13 Science and Production in Venezuela: Two 'Emergencies'

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This article attempts to analyze two historical moments in the evolution of Venezuela's scientific community. Both these periods can be summed up by the Spanish word *emergencia*, whose double meaning—emergence and emergency—allows us to draw a path from its origins to the present crises along an elliptical path. Thus, Venezuela's scientific community will be studied at two moments in its history—first, when it emerged, looking at the conditions surrounding its birth; and second, in the present crisis, within a context of changing social 'paradigms'. Thus, this chapter will proceed to analyze the scientific community from its emergence to its state of emergency.[1] One central explanatory theme runs throughout this essay: the link between science and production which constituted a basic and constant desire during the formation of the scientific community, its practices, styles, its world image, as well as in its changing relationships with society.

The chapter is divided into two parts. The first is a brief socio-historical outline of the processes of emergence, institutionalization and crisis which have conformed Venezuela's scientific community. Hence, the intention is to show that since its origins as a community of scientific researchers, local science has been constructed upon a socially, politically, economically, and even culturally, weak basis from which it has tried to grow and multiply.[2] Thus, we would like to show the diverse scientific styles which have been forged in the confrontation between the actors of scientific and technological practice on the one hand, and the social, political and economic space in which they were embedded on the other. In the transcourse of this confrontation, a new important political space was created in Venezuela, namely, that of science policy.

The second part, as will be explained in more detail, is based on two empirical investigations: one on entrepreneurs' attitudes when facing technological change and the other on the main characteristics of the behaviour of Venezuela's scientific community. These investigations demonstrate that the weaknesses inherited from the intermittent and uncertain legitimacy of the scientific community in a context of continuous political uncertainty

created a profound paradox, which can only provoke surprise. On the one hand, one observes serious material limitations and a low standard of living for researchers and, on the other, there appears a kind of 'Dutch disease' in science, that is, an abundance of resources far more than are needed that provokes a sort of financial intoxication. By intending to understand this situation, these pages try to contribute to the self-awareness of the local scientific community and to provoke a discussion on current local scientific and technological policy.

The Emergence of the Scientific Community

The Conformation of the Actors (1936–1969)

THE SCIENTIFIC COMMUNITY: The bond between science and production is present in the initial discourse of Venezuela's scientific community. From the very beginning and in one way or another it underlies all relationships between the actors in the process. What each one understands as 'science' and 'production' is something we will try to understand throughout this chapter. However, the so-called 'modernization' in Venezuela which appears with the death of the dictator Juan Vicente Gomez in 1936 was always accompanied by the ideal of democratization through 'science as the basis for progress'. In other words, the old, radical and authentic positivist ideal, almost one hundred years later survived as the intellectual model that was used in the development of new institutions and new scientific practices.[3] Elsewhere (see Arvanitis, 1990; Rengifo, 1990), we have explained these simultaneous events: modernization provided the opportunity to create new spaces for scientific practice, especially within the state, bringing together foreign consultants, local professionals and international foundations for agronomy related problems (Arvanitis and Bardini, 1992) or in the struggle against malaria (Gutiérrez, 1992). Those who were guiding the process within the state had been the active opponents of the preceding dictatorship, embodying a democratic ideal.

These first steps led to the constitution and institutionalization of Venezuela's scientific community—a process that can be characterized as being overdue, difficult and incomplete, just as the national development scene has been. Overdue, in relation to the maturity of other regional communities such as Argentina, Brazil and Chile for example; difficult, because its main interlocutors either frequently changed the rules of the game or interfered in the affairs of the academic community; and finally, incomplete, because institutionalization cannot take place without social legitimacy. What has limited the legitimacy of Venezuela's scientific community facing other actors, such as the state, entrepreneurs and society in general, has been the

continuous misunderstandings on what science should be for and how it should grow (Rengifo, 1986).

One example can be shown by asking the following question: when can we first speak of a scientific community in Venezuela? Marcel Roche[4] believes that it came into being with the foundation in 1950 of the Asociación Venezolana para el Avance de la Ciencia (AsoVAC), which may be considered as an initial achievement. However, Venezuela's research community was no more than ten individuals during this period (Ardila, 1981). This very small number, however, covered a varied range of professionals who carried out part-time or full-time scientific work such as collecting data and elaborating scientific and experimental analysis along with other tasks, mainly professional ones (such as medicine, agronomy and engineering). These professionals were also active administrators and managers of research as well as practitioners themselves (physicians, engineers or experts). The outstanding figures of science in Venezuela were known as much for their professional activities as for their research activities. In short, they were professionals who carried out 'applied' work and their exclusion is the claim of a rupture within the scientific community.[5] By stating that the scientific community is so small and emerges only in 1950 or after that, a cut is postulated between research and all other 'scientific' activities, that is, activities that use scientific knowledge. Such a cut can only be operated at the very high cost of misunderstanding by the rest of society. It is because such a cut is operated that there appears a need to construct a discourse on 'applied' research.

As Arvanitis (1990) has clearly pointed out, the discourse on 'applied science' with all the burden of confusion, desperation and error is the key to understanding the development of science in Venezuela.[6] Apart from conveying a linear and erroneous image of the process of research, this discourse has obliged scientists to obtain social, political and cultural legitimacy appealing to the usefulness and applicability of scientific effort to resolve national problems. The lack of clarity in this discourse and the diverging positions adopted by scientists contributed to eclipsing the community's attempts to obtain legitimacy. One very illustrative episode has been the opposition of scientists in 1969 when CONICIT was created. 'Academic' scientists opposed the 'applied' scientists, and the former won over the latter both an ideological battle and a political fight, since the more famous 'academic' scientists acquired the governance of CONICIT (Texera, 1983; Rengifo, 1990). 'Applied' scientists were excluded from the governance of the scientific community, a fact that needs to be analyzed in order to understand the rupture which took place, or rather the silent confrontation, between two 'scientific styles'. Table 13.1, extracted from our previous research, summarizes this opposition.[7]

The 'applied' scientists were born within the state framework and they could be considered as an expression of its urgent need to modernize,

