Government policies for successful inter-firm technological collaboration in MERCOSUR

Ludovico Alcorta*

Resumen

Este ensayo examina algunas experiencias de intercambio de información y conocimiento que involucran a firmas del MERCOSUR y el papel que desempeña el gobierno en asegurar su éxito. El análisis de la colaboración tecnológica sugiere que mientras mejor preparada esté una corporación al formar parte de un acuerdo, más probabilidades de éxito tendrá. Asimismo, anota que ahí donde las interacciones fueron intensas, bien intencionadas, transparentes, incluyeron intercambio de personal e involucraron participantes receptivos, el aprendizaje progresó armónicamente y los socios obtuvieron una mayor satisfacción. Los beneficios de la colaboración incluyeron nuevos productos patentables y no patentables, nuevas factorías y también la generación de confianza entre los socios. Los gobiernos pueden facilitar la colaboración mediante la provisión de un ambiente económico y político saludables, y de políticas macro y sectoriales consistentes. Las políticas gubernamentales pueden contribuir a iniciar y sostener sociedades tecnológicas a través del establecimiento de fuentes alternativas de información y conocimiento, o foros de intercambio y discusión; de la promoción y el financiamiento de investigación y proyectos de desarrollo; del arbitraje y la delimitación de responsabilidades entre socios potenciales; y mediante la provisión de mercados. Finalmente, los gobiernos pueden contribuir al éxito en la colaboración tecnológica, si logran involucrar a las asociaciones empresariales y otras instituciones relevantes.

Abstract

This paper examines some of the experiences in information and knowledge sharing involving MERCOSUR firms and the role of government in ensuring their success. The analysis of technological collaborations suggested that the better prepared a corporation entered an agreement the more successful it was likely to be. It also pointed out that where interactions were intense, well intended and transparent; included personnel exchange; were properly assessed; and,

* E-mail: Alcorta@msm.nl.

involved receptive participants, learning progressed smoothly and partners were satisfied. Benefits of the collaborations included new patentable and non-patentable products and new factories as well as building trust between partners. Governments can facilitate collaborations by providing a sound economic and political environment and consistent macro and sectoral policies. Government policies can help initiating and sustaining technological partnerships by becoming an alternative source of information and knowledge and a forum for information exchange and discussion, by promoting and funding research and development projects, by brokering and delimiting responsibilities between potential partners and by providing markets. Finally, governments can assist in the success of technological collaborations by involving business associations and other relevant institutions.

INTRODUCTION

It is increasingly being acknowledged that firms' ability to exploit new technologies and innovate is contingent upon the interactions and relationships they build with other firms. The main purpose of these interactions and relationships is to share information and knowledge. These interactions or technological collaborations have grown in significance in recent years. Although not new, there has been an increase in the number of agreements, the range of industrial sectors involved and the amount and kind of international and domestic technological alliances[1].

This paper aims at examining the role of government policy in ensuring the success of information and knowledge sharing experiences involving MERCOSUR (Argentina, Brazil, Paraguay, Uruguay and Chile as an associated member) firms. Much has been done in advanced countries to study technological collaboration agreements particularly with regard to firms' motivations in entering agreements, the evolution and learning processes involved in collaborations and the effects and outcomes of the cooperations[2]. What seems less explored, however, is the role of 'external' influences, particularly governments. By providing the appropriate incentives, governments may help to ensure technological collaborations become successful. In developing countries, only recently interest has arisen into studying existing technological collaborations but there is even less knowledge on the role of government policy.

The paper will consist of five sections. After this introduction the section that follows will discuss the trends and rationale for technological collaborations. The second section explains the approach undertaken to identify partnerships and describes the extent and main

1. Chesnais, F., "Technological Agreements, Networks and Selected Issues in Economic Theory"; and Coombs, R., A. Richards, P.P. Saviotti, and V. Walsh, "Introduction: technological collaboration and networks of alliances in the innovation process", both in Coombs, R., A. Richards, P.P. Saviotti, and V. Walsh (eds.), *Technological Collaboration: The Dynamics of Cooperation in Industrial Innovation*, Cheltenham: Edward Elgar Publishings, 1996.
2. Contractor, F. and P. Lorange, "Why Should Firms Cooperate? The Strategy and Economics Basis for Cooperative Ventures", in Contractor, F. and P. Lorange (eds.), *Cooperative Strategies in International Business*, Lexington, Mass: Lexington Books, D.C. Heath and Company, 1988a; Hagedoorn, J., "Understanding the Rationale of Strategic Technology Partnering: Interorganizational Modes of Cooperation and Sectoral Differences", in *Strategic Management Journal*, vol. 14, England, New York: John Wiley & Sons, 1993, pp. 371-385; Hagedoorn, J. and J. Schakenraad, "The Effect of Strategic Technology Alliances on Company Performance", in *Strategic Management Journal*, vol. 15, England, New York: John Wiley & Sons, 1994, pp. 291-309; Harrigan, K.R., "Joint Ventures and Competitive Strategy", in *Strategic Management Journal*, vol. 9, England, New York: John Wiley & Sons, 1988, pp. 141-158; and *Strategies for Joint Ventures*, Lexington, Mass.: Lexington Books, D.C. Heath and Company, 1985; Senker, J. and M. Sharp, "Organizational Learning in Cooperative Alliances: Some Case Studies in Biotechnology", in *Technology Analysis and Strategic Management*, vol. 9, No. 1, London, New York: Taylor and Francis Group, 1997.

characteristics of the collaborations analysed. The next section will examine the main success factors emerging in the collaborations under study so that policy initiatives can be clearly related to each one of these factors. The fourth section will analyse the impact of MERCOSUR governments' policy efforts in relationship to the establishment, development consolidation of agreements. The paper will end with some conclusions and suggestions for policy improvements.

I. TECHNOLOGICAL COLLABORATIONS: DEFINITION, TRENDS AND RATIONALE

I.1 What are technological collaborations?

The concept of technological collaborations also often referred as 'strategic technological partnerships' has been used to depict a number of relationships. Established and well researched means of domestic and international technology transfer such as foreign direct investment, licensing and technical services contracts between firms or between firms and research institutes and universities are included together with relatively novel and less known research and development agreements and joint ventures.

In general, inter-firm cooperation agreements or *technological collaborations* can be defined as understandings between corporations aimed at sharing information and knowledge for innovation. Technological collaboration may involve a one way or asymmetric flow of information, like in the case of licensing agreements as the flow goes from licenser to licensee, or may be of the two-way flow type, with each firm bringing into the relationship its resources, competencies and knowledge. The latter type, which also includes agreements made to address a common technological problem as the resolution to the problem should eventually result in an organisational or process modification, will be the focus of this paper.

Technological collaborations can be deemed 'strategic' when they share common overall research and development objectives and approaches, and are open-ended in terms of its time span or can be characterised as 'specific' when the objective is a predetermined product or process, and the collaboration only lasts until the objective is achieved. The intensity of co-ordination, consultation and interdependence, therefore, varies accordingly.

Agreements can be put into effect through a variety of mechanisms or modes of governance, ranging from an informal agreement, a simple memorandum of understanding to a joint-venture and can involve two or more enterprises. Hence, they neither involve alternative organisational or contractual arrangements nor equity partnership.

I.2 Rationale underlying the emergence of partnerships

Technological collaborations arise from the need for an interactive exchange of information and knowledge that underlies innovation and technical change and is the result of the continuous creation of very *specific knowledge* at each stage of the process. The knowledge generated at the design stage is often similar to pure academic science while the knowledge generated at the development stage is more of a 'systems' nature in the sense that the main concern is how components interact and the 'whole' performs[3]. Indeed, knowledge specificity need not be circumscribed to different stages within an individual firm but could also come from other firms or institutions. Only through the mutual exchange and accumulation of the often-dispersed information can alternative designs of new, and improvements and adaptations of existing, products and processes are achieved.

The functional importance of interaction is further highlighted by the *tacit* nature of some of the knowledge generated during the innovation process[4]. Tacit knowledge implies the understanding of the ways techniques, methods, processes and designs work and of their consequences without being able to explain why. It typically arises out of the complexity of the analyses involved and the constant resorting to practical experimentation and testing which characterises innovation. Thus, tacit knowledge cannot be easily formalised nor transmitted in written form making it virtually impossible to make it subject to a contract[5]. It can be codified through research and replication until the underlying principles are understood, but in doing so new tacit knowledge is created. Transmission takes place mainly through demonstration and discussion[6].

An additional factor underlying technological collaborations emerges from the fact that innovation is a process that necessarily involves *complementary* knowledge. Following Milgrom and Roberts[7], complementarities can be said to exist if any additional knowledge of one kind increases the marginal return of any other knowledge brought into the collaboration. Complementarities arise from the technological and economic 'interdependencies' or 'interrelatedness' that emerge during the innovation process[8].

3. Kline, S.J. and N. Rosenberg, "An Overview of Innovation", in Landau R. and N. Rosenberg (eds.), *The Positive Sum Strategy*, Washington, D.C.: National Academic Press, 1986.
4. Senker, J. and W. Faulkner, "Networks, Tacit Knowledge and Innovation", in Coombs, R., A. Richards, P.P. Saviotti, and V. Walsh (eds.), *Technological Collaboration: The Dynamics of Cooperation in Industrial Innovation*, Cheltenham: Edward Elgar Publishings, 1996.
5. Yamin, M., "Understanding 'Strategic Alliances': The Limits of Transaction Cost Economics", in Coombs, R., A. Richards, P.P. Saviotti, and V. Walsh (eds.), *Technological Collaboration: The Dynamics of Cooperation in Industrial Innovation*, Cheltenham: Edward Elgar Publishings, 1996.
6. Foray, D., "Generation and Distribution of Technological Knowledge: Incentives, Norms and Institutions", in Edquist, C. (ed.), *Systems of Innovation: Technologies, Institutions and Organisations*, London: Pinter Publishers, 1997.
7. Milgrom, P. and J. Roberts, "The Economics of Modern Manufacturing: Technology, Strategy, and Organization", in *The American Economic Review*, vol. 80, No. 3, Nashville, TN: The American Economic Association, 1990.
8. OECD, *Technology and the Economy: Key Relationships*, Paris: OECD, 1992; Rosenberg, N., *Inside the Blackbox: Technology and Economics*, Cambridge: Cambridge University Press, 1982.

I.3. Trends in Technological Collaborations

Drawing on the MERIT-CATI database, which records both single and bi-directional agreements, Hagedoorn and Schakenraad[9], Narula[10] and Narula and Sadowski[11] found a threefold increase in technological agreements over the last few years, from around 225 in 1980 to 670 in 1994[12]. Developed countries account for the bulk of the agreements signed which is consistent with the view that the technological activities of corporations are attracted into countries with similar technological capabilities[13]. The share of developing countries' and Eastern European firms in around 6.700 international technological agreements, although growing, has only averaged 6,2% of the total between 1980-1994, and is heavily concentrated in East Asian NICS (Taiwan, South Korea, Singapore and Hong Kong) and Eastern Europe[14].

