11 Bitter Harvest: The Growth of a Scientific Community in Argentina

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Together with Canada, Australia and New Zealand, Argentina may also be classified in that small category of countries known as 'regions of recent settlement'. By the end of the nineteenth century, all these countries were characterized by an abundance of land relative to labour and capital. During the twentieth century, most of them became modern industrial societies. Argentina, however, since the 1920s has been unable to build the society that most Argentines envisioned, nor has its economic growth matched that attained by countries of comparable standing at the beginning of the twentieth century. Uneven and ultimately failed development became a problem in Argentina ever since the early decades of this century. Although it possessed some *requisites for becoming a modern country*—not the least being its high rate of economic growth between 1880 and 1930—those conditions did not suffice. In retrospect, government policies during the 1940s appear to have been short-sighted and political instability set in (Korol, 1991). Past economic growth helped raise expectations that could not be met. As a result, mythical views of the past tended to prevail. A better understanding of the Argentine past requires more complete knowledge of Argentine economic and social history. A number of issues remain obscure. This paper contributes to the understanding of the difficult consolidation of a scientific community in the course of the last hundred years. As in other peripheral contexts, the history of Argentine science is littered with examples of valuable endeavour followed by collapse, unbounded optimism followed by pessimistic indifference, and a lack of public trust in long-term intellectual endeavour.

The Elements of 'The Promise'

The Argentine 'promise' consisted of the combination of European immigration, universal education, European capital and natural wealth. This is supposed to lie at the bottom of the 'miracle' of the 1880–1930 period.

With regard to the first aspect of immigration, Argentina is second among the nations that received the largest contingent of European

immigration in the century extending from approximately the middle of the nineteenth century to the 1950s. If we take into account the immigration volume in relation to the total size of the receiving population, the Argentine case is even more outstanding, for it was the country that had the largest European immigratory impact during that period. On the other hand, Argentina is today one of the most urbanized countries in the world, with approximately 80 per cent of its population residing in urban conglomerates; international migrations in the first place and domestic migrations later were the main demographic factors that determined such urbanization (Lattes and Sautu, 1978). Already, by the turn of the century, Buenos Aires was a cosmopolitan city from the point of view of its population.[1]

The children of immigrants formed part of the broad contingent that benefited from the increase in the literacy rate and schooling, which leads us directly into the second aspect—education.[2] Around the 1880s, the structure of education at all levels suffered deep changes. Argentina, the same as Uruguay, Costa Rica and, to a lesser extent, Chile, accompanied its incorporation into the world market as an exporter of raw materials and an importer of manufactured goods, with a social and legal organization that involved the inclusion of all the population in the basic circuits of cultural diffusion. The global mass of population had access to a minimum of basic schooling aimed at guaranteeing cultural homogeneity (Tedesco, 1985). The progressive Argentine democratic free public school was aimed at spreading secular values, republican principles and a certain scientistic outlook which reflected the cultural order of the most dynamic sectors of society. The elite had access to more elaborate intellectual manifestations in the universities.

These educational changes had a deep and long-lasting impact on society. By the 1920s, the growth of secondary schooling was massive. Many young people got started on the road to upward social mobility through education. They entered the university or began to dispute places in the cultural domain and the liberal professions. Argentina was the Latin American country that achieved the earliest institutionalization of science. Indeed, with 27.8 per cent of qualified human resources in the economically active population (EAP) in 1950, the availability of highly qualified staff was not a problem for scientific and technological national development, except for individual specialities. More problematic, however, has been the country's inability to retain its scientists.[3] As to the third aspect, that is capital, around 1918 Buenos Aires, the door to the 'world's granary', was the second Atlantic city after New York. Except for commercial centres of import and distribution such as in Holland and Belgium, no other country in the world imported as many goods per capita as Argentina. In 1911, its foreign trade was larger than Canada's and one-fourth that of the United