TABLE 13.1
Two 'Scientific Styles' of Scientists

Applied Scientists	*Academic Scientists*
The subject of science policy is the research team	The subject of science policy is the individual researcher
Research priorities are determined by the state	Research priorities are determined by the scientists
Applied science should be the first priority	Basic science should be the first priority
Research serves the solution of national problems	Research serves the development of science

which became explosively apparent in 1936: malaria *had* to be eradicated so that oil exploration could take place and the modernization of agriculture could continue. The latter, along with cattle breeding, needed agronomic and veterinary research. All these activities needed expertise on water distribution and use. Thus, these 'experts' were from the beginning legitimate and all they needed was to project their image to the rest of society. In a nutshell, they did not have to justify the 'usefulness' of their knowledge. In contrast to the 'applied' scientists, the 'academic' scientists belonged to a younger generation—the one that came to maturity with the foundation of AsoVAC in 1950—who considered themselves as the country's founders of modern science and all its predecessors as scientific 'forerunners'. Their source of legitimacy was not these professional activities but research itself. Their main aim was to promote the 'ethos' of science (Freites, 1984; Vessuri, 1992). As regards their international links, the 'applied' scientists were very closely linked to the oil companies, the World Health Organization, the Rockefeller Foundation and to various international experts and consultants that visited the country.[8]

The 'academics' for their part had a more tense relationship with the state. This tension was first of all on political matters. In 1950, a new dictatorship, that of Perez Jimenez (1950–1958), closed the universities and relegated a growing number of academics with overseas qualifications either to private professional practice or to autonomous spaces which were created at that moment, such as the Luis Roche Foundation (Roche, 1987). The 'academic' groups were mostly democrats and because of that, after the dictatorship, they were to take command. Again, the link between a social project—modernization—and a political project—democratization—was drawn. But this time, it was not the scientific 'experts' but rather the scientific 'researchers' who were to materialize it.

By contrast to what occurred with the 'applied' scientists, international science did not come to Venezuela as the result of the expertise associated with local public scientists. Rather, new scientific areas began to spring up first in the country due to the action of young researchers who had active

links with international science. Thus, the formerly 'applied' work carried out by the state enrolled science (the malaria division of the Ministry of Health or the research division of the Ministry for Agriculture, for instance) was seen by the 'academics' as mere 'modifications' or reproductions of protocols designed by experts or international agencies. Furthermore, academics believed that the administrative tasks associated with 'applied' science influenced research negatively because of a lack of exclusive dedication to research.[9]

These differences are central to an understanding of the weaknesses and obstacles of the local scientific community. With the advent of democracy in 1958, the leaders of the 'academic' scientists, such as De Venanzi, Roche and Garcia Arocha, came to occupy important posts. Their power to summon the community along with their national recognition and prestige made them the creators of the community's most important project since its institutionalization in 1950, that is, the creation of a research council (CONICIT). Throughout the period from 1950 up to the creation of CONICIT in 1969, the arguments of the 'academics' were to clash with those of the 'applied' scientists (see Table 13.1). However, both groups used the motto 'science is the basis for progress' and recognized the need to link science and production. Gradually, the local scientific community was to increasingly identify itself with the themes and priorities of the international scientific system, which was its main source of recognition, and it continued to develop in the midst of constant criticism based on its lack of usefulness.

Ironically, twenty years after the creation of CONICIT, when the division between 'academics' and 'applied' scientists was resolved in favour of the 'academic' scientists, the strategies and arguments which were those of the 'applied' scientists were to surface again in a different political and institutional context.

THE STATE: In the course of the process of emergence of the scientific community, the role of the state has varied. At the end of the Gomez dictatorship (which came to an end in 1936), the opening of the country led to new political and economic sectors, which in turn created a demand for modernization. The Venezuelan state needed specialized knowledge in various fields such as health, agriculture and cattle breeding, transport and administrative organization. It began to modernize education through the creation of institutes, schools and new professional careers.[10]

One probable reason for this intense institutional creation may have been the role of academia. The attitude of the university in this process has been of resistance to change.[11] While the state and local society were pressing for modernization through scientific knowledge, the university maintained its traditional 'aloofness' (Silva Michelena and Sonntag, 1970)

by being inaccessible, isolated from society's demands and resistant to change.[12]

Thus, the state has been an essential actor in creating new scientific spaces, even under the dictatorship of Perez Jimenez (1950–1958). While the capacity of scientific expertise within the state grew, there no longer appeared any scandalously urgent areas, such as the sanitary matters of the 1930s. Moreover, the state was able to begin tasks linked to industrialization, modern agriculture and the frontiers of knowledge itself, since the state could count on a technical and administrative infrastructure for its operations. In fact, it then had at its disposal 'translators' which allowed it to identify needs and propose solutions. Ironically, when the first 'science policy' was implemented in 1950, the debate over science and its relevance to society's needs as administered by the state began to disappear.

But it was a 'science policy' with a very special flavour. The modernization promoted by the Venezuelan state (at that moment under the hard rule of dictatorship) was a modernization *sui generis* crystallized in the 'New National Ideal' formulated by the dictator Perez Jimenez, supported by the wealth from oil and aimed at the development of basic industries.[13] Some scientists, like Fernandez Moran, lent themselves to become part of the delirium of the dictator, who in his military megalomania dreamt of atomic weapons, and in exchange of the financing of a nuclear reactor accepted the creation of a research centre on neurology (Ruiz Calderón, 1987). Probably a larger portion of the scientists, many of whom were founders of AsoVAC, became scientific leaders after the late 1950s. They tasted the fruits of international science through their postgraduate studies, understood the significance of state supported science, knew of the Manhattan Project and wanted actively to be part of the feast of science, 'not only eat the rest of the banquet' (as stated by Roche in 1963, cited in ibid.: 251).

In this outline of the 1950s what must be emphasized is the misunderstanding which arose in the dialogue between science and the power structure, the consequences of which are still being felt. This exchange was ambiguous because neither the state was interested in the type of science offered by a small scientific community increasingly oriented to the external world and politically hostile, nor was this community dotted with the political, technical and attitudinal features able to satisfy the state's needs for symbolic and practical knowledge. This mismatch clouded the discussion and its influence was felt when scientific policy got crystallized later on in the formation of CONICIT in 1969.

THE ENTREPRENEURS: Where were the entrepreneurs in this process where science links with production? What role did the actors in-charge of the productive apparatus play? This is not the place to analyze the pattern of national industrialization which would answer these questions. However,

an attempt will be made to give a brief answer based on a Weberian type hypothesis and some structuralist explanations as to Venezuela's position in the international division of labour.[14] The conformation of the local elites and their presence in a state with an increasing distributive and productive capacity are the cornerstones of this analysis.

Venezuela's leaders did not include industrialization at the onset in their ideological framework. Thus, arts and crafts and technical applications were considered to be of lesser importance and even disdainful activities in Hispanic–American culture. This disdain for the 'mechanical arts' was certainly not conducive to the creation of a 'Schumpeterian' entrepreneurial spirit, and specially so an industrial spirit.[15] Furthermore, the presence of a very rich state, which distributed quite liberally the wealth gained from oil, encouraged parasitic social conducts to a much greater degree than ever imagined even by Gunder Frank of those who he called, with some irony, the 'lumpen bourgeoisie'.