The relatively low share of technological collaborations by Latin American and African countries is confirmed by data on 23.802 technological collaborations on information technology between 1984 and 1994 (see Table No. 1)[15] [16]. Developing countries and Eastern European firms accounted for 9,9% of the total. Of them, agreements involving Asian firms, mainly from China, Hong Kong, Taiwan, South Korea and Singapore accounted for 61,6%, Eastern Europe and former USSR firms accounted for 21,2% while Latin American and African firms accounted for 15,5% and 1,7% respectively.

9. Hagedoorn, J. and J. Schakenraad, "Inter-Firm Partnerships and Co-operative Strategies in Core Technologies", in Freeman, C. and L. Soete (eds), *New Explorations in the Economics of Technical Change*, London: Pinter Publishers, 1990.
10. Narula, R., "Forms of International Cooperation between Corporations", in Jrpma, C.J. and A.P. Hoen (eds.), *International Trade: A Business Perspective*, Harlow: Longman, 1996a, pp. 98-122; and "Strategic Alliances in Developing Countries: Prospects and Problems", mimeo, Netherlands: University of Maastricht, 1996b.
11. Narula R. and B. Sadowski, "Technological catch-up and strategic technology partnering in developing countries", in *MERIT Research Memoranda*, 98-02, Netherlands: Maastricht Economic Research Institute on Innovation and Technology, 1998 (forthcoming in *International Journal of Technology Management*).
12. The MERIT-CATI database includes 10.000 agreements involving 3.500 different parent companies. The main sources of information are the business press and journals, company annual reports and company directories and yearbooks. The focus is agreements that involve technology and the types of agreements included are multidirectional, including joint ventures, joint research companies, joint R&D, technology sharing agreements and cross-equity investments; and unidirectional, such as second sourcing, customer supplier relations and technology licensing.
13. Cantwell, J., "The International Agglomeration of R&D", in Casson, M. (ed.), *Global Research Strategy and International Competitiveness*, Oxford: Blackwell, 1991.
14. Narula, R., *op. cit.*
15. Vonortas, N.S. and S.P. Safioleas, "Strategic Alliances in Information Technology and Developing Countries Firms: Recent Evidence", in *World Development*, vol. 25, No. 5, London, New York: Elsevier Science B.V., May, 1997, pp. 657-680.
16. Data based on the Information Technology Strategic Alliances (ITSA) database compiled by Itsunami Inc. Like the MERIT-CATI database, this one is also built on the basis of newspapers and trade magazines. Definitions on what a collaboration or a 'strategic alliance' is, however, broader as ITSA includes all kinds of mergers and acquisitions, joint ventures, R&D agreements, licensing, equity investments, contractual agreements, standards coordination agreements and university-industry cooperation agreements.

Table No. 1
Technological collaborations in developed and developing countries, 1980-1994
(Number and %)

	1980-1994	1980-1987	1988-1994
Average annual number	452	364	552
Developed countries share (annual average)	93,9	94,5	93,1
Developing countries share (annual average)	6,2	5,5	6,9
Of which: East Asian New Industrialised Countries	3,6	3,5	3,9
Other Asia and Africa	0,5	0,9	0,4
Latin America	0,3	0,3	0,2
Eastern Europe	1,8	0,8	2,4

Source: Our own calculations on the basis of Narula R. and B. Sadowski, "Technological catch-up and strategic technology partnering in developing countries", en *MERIT Research Memoranda*, 98-02, Netherlands: Maastricht Economic Research Institute on Innovation and Technology, 1998.

I.4 Why the recent upsurge?

One of the most important factors underlying the recent growth of technological collaborations is the rapid development and diffusion of *new 'generic' technologies*[17] [18]. Since the mid-seventies the world has been facing the emergence of technologies such as information technology, biotechnology and new materials that are deeply affecting the innovation process. These technologies are pervasive in the sense that they affect the 'conventional wisdom' and day to day practices of engineers, managers and designers in all sectors of the economy as well as in their intersectoral relationships. They also affect every function of the firm. The upshot of these new technologies is that product research and development requires a considerable backlog of knowledge in, and the integration of, 'old' disciplines including physics, chemistry, mathematics, electrical and mechanical engineering together with 'new' ones such as computer science and electronics[19]. This, in turn, increases the demand for complementary knowledge and skills. It also involves the creation of 'radical' or 'never-before-seen' products that are in the technological frontier which not only require an even larger scientific input, but also much more experimentation and trial[20]. These products are also technically more complex in the sense that they require

17. Freeman, C., 'Networks of Innovators: A Synthesis of Research Issues", in *Research Policy*, vol. 20, No. 5, North Holland: Elsevier Science B.V., October 1991, pp. 499-514.
18. Around 40%, 20% and 10% of all the agreements recorded in the MERIT-CATI database were in the information technology, biotechnology and new materials fields respectively (Hagedoorn, J. and J. Schakenraad, "Inter-Firm Partnerships and Co-operative Strategies in Core Technologies", in Freeman, C. and L. Soete (eds), *New Explorations in the Economics of Technical Change*, London: Pinter Publishers, 1990).
19. Mody, A. and D. Wheeler, *Automation and World Competition*, London: Macmillan Press, 1990.
20. Kline, S.J. and N. Rosenberg, *op. cit.*

more components and parts and therefore are more difficult to design and build. In addition, the life cycle of many products is said to have shortened due to intense competition, adding pressure on firms to come up with new products much more quickly[21]. Many firms neither have the technical competencies nor the human, material and financial resources to engage in all of these kinds of activities.

There is yet another closely related reason for the increase in technological collaboration; namely, the *higher uncertainty* attached to present-day innovation. As Kline and Rosenberg[22] point out, because innovation implies creating novelty it is always uncertain whether a new product or process can be produced at all and at what cost, whether it can be produced with the desired technical or functional properties or whether it will be accepted by the market. It is true, of course that the degree of uncertainty will also depend on the extent of the innovation. In the cases of minor innovations, which imply small transformations of the characteristics of existing products and processes, the risks of failure are modest. But where 'radical' innovations are involved, as those that are emerging today, the uncertainties are obviously much higher. By sharing risks with other firms, any one firm's own uncertainty and risk could be reduced, making innovations, even of the 'radical' kind, much more attractive.

To sum up, technological collaborations arise out of three interrelated dimensions of the information and knowledge that flow during the innovation process, namely, specificity, tacitness and complementarity. The outcome of the interaction of these and the codified dimension of knowledge is cumulative, in that innovation results from the often-slow summation of minute pieces of information and knowledge. Available innovations, in turn, are the basis for the generation of more information and knowledge and hence a dynamic or 'snow-ball' process arises[23]. Technological collaborations vary widely in their intensity and forms and involve a one or a two-way flow of information. Their recent unprecedented growth is accounted for by the emergence of new generic technologies, such as information technology or biotechnology, which open immense possibilities for the generation and development of new products and processes and the growing research and development costs and uncertainty attached to these new technologies.

21. Stalk, G., "Time-The Next Source of Competitive Advantage", in *Harvard Business Review*, No. 88410, Boston, MA: Harvard Business School Press, 1988.
22. Kline, S.J. and N. Rosenberg, *op. cit.*
23. OECD, *op. cit.*; Rosenberg, N., *op. cit.*

II. THE CASE STUDIES

II.1 Extent of MERCOSUR collaborations and research approach

There are no accurate estimates of the extent of technological collaborations by MERCOSUR firms. On the basis of the MERIT-CATI database[24] there were around 18 agreement involving Latin American firms over the fifteen-year period when data was recorded. Not all of them would involve MERCOSUR firms nor would exclusively refer to bi-directional interactions. Considering the more broadly defined information technology agreement database the situation is only slightly improved as Brazil and Argentina accounted for around 80 and 33 agreements respectively between 1984-1994.

Given the small number of technological collaborations in MERCOSUR it seemed reasonable to base the study on structured case studies. Sao Paulo university had, for some time, build a number of technology oriented case studies which was possible to draw on[25]. Eleven collaborations were identified on the basis of archival material, published research and interviews were held in some firms to complement available data. Interviewees included the main owners, presidents of companies, board members, production, research and development and sales managers and individuals responsible of the collaboration projects, mainly in the local firm involved. Table No. 2 presents a summary of their main characteristics[26].

II.2 Key characteristics of collaborations

A first inspection of the case studies suggests that technological collaborations by MERCOSUR firms were concentrated in *medium to low tech sectors or in relatively less advanced technologies*, such as garments, mechanical engineering or at the lower end of

24. Hagedoorn, J. and J. Schakenraad, "Inter-Firm Partnerships and Co-operative Strategies in Core Technologies", in Freeman, C. and L. Soete (eds), *New Explorations in the Economics of Technical Change*, London: Pinter Publishers, 1990; Narula, R., *op. cit.*; Narula R. and B. Sadowski, *op. cit.*

25. For a fuller information and description of method and results see Alcorta, L., G.A. Plonski and C.A. Rimoli, "The Experience of Technological Collaborations by Mercosur Companies", in *Technology Analysis and Strategic Management*, vol. 10, No. 3, London, New York: Taylor and Francis Group, 1998; *Business Week*, "The New Latin Corporation"-International Cover, Boulder, Co: The MacGraw Hill Companies, October 27, 1997; Rimoli, C.A., "O Desempenho Competitivo de uma Pequena Empresa em um Setor em que a Atualização Tecnológica é Fundamental", mimeo, Sao Paulo: FEA/USP, 1997, and "Marketing Estratégico e Competitividade: um Estudo de Casos em Empresas que atuam no Mercosul", MA dissertation, Sao Paulo: FEA/USP, 1996; Sbragia, R. and M. Barra, "O Compartamento Inovador de Pequenas, Médidas e Grandes Empresas Latino-Americanas", CYTED Subprogram XVI, NPGCT-USP, No. 14, São Paulo: 1994; Stal, E., "Estudo de Caso: Metal Leve S.A.", *Cuadernos de Gestao Tecnológica*, No. 1, Programa Iberoamericano de Ciencia y Tecnología para el Desarrollo (CYTED), Subprograma de Gestión de la Investigación y el Desarrollo Tecnológico, December 1993; UNIDO, *National Case Studies: Brazil*, mimeo, Viena, Austria: UNIDO-ICS Guide, 1997; Vasconcellos, E. and R. Silva W., "Monitoring the "Health" of a Technology Alliance: Framework and Application", *Proceedings of the European Conference on Management of Technology*, United Kingdom: Aston University, July 1995.