States. In 1914, the per capita income of Argentina equalled that of Germany and the Low Countries and was higher than that of Italy, Spain, Switzerland and Sweden, having grown at an annual rate of 6.5 per cent since 1869.[4]

Nevertheless, in contrast to an older image, recent literature gives a more nuanced image of Argentina's fantastic natural endowment. It was never as rich a country as Australia, although its rate of growth was remarkably high. It has been argued that the most important differences between these two countries are in their immigration policies which affected their GDPs.[5] Also, in contrast to a diversified Canadian dominant class, where mercantile, financial, and eventually industrial interests had to compromise with agrarian groups, the large pampas landowners (the famous beef producers) were the exclusive dominant class in Argentina, being only concerned with cattle raising (Solberg, 1987). This class helped consolidate a pattern of land tenure that made medium and small owner–farmers more the exception than the rule on the Argentine pampas. Rather, a system of itinerant tenant farmers made possible the rise of grain cultivation in Argentina. This system, however, was undermined by government policies that made it almost impossible for farmers to buy land and did nothing to lower railway rates or to improve agricultural research, technology and market systems.[6] Another difference seems to lie in the import-substitution programme that, particularly since the 1960s, became the core of capital accumulation and reproduction. Industrial production was directed towards the internal market, and this strategy proved to be an obstacle to further growth due to market limits. Problems inherent in industrial expansion did not assure a process of long-term, self-sustained growth. Alternative policies could have been developed, but it is far less obvious whether a social base existed to support them or that they would have been viable in the international context of the times.

The Stage of Scientific Institutionalization

Formative Period: 1880–1915

Towards the end of the nineteenth century, the country started a process of economic and political reconstruction marked by an expansion of the export economy and a consolidation of the civilian oligarchy. European positivism was received favourably, for reasons partly political, for it offered intellectuals and politicians a conceptual scheme to situate history and society within a framework of progress, reinforcing a sort of 'official ideology' of the civilian elite. It was basically an adherence to a certain

moment of European culture, mostly as participation in the reservoir of ideas, notions and attitudes that constituted the nineteenth century's legacy, as it was perceived at the closure of such a rich era.[7]

The achievement of an appropriate institutional context wherefrom men and their theories could become stronger was strenuously won, and the source of legitimation was almost inevitably linked to the representatives of the scientific centres in the metropolitan countries. Such was the case of the American astronomer Benjamin A. Gould, who was in-charge of the Observatory at Córdoba for fifteen years from 1870 to 1885, making it the leading scientific institute in the country, and who produced a magnificent work about the southern skies.[8] But given the fact that a large proportion of the few resident scientists were expatriate Europeans and that there was no local scientific tradition, and due to the sheer discrimination of locals by arrogant and rigid European teachers or researchers, it was not rare for conflicts to arise for authority and legitimacy. It was not always easy for a native scientist to prove his worth in a particular field. The struggle for recognition and power of palaeontologist Florentino Ameghino, a self-taught disciple of Herbert Spencer, in his confrontation with German zoologist Karl Burmeister is a case in point.

For a long time Burmeister was in a powerful position as director of the Buenos Aires Natural History Museum and prevented Ameghino from developing his scientific career locally until long after Ameghino became recognized in European circles. Argentine palaeontology had reached a critical mass, contributing an original approach to evolutionary studies. Among the signals of maturity were the presence of an interconnected disciplinary group, the control by this group of one of the two first-rate museums in Argentina (the one at La Plata), the support of the Ministry of Education and extended contacts with the European research front (Ameghino's early works were published in France and the United States and he kept intense contact, even an active collaboration with Henri Gervais, one of the great figures of French transformism).[9] Ameghino rallied to his cause nationalist forces that gave him support (Glick, 1982). However, Burmeister's resistance to the Argentine researcher was such that even at the point of death he appointed someone else as his successor to direct the Museum, although Ameghino was considered by the Argentine government to be the most adequate candidate.