These two factors together generated a modernization financed by oil without having to pay the cultural and political price for it. This is clearly expressed in the phrase which was coined by Uslar Pietri, 'sowing oil'; it reveals a proposition for an agrarian Venezuela away from industrial chimneys and, more importantly, hostile to a civilization based on technology.[16] Two historical facts serve to reinforce this argument. One being that the Reciprocal Trade Treaty with the United States existed until industrialization was under way in 1970, and was elaborated with the consent of the economically powerful groups even though it mortgaged the possibility of industrialization. The other fact, supported by today's reality, is the enormous number of immigrants in the creation of industry, almost 75 per cent by the end of the 1970s.[17]

An entrepreneurial class with these characteristics, isolated from the image of the 'captains of industry', with inappropriate business skills either due to the absence of a tradition or fragmentation could only be little concerned with the place of scientific and technical knowledge in production. In addition, the economic policy based on an overvalued Bolívar and protectionism completed the picture. In this context, the productive sector's representation to the debate could only be a rhetorical figure. In spite of the sporadic participation of some business personalities, who were typical representatives of the 'phantom' body of national bourgeoisie, they led a movement known as 'Pro-Venezuela'.[18]

Science, Production and the State (1969–1985)

The historical stage to be evaluated now is that of the institutionalization of the scientific community and science policy. In this period, we observe a plethora of diagnoses, planning, abundant self-criticism and persistence of errors. During these years the science–production relation

was given priority in policy studies, public discourse and 'naive' commentaries.

NATIONAL COUNCIL OF SCIENCE AND TECHNOLOGY (CONICIT): THE PLANNING DELIRIUM: The study of this period must be centred around its principal protagonist—CONICIT.[19] The leading role that this institution has played is an indisputable fact, which is unusual in a country where every social initiative is influenced positively or negatively by the logic of the state or its institutions. The first thing to highlight is the genesis of CONICIT as a space for the 'explicit' formulation of science policy. The distinction between explicit and implicit science and technology policy as put forward by Amilkar Herrera has a descriptive relevance here. As it has been stated with little success since 1975,[20] institutional S&T policy in Venezuela was regulated more thoroughly and implicitly by many different government ministries than by the explicit science policy authority, which was CONICIT.[21]

In effect, the Ministry of Education (more than 60 per cent of all research was carried out in public universities), the Ministry of the Economy (which directed industrial and thus technology policy), the Ministry of the Treasury (the public treasury's instruments as well as the tax laws influenced the rhythm of technical change) and, finally the Petroleros de Venezuela, S.A. (PDVSA), the state oil company (its research centre INTEVEP is the research institution with more resources than any other in the country), all in varying ways directed the S&T policy. Moreover, PDVSA and the Corporación Venezolana de Guayana (CVG), another state holding which controls the steel, aluminium and electricity sectors, together managed industries which generated around three-quarters of the GNP, and yet none of their policies, not even those with a very explicit science or technological content, had anything to do with the policies and even less with the opinion of CONICIT.[22]

By the ennd of the 1960s, the country's first diagnosis related to science was made by Gasparini (1969). Some results can be recalled: a minimum of 1,629 and a maximum of 2,109 people declared that they were researchers, but only between 549 and 711 of these researchers had published at least two publications and 41 per cent belonged to the 'hard' sciences, 31 per cent to the social sciences and the rest were scattered throughout the humanities.[23] In addition, Gasparini showed there existed a role tension or latent conflict which appeared to be the expression of the lack of recognition and legitimacy suffered by the local scientific community. The ambiguous discourse in relation to the usefulness of science already mentioned produced this role tension because the role itself (research) had no 'social density'.[24] It is this small scientific community, led by such great men as De Venanzi and Roche, which tried to convince the executive of the need for an autonomous research council to be controlled by the research community, and whose role would be to administer and not plan. The council eventually did emerge and could be described, as far as its 'science' policy

was concerned, as a 'petty cash box' for science but with a lot of money. Such an omnipresent state as the Venezuelan one could not accept such an extreme laissez-faire proposition from the scientific community, even less so when it was campaigning to centralize its power and resources. Moreover, within the very public administration itself, in the Ministry of the Economy, the 'applied' scientists could be heard lobbying for a useful science, 'really really useful' under state control. So there was an urgent need to define a technology policy. But the lack of entrepreneurs in the debate, the lack of importance granted to knowledge in production and, furthermore, the non-selective importation of technological solutions against the choice of 'alternative' technologies or the construction of the country's own technological capacity all conspired against the definition of a technology policy (Avalos, 1984).

The concern for technology, beyond the inevitable adaptations of processes and products to local conditions, was not more than either a rhetorical stance, a symbol of modernity of every respectable company, or an individual effort by some entrepreneurs in specific sectors who demanded technology on a daily basis almost going against the current of local industry. In this context, entrepreneurial participation in the design of CONICIT was a personal adventure achieved by industrialists who can easily be named and who were concerned about the future of the country.

CONICIT emerged as an interesting offspring of these diverging projects, but with one element which initially was the cause for 'terror' among the scientific community and which later on would produce 'noise' in the communication between the different actors, that is, CONICIT's planning role. Just like the Greek gods or Feurerbach's god, CONICIT freed itself from its creators, acquiring the status of an independent social actor, or in philosophical language it alienated itself.[25] The planning capacity had an objective of its own: 'non dependent technological development', 'self-reliance' and other similar maxims appealing to the need for a useful science and for applied research.

To understand this situation better, a comparison related to radio will be employed (Pirela, Rengifo and Arvanitis, 1991; Pirela, Rengifo, Arvanitis and Mercado, 1991). The relationship between science and the productive apparatus in Venezuela is analogous to that between FM and AM radio frequencies: independently of whether their broadcasts coincide or not, the researchers transmit and receive in FM, while the firms do the same in AM. These are two incompatible frequencies because they represent different practices performed by diverse social actors in a locus which is equally dissimilar, while simultaneously each participant relies on different financial sources (Pirela, Rengifo, Arvanitis and Mercado, 1991). As was stated at the beginning of this article, the differences must be made clear before the similarities are highlighted. And there are a lot of differences

between those who value knowledge and those who understand value; both represent distinct cultural codes (Rengifo, 1990).