26. Some of the names of the companies are fictitious due to requests for confidentiality.

Table No. 2
Technological Collaborations by MERCOSUR Companies

Firm or Firm Grouping Name	Collaborator	Nationality of Partners	Size of Partners by Employment*	Sector	Purpose of Cooperation	Brokered by	Mode of Governance	Approximate Duration of Partnership	Benefits to MERCOSUR Partner	Outcome of Cooperation
Acetila	Sucralc	Brazil/Brazil	Medium/ Medium	Chemical	Improve Quality and Increase Output	Sucralc	Informal Agreement	2 years	Improved Alcohol and Solvent Process	Possible Merger
Americana	32 Partners	Brazil	Small	Textiles/ Garments	Process Improvement	SEBRAE, ACIA	Informal Agreement	3 years	None yet	Continuing
Biobrás	Eli Lilly	Brazil /United States	Large/ Large	Pharmaceutical	Development and Production of Insulin Crystals	Brazilian Ministry of Health BNDES	Joint-venture	6 years	Plant for Insulin Crystals	Terminated
Biotira	Semantes Agroceres	Argentina /Brazil	Small/ Large	Agroindustry	Development and Production of Potato Seeds	CABBIO	Contractual Arrangement	5 years	Production of New Potato Variety	Terminated
CONIFARMA	21 Partners	Argentina, Brazil, Paraguay, Uruguay, Chile	Medium and Small	Pharmaceutical	Development of New Products and Process Improvement	Both Partners	Informal Agreement	2 years	Process Specialisation, Improvement and Problem Solving	Continuing
Freios Varga	Lucas	Brazil /United Kingdom	Large/ Large	Auto Components	Development of New Product and Process	Freios Varga	Equity Investment	15 years	New Plants and Brake Technology	Production and Regional Restructuring
GAMDI	15 Partners	Brazil	Medium and Small	Chemical, Food and Beverages	Process Improvement	Both Partners	Informal Agreement	5 years	Problem Solving	Continuing
Metal Leve	Allen Bradley	Brazil /United States	Large/ Large	Auto Components	Product Development	Partners	Joint-venture	7 years	Automation on Request by Customers	Continuing
Metal Leve	Kolbenschmidt	Brazil/Germany	Large/ Large	Auto Components	Process Development	Both Partners	Joint-venture	6 years	New Plants	Continuing
Vallée	International Health Corporation (IHC)	Brazil/Europe	Medium/ Large	Pharmaceutical (Veterinary)	Product Development	Both Partners	Contractual Arrangement	2-3 years	None	Terminated
Vallée	Vetcorp	Brazil/Australia	Medium/ Medium	Pharmaceutical (Veterinary)	Product Development	Vallée	Contractual Arrangement	1-2 years	None yet	Continuing

* A firm is classified as small if having less than 100 employees, medium if over 100 but less than 500 and large when more than 500 staff are employed.

pharmaceuticals and biotechnology. Three collaborations involving Freios Varga and Metal Leve, perhaps among the most successful firms in the region in terms of technological achievement and international competitiveness, are vehicle component manufacturers, which normally do not have a high research and development intensity. Technological collaborations in the biotechnology and pharmaceutical areas also are not in frontier areas. The collaborations between Sementes Agroceres and Biótica, between Biobrás and Eli Lilly and between Vallée and Vetcorp and Vallée and International Health Corporation (IHC) were in traditional areas of biotechnology such as micropropagation and use of living organisms for insulin extraction, i.e. did not involve genetic manipulation. In the case of CONIFARMA, an agreement between pharmaceutical companies from all MERCOSUR countries, the collaboration was only beginning to engage in new product research, which may eventually involve the use of genetic manipulation but at the moment it did not[27].

A pattern would also seem to be emerging with regards to firm size. Large firms are involved in agreements, which *create new products or processes*. Each partner's knowledge is combined so that a 'third' technology that is different from the inputs of both partners emerges. This is sometimes referred as 'fusion'[28]. Large firms in the sample had the finance and technological capacity to be part of these agreements. For example, the joint venture involving Sementes Agroceres, a manufacturer of agricultural seeds and animal food, aimed at researching and developing potato seeds that would later be put into large-scale production. Another collaboration, involving Biobrás and Eli Lilly, aimed at using Biobrás's production expertise internationally, developing and manufacturing insulin crystals and exporting them through Eli Lilly's distribution network. Freios Varga's collaboration with Lucas from the UK eventually developed new brake technology while the collaboration between Metal Leve and Allen Bradley, a US manufacturer of electronic controls and factory automation, focused on designing and manufacturing automation adaptable to developing countries' conditions.

In the case of medium and small firms the kinds of agreements entered would seem to vary much more in their nature. At one end, there is the case of Biótica, which was clearly

27. The relatively modest efforts in advanced biotechnology were quite surprising. Agriculture has always been a key sector for MERCOSUR countries and some 'easy' opportunities for new developments should constantly arise. There is a long-standing medical sciences tradition in Argentina, including a couple of Nobel laureates, which in principle should have some effect on innovation and technological collaborations. Indeed, a recent study on citations of scientific publications by Amsden and Mourshed ("Scientific Publications, Patents and Technological Capabilities in Late-industrializing Countries", in *Technology Analysis and Strategic Management*, vol. 9, No. 3, London, New York: Taylor and Francis Group, 1997) pointed at a 36% share of the biology, biochemistry and medicine fields in the total publications of authors from Argentina, Brazil, Chile and Mexico. Publications in the agriculture field accounted for another 20%.

28. Afriyie, K., "A Technology-Transfer Methodology for Developing Joint Production Strategies in Varying Technological Systems", in Contractor, F. and P. Lorange (eds.), *Cooperative Strategies in International Business*, Lexington, Mass: Lexington Books, D.C. Heath and Company, 1988b.

involved in innovation with the much larger Sementes Agroceres. The small firm could offer specific vegetable micropropagation and new potato seed technology that could be used in the partnership for the development of new products. At the other end, there were two collaborations encompassing small firms where the objective of the partnership was addressing specific problems or bottlenecks common to all. In these cases each partner provides an input in which each one has a distinct advantage but without leading into another product or technology but to improving existing information and knowledge. Americana, for instance, was a collaboration of 32 small and medium Brazilian textile and garment companies aimed at production process improvement, standardisation of quality, machine sharing and introduction of computerised design. These *problem-solving* kinds of agreements would seem to be more important to small enterprises, as large enterprises normally have the capacity to deal with these kinds of problems by themselves.

Turning to the country of origin of the collaborations the case studies suggested an important regularity. Where firms from advanced countries participated they were multinational corporations, often leading manufacturers of the products or processes under consideration and much larger in size than their domestic partner. In addition to technical exchanges multinational corporations were nearly invariably also seeking market access[29]. A case in point was the collaboration between Biobrás and Eli Lilly, the US transnational pharmaceutical company. The collaboration did not only involve knowledge exchange but was Eli Lilly's entry point to Brazil's insulin market. Collaborations by Freios Varga with Lucas, at least initially, and by Metal Leve with Allen Bradley were as much about developing jointly manufacturing facilities and new automation and brake technology as entering the local market. A similar relationship was found in one of the two case studies were Brazilian and Argentinean firms were involved together. Indeed, it has been suggested that *size and knowledge asymmetries* and *multiplicity of objectives* was also characteristic of technological collaborations between Brazilian and Argentinean firms, with the former normally being the largest and interested both in technology and market access[30].

By contrast, where collaborations involved firms from the same country there would seem to be a more exclusive emphasis on technology and knowledge exchange. In these

29. The importance of market entry as a key motivation for foreign firms when entering joint ventures with Brazilian firms has also been pointed out in other research. Dahab *et al.* ('Transferencia Tecnológica E Joint-Ventures No Brasil', in *Organizacao e Sociedade*, vol. 1, No. 1, Salvador: December 1993) show that in one-third of the joint-ventures established between 1989 and 1991 by a foreign and a Brazilian partner, the main motives given by foreign firm were accessing a new market, either in Brazil or abroad.
30. Ferraro, C.A. and F. Gatto, *Cooperación Empresarial en la que intervienen Firmas Brasileñas y Argentinas: Primeras Reflexiones que surgen del Trabajo de Campo*, Buenos Aires: UN/CEPAL, 1994; Gatto, F. and C.A. Ferraro, *Internacionalización de las Pequeñas y Medianas Empresas Argentinas en el MERCOSUR: Exportaciones y Modalidades de Cooperación Empresarial*, Buenos Aires: UN/CEPAL, 1994.

circumstances all partners equally use the assets contributed to the collaboration as they are geared to the same market. This was the case of Americana, although geographical proximity would seem to have facilitated the collaboration between partners. The collaboration between Sucralc and Acetila, two Brazilian firms involved in manufacturing alcohol from sugar cane and alcohol based solvents, was intended to increase the quality and volume of inputs and output in the Brazilian market.

As to the success of collaborations, most collaborations achieved what they intended and also reaped commercial gains. Out of the eleven collaborations examined five resulted in new products and processes. These included the production of potato seeds or insulin crystals or the establishment of new plants. In three other collaborations process improvements were achieved. For instance, Lord SA, one of GAMDI's member was able to perform urgent chromatographic analysis on a regular basis that otherwise would not be possible. The collaboration between Vallée and IHC failed and two others have not yielded any benefit yet.

III. SUCCESS FACTORS IN TECHNOLOGICAL COLLABORATIONS

III.1 Thorough Preparation

One of the major factors underlying the success of studied collaborations was the intensity of the managerial and financial *search efforts* that needed to be undertaken prior to the establishment of an agreement. It was clear in the cases of the collaborations involving Freios Varga, Sucralc and Vallée that the companies were not fully aware of the emerging trends in international technology development and partnership already evident to many firms elsewhere in the world. In all three of them it was only after commissioning reports from international consultancy firms that management was able to access the *relevant information* and to decide on the usefulness of a possible technological collaboration for their companies' strategies. In Sucralc's case the partnership eventually materialised with a local firm but by then the company had researched world-wide on possible new fermentation processes from sugar cane and on new sugar derived products.

Searching for the *right partner* was another major preparatory task. Finding an appropriate partner seemed to be an issue as the process of searching went well beyond spotting firms in the same industry or with apparently the same technologies and needs. In the partnerships involving Sucralc and Vallée information was requested to enable management to assess technically and economically several potential partners, many of them from abroad. Special efforts were made to establish the precise technical competencies of the potential partner

and how to mesh them with own competencies. Evaluations were also made on potential partners' organisational culture and on whether the companies will be able to work together.

Ensuring the *collaboration eventually runs smoothly* was not free of early effort either. After having had a negative experience with one of its collaborations Vallée also invested heavily in consultants and lawyers and in own management time to prepare for its agreement with Vetcorp. A number of dimensions were looked into prior to the new agreement. The first was the mode of cooperation, e.g. whether and what type of equity or non-equity agreement should be established. The second was financial and involved making accurate valuations of the assets and human resources to be contributed and estimates of potential benefits. This also included defining ways of protecting and appropriating the results of the partnership. The third dimension was managerial and involved devising the management procedures and practices that the partnership will have to follow. The fourth was developing negotiation and communication skills as the eventual success of the partnership was partially determined at the negotiating stage. Finally, given that foreign firms were to be involved there was the need to examine national business culture diversities, such as financial disclosure rules and styles of human resource management which, if very different, could become a an impediment to the activities of the partnership.

III.2 Clarity and Commonality of motives and method

The potentially negative impact of lack of *clarity and commonality of objectives* is perhaps best illustrated by the experience of Vallée. The company is a Brazilian manufacturer of pharmaceutical products for bovines, including vaccines, therapeutic drugs and anti-parasiticides. In the early nineties the company entered collaborations with IHC, an European company world leader in poultry and pork vaccines, aimed at developing poultry vaccines for the Brazilian market and with Vetcorp, an Australian local manufacturer of bovine vaccines beginning its expansion abroad, aimed at developing new bovine vaccines and diversifying product range also initially for the Brazilian market.

