exiting from strategic alliances



Of the 170 technological capabilities resulting from the bio-pharmas studied strategic alliances, 59 (35%) were retained by the bio-pharmas (55% were TOS for molecule research). According to the empirical evidence, the majority of these TOS for molecule research resulted from in-licensing with small & research-intensive companies and other bio-pharmas. Bio-pharmas also acquired a considerable number of molecules (32%) through in-licensing and molecule research mechanisms. This, again, confirm their interest in molecules.

Figure 10. Small & research-intensive firms' innovative capabilities exiting from strategic alliances



Of the 109 technological capabilities resulted from the studied strategic alliances, only 17 (16%) of them were retained by small & research-intensive companies. It was observed that the majority of them were based on TOS for molecule research (71%). This type of company also acquired a considerable number of drugs, which, in turn, seems to suggest their interest in gaining share in the pharmaceutical market.

In sum, we have found that:

(1) In terms of contribution with technological capabilities to strategic alliances: (i) big-pharmas participated with 11% of 169 technological capabilities; (ii) bio-phamas participated with 44% of 143 technological capabilities; (iii) small-sized intensive research companies participated with 72% of 95 technological capabilities.

(2) In terms of the composition of technological capabilities obtained from strategic alliances when compared with the configuration of the technological capabilities which were made available for the strategic alliances: (i) big-pharmas increased the proportion of molecules (16% to 55%); (ii) bio-pharmas increased the participation in molecules (22% to 32%) and techno-organizational system to molecule research (49% to 55%); (iii) small & research-intensive companies started new activity: drug commercialization on pharmaceutical market with a corresponding increase of drugs (3% to 29%). Furthermore, this type also company updated its

techno-organizational system (TOS) for molecule research.

Finally, Table 3 shows the percentage of each technological capability which was made available during the start of the studied strategic alliances by each kind of company. It also shows the percentage of each technological capability which was obtained by each of the three types of companies from the same strategic alliances.

Table 3. Entry and exit innovative capabilities of pharmaceutical companies involved in strategic alliances

Types of innovative capability	Big Pharmas		Biopharmas		Small & research-companies	
	ENTRY*	EXIT**	ENTRY*	EXIT**	ENTRY*	EXIT**
Drugs	47 **%**	22%	29 **%**	13%	3 **%**	29%
Galenic TOS	No participation	No capability addition	No participation	No capability addition	No participation	No capability addition
Molecules	16 **%**	55%	22 **%**	32%	3 **%**	None
TOS for molecule research	32 **%**	23%	49 **%**	55%	72 **%**	71%
TOS for TOS creation	5 **%**	No capability addition	No capability addition	No capability addition	22 **%**	No capability addition
Total	100%	100%	100%	100%	100%	100%

Note: (*) Innovative capabilities that were made available at strategic alliances
(**) Innovative capabilities that were obtained from the strategic alliances

The evidence in Table 3 allows us to observe some modifications in the compositions of the technological capabilities of the companies involved in the examined strategic alliances. In general, big-pharmas participated in strategic alliances in order to obtain innovative capabilities; bio-pharmas sought to complement their capabilities, while small & research-intensive companies were interested in starting new activities and entering the pharmaceutical market.

5. Conclusions

Although there have been a number of studies on strategic alliances and technological capabilities and those that point to division of innovative labour in the pharmaceutical industry, our study have sought to add, although in a very descriptive manner, a concrete notion of the extent to which pharmaceutical companies benefit from their strategic alliances in terms of technological capabilities.

Based on the empirical evidences, it was observed that the participation of the three groups at the strategic alliances was influenced by the availability of technological capacity: big-pharmas participated mainly with financial support; the small-sized intensive research companies with their technological capacities and the bio-pharmas with their technological capacities and financial support, depending on the partners.

According to the technological capacities resulting from the strategic alliances, it can be inferred that big-pharmas detained molecules to guarantee the market competitiveness; bio-pharmas detained molecules to improve the financial structure as well as TOS for molecule research to maintain their P&D activities; and the small-sized research companies acquired drugs to enter the pharmaceutical market.

Taking into consideration that big pharmas have held the largest amount of technological capacities from the strategic alliances, in particular molecules, it can be understood that their interest in participating in strategic alliances should be a way of reacting at internal and external changes, with the objective of keeping competitiveness in the pharmaceutical market. This reaction has modified the main business model (FIPCO) followed by this company profile. This business model, which is integrated and self-sufficient, now starts to accept external technological capacities that have led to the reduction of the resource waste.