Progressive autonomy as regards CONICIT was a process where the institution began to formulate its objectives in a way different than was dealt with either by the scientists or the 'productive' sector. In terms of the comparison with radio, the planning body tried to make everyone transmit on only one frequency in an attempt to create a type of powerful meta-frequency. The result has been the emergence of another frequency, a type of short wave which does not coincide with either FM or AM but produces its own 'noise' which recurrently 'pollutes' the atmosphere.[26] The abundance of laborious and seemingly useless plans of S&T appeared in their maximum expression at the end of the 1970s. It is not surprising that Antonorsi and Avalos concluded their overview of the planning of S&T with the suggestion: 'Planning cannot, at least now, be total and global. It cannot even be ambitious. It has to be full of Franciscan humility and tend toward the concentration of effort . . . in specific exercises' (Antonorsi-Blaco and Avalos, 1980: 174).

THE 'REAL COUNTRY': Far away from the paper moving bureaucracy, in the period we examine (1969–1989), the 'real country' is significant from what could be labelled the 'easy' import-substitution model. In spite of Venezuela's exceptional circumstances of being an oil producing country with a semi-open economy (Mommer, 1987, 1989), its over-protected industry selling in captive markets soon weakened. The option of producing capital goods arose, with its need to pass through more complex phases of the industrial process incorporating greater local added value through vertical integration of companies and, for the first time, to explicitly pay more attention to the issue of technology. This process expanded in the mid-1970s in the midst of contradictions resulting from the crisis of the world industrial model and the simultaneous three-fold increase of oil income. The 'crisis' was to act as a 'catalyst' for concern about technology affecting some industrialists and the state, as shown by the creation of the Council for the Development of the Capital Goods Industry (CONDIBIECA) and the Technology Direction in the Ministry of the Economy.

A detailed revision of this period is however not necessary and only some relevant points will be mentioned. The main aim of these policies and the concern of industry were geared towards the negotiation of technology. Topics such as the diffusion of information on alternative technologies, the necessary disaggregation of technological packages, the avoidance of restrictive clauses in technology contracts, the licensing of trademarks and patents and the strict regulation of foreign investment became the major issues of discussion. These concerns can be summed up in this way: control over the demand for foreign technology and orientation towards local

supply. This scheme, although it seemed reasonable, never worked for several reasons. One of the reasons is that precisely in the 1970s there appeared the first signs of a distinct techno-economic model (Pérez, 1985).[27]

New technologies such as micro-electronics and informatics, biotechnology, new materials, and alternative energy sources made their first industrial appearance at that moment. Industry was facing emergent globalization, the changing structure of costs and new forms of organizing production (flexible production scales, 'Toyotism' or Japanese style management of labour and production, total quality control). Knowledge intensive industries became more widespread. To all this must be added the ideological crises due to the advance of a postmodern culture, the plummeting of socialist models and the consequent adaptations of the world system and, particularly in Latin America, the onerous foreign debt. The chain reaction which this new wave of innovations caused along with social imbalances evinced the faint attempts made by the state to link research and production. Nobody really attempted to formalize a policy that would go beyond the 'linking' of university with the productive sector. This is because nobody really had a proper diagnostic analysis of what was going on in industry and what types of activities the firms developed in their laboratories and R&D units. Some of these issues are discussed in the next section.

Among some sociologists, the firm and the entrepreneur became an object of study and of political action because they were the spaces of technological change. But still, discourse was more on applied research and its linkage to the firms rather than the advent of 'technological research', the learning processes, the emergence of hybrid areas of academic research under the interests of industry, or the network model brought about in the context of rapidly changing technology.[28]

The Open Economy Model: Technology becomes Fashionable

The collection of new policies initiated in 1989, popularly known as 'the package', was implemented in the midst of so many and varied planetary transformations taking place so vertiginously that Lampedusa's phrase is involuntarily brought to mind: everything changes so that everything stays the same. So this part of our text is 'fragile' and rather fragmentary, even more than what should be the norm for social sciences.[29] The fact is that from 1989 the first steps towards constituting an open economy were taken. The following text of Avalos (1991: 32) is an extract which can be deemed as the best 'provisional interpretation' that is available so far till the end of 1991 in Venezuela.

> In synthesis, what is implemented in Venezuela is a market economy, as open as possible, so that the country can efficiently and advantageously

be inserted in the process of economic globalization. Lack of state intervention, privatization, deregulation, competitiveness, exports, trade reforms, are key aspects of the scheme, and are part of the first transformations which have taken place . . . . I would say that certain extreme positions are being adopted due to the desire to break all links with the past; I hope that soon we will be again able to speak of subsidies and social justice without having to be labelled enemies of the market economy and of productivity. I would also say that we are trying to go too fast without taking into account the doses of change which our productive structures can take. This last point is especially relevant . . . technological development, the corner-stone of the reforms to be implemented, is a question of time, of a long time, if we take into account our starting point.

In spite of what I have just stated, I admit that we couldn't keep going on as before and that the country is generally headed in the right direction given in its own circumstances and especially those which the world is experiencing which were outlined, if I may be allowed to oversimplify, in the meetings of the GATT. The new rules of the game have been laid down and they must be known, interpreted and managed. In other words we must learn to play the economic game according to their rules and obtain the greatest benefit possible.

As we said, technology is now the main interest of the policies of the state. Technology management, initiatives for research–firm links, and prospective technology are all priority issues in CONICIT's discourse. We insist on saying discourse, because despite good intentions this institution does not have any real impact in either the productive plant or at the decision levels where industrial policy is designed. So it will still have to forge a discourse on the usefulness of science, very far from the practice of using science. Moreover, the science policy of the state and the everyday functioning of the scientific community will create a rather paradoxical situation: the scientific community is going to live the coming years between the boundaries of bare survival and financial intoxication. And the struggle to escape from the former and take part in the latter may be complicated and risky since the rules are still not well known. In effect, one of the results of the open economy has been that the state has sold a great deal of assets in public firms. This money is in part reversed to CONICIT. Moreover, a great deal of new technology programmes with support from the Inter American Bank (a project financing bank as the World Bank) are still in operation. Thus, there are large amounts of money that can be oriented towards projects, while at the same time the normal budgetary size seems grossly insufficient for reasons that have more to do with the accumulated deterioration of the financial situation and infrastructure of the universities.