Vallée's collaboration with IHC contemplated a first stage were IHC products would be registered by Vallée in the Ministry of Agriculture and if registration was obtained quickly the products would be sold in the Brazilian market. In the meantime a fully blown technological collaboration would begin to be negotiated and implemented. Registration is a long and cumbersome process which normally takes years and modifications over existing registrations are easier to process so it made sense to have a marketing agreement while 'fine-tuning' the technical side of the agreement. The agreement began in 1991 with Vallée allocating two managers and four employees to IHC activities, submitting product registration papers to the Ministry of Agriculture and launching a market study for selling

poultry vaccine in Brazil. Up to this stage communications had been between Vallée's and IHC's top management in Brazil and occasionally with manager's from IHC's headquarters and had been formal and professional. Soon after the beginning of the agreement Vallée approached IHC for discussions on exchange of technical information and the establishment of joint production facilities particularly since IHC's product prices were 50% higher than those available for similar products in Brazil. Suggestions were also made for the involvement of technical personnel in the discussions. To Vallée's surprise, however, IHC always avoided to engage in a substantive discussion on technical exchange something that was compounded by the continuous change of IHC's management in Brazil. Also, IHC established its own subsidiary in Brazil and requested Vallée to transfer authorised products to the newly established subsidiary. Eventually, contacts broke down and the dispute had to be settled through arbitration. Vallée argued that IHC did not really want to collaborate with it but only wanted product registration. IHC pointed out that Vallée was using its power of registration to exact technology and money from it and was not interested in selling IHC's products.

Vallée, however, was not deterred by its relationship with IHC and as pointed out before engaged consultancy companies and lawyers offices to devise ways of being more successful with future collaborations. It is in this context that the collaboration with Vetcorp began. In this case initial negotiations were longer and protracted and although they also involved initially a local market distribution agreement, as products needed to be registered at the Ministry of Agriculture, the more technical issues and objectives to be achieved were brought up-front and clearly specified in the initial agreement. They had been much more vaguely referred to in the agreement with IHC. Vallée also made a point of immediately raising any doubt it had about the collaboration at whatever level was necessary and went at length at discussing with Vetcorp its expectations with the agreement and at explaining to its counterpart about local accountancy and business practices. At the moment both companies are beginning joint research on new products and examining the possibility of establishing new joint production facilities first in Brazil and later in Australia. There have been several visits by Vallée's technical and production personnel to Vetcorp's laboratories and production sites in Australia.

It is evident from both of Vallée's collaborations that the issue of the underlying objectives was approached differently. In the case of its agreement with IHC both companies would seem to have been pursuing different objectives. While Vallée seemed to be aiming at new product development apparently IHC was more interested in entering the Brazilian market with its own products or, to say the least, was ambiguous about its intentions. From the outset the collaboration had been 'loosely' approached as the discussion of key technical

dimensions was left for later. In fact, it was never undertaken. The divergence in objectives was complicated by what seemed to be poor communication between the management of both companies. By contrast, in the collaboration with Vetcorp the issue of what types of products, how would they be developed and what would each company contribute was addressed from the very beginning of the relationship. Only once both companies understood and agreed on the objectives did the collaboration proceeded even if this meant additional costs.

Once both partners have agreed with the objectives it was crucial for the success of the collaboration to introduce an *appropriate mode of governance* as these vary according to the type of exchange. Where exchanges involve process and problem solving technology and knowledge the main mechanism is an informal agreement. The main reason is that collaborations occur as and when a need arises or is not meant to create new knowledge and therefore a flexible and informal approach is more effective. This was the case, for instance, of the agreement between Sucralc and Acetila as the partnership was sanctioned by a 'gentlemen's' agreement' backed by a 'confidential' memorandum although later it may turn into a fully blown merger, as will be seen later. Where the collaboration involve the exchange of product and process knowledge the collaborations is better organised as an equity investment, a joint-venture or a contractual arrangement. In these cases the exchange of information and tacit knowledge is more intense and sustained and it is necessary to have a clear distribution of the outcome.

III.3 Creation of the Conditions for Learning

It is argued in the literature that technological collaborations are as much an agreement as a learning process, and a very draining one, between companies[31]. Over time learning is expected to occur on the environment the collaboration is facing, on the way the tasks are being performed, on the similarities and differences in procedures and organisations, on the actual skills each partner has and on the attitude of partners towards the goals of the collaboration[32]. Through a process of cognitive and behavioural learning and evaluation, or unlearning in certain cases, partners modify or improve on their initial conditions and trigger a virtuous evolutionary path for the collaboration or frustrate it. Transparency or openness and receptivity to information and knowledge exchange by partners need to

31. Doz, Y., "The Evolution of Cooperation in Strategic Alliances: Initial Conditions or Learning Processes?", in *Strategic Management Journal*, vol. 17, England, New York: John Wiley & Sons, 1996, pp. 55-83; Hamel, G., "Competition for Competence and Interpartner Learning within International Strategic Alliances", in *Strategic Management Journal*, vol. 12, England, New York: John Wiley & Sons, 1991, pp. 83-103; Spekman, R.E., L.A. Isabella, T.C. MacAvoy and T. Forbes, "Creating Strategic Alliances which Endure", in *Long Range Planning*, vol. 29, No. 3, North Holland: Elsevier Publishers B.V., 1996, pp. 346-357.
32. Doz, Y., *op. cit.*

underlie this process and are key to ensure each and all the dimensions of learning are 'appropriated' by both sides[33]. This learning process has a number of prerequisites including the degree of interaction and exchange of ideas, the extent of personnel movement and training, the building of trust and the adoption of methods of process assessment and monitoring.

As far as the *intensity of interaction* was concerned in most partnerships discussion teams involving all levels of management and relevant operational staff were created to implement the collaboration. In the case of collaborations organised as joint ventures personnel needed to be allocated, which in the case of Biobrás and Eli Lilly's joint venture, involved more than 100 staff from administration, research and development, production and marketing, from both companies. Biobrás, which had been producing enzymes for a number of years had been also successfully researching the extraction of insulin crystals from pork pancreas, as the technology was not far from enzyme extraction, although its main strength lied in manufacturing. Eli Lilly, who was a world leader in the extraction of insulin from living organisms, also brought its own approach to extraction. Although there was some friction over extraction methods the discussions would seem to have always been candid and in the end Eli Lilly's formulas and Biobrás's production methods were eventually chosen. As a result there was a continuous flow of information and knowledge according to both partners, both within the joint venture as well as between Biobrás's and Eli Lilly's management and an industrial plant was built after around two years.

Like in the Biobrás and Eli Lilly collaboration communication and open exchange of ideas was intense between successful partners although it seemed to be slightly higher in situations were there was a strong personal relationship or a clear commitment to the partnership at top management level. Also, information seemed to flow better between companies were a combination of formal, i.e. called by management, informal meetings, i.e. called by any staff member, together with collegial personal relationships emerged. The more often the discussions took place the more the partners seemed to learn from each other although some managers complained of the inordinate amount of time spent in meetings and preparations.

It is, again, the collaborations undertaken by Vallée that illustrate best how potential learning can be blocked by the lack of transparency and receptivity to the concerns of each other[34]. In Vallée's collaboration with IHC it was clear that IHC avoided discussing

33. Hamel, G., *op. cit.*
34. *Ibid.*

the technical aspects of the collaboration and established its own subsidiary apparently without informing its partner. Yet, Vallée may have not made enough efforts to identify markets that may have been willing to pay a premium price for IHC's products, and therefore was not receptive to IHC's marketing concerns. None of the partners believed that they were being fairly treated by the partner and that the partner was accommodating for its demands, but they never said so. In sharp contrast, Vallée's collaboration with Vetcorp discussions prior and during the collaboration took place slowly but frankly and at different levels within the companies. Partners tried to accommodate for each other and both companies have expressed a positive attitude to each other and a feeling of achievement.

Another major prerequisite for learning was *exchange of personnel and training*. The tacit nature of some of the knowledge that is created during collaborations requires secondment and training of personnel 'on-site'[35]. In five of the technological collaborations studied, all of them involving at least one foreign firm, study and training visits to the foreign partner's headquarters or offices elsewhere were often arranged as was the exchange of personnel between research and development centres. The Biobrás-Eli Lilly partnership, for instance, involved training of personnel in US and Argentina for up to eight months. In both of Metal Leve partnerships, with Allen-Bradley and Kolbenschmidt AG, there were regular exchanges of researchers between Metal Leve's technological centres in Sao Paulo and Ann Arbor, Michigan, and the research facilities of its counterparts in the US and Germany. Indeed, Metal Leve, not only had regular professional contacts with its foreign partners but had established research links with the universities of Standford, Batelle and Michigan in the US and the universities of Leeds, Aachen, Delft and Copenhagen in Europe. Often the same researchers involved in the partnerships had links with the universities.

Trust building also helps learning[36]. Following Humphrey and Schmitz[37] three types of trust were identified: contractual, competence and goodwill. Contractual trust involves partners obeying what is stipulated in the agreement. It helps learning by focusing the efforts of the collaboration. It would seem to have developed in the cases of CONIFARMA and GAMDI, as partners have always complied with the terms of their cooperation even though there is no contractual or otherwise means of enforcing it. By contrast, the

35. Senker J. and W. Faulkner, *op. cit.*
36. Aulakh, P.S., M. Kotabe and A. Sahay, "Trust and Performance in Cross-Border Marketing Partnerships: A Behavioral Approach", in *Journal of International Business Studies*, vol. 27, No. 5, Special Issue, Copenhagen: Copenhagen Business School, 1996, pp. 1005-1032; Doz, Y., *op. cit.*; Hamel, G., *op. cit.*; Johnson, J.L., J.B. Cullen, T. Sakano and H. Takenouchi, "Setting the Stage for Trust and Strategic Integration in Japanese-U.S. Cooperative Alliances", in *Journal of International Business Studies*, vol. 27, No. 5, Special Issue, Copenhagen: Copenhagen Business School, 1996, pp. 981-1004.
37. Humphrey J. and H. Schmitz, *Trust and Economic Development*, IDS Discussion Paper, No. 355, UK, Bringhton: University of Sussex, Institute of Development Studies, August 1996.

relationship between Vallée and IHC would seem to have been built on the basis of suspicion and distrust. Competence trust refers to the confidence in each other's ability to perform at its best. Vallée's relationship with Vetcorp would seem to have resulted in competence trust as at least the Brazilian partner was making every effort to match and improve on the Australian's partner knowledge. Goodwill trust is related to mutual expectations of open commitment to each other, implying that partners are dependable and can be endowed with great discretion. Where goodwill trust exists partners are able to enter into high-risk research areas. This would seem to have appeared in the case of Freios Varga and Lucas.