With innovative molecules and acting in an intensive way on P&D, the efficient and profitable bio-pharmas have been adopting strategic alliances in order to complement their technological capacities, as well as outsourcing the biotechnological products manufacturing. It was observed that this group participated in a diversified way at the strategic alliances with technological capacities; financial support; targeting molecules and technical-operation systems. It. seems that all these efforts are being made to reach revenues higher than those of the big-pharmas.

On their turn, small-sized intensive research companies can take advantage of their innovative capabilities to enter the pharmaceutical market through the commercialization of the drugs acquired by strategic alliances. Due to the fragile financial structure, this group is more affected by the election of the partnership. The partner has to optimize their technological capacities and to reinforce their technological bases (Meyer *apud* Forrest, 1990).

The strategic advantage demands more and more integration of the external technological capacities. Some positive conclusions for strategic alliance can be considered, like the sharing of responsibilities, the technological capacities complementation, the creation of economic values.

References

Arora and Gambardella (1994) "The changing technology of technological change: general and abstract knowledge and the division of innovative labour", *Research Policy*, V. 23, Nº 5, pp. 523-532.

Bell, M. and K. Pavitt (1995), 'The Development of Technological Capabilities', in I. u. Haque (ed.), *Trade,Technology and International Competitiveness*, The World Bank: Washington.

Figueiredo, Paulo N. (2001), *Technological Learning and Competitive Performance*. Edward Elgar: Cheltenham, UK & Northampton, MA.

Forrest, J. E. (1990), Strategic Alliances and the Small Technology-Based Firm, *Journal of Small Business Management*, Vol. 28, Nº 3, pp. 37-45.

Forrest, J. E. and M. J. C. Martin (1992), Strategic alliances between large and small-sized research intensive organizations: experiences in the biotechnology industry. *R&D Management*, v. 22, n. 1, pp. 41-53.

Gambardella, A. (1995), *Science and Innovation: The Us Pharmaceutical Industry During the 1980s*, Cambridge University Press

Iyer, K. (2002). Learning in strategic alliances: an evolutionary perspective. *Academy of Marketing Science Review*, v. 10, pp. 1-16.

James. B. G. (2003), Big Pharma: The beginning of the end or the end of the beginning, *Spectrum Pharmaceutical Industry Dynamics, Decision Resources*, 5 May pp. 1-18.

Kotabe, E.M. and K.S. Swan (1995). The role of strategic alliances in high-technology new product development**.** *Strategic Management Journal*, vol. 16, pp. 621-636.

Koza, M. P. and A.Y. Lewin (1998), The Co-evolution of Strategic Alliances. *Organization Science*, V. 9, Nº 3, pp. 255-264

Leonard-Barton, D. (1995). *Wellsprings of Knowledge: Building and Sustaining the Sources of Innovation*, Harvard Business School Press: Boston, MA.

Mazzucato, M. and G. Dosi (2006) '*Knowledge accumulation and industry evolution: the case of pharma-biotech'*, Cambridge University Press.

Nightingale, P. and S. Mahdi (2004) *The evolution of pharmaceutical innovation* Knowledge Accumulation and Industry Evolution. Cambridge University Press

Orsenigo, L.; Pammolli, F. and Riccaboni, M. (2001) "Technological change and network dynamics: lessons from the pharmaceutical industry", *Research Policy*, 30, pp. 485-508.

Pavitt, K. (1990). What we know about the strategic management of technology. *California Management Review*, vol. 32, nº 2, pp. 17-26.

Powell, W. (1996) Inter organizational Collaboration and the Locus of Innovation: Networks of Learning in Biotechnology. *Administrative Science Quarterly*, vol. 41, no. 1 , pp. 116-145.

Rothaermel, F. D. L. Deeds (2004) Exploration and exploitation alliances in biotechnology: a system of new product development. *Strategic Management Journal*, vol. 25, pp. 201-221

Teece, D. and G. Pisano (1994), 'The dynamic capabilities of firms: an introduction', *Industrial and Corporate Change*, Vol.3, No. 3, pp. 537–56.

Tidd, J.; J. Bessant and K. Pavitt (2001) *Managing Innovation: Integrating Technological Market and Organization Change*. West Sussex: John Wiley & Sons.

Tyebjee, T., Hardin, J. Biotech-pharma alliances: Strategies, structures and financing. In: Journal of Commercial Biotechnology, v. 10, nº 4, June, 2004.