Away from CONICIT, and as a consequence of the opening of the economy, technology has acquired some spaces where an efficient linkage between science and production could arise: among others, the Technological Innovation Fund (FINTEC), the Council for the Development of the Capital Goods Industry (CONDIBIECA) and the Metal-Mechanics Industry Fund for Productivity (FIM-Productividad), in addition to the universities which have created linkage structures with business. Unfortunately, a dogmatic interpretation of what has been called 'Reaganomics' says that 'winners should not be picked' so that market mechanisms can function alone. Thus, although funds exist, there is no real demand for them. One of these funds has already disappeared (FINTEC).[30] Using the now more commonly used expression, what has failed is the lack not so much of an S&T policy (either explicit or implicit), but rather the inoperativeness of the national system of innovation.[31] In defence of the Venezuelan authorities in policy decisions, one could mention that this field of policy is rather new, even in the OECD countries (see OECD, 1992b). It is across this shifting scenario that Venezuela's scientific community is shifting. The administrative and political crisis in the leading universities, which has dragged on since 1985, continues to still bother the community. The deterioration in the income level of researchers as well as other sections of the middle class is indeed a problem for retaining good researchers as in other Latin American countries. What bearings do these problems have on the scientific community? How has this community responded to the deterioration of both its working conditions as well as the personal income of researchers? To answer this is to account for the present phase, where we can apply the second meaning of the Spanish word *emergencia*, that is, emergency.

The Scientific Community in an 'Emergency'

Since the beginning of our research on the ties between science and production we have used a metaphor that, perhaps because of its extreme nature, has helped us clarify the question at hand: we spoke of that link as a 'marriage'.[32] The metaphor, in addition, alludes to the fact that beyond the obvious difficulties, obstacles, constraints and possibilities, there exist other actors surrounding the 'couple' who, although not always, can generate a variety of conflicts. To explore the present tensions the Venezuelan scientific community is experiencing, we shall make use of two empirical studies which were carried out by our research team as the main sources of analysis. Hence, we shall speak of concrete companies and of concrete research groups. More specifically, we are going to discuss the topic of the relationships between the research capacity of universities, which account for around 70 per cent of the research conducted in the

country, and the real demand created by production units. By looking at how the 'marriage' has been 'consummated', we shall attempt to understand why only a 'platonic' relationship has prospered.

Enterprises and Entrepreneurs: The Process of Technological Learning

There is very little empirical research on the technological reality of Venezuela's industry. Probably, our research on the chemical and professional electronics sectors is one of the very few research studies that presents a radiograph of the behaviour of this pole of the relationship that concerns us.[33] Table 13.2 summarizes the responses given by business people from the chemical sector, which is the most highly developed from the standpoint of technology. These responses emerge from a questionnaire we administered to 119 companies in the chemical sector. The table 13.2 shows the responses given to questions on various activities where the company has experience:

TABLE 13.2
Technological Learning in Sampled Firms

Technological Learning	*No.*	*Percentage*
Search for specialized information on technological alternatives	83	69.6
Technology negotiation	63	52.9
Development of new products	98	82.3
Machinery and equipment adjustment and alterations	72	60.5
Self-manufacturing of parts and equipment	56	47.1
Process design	57	47.9

Note: For a detailed description of each activity see Pirela, Rengifo, Arvanitis and Mercado (1993).

This data, as well as those from the technical relationships that the firms are engaged in; the licensing activity; their internal technical activities such as engineering; types of quality control; and R&D were used to construct a taxonomy of this industry. It tells us that close to 66 per cent of the companies have learned to handle the technology they have acquired, not only by adapting technologies but also by genuinely introducing changes in products and processes in order to respond to a particularly restricted market. Thus, these companies have constructed a certain 'flexible' production capability, very consistent with the global trends in the chemical sector. The trend is towards small production units or small specialized productions oriented towards specific demands. The constraints these firms have to face lie more in raising the level of specialization and sophistication

of the products they manufacture, which entails strengthening the ability to innovate products rather than 'trouble shooting'.

Another group of companies (34 per cent), mostly small, quite isolated and many of which are monoproducers, have concentrated their attention on adaptations and modifications of spare parts and machines, and on the manufacturing of equipment and parts itself. Similarly, they show only little experience in the other steps of technological learning and a weak capacity, particularly in developing products and designing processes. Hence, an important part of the experience these establishments develop in this field is not only in a certain sense inconsequential for a competition minded company in the chemical sector, but, in addition, the work they do fails to generate a true technological learning since they lack structures allowing them to build a memory capable of projecting the momentary activity towards the future. In some cases, we found that we were dealing with companies that import or buy a product on the local market and then package it directly or after making a simple mixture. The technical activity of these companies is aimed basically at 'trouble shooting' and at corrective maintenance with little effort to innovate.

In addition, a factorial analysis permitted the identification of four characteristic profiles of the behaviour of business vis-à-vis technology (Pirela, Rengifo, Arvanitis and Mercado, 1991, 1993). Only one of these, which were present here, has established any noteworthy link with the academic sector. We call this group 'active companies'. It includes twenty-eight of the 119 companies analyzed, which represent, to differing degrees, the 'cream of the crop' of Venezuela's chemical industry. Most companies are located in the basic or intermediate sectors and, it should be noted, include the presence of a large number of companies devoted to the production of resins.

These companies' external technical links are rather broad and complete, especially for the development of new products for which purpose they establish ties in nearly equal proportions with universities and domestic or foreign firms (62, 65 and 57 per cent respectively). Regarding processes, they prefer to establish ties with foreign or domestic firms (42 and 58 per cent respectively), and almost none (8 per cent) have links with universities for this particular task. For equipment manufacturing they prefer, to a significant degree, domestic firms (85 per cent) over foreign firms (38 per cent), and none prefer universities. Technical assistance is realized mainly through foreign firms first, then domestic firms, and finally universities (65, 42 and 23 per cent respectively). A surprisingly high proportion (89 per cent) of these firms have had some contact with universities or domestic research centres even though this may not be a research contact.[34]

Some uncommon or unexpected facts observed in the study deserve mention here. None of the four profiles of firm behaviour vis-à-vis technology show significant differences in economic results. Briefly put, somehow provocatively, we found little relation between economic variables

and technological variables prior to the economic policy of economic 'aperture' in 1989. In the context of highly protected markets, economic efficiency is not the central motivation for dealing with technological problems, except those that could hamper companies from continuing to produce. The key problem is that Venezuelan firms (this is a trait observed in nearly all sectors [Pirela, 1984]) have operated in a wide range of markets where the degree of competition is low with essentially monopolistic structures and highly protected from foreign competition. Indeed, in our survey the response to competition as an influential factor for introducing innovations is, in general, unimportant. In reality, the competition factor has exercised less pressure on firms than the difficulties to obtain raw materials, the needs stemming from the diversification of production or from the needs to meet customers' requirements. In addition, the competition factor has the same weight as that of satisfying the aim of a personal or professional challenge. To continue with our metaphor of the relationship between the university and firms, we can say that some firms were preparing for the 'wedding'.