Having established process *assessment and monitoring procedures* allows further learning by making evident the technical advances, or lack of them. Five partnerships had elaborate evaluation schemes of the progress of the collaboration and a further three had some kind of informal assessment procedure. In the case of the three joint ventures studied the assessment involved analysing the usual operational and financial indicators in addition to monitoring the progress of the collaboration. The advance of the collaboration was evaluated once a particular stage in its evolution was completed or meant to be completed. At this moment the progress in technical aspects as well as the quality of the relationship was examined and the decision to move forward or to terminate the collaboration is taken. In the case of Vallée-Vetcorp's collaboration although it is still in progress a number of advantages are already emerging. Regarding technology, the collaboration is providing the knowledge inputs required at this stage and is forcing Vallée to make efforts to match the knowledge received with some new knowledge of its own. Concerning human resources, the agreement has resulted in an increase in motivation of the people involved in it, thus increasing their performance. The agreement with Vetcorp is also teaching Vallée how to integrate a partnership into its own organisation.

It is instructive to examine the collaboration between Freios Varga and Lucas as it seems to have progressed successfully through most of the learning cycle. The partnership has its origins in the early eighties as a marketing and technology transfer agreement for Lucas to enter the Brazilian market. A few years later, Freios Varga assessed its performance and decided to expand initially into Argentina and later into the US. Freios Varga approached Lucas to join it, this time as a partner. Lucas would continue providing its brake technology while Freios Varga would contribute with some initial knowledge of the US market, considerable knowledge about the Argentinean and other Latin American markets and especially, with very strong brake manufacturing capabilities. Freios Varga had improved its process technology significantly through minor adaptations and 'capacity stretching' and became known as one of the most efficient producers in the region and was beginning to develop its own brake technology. Lucas assessed the situation and concluded that the progress

made over the years in product and process technology by Freios Varga was significant and that it was worthwhile entering the partnership. As a result joint production facilities were opened both in Argentina and the US. But the collaboration did not end there. After further working together, Freios Varga and Lucas engaged jointly in developing, manufacturing and marketing a special kind of ABS brake technology for the US, Canadian and Latin American markets.

The learning process in the collaboration between Sementes Agroceres and Biótica was much bumpier. The former was a large company with 2.500 employees while the latter had only 28 employees and was strongly research oriented. Communications between owners and top management were cordial but vague in terms of technology. Indeed the decision to collaborate was taken by owners alone on the basis of the potential financial benefits. Technological specificity were always left to lower levels of management and operational levels and there were continuous conflicts between both firms arising from different understandings of what the aims of the collaboration were and the more rigid and structured business culture of the larger enterprise and the more relaxed and informal approach of the smaller one. There was no report of personnel exchange something that may have eased tensions and there were differences in methods to evaluation with management from the former focusing on financial results while staff from the latter was more concerned with technical advance.

III.4 Completion of Collaborative Cycle

Ensuring the success of collaboration also depends on whether the collaboration is actually achieving what it was meant for or, put in learning terms, whether the collaborative cycle has been completed. Around the time or when an expected breakthrough materialises a major review of the achievements needs to be made. The decision to continue, in which case new and perhaps closer ties begin, or to terminate the collaboration has to be taken. Termination does not necessarily mean failure as it often that the expected new knowledge has already been created or a new product launched into the market and therefore it is not necessary to continue the partnership[38]. There was an implicit time framework in the agreement[39].

38. Harrigan, K.R., *Managing for Joint Venture Success*, Lexington, Mass.: Lexington Books, D.C. Heath and Company, 1986.
39. Harrigan (*Ibid.*) shows that most technology cooperation agreements tend to be of *limited duration*. Around 50% of agreements considered successful by partners in the US are terminated in less than four years. Narula, R. ("Strategic Alliances in Developing Countries: Prospects and Problems", mimeo, Netherlands: University of Maastricht, 1996b), quoting *Business Week*, points at a failure rate of 70% in all international cooperative agreements.

The completion of the collaborative cycle involves achieving *tangible economic benefits.* In the collaboration between Sementes Agroceres and Biótica a new variety of potato seed was developed which was then planted and scaled up to industrial production levels in Argentina four years after the initiation of the project. The cost of the initial batch of new potatoes was US$ 90.000 per hectare, which was reduced to US$ 10.000 per hectare after the first year of full production. Given that there are further process improvements to make and as the company moves down the learning curve it is expected that the cost per hectare will be reduced to US$ 6.000, a figure that will make the collaboration a leading player in the Brazilian potato market.

The joint-venture between Biobrás and Eli Lilly led to the development and manufacturing of insulin crystals which are sold to Eli Lilly for distribution to chemists and the Ministry of Health. As a result Biobrás sales rose from US$ 2mn to US$ 10mn in the early eighties, doubled to US$ 20mn by the early nineties and increased again to US$ 40mn in the mid-nineties. The collaborations of Freios Varga and Metal Leve led to four new more efficient plants being built, two of which were in the US, and to the development of several new patentable brakes and pistons. The Pablo Casará pharmaceutical company, a member of the CONIFARMA partnership, was able, thanks to the technical exchanges with other members, to rationalise and improve the production process of anti-asthmatic devices and odontological and ophthalmologic products and as a result make available financial resources for research and development which would not have been possible prior to the collaboration.

Once collaborations have achieved intended results it is important to *question the continuation of the collaboration.* Although the partnership may have been successful both in terms of interactions and achievements they should continue or even be developed further only if objectives can continue to be fulfilled or new ones can be identified. Indeed, the outcome of the eight collaborations that had achieved intended results varied greatly. Two of them, Freios Varga-Lucas and Sucralc-Acetila had or were considering travelling towards higher stages of 'collaboration'. Since the mid-nineties Freios Varga and Lucas began engaging in a process of production and organisation integration involving production restructuring and relocation and co-ordination of production between factories in different countries. For Freios Varga this meant access to advanced technologies in all fields of brake manufacturing and a much higher level of output partially arising from economies of scale due to factory specialisation. It also meant access to Lucas's traditional markets in Europe and eventually in the Far East. In the case of Sucralc and Acetila, merger negotiations are at an advanced stage as the distribution of management and functions in the new company and the amount of shares to be exchanged between companies have already been agreed. There are clear technological and economic advantages to a merger between

both companies. A 30% cost reduction could be achieved only if alcohol and solvent production is concentrated in a single plant. Jointly, the new merged company would also be able to free resources for research and development and to combine their knowledge of sugar fermentation and alcohol based solvents. The only doubt in the horizon is whether alcohol based solvents can in the long run compete with petrochemical-based ones.

There were three collaborations that were consolidating at the present level of activity. Metal Leve agreement with its German partner was going well in terms of sales and there was no intention of upsetting it. The process improvement nature of GAMDI's and partially of CONIFARMA's collaborations meant that, in principle, they should be an ongoing affair and therefore no major change should take place. In the case of GAMDI there were some discussions to formalise the collaboration so that more regular use of the pool of equipment could be made but that was as far as the consolidation stage went.

But there were also three collaborations that terminated. One of these collaborations that ended was between Biobrás and Eli Lilly. In the mid-eighties, six years after the collaboration had started, Eli Lilly approached Biobrás to terminate the joint-venture. The reasons why Eli Lilly took such a step are not clear but are probably related to Eli Lilly's growing success in obtaining insulin through genetic engineering which would eventually reduce the cost of the product substantially and implied that insulin crystals made through traditional methods would be out-phased world-wide. Termination meant for Biobrás buying back the 45% share holding of Eli Lilly and more importantly, losing its main distribution channel.

Where termination is to take place it seems important that it is done in *amicable terms* as both partners may still gain after the collaboration has ended. In Biobras' and Eli Lilly's collaboration termination was achieved on friendly terms resulting in Biobrás obtained a two-year extension of the cancellation of the distribution agreement. The extension in turn gave it time to build its own distribution channels and move onto the production of insulin rather than only insulin crystals. It also gave it time to obtain backing of BNDES for the buy back of shares. Initially Biobrás controlled 90% of the insulin market but since liberalisation that share has fallen to 70% and is continuing to drop so the company is now considering also using genetic engineering techniques. One of its main competitors is Eli Lilly.

The two other collaborations that terminated were Metal Leve-Allen Bradley and Sementes Agroceres-Biótica. In the case of the former the reasons would seem to be financial and strategic. In the early nineties there was a sharp drop in the demand of vehicles and therefore of vehicle components prompting Metal Leve to restructure its operation. Initially

Metal Leve stopped financial support for the joint-venture but it soon realised it had to divest in order to strengthen other parts of the company. Metal Leve assessed its diversification strategy and concluded that its main competencies were in manufacturing vehicle components, not in selling the equipment that produced those components, so the partnership with Allen Bradley made no longer sense. The reasons were well understood by Allen Bradley who bought Metal Leve's shares in the joint-venture and since operates as an independent company.

IV. THE ROLE OF GOVERNMENT POLICY

Technological collaborations are essentially a private matter because they involve interactions between firms. External knowledge and institutional inputs are always required but the ways these are combined remain 'internal' to the firm. Yet, governments may help to establish and ensure their success by providing an adequate environment for their progress and through policies that help initiate and sustain collaboration and that bring about the involvement of other relevant institutions. Governments, however, can also hinder collaborations' development by sending confusing signals or plainly discouraging them.

IV.1 Creating an 'enabling' macroeconomic and policy environment

A significant contribution by government to the success of partnerships had been in the eyes of the managers of several collaborations the recently found *overall economic and political stability*. The previous murky economic and political conditions had been a major limitation to technological collaborations because of the large risks already involved in innovation. Foreign partners, in particular, did not want to add other major sources of risk such as high and variable inflation, repetitive devaluation and political and personal insecurity. It was mentioned that stability in Brazil and Argentina since 1990, costly in human and economic terms as it had been even to some surveyed firms, had allowed companies that had been able to weather the adjustment process successfully the possibility of planning better their investments and to look long term. To the extent that research and development (R&D) is a long-term investment it benefits from stable conditions. Stability was also felt to draw resources into productive rather than financial activities as there was no need for quick profits to compensate for high uncertainty. According to Matesco[40] this is not a factor raised in the literature as developed countries normally do not face the conditions faced in developing countries. But it is crucial for MERCOSUR firms, which have

40. Matesco, V., "Atividade Tecnológica deas Empresas Brasileiras: Desempenho e Motivação para Inovar", in *Perspectivas da Economia Brasileira 1994*, vol. 1, Rio de Janeiro: Instituto de Pesquisa Econômica Aplicada (IPEA), 1993, pp. 397-419.

gone through a period of intense economic instability. Stable economic and political conditions when accompanied by high and sustained growth rates could increase even further the potential for innovation and technological collaborations.

While the overall economic and political setting was favourable, particularly since 1990, and MERCOSUR governments began to get interested in encouraging partnerships there were some other sectoral policies that were at cross-purpose with government intentions. As was the case with Metal Leve the termination of the Sementes Agroceres-Biotica collaboration had also been prompted by financial strictures. At the beginning of the nineties the partnership faced a severe financial crunch due to an overall reduction in demand which affected consumption of corn seeds and human health diagnostic kits, the main products of both companies respectively. There was, however, one additional crucial factor that led to the termination. A number of health and import regulations were passed in Argentina and Brazil which difficult the trans-border trade of trans-genetic seeds and the equipment used in their manipulation. Given that the agreement involved the research stage of potato seed development in Brazil, the development of the seeds in fields in Argentina and the marketing back in Brazil, the regulation in effect killed the project. Agroceres had to close its research and development unit dedicated to plant biotechnology and transferred the know-how to Biótica in case it wanted to continue with the project. Agroceres has also stopped selling new potatoes in Brazil. The termination of this collaboration suggests that successful collaborations do not only benefit from a stable overall environment but that it is necessary to also ensure *consistency between macro and sectoral policies*, something that was not always the case in MERCOSUR countries.