The key institutions of the new 'positive science' were the observatory, the natural science museum and the university, typically structured as almost independent 'faculties' in the French sense, to which the other two kinds of institutions became linked. The three universities in this period were the ancient National University of Córdoba (UNC), that of Buenos Aires (UBA), and the newly created National University of La Plata (UNLP). In the UNC (founded in 1613), in the heart of the country, the weight of the traditional oligarchy and of the clergy was stronger than in

Buenos Aires. Science in Córdoba, as in most other Latin American universities, was subordinated to liberal education. Scientific topics were taught because they were assumed to discipline the mind, but most science teaching did not go beyond elementary notions. Students had to learn physics and mathematics not to become scientists or engineers, but to improve their education. With few exceptions, science was taught by the methods of reading and recitation. Students rarely entered a laboratory to question nature, but learned in one or more text-books what nature ought to say. Not infrequently, teachers were priests who responded to the Church hierarchy. But the University was ripe to produce its own transformation. A growing feeling of frustration within the academic profession and among students exploded soon after the first Unión Cívica Radical Party got into office in 1916, which I take as the beginning of the second stage. It was at UNC that the University Reform Movement of 1918 exploded, to which most of the university community adhered, both in Argentina and in the rest of Latin America,[10] and which gave origin to the 'peculiar Argentine system' of university co-government by teachers, students and graduates.

Since the last decades of the nineteenth century, there had been growing contact between the University of Buenos Aires and *porteño* society. By the centenary celebration of independence in 1910, the university already had 4,000 students who had begun to organize themselves in the Student Centres of Medicine (1900), Engineering (1903) and Law (1905), and continued to grow incessantly in the following half century. The renewal task, delayed since the mid-nineteenth century, was urgent: positivism had meant the first effort in the country to give professional dignity to activities linked to science and culture. That effort, however, was undermined by the insufficiencies and dilettantism of many of its protagonists. The predominantly professional orientation of the University had not disappeared and (except in part in the case of the Faculty of Exact Sciences)[11] an authentic and deep scientific–cultural concern was absent (Halperín Donghi, 1962). A radical change of work style in the scientific and cultural domains was demanded and a tradition of research got established in several research institutes, from those of Ethnography and Historical Investigations, created in 1905, to the Institute of Physiology (1919), where Bernardo A. Houssay would begin to contribute to international science.

The University of La Plata was the embodiment of a project for the institutional development of the natural, physical and exact sciences started in 1905 on the basis of pre-existing non-university institutes. Its promoter, Joaquiín V. González, wanted to establish a modern university with strong emphasis on research, following the museum—institute—faculty model, better adapted to the 'taxonomic' natural sciences. Germany had a decisive role in the profile and level of science at La Plata (Pyenson, 1984). From the beginning of the century, this country wanted to gain influence in Latin

America and, acknowledging Argentina's leading role in the region, tried to get advantage from it. With the support of the Imperial Department of Foreign Relations, German science became implanted in La Plata in open competition with North American interests in the local context. The development of physics was entrusted to Emil Bose, one of the first students of Walther Nernst's physical–chemistry institute in Götingen.[12] In La Plata, Bose got the services of Johann Laub, who in turn was Einstein's first scientific collaborator, and of Konrad Simons, a pupil of Emil Warburg, for teaching electrical engineering. It has been argued that in 1913, La Plata was the major centre for theoretical physics outside Western Europe and maybe even outside German-speaking lands (Pyenson, 1984). German tradition in the basic sciences dominated Argentine scientific research until 1950.[13]

Around these three institutional centres grew the core of Argentine science during this stage, very strongly concentrated in the Buenos Aires–La Plata axis and the Mediterranean traditional cultured centre of Córdoba. Many a professor taught both at La Plata and Buenos Aires. The international trend of development of scientific laboratories received government support, with special concern for public health and agricultural production.[14] The state laboratories and research centres for a while became a model in their kind.[15] The new intellectual climate also led to innovations in secondary education