Academics and Academia

As dealt with in the preceding section, we shall present a summary of an empirical analysis of data gathered through a survey directed at researchers.[35] This survey tried to evaluate the socio-economic context and the 'labour' situation of researchers (job satisfaction, workplace efficiency, and so on), the amount of time that researchers devoted to activities directly related to the production sector, the attitudes of researchers towards industry, and the flow of researchers from research centres and universities towards industry (the 'internal' brain drain).[36]

THE SURVIVAL OF THE SCIENTIFIC COMMUNITY IS BEING THREATENED: The average level of seniority or the average number of years of experience in research increased considerably between 1983 and 1991. Whereas the average age increased by 2.5 years, the average number of years of seniority increased by nearly four years. This disparity is explained by the 'brain drain' phenomenon, both to domestic industry and to other countries, and by the absence of a renewal of researchers. Among the older researchers, only the most experienced remained in research. This clearly indicates the relative absence of a good recreation system or the rapid dropout of professionals who are being trained. Indeed, in the last three years, approximately 20 per cent of the researchers in the various research centres where surveys were conducted had left, either to join industry or go abroad.

All available evidence indicates that the effects of this phenomenon had not been fully understood. The opinions expressed ranged from alarm in

the face of the danger of a possible annihilation of the scientific community (expressed by the core of the community itself and from its union or political representatives) to the satisfaction expressed by many business people who have found in universities and research centres a 'reservoir' of highly skilled labour which is often cheaper than the professionals they had earlier imported from abroad at a relatively high cost. It may be pointed out that until the Bolívar was devalued in 1984, many companies with a certain formal structure or interest in R&D had a policy of hiring staff from abroad. The issue is, however, more complex. It may also be pointed out that the mobility of researchers towards domestic industry is not by all means necessarily a negative factor. On the contrary, this might contribute significantly to the creation and strengthening of a local capacity for R&D in industry itself, which is an essential condition for the true construction of an integrated system of innovation.[37]

After acquiring a certain degree of experience, to make a transition 'free of traumas' to industry by the researchers can benefit the institutions they leave in some ways: (*a*) these people renew their research fields consistently with the changes in productive knowledge; (*b*) the institution enhances its links with industry, insofar as the persons who leave contribute to that linkage; and (*c*) the constant turnover of personnel allows the natural inter-personal and inter-group tensions, frequent in academic centres, to be mitigated temporarily. At the same time, this inhibits the formation of informal structures or of internal pressure groups, the so-called cliques, and their deleterious effects on the performance of research centres.

We know that the model that has been described in the preceding paragraphs holds only if an adequate flow of incoming researchers is guaranteed, to avoid the total dismantling of the R&D capability in universities and other research centres. If the constant training of upcoming generations is not guaranteed, there emerges a trend towards institutional aging, deterioration in the quality of research projects, and, above all, delays in research fields, topics and proposals due to the departure of 'the best' or those in highest demand by industry. In addition, this translates into universities and research centres increasing their degree of isolation from society and its needs; increasing bureaucratization, backwardness and mediocrity; a lack of dynamism; a deterioration in the internal atmosphere; inter-personal and inter-group conflicts; as well as an unhealthy dynamic, characterized by the presence of groups whose main objective is to pursue internal positions of power 'at any cost'. This clearly leads to an increasingly high degree of deterioration in the institutions. This phenomenon becomes considerably worse in periods of political and administrative crisis in universities and, particularly, in periods of rapid erosion of the purchasing power of university professors' salaries, as has been the case in Venezuela in recent years.

THE INSTITUTIONAL CRISIS: A second problem is related to the decline of the identity of researchers with the institutions themselves. Among the most serious problems that can face an organization is when its members cease to identify with it, and in some cases this can even translate into a feeling of isolation and alienation vis-à-vis the institution. The results that emerge from our survey provide potentially alarming evidence of what may be a 'dangerous' deterioration of the identification of the scientific community vis-à-vis the institutions to which they belong, mainly the university settings.

Forty-one per cent of the respondents felt that the decision to join industry from the academic setting is favourable or very favourable. At the same time, an overwhelming (89 per cent) felt that the decision is unfvourable for the institution of origin. Among the reasons which led the researchers to take a decision to leave their research institution and work for industry are (in their order of importance): the high cost of living, better working conditions elsewhere, the lack of recognition and of promotional avenues in universities, the lack of resources for research, the lack of support from the university institution, deterioration of the university environment, the low degree of support for research work, and, lastly, only 4 per cent mentioned the low research budgets at universities. From their standpoint, the problem has more to do with the economic context, with administrative structures and with political problems than with mere budget concerns. This indicates that the traditional image, disseminated by university spokespersons, according to which the most important problem of these institutions is low budgets is not an argument with which researchers identify.

Moreover, although 68 per cent of the respondents indicated they were satisfied with their work, nearly all said this was due to the freedom they have to carry out their activities. In addition, those who indicated they were dissatisfied attributed this to deficient working conditions, to political sectarianism and to the 'bureaucracy'. Sixty per cent complained of the 'lack of material rewards for the efficient development of research activities'. In addition, only 19 percent said that 'the institution provides them with clear goals in research and development'. Thus, the most important factor for researchers' satisfaction is absolute freedom, that is, ability of the institution to define objectives and goals. In some sense, those inside the universities stay there because they feel very little constraint and at the same time very little identification with the institution.

THE PERCEPTION OF THE MARKET: It has been pointed out many times how researchers work on themes unrelated to the country's needs and industry's potentials. More precisely, this is a common sense perception, the reality being that researchers choose their subjects on themes that are related to the *country's* needs but not to *industry's* needs. Although 41 per

cent stated that when a research problem is chosen they do not have in mind the potential utility of the results for the production of goods and services; however, this is higher among science-oriented researchers (58 per cent) than among technology-oriented researchers (only 16 per cent). Nearly all our respondents knew which industries could use their results: 42 per cent mentioned the petroleum, petrochemicals and chemical substances; 10 per cent the steel and metal industries; and 8 per cent the coal industry. This corresponds not only to a rough rating of the importance of the various industrial sectors in the country but mainly of those industries that have developed a real technical dominion and have the capacity to absorb research findings. As we have shown elsewhere (Pirela, Arvanitis, Rengifo and Mercado, 1992), it is only when a company has built an R&D capacity of its own can it integrate, assimilate or transfer research findings produced in universities and research centres.[38] Thus, researchers have a relatively exact sense of who could be the main users of scientific knowledge in their country and are better informed than the policy imperatives suggest.