IV.2 Introducing policies aimed at establishing and sustaining collaborations

Among MERCOSUR countries Brazil has a range of federal, state and local programmes and institutions with the potential to initiate and support technological collaborations. One of the most important initiatives is the Program to Support Industrial Technological Capability (PACTI). PACTI provides grants of up to 50% with a maximum of US$ 200.000 of the cost of research and development projects. These projects can be submitted jointly by private firms or between them and research institutions from the public sector. Financing for research and development projects can also be obtained from the National Development Bank (BNDES) and the Feasibility Studies Agency (FINEP), which can provide loans and equity investment for technological development. Similar funding programs are also run at the state level. Another key initiative is the Brazilian Service to Support Micro and Small Companies (SEBRAE). Established nationally in 1991 but operating at the state level with private sector participation, SEBRAE has among its objectives supporting the technological modernisation of medium and small firms through the provision of training, business services and finance and by bringing together firms encountering similar problems.

In Chile the government introduced in 1992 a number of funds aimed at strengthening the research and development (R&D) capacity of universities, research centres and enterprises. Included within them is the National Fund for Technological and Productive Development (FONTEC) which co-finances R&D, and technological infrastructure and services projects presented by private firms or group of them. University and research centre participation in the projects is also encouraged. In Argentina the Ministry of Industry has also started industrial extension programs aimed small and medium enterprises.

The impact of some of these initiatives and others on our case studies is illustrated by the experiences of the Biobrás-Eli Lilly and Americana collaborations. In the case of the Biobrás-Eli Lilly collaboration the Brazilian government played a key role throughout the partnership. To begin with, the Ministry of Health provided the initial information and identified the relevant partner for Eli Lilly by telling the foreign company about Biobrás's research on and intention to manufacture insulin and its technological capabilities. The Health Ministry was also involved in resolving the major technical and economic dilemmas that emerged during negotiations. It established a division of labour whereby the manufacture of the main raw material or insulin crystals would be done by collaboration between Biobrás and Eli Lilly and the production and distribution of insulin exclusively by Eli Lilly. It suggested the distribution of shares and the legal form of the collaboration, which eventually became a joint-venture with 55% of the capital owned by the Brazilian partner. It gave the joint-venture the monopoly of the production of insulin crystals in Brazil and Eli Lilly the possibility of selling directly to chemists and to the Ministry of Health diabetes programme. Finally, it arranged for Brazil's official development bank BNDES, to provide the financing for the venture.

In Americana's case a similar role was performed by SEBRAE. Americana, is a small city located in São Paulo State, Brazil. Americana is said to have the greatest concentration of textile and garment companies in the country, mainly small and medium enterprises (SME)s. The total number of companies exceeds 900, of which around 50 provide sewing services. Although very successful for a number of years, it was increasingly felt by some of Americana's companies that they had to modernise if they were to remain competitive.

It is in this context that SEBRAE, jointly with the University of Sao Paulo and the local small and medium enterprise association (ACIA) approached the enterprises to join in a co-operative effort to achieve cost reductions and improve the production and marketing processes. Some 32 firms decided to cooperate. SEBRAE first suggested to the companies to immediately co-ordinate technological and investment decisions to avoid duplication and unnecessary increase in productive capacity. SEBRAE then selected a sample of 10

firms to be assessed by specialists in technology, manufacturing process, marketing, finance, accounting and law. SEBRAE would then provide the technical and financial support to implement the recommendations of the assessment. The recommendations are now being implemented and involve brand and quality standardisation; joint buying, selling and sewing facilities; sharing underused equipment and maintenance costs; improving design capabilities by obtaining information on international fashion trends, establishing a technical library, and adopting computer-aided-design systems; and, developing and implementing management and control systems.

It is difficult to pass a general judgement on the overall effectiveness of government policies on the basis of the few case studies analysed. Nonetheless, these few experiences suggest first, that government programmes and institutions can perform a unique and positive role in initiating collaborations *by becoming an alternative source of information and knowledge, a forum for information exchange and discussion, promoters and funders of R&D projects and by brokering between potential partners.* To an extent, they can substitute for firms' initial internal efforts. Second, they can provide the conditions for the successful operation of partnerships by *delimiting responsibilities* and modes of governance and therefore the proceeds of the collaboration and eventually by providing a market for the output of the collaboration. Third, the effectiveness of government policies in initiating and sustaining technological collaborations would seem to be related to the *specificity of the programmes*, with the closer to the sector or the technology the greatest their success, as the needs of firms vary widely from one sector or even subsector to another.

IV.3 Partnering with representative organisations

One further element in ensuring effective government policy implementation would seem to be the participation or even operating through relevant institutions such *as business associations, research centres or universities.* These institutions have first hand knowledge of the precise needs of some of their members and often have the information and experience required initiating and sustaining collaborations. As was seen in the case of Americana, SEBRAE operated in collaboration with the local small and medium enterprise association (ACIA) which made it much easier to bring firms together and get them to collaborate. The importance of involving business associations was evident also in the collaboration between Sementes Agroceres and Biótica. In this case, it was the Brazilian-Argentinean Centre for Biotechnology (CABBIO), a joint government funded but privately run association of firms and individuals concerned with the development of biotechnology in Argentina and Brazil and established in the context of MERCOSUR's biotechnology industry protocol. CABBIO brought the partners together, supported the collaboration through organising meetings and discussions on the potential for new potato varieties consumption in the region, financed

the initial contacts and work required to get the agreement of the ground and set the guidelines for the eventual contract. Other research has also pointed out at the positive role business associations such as those of sugar/alcohol (COPERSUCAR), shoes, leather and ceramic products manufacturers have had in initiating technological collaborations[41]. These associations initially acted as a political lobby but then turned into the promotion of information exchange and improving the technological capabilities of their members.

V. FINAL REMARKS

In analysing technological collaborations by MERCOSUR firms it was found that the better prepared a corporation entered an agreement the more successful the collaboration was likely to be. It was not only a matter of finding the right match technologically, which in itself was a difficult task and required screening locally and internationally the advances taking place in the field of interest, but also identifying the correct institutional match as corporations had also to coincide in their expectations and the means to achieve them and should be able to combine their national and business cultures with that of their partners. A casual approach to collaboration can very quickly turn into conflict and termination without any concrete benefits.

The case studies revealed that it was not only a solid preparation that guaranteed success in collaborations. It was also necessary during the implementation of the cooperation to engage in a collaborative learning process or learning cycle. This learning cycle required intense technical interactions and exchange of ideas with partners, exchange and training of personnel and the adoption of methods of assessment. Where technical interactions were well intended, transparent and participants were receptive to each other the collaboration would seem to have progressed smoothly and partners felt that the relationship had been fair and accommodating to their interests. The flow of information and knowledge was greatly enhanced where interactions took place at different levels of the firm and had been mediated by a combination of formal, informal and personal relationships. Exchange of personnel and training brought an even better understanding of the technical and institutional differences between partners while continuous assessment provided the partnership with a sense of achievement both in terms of the fairness and adaptability of partners and in terms of output. Indeed, the trajectory followed by some collaborations suggest a cumulative and mutually beneficial pathway of learning for firms entering and being successful with even the most basic kinds of collaborations but that quickly and

41. Tendler, J. and M. A. Amorim, "Small Firms and Their Helpers: Lessons on Demand", in *World Development*, vol. 24, No. 3, London, New York: Elsevier Science B.V., March 1996, pp. 407-426; UNIDO, *op. cit.*

accurately assess their technical and economic performance and capitalise on previous success by moving on to a next stage.

An important finding that deviates even further from the literature has to do with the role of government. It was clear that some of the more restrictive government policies would seem to have partially hampered the continuation of one of the collaborations studied. Yet, in mot cases they had a key positive role. Government policies, programmes and institutions brought partners together by providing information and acting as a forum for discussion; creating the conditions for the successful operation of the partnerships; granting financial support for the creation of and at crucial junctures in partnerships; and, establishing the mechanisms or modes of governance in some of the collaborations analysed. Governments' effectiveness in initiating and sustaining technological collaborations would seem to be related to the capacity to bring other relevant institutions and the specificity of the associations and programmes, with the closer to the sector or the technology the greatest their effectiveness, as the needs of firms vary widely from one sector or even subsector to another.

Expanding technological collaborations will be no easy task for the majority of MERCOSUR firms. It requires major investments in capital goods, scientific instrumentation, new organisational techniques, R&D and R&D personnel. It also requires unremittingly engaging in all the phases of the innovation process. But the government could play an even more facilitating role.

One first area for further policy intervention is increasing the *efficiency of existing government programs aimed at innovation*. At the moment there are a number of programs or institutions, such as PACTI or SEBRAE, which are promoting technological collaboration and innovation with varying degrees of success[42]. The efficiency of these programs could be increased by incorporating a number of interrelated ideas arising in the field of economics of asymmetric information[43]. One first idea refers to the use of incentive contracts. These are basically contracts that introduce incentives to achieve a particular objective without taking all the risk away from the beneficiary. Existing co-sharing agreements go some way in this direction but a fixed proportion of cofinancing, as most of the existing promotional mechanisms have, does not address the specificities of the risks involved in each project. A related idea is a change in the criteria for eligibility ('signalling') in government programmes. The experience of use of government programs shows that only those firms that are more

42. Tendler, J. and M. A. Amorim, *op. cit.*
43. Alcorta L. and W. Peres, *Sistemas de Innovación y Especialización Tecnológica en América Latina y el Caribe*, Serie Desarrollo Productivo, No. 33, Santiago de Chile: CEPAL, 1996.

advanced technologically are the ones that use those programs. Human resource requirements, such as having a number of PhDs for research, for instance, contribute to that as most firms have never seen a PhD. A switch towards criteria that better reflect the objectives or results being sought would further increase the efficiency of programmes. A third idea refers to the use of insurance contracts that would reduce the risk of failure to firms and as a result prompt them to enter high-tech sectors.

Public policy could also have a larger and direct impact on the growth and quality of technological collaboration agreements. Obviously there is the need for more systematic research and data on the impact of policy on technological collaborations in MERCOSUR. Meanwhile, however, there are a number of concrete policy initiatives that could be useful given the present state of knowledge. One first policy initiative refers to making *information on the potential of technological collaboration* and on possible specific cooperation more widely available. This would be of particular use to SMEs, which do not have the resources to hire external consultants. More extensive awareness and publicity campaigns, as those already initiated in Chile, could be quite effective too. The second policy initiative refers to *allocating specific funds or loans for technological partnering*, particularly between firms as although programmes allow for this the emphasis is not on inter-firm collaborations[44]. Funding could go to brokering or consultancy services to identify possible partners and assist negotiations or to financing specific aspects of an agreement, especially in high-tech fields. A third policy initiative would be to introduce specific funding mechanisms for *upgrading partnerships*, which involve only marketing agreements. One final, rather bold, policy initiative would be to support strictly technical *collaboration agreements with firms that have no presence in the MERCOSUR* region, particularly with regards to information technologies, biotechnology and new materials. Preferably this should be done with small and medium enterprises from developed countries or equivalent firms from developing countries to avoid possible size and knowledge asymmetries as the collaboration between Vallée and Vetcorp illustrated. This would have the advantage of bringing new knowledge into the region and should result in the emergence of new high-tech businesses.