THE CHANGING VALUES: THE FOUNDATIONS OF A SOLID ECONOMIC LEGITIMIZATION: The scientific community we examined is in a process of transition from professional science to the professionalization of science, that is, from 'conducting good science' (which has been the objective of the founders of that community) to what is presently an unavoidable challenge in the light of global transformations, in particular, in the context of Venezuela's recent process of economic opening.[39] Although the academic community itself appears to be accommodating to these changes, institutions stand out for their backwardness and operations according to the old models. Hence, some such institutions are standing in the way of the connectivity of the scientific community with the rest of society.

As far as researchers are concerned, we have observed that they now accept a change of values. They accept that knowledge is not 'free' information and that they have to receive some reward for working with industries. Thus, they depart from the old vision that implied that the country was to receive the philanthropic aid of the researchers. Giving a price to scientific activity is, as our sampled researchers suggest, a way of giving value to science for the country. Thus, researchers move from a world of 'barter' to a world of 'exchange' (Pirela and Rengifo, 1991). Exchange does not necessarily mean market exchange, but it does mean monetary exchange. Thus, institutions need to change in order to permit these continuous flows between academia and the productive sector. The problem lies in accepting the basic asymmetry between research and technological development. Beyond the differences of context between the two domains, the internal and external determinants of the two activities—epistemological,

methodological and those related to the organization of labour—imply new institutional spaces which could handle some complex situations provoked by issues such as that of industrial secrecy, the payment of royalties, rewards for consultancy, legal frameworks for university–firm contracts and so on. To surpass these obstacles, political, institutional and legal forums must be created to act as translators of the diversities of these two 'worlds'. Hence, the development of a common technological 'culture' can serve as an axis between these forums: the point of departure to overcome the asymmetries might lie in the generation of a productive experience in the research centres (university companies might be one solution) and of research structures in firms, and between the two, instruments and structures aimed at developing shared, specialized information systems.

Conclusion

In sum, until now Venezuelan firms were not interested in developing ties with universities because they lacked a technological capability of their own, and a structure and an internal research capacity able to identify their needs. On the other hand, the academic sector had little to offer, given the behaviour of the institutions in which academics work and, especially, given the way scientists valued their own contribution to development. The state set out to try to convince both sides, creating a third forum for interests which had little to do with either the scientists or the firms. The 'marriage' could not work since the parties were not in 'love'—and in some cases may have been guilty of 'bigamy' given their relations with the foreign world—or 'loved' only platonically. This affair worked even less when a third party, a self-serving 'cicerone', spent too much time trying to demonstrate the wonders of a possible wedding. In any event, experience indicates that at least with the matter at hand the idea is not to 'marry' but rather to construct a modern, 'systematic relationship', with autonomy for both parties and free of 'guardians'.

Finally, a modern link such as the one we have outlined would allow the risks noted a few pages earlier, such as survival on the verge of disappearance, the distortion of scientific work and the intoxication of funds without clear policies or without any insertion structures, to be averted, at least partially. Thus, the legitimization that has been postponed, or mistakenly constructed, must give way to a contemporary relationship with society.

Notes

1. This analysis is based on work developed in the Department of Science and Technology in the Central University of Venezuela (CENDES). The empirical research on scientists and firms was carried out by our group in collaboration with the Department.

2. This part is based on the work presented at the first ALFONSO workshop (see Rengifo, 1990). It re-interprets the abundant literature on the history and sociology of science in Venezuela. It, however, follows the seminal work developed by Díaz et al., 1983; Vessuri, 1984, 1987a.
3. See, for instance, the 'Plan de Febrero' of General López Contreras who followed Juan Vincente Gómez in 1936 (Ruiz Calderón, 1992a) or the anti-malaria campaigns (Gutiérrez, 1992). For a review of the profusion of scientific institutions created between 1936 and 1948 see Freites and Texera (1992).
4. Marcel Roche, a doctor and researcher in bio-medicine, was the founder of a research institution in the 1950s, first director of the Institute for Basic Science (IVIC) after 1958, and founding member of the National Commission for Science and Technology (CONICIT).
5. Many examples can be given. On botanics and its link to expertise see Texera (1991). On the coexistence of legitimate professionals before 1936 see Freites (1988) and after that Freites (1987). On the role of engineers see Licha (1987) as well as the articles of Gutiérrez mentioned in note 3, and Arvanitis and Bardini (1990, 1992). More examples of scientists–practitioners can be found in the chronicles of Marcel Roche (1988).
6. Arvanitis' (1990) doctoral thesis to be published in Spanish.
7. It has to be noted that these positions are clearly written in two policy documents: the Trompiz Memorandum and the Casperson Commission recommendations, both of which were discussed at the foundation of CONICIT.
8. This is striking in areas such as agriculture. See, for example, the great amount of 'experts' in the Ministry of Agriculture of Venezuela (Balderrama, 1992) and the Ministry of Health.
9. This has been the argument explicitly expressed by Roche against 'applied' science. See Roche's intervention in Aguilera et al. (1983).
10. On these historical aspects there are now numerous published articles. See Díaz et al. (1983) and Vessuri (1983); Freites (1988); Texera (1991); Freites and Texera (1992) and the work compiled in Vessuri (1984, 1987b).
11. See the introduction of Freites and Texera in their compiled book (1992). Also the work of Vessuri (1988) and Texera (1992). An extensive discussion of the role of universities in Venezuela has been published (Di Prisco and Wagner, 1990). This book contains a debate triggered on the theme in *Interciencia* after a fine article by De Venanzi (1987), the rector of the Democratic University in 1958. A review of the prospects and consequences of the debate can be also found in Vessuri (1987b).
12. This continued until the state was forced to create institutions such as the School of Chemistry and Agromony outside the universities (Díaz et al., 1983).
13. All industrial projects were to be submitted to the rules of the Reciprocal Trade Treaty with the US which obliged Venezuela to develop industries that were not in competition with US imports. The Treaty was abandoned in 1970 when industrialization was well under way (see Arenas, 1989).
14. Explanations on the industrialization of Venezuela usually call for an explanation of the technology gap of the country because of economic dependence. Another argument suggests that the gap is due to an insufficient amount of resources dedicated to S&T—an argument much developed and promoted by international institutions like UNESCO (1981). We have challenged these explanations in the first chapter of our book (Pirela, Rengifo, Arvanitis and Mercado, 1991). A conceptual critique of the 'school of dependency' is in Pirela (1990).
15. We know the argument has been challenged. But works on entrepreneurs in Tunisia, China or Taiwan do support the hypothesis that there is a strong cultural component that needs to be present in order to have an entrepreneurial attitude, although there is no concordance on how it emerges (see Sverrisson, 1990; Denieuil, 1992; Berger, 1993). Specifically, on 'industrialization before industrialization' see the important book

of Kriedte et al. (1986). We tend to accept the Baechler hypothesis that the 'bourgeois' entreprenuer emerged in a social space that was not of interest either to the Church or to the power structure—literally a 'meaningless' social area at that moment.