Another area for public policy is complementing supply with *demand oriented incentives*. Although a more general justification for demand driven programs is still pending, it does seem reasonable to say that they could be a good complement to supply driven ones[45]. The impact of government procurement policies in countries such as the US, Korea or Taiwan has been extremely positive in developing local productive and technological capabilities

44. Baranson, J., *Strategic Alliances with Global Industry: Case Study of Mexico*, Working Paper Series 166, Washington, D.C.: Inter-American Development Bank, September 1993.
45. Tendler, J. and M. A. Amorim, *op. cit.*

and technological partnerships in high tech areas. But demand oriented policies need not limit themselves to government procurement. Promoting the sale of new products to foreign markets or promoting agreements between local partners or between local and foreign partners for exports of new products, could be an effective way of linking technology and trade policies. Egan and Mody[46] point out that these kinds of export agreements reduce barriers to entry to foreign markets and provide information about markets that otherwise would not be available. And, policies promoting export-oriented partnerships would not contravene any of the current international trading regulations.

There is also a role for public policy intervention in the *simplification and flexibilisation* of rules and institutions and in creating *homogeneity in technological collaboration regulations* across MERCOSUR countries. Given the repeated complaint by business 'clients', there does seem to be a clear-cut case now for simplifying the cumbersome and bureaucratic procedures to access innovation and technological partnership programs and identify mechanisms that are precisely tuned to collaborations. Universities' 'liaison' offices would seem to be an appropriate model for the academic sector and perhaps a similar approach could be used by government agencies. Whatever institutional solution or approach is chosen it has to be vested with great flexibility and discretion. Only if the new or modified institutions and approaches have those capacities will they be able to tailor programs, incentives and contracts to the specific needs, and perceptions, of users. Regarding homogeneity, there seems to be ample scope for the promotion of intra-MERCOSUR partnerships. Collaborations are already taking place and they are only likely to increase as integration expands. But sustaining growing partnerships will require more commonality in legislation and incentives between MERCOSUR countries in order to avoid unnecessary costs and misunderstandings. More interactions between local firms and individuals will help to address the problem of differences in business cultures. Exchange and mobility programs between professionals, technicians, researchers and students should also help to reduce differences.

46. Egan, M.L. and A. Mody, "Buyer-Seller Links in Export Development", in *World Development*, vol. 20, No. 3, London, New York: Elsevier Science B.V., 1992.

REFERENCES

Afriyie, K., "A Technology-Transfer Methodology for Developing Joint Production Strategies in Varying Technological Systems", in Contractor, F. and P. Lorange (eds.), *Cooperative Strategies in International Business*, Lexington, Mass: Lexington Books, D.C. Heath and Company, 1988b.

Albornoz, M., "De la "Anomalía Argentina" a una Visión Articulada del Desarrollo CyT", in *Redes*, No. 7, vol. 3, Buenos Aires: Universidad de Quilmes, September 1996, pp. 53-77.

Alcorta, L., *Flexible Automation and Developing Countries*, London and New York: Routledge, 1998.

Alcorta, L., G.A. Plonski and C.A. Rimoli, "The Experience of Technological Collaborations by Mercosur Companies", in *Technology Analysis and Strategic Management*, vol. 10, No. 3, London, New York: Taylor and Francis Group, 1998.

Alcorta L. and W. Peres, *Sistemas de Innovación y Especialización Tecnológica en América Latina y el Caribe*, Serie Desarrollo Productivo, No. 33, Santiago de Chile: CEPAL, 1996.

Amsden, A.H. and M. Mourshed, "Scientific Publications, Patents and Technological Capabilities in Late-industrializing Countries", in *Technology Analysis and Strategic Management*, vol. 9, No. 3, London, New York: Taylor and Francis Group, 1997.

Arocena, R., *Competitividad: ¿hacia dónde puede ir Uruguay?*, Montevideo: Ciesu, Ediciones Trilce, 1996.

Associação Nacional de Pesquisa e Desenvolvimento das Empresas Inovadoras (ANPEI), "Indicadores Empresariais de Inovação Tecnológica: Resultados da Base de Dados", Rio de Janeiro: ANPEI, 1996.

Aulakh, P.S., M. Kotabe and A. Sahay, "Trust and Performance in Cross-Border Marketing Partnerships: A Behavioral Approach", in *Journal of International Business Studies*, vol. 27, No. 5, Special Issue, Copenhagen: Copenhagen Business School, 1996, pp. 1005-1032.

Baranson, J., *Strategic Alliances with Global Industry: Case Study of Mexico*, Working Paper Series 166, Washington, D.C.: Inter-American Development Bank, September 1993.

Bortagaray, I. and J. Sutz, *Una aproximación primaria al Sistema Nacional de Innovación de Uruguay*, Montevideo: Ciesu, Ediciones Trilce, 1996.

Bruno, M.A.C., *Gestão da Cooperação Técnica entre Empresas e Estratégia Empresarial: Estudos de Caso no Setor Químico*, São Paulo: Universidade de São Paulo, 1995.

Business Week, "The New Latin Corporation"-International Cover, Boulder, Co: The MacGraw Hill Companies, October 27, 1997.

Casson, M. (ed.), *Global Research Strategy and International Competitiveness*, Oxford: Blackwell, 1991.

Cantwell, J., "The International Agglomeration of R&D", in Casson, M. (ed.), *Global Research Strategy and International Competitiveness*, Oxford: Blackwell, 1991.

Catullo, J.C., "Mercosur, Ciencia, Tecnología e Innovación: una Nueva Etapa", in Sbragia, Roberto, J. Marcovitch y E. Vasconcellos, *Gestão da Inovação Tecnológica*, Anais do XIX Simpósio de Gestão da Inovação Tecnológica, USP/PGT/FIA/PACTo, São Paulo: Tec-Art Editora, 1996, pp. 67-85.

Chesnais, F., "Technological Agreements, Networks and Selected Issues in Economic Theory", in Coombs, R., A. Richards, P.P. Saviotti, and V. Walsh (eds.), *Technological Collaboration: The Dynamics of Cooperation in Industrial Innovation*, Cheltenham: Edward Elgar Publishings, 1996.

Chudnovsky, D. and A. López, *Política tecnológica en Argentina: Hay Algo Más que Laissez Faire?*, Documentos de Trabajo, 20, Buenos Aires, Argentina: Centro de Investigación para la Transformación (CENIT), 1996.

Confederação Nacional da Indústria, Serviço Nacional de Aprendizagem Industrial (CNI-SENAI), *Demanda por Informação Tecnológica pelo Setor Produtivo: Pesquisa 1996*, Rio de Janeiro: CNI, DAMPI e SENAI-CIET, 1996.

Conselho Nacional de Desenvolvimento Científico e Tecnológico, Ministério da Ciência e Tecnologia, *Brasil: Indicadores Nacionais de Ciência e Tecnologia 1990-1995*, Brasilia: MCT/CNPq, 1997.

Contractor, F. and P. Lorange, "Why Should Firms Cooperate? The Strategy and Economics Basis for Cooperative Ventures", in Contractor, F. and P. Lorange (eds.), *Cooperative Strategies in International Business*, Lexington, Mass: Lexington Books, D.C. Heath and Company, 1988a.

Contractor, F. and P. Lorange (eds.), *Cooperative Strategies in International Business*, Lexington, Mass: Lexington Books, D.C. Heath and Company, 1988b.

Coombs, R., A. Richards, P.P. Saviotti, and V. Walsh, "Introduction: technological collaboration and networks of alliances in the innovation process", in Coombs, R., A. Richards, P.P. Saviotti, and V. Walsh (eds.), *Technological Collaboration: The Dynamics of Cooperation in Industrial Innovation*, Cheltenham: Edward Elgar Publishings, 1996.

Coombs, R., A. Richards, P.P. Saviotti, and V. Walsh (eds.), *Technological Collaboration: The Dynamics of Cooperation in Industrial Innovation*, Cheltenham: Edward Elgar Publishings, 1996.

Dahab, S.S., F. Guimaraes, and J.R. Dantas, "Transferencia Tecnológica E Joint-Ventures No Brasil", in *Organizacao e Sociedade*, vol. 1, No. 1, Salvador: December 1993.

Dahlman, C.J. and C.R. Frischtak, "National Systems Supporting Technical Advances in Industry: the Brazilian Experience", in Nelson, R.R. (ed.), *National Innovation Systems: A Comparative Analysis*, Oxford: Oxford University Press, 1993.

Dahlman, C.J. and F.V. Fonseca, "From Technological Dependence to Technological Development: The Case of Usiminas Steelplant in Brazil", in Katz, J. (ed.), *Technology Generation in Latin American Industries*, London: Macmillan Press, 1987.

Doz, Y., "The Evolution of Cooperation in Strategic Alliances: Initial Conditions or Learning Processes?", in *Strategic Management Journal*, vol. 17, England, New York: John Wiley & Sons, 1996, pp. 55-83.

Edquist, C. (ed.), *Systems of Innovation: Technologies, Institutions and Organisations*, London: Pinter Publishers, 1997.

Egan, M.L. and A. Mody, "Buyer-Seller Links in Export Development", in *World Development*, vol. 20, No. 3, London, New York: Elsevier Science B.V., 1992.

Ferraro, C.A. and F. Gatto, *Cooperación Empresarial en la que intervienen Firmas Brasileñas y Argentinas: Primeras Reflexiones que surgen del Trabajo de Campo*, Buenos Aires: UN/CEPAL, 1994.

Freeman, C., "Networks of Innovators: A Synthesis of Research Issues", in *Research Policy*, vol. 20, No. 5, North Holland: Elsevier Science B.V., October 1991, pp. 499-514.

Freeman, C. and J. Hagedoorn, "Catching Up or Falling Behind: Patterns in International Interfirm Technology Partnering", in *World Development*, vol. 22, No. 5, London, New York: Elsevier Science B.V., May 1994, pp. 771-780.

Freeman, C. and L. Soete (eds.), *New Explorations in the Economics of Technical Change*, London: Pinter Publishers, 1990.

Foray, D., "Generation and Distribution of Technological Knowledge: Incentives, Norms and Institutions", in Edquist, C. (ed.), *Systems of Innovation: Technologies, Institutions and Organisations*, London: Pinter Publishers, 1997.

Gatto, F. and C.A. Ferraro, *Internacionalización de las Pequeñas y Medianas Empresas Argentinas en el MERCOSUR: Exportaciones y Modalidades de Cooperación Empresarial*, Buenos Aires: UN/CEPAL, 1994.

Hagedoorn, J., "Understanding the Rationale of Strategic Technology Partnering: Interorganizational Modes of Cooperation and Sectoral Differences", in *Strategic Management Journal*, vol. 14, England, New York: John Wiley & Sons, 1993, pp. 371-385.

Hagedoorn, J. and R. Narula, "Choosing Organizational Modes of Strategic Technology Partnering: International and Sectoral Differences", in *Journal of International Business Studies*, vol. 27, No. 2, Copenhagen: Copenhagen Business School, 1996, pp. 265-284.

Hagedoorn, J. and J. Schakenraad, "The Effect of Strategic Technology Alliances on Company Performance", in *Strategic Management Journal*, vol. 15, England, New York: John Wiley & Sons, 1994, pp. 291-309.

Hagedoorn, J. and J. Schakenraad, "Inter-Firm Partnerships and Co-operative Strategies in Core Technologies", in Freeman, C. and L. Soete (eds), *New Explorations in the Economics of Technical Change*, London: Pinter Publishers, 1990.

Hamel, G., "Competition for Competence and Interpartner Learning within International Strategic Alliances", in *Strategic Management Journal*, vol. 12, England, New York: John Wiley & Sons, 1991, pp. 83-103.

Harrigan, K.R., "Joint Ventures and Competitive Strategy", in *Strategic Management Journal*, vol. 9, England, Nueva York: John Wiley & Sons, 1988, pp. 141-158.

Harrigan, K.R., *Managing for Joint Venture Success*, Lexington, Mass.: Lexington Books, D.C. Heath and Company, 1986.

Harrigan, K.R., *Strategies for Joint Ventures*, Lexington, Mass.: Lexington Books, D.C. Heath and Company, 1985.

Humphrey J. and H. Schmitz, *Trust and Economic Development*, IDS Discussion Paper, No. 355, UK, Bringhton: University of Sussex, Institute of Development Studies, August 1996.

INOVA, Gestão & Tecnologia, "O Impacto das Mudanças Globais na Transferência de Tecnologia", ano IV, No. 14, Boletim do Núcleo de Política e Gestão Tecnológica da Universidade de São Paulo, São Paulo: NPGCT/USP, 1997.

Jepma, C.J. and A.P. Hoen (eds.), *International Trade: A Business Perspective*, Harlow: Longman, 1996, pp. 98-122.

Johnson, J.L., J.B. Cullen, T. Sakano and H. Takenouchi, "Setting the Stage for Trust and Strategic Integration in Japanese-U.S. Cooperative Alliances", in *Journal of International Business Studies*, vol. 27, No. 5, Special Issue, Copenhagen: Copenhagen Business School, 1996, pp. 981-1004.

Katz, J., "Domestic Technology Generation in LDCs: A Review of Research Findings", in Katz, J. (ed.), *Technology Generation in Latin American Industries*, London: Macmillan Press, 1987.

Katz, J. (ed.), *Technology Generation in Latin American Industries*, London: Macmillan Press, 1987.

Kline, S.J. and N. Rosenberg, "An Overview of Innovation", in Landau R. and N. Rosenberg (eds.), *The Positive Sum Strategy*, Washington, D.C.: National Academic Press, 1986.

Landau R. and N. Rosenberg (eds.), *The Positive Sum Strategy*, Washington, D.C.: National Academic Press, 1986.

Marcovitch, J., "Competitividade e Tecnologia no Brasil", São Paulo: Universidade de São Paulo, unpublished document, 1992.

Marcovitch, J., J. Dellacha and J.C. Carullo, *Revisión de las Políticas de Tecnología Industrial en América Latina*, Viena: UNIDO, 1995.

Matesco, V., *Esforço Tecnológico das Empresas Brasileiras*, Discussion text No. 333, Rio de Janeiro: Instituto de Pesquisa Econômica Aplicada (IPEA), 1994.

Matesco, V., "Atividade Tecnológica deas Empresas Brasileiras: Desempenho e Motivação para Inovar", in *Perspectivas da Economia Brasleira 1994*, vol. 1, Rio de Janeiro: Instituto de Pesquisa Econômica Aplicada (IPEA), 1993, pp. 397-419.

Maxwell, P., "Adequate Technological Strategy in an Imperfect Economic Context: A Case-Study of the Evolution of the Acindar Steelplant in Rosario, Argentina", in Katz, J. (ed.), *Technology Generation in Latin American Industries*, London: Macmillan Press, 1987.

Mercosul: Revista de Negócios - Mercado do Cone Sul, "Via Láctea nos Pampas", No. 58, Año VI, São Paulo: Superintendência de Comunicação Social da FCESP, May 1997, pp. 20-21.

Milgrom, P. and J. Roberts, "The Economics of Modern Manufacturing: Technology, Strategy, and Organization", in *The American Economic Review*, vol. 80, No. 3, Nashville, TN: The American Economic Association, 1990.

Mody, A. and D. Wheeler, *Automation and World Competition*, London: Macmillan Press, 1990.

Narula R. and B. Sadowski, "Technological catch-up and strategic technology partnering in developing countries", in *MERIT Research Memoranda*, 98-02, Netherlands: Maastricht Economic Research Institute on Innovation and Technology, 1998 (forthcoming in *International Journal of Technology Management*).

Narula, R., "Forms of International Cooperation between Corporations", in Jepma, C.J. and A.P. Hoen (eds.), *International Trade: A Business Perspective*, Harlow: Longman, 1996a, pp. 98-122.

Narula, R., "Strategic Alliances in Developing Countries: Prospects and Problems", mimeo, Netherlands: University of Maastricht, 1996b.

Nelson, R.C., "Strategic Alliances and Bargaining in Chile", prepared for delivery at the 1995 meeting of the Latin American Studies Association, Washington, D.C., September 28-30, 1995.

Nelson, R.R. (ed.), *National Innovation Systems: A Comparative Analysis*, Oxford: Oxford University Press, 1993.

Organisation for Economic Cooperation and Development (OECD), *Reviews of National Science and Technology Policy. Republic of Korea*, Paris: OECD, 1996.

Organisation for Economic Cooperation and Development (OECD), *Technology and the Economy: Key Relationships*, Paris: OECD, 1992.

Perrone, I. and N. Tello, "En la Línea de Largada", in *Mercosul: Revista de Negócios - Mercado do Cone Sul*, No. 54; Año V, São Paulo: Superintendência de Comunicação Social da FCESP, December, 1996, pp. 32-33.

Rimoli, C.A., "O Desempenho Competitivo de uma Pequena Empresa em um Setor em que a Atualização Tecnológica é Fundamental", mimeo, Sao Paulo: FEA/USP, 1997.

Rimoli, C.A., "Marketing Estratégico e Competitividade: um Estudo de Casos em Empresas que atuam no Mercosul", MA dissertation, Sao Paulo: FEA/USP, 1996.

Rosenberg, N., *Inside the Blackbox: Technology and Economics*, Cambridge: Cambridge University Press, 1982.

Santos, S.A., H. Rattner, V. Beraldo, "Pólo de Modernização Empresarial: Desenvolvimento nas Micro e Pequenas Empresas", in *Revista de Adminstração*, vol. 28, No. 1, São Paulo: FEA/USP, Jan-Mar., 1993, pp. 14-24.

Sbragia, R. and M. Barra, "O Compartamento Inovador de Pequenas, Médidas e Grandes Empresas Latino-Americanas", CYTED Subprogram XVI, NPGCT-USP, No. 14, São Paulo: 1994.

Sbragia, R. and J.C.C. Terra, *Embraer: Trajetória de uma Empresa de alta Tecnologia Brasileira*, Cadernos de Gestão Tecnológica, No. 8, São Paulo: CYTED, Subprogram XVI, NPGCT Universidade da São Paulo, 1993.

Senker, J. and M. Sharp, "Organizational Learning in Cooperative Alliances: Some Case Studies in Biotechnology", in *Technology Analysis and Strategic Management*, vol. 9, No. 1, London, New York: Taylor and Francis Group, 1997.

Senker, J. and W. Faulkner, "Networks, Tacit Knowledge and Innovation", in Coombs, R., A. Richards, P.P. Saviotti, and V. Walsh (eds.), *Technological Collaboration: The Dynamics of Cooperation in Industrial Innovation*, Cheltenham: Edward Elgar Publishings, 1996.

Spekman, R.E., L.A. Isabella, T.C. MacAvoy and T. Forbes, "Creating Strategic Alliances which Endure", in *Long Range Planning*, vol. 29, No. 3, North Holland: Elsevier Publishers B.V., 1996, pp. 346-357.

Stal, E., "Estudo de Caso: Metal Leve S.A.", *Cuadernos de Gestao Tecnológica*, No. 1, Programa Iberoamericano de Ciencia y Tecnología para el Desarrollo (CYTED), Subprograma de Gestión de la Investigación y el Desarrollo Tecnológico, December 1993.

Stalk, G., "Time-The Next Source of Competitive Advantage", in *Harvard Business Review*, No. 88410, Boston, MA: Harvard Business School Press, 1988.

Tendler, J. and M. Alves Amorim, "Small Firms and Their Helpers: Lessons on Demand", in *World Development*, vol. 24, No. 3, London, New York: Elsevier Science B.V., March 1996, pp. 407-426.

UNESCO, *World Science Report*, Paris: UNESCO, 1996.

United Nations Conference on Trade and Development (UNCTAD), *Technological Capacity-building and Technology Partnership: Field Findings, Country Experiences and Programmes*, New York and Geneva: UN, 1995.

United Nations Conference on Trade and Development (UNCTAD), *Country Case Study Submitted by Argentina*, Geneva: Trade and Development Board, Ad Hoc Working Group, TD/B/WG.5/Misc.10, November 1993.

UNIDO, *National Case Studies: Brazil*, mimeo, Viena, Austria: UNIDO-ICS Guide, 1997.

Vasconcellos, E. and R. Silva W., "Monitoring the "Health" of a Technology Alliance: Framework and Application", *Proceedings of the European Conference on Management of Technology*, United Kingdom: Aston University, July 1995.

Vassalo, C., "Aonde vai a Cofap?" in *Exame*, São Paulo: June 19, 1996, pp. 56-58.

Vassalo, C. and P. Nogueira, "Como a Metal Leve perdeu o passo", in *Exame*, São Paulo: July 3, 1996, pp. 74-76.

Vignolo, F. and G.P. Wechsler, "La Innovación Tecnológica en Chile: Lecciones de un Estudio de Casos de Empresas Manufactureras Exitosas", Serie Documentos de Trabajo, Universidad de Chile: Departamento de Ingeniería Industrial, 1992.

Vonortas, N.S. and S.P. Safioleas, "Strategic Alliances in Information Technology and Developing Countries Firms: Recent Evidence", in *World Development*, vol. 25, No. 5, London, New York: Elsevier Science B.V., May 1997, pp. 657-680.

Waissbluth S., M., E. Testart T., and R. Buitelaar, *Cien Empresas Innovadoras en Iberoamérica*, Santiago de Chile: Programa CYTED-D, Universidad de Valparaíso, 1992.

Yamin, M., "Understanding 'Strategic Alliances': The Limits of Transaction Cost Economics", in Coombs, R., A. Richards, P.P. Saviotti, and V. Walsh (eds.), *Technological Collaboration: The Dynamics of Cooperation in Industrial Innovation*, Cheltenham: Edward Elgar Publishings, 1996.