16. Balderrama has called this attitude 'physiocratic dreaming' because the elites have maintained this idea that wealth in Venezuela could be the result of the exploitation of land, when it was obvious that it was oil that nourished the country. One of the main critiques of the parasitic conducts supported by this distributed wealth has been one of the principal advocates for a rational exploitation of the mineral resource and founding father of OPEC, Juan Pablo Pérez Alfonso.
17. This figure is extracted from Bonilla and Michelena (1967). This figure has been supported by a research on innovation in industry by Pirela et al. (1991).
18. Some of these very peculiar entrepreneurs were later on directing not only the more important industrial firms, but they can be found in the list of those who created some scientific institutions. See, for example, the case of the Venezuelan Institute for Industrial Research (INVESTI) (Pirela, 1987). In any case, this participation of the private sector in the growth of science has been much less important than in other Latin American countries, as for instance Mexico. For a comparison see Story (1986).
19. The bibliography on the CONICIT is quite extensive (see Avalos and Rengifo, 1978; Texera, 1983; Rengifo, 1986). The most important critique of CONICIT's role is in the book by Antonorsi-Blanco and Avalos (1980).
20. This is the date of the publication of the Venezuela Report of the Science and Technology Instruments Projects, financed by the Canadian IDRC, The Organization of American States and many international and national institutions. The project aimed at comparing the S&T policies of Venezuela, Colombia, Argentina, Peru, Egypt, Yugoslavia, South Korea and India. The Venezuelan team was coordinated by Ignacio Avalos and R. Rengifo, who was a team member (see Avalos and Rengifo, 1975).
21. CONICIT is directly assigned to the Presidency of the Republic. It was a Ministry for Science and Technology from 1985 until February 1992.
22. This has also been the argument used by Roche and Freites when they examined the lack of influence of CONICIT's priorities on scientists (see Díaz et al., 1983).
23. Figures are quite uncertain, even in the later diagnosis by CONICIT (1973) or the 1983 bulletin 'Ciencia y Tecnología en Cifras'. One of us has attempted a more precise measurement (see Annex 1 of Arvanitis, 1990) which is based on publication figures and various particular studies. We arrived at an estimation of between 600 and 1,200 researchers for 1985. The CONICIT at that moment spoke of 3,000 researchers. The figures we had obtained were a good guess since the Programme for the Promotion of Researchers finally financed little more than 600 researchers when it was initiated in 1991.
24. A similar point of view has been expressed in quite different terms by Vessuri in the debate over the social role of scientists in Venezuela (see Auguler et al., 1993).
25. The whole process has been extensively examined and criticized by Antonorsi-Blanco and Avalos (1980).
26. To examine the details of this process would be beyond the scope of this chapter. Let us only mention that this progressive autonomy of the 'planning function' (and not the institution itself) belongs to the category of phenomena that can be titled 'monsters produced by reason'. Moreover, it is not all of CONICIT that was concerned but a specific function driven by specific cliques of sociologists, economists and engineers.
27. The literature on this topic is now abundant. A good theoretical overview of this new area is given in Dosi et al. (1988) and Dosi et al. (1990). The recent OECD report on technology and the economy is quite a definitive reference (OECD, 1992a).
28. It should be remembered that this was not a unique phenomenon. Chemistry and the chemical industry in the 1930s in Germany and in the US invented a science that was entirely devoted to industry but with very basic and academic interests (see Haber, 1971; Freeman et al., 1982; Aftalion, 1989).

29. This is more a prospective than a retrospective part. May we just remind the attentive reader that our proposal of studying the actors at the micro level, with particular emphasis on their cultural determinants, was undertaken by the need for such a prospective proposal in the early 1980s.
30. This situation where funds exist and no demand emerges was known much before the opening of the economy in Venezuela (see the reports of the July 1986 Conference organized by CONICIT on 'Funds for the Financing of Technological Research'). In other countries, the same phenomenon appears. See the case of Colombia (Lópes, 1987).
31. The word is coined by Freeman (Freeman, 1987) and the economists at Lund (Lundvall, 1992), but now has a much larger scope (Nelson, 1993).
32. 'Firms and Academics: An Impossible Marriage' (Arvanitis et al., 1988) was the title of our first essay on the theme (Pirela, Rengifo, Arvanitis and Mercado, 1991, Chapter 4).
33. The research on firms began in 1987. A history of the project has been reported in Arvanitis and Pirela (1993). Two different surveys were realized in 1988 and 1992. Most results of the 1988 research have been reported in the publications of the research members of the team refered to in this article and the 1992 survey has been presented in an international conference on 'Conducta empresarial y cultura technológica en América Latina: La industria química y petroquímica', Caracas, March 1992.
34. The basic difference between a 'technical task' link with the universities and a 'research link' with them has been extensively reported in Pirela, Arvanitis, Rengifo and Mercado (1992).
35. This research was financed by the Instituto de Ingenieria, a dependent of the Ministry of the Economy and to a less degree by ORSTOM, University of Zulia and Fundacite-Zulia. Rengifo and Pirela along with Gerardo Díaz and Eduardo Ynaty designed the survey (Pirela, Rengifo and Ynaty, 1991).
36. The information comes from a survey of 150 researchers, of whom 100 are located in Caracas and fifty in Maracaibo. The sampling was taken from the fields of science (59 per cent) and technology (41 per cent) from the registry of researchers compiled by the Programme for the Promotion of Researchers, except for Maracaibo where a special registry was compiled.
37. As was the case in Germany (Meyer-Kramer, 1990), but not for instance in Japan (see Freeman, 1988). For an extension of the concept of the system of innovation see the work by Lundvall (1992). A somewhat more descriptive approach is promoted by some researchers (OECD, 1992a, 1992b; Nelson, 1993).
38. This also corresponds to findings of other authors on the science–technology relation, such as the classical work by Freeman (1974) or by Gibbons and Johnston (1974), analysis of specific research projects as done by Maguire and Kench (1984) and the work on the global relation between science and technology by Mowery and Rosenberg (1989).
39. This is why we are not comparing the view of Roche and Freites that the Venezuelan scientific community has been moving from rise to twilight, although we do accept that the dangers the community has been facing are not simple and could convert to a nightmare. Moreover, their data is quite old (1976–1978 survey). That is the reason why they project a 'practically idyllic' image of the scientific community (Roche and Freites, 1992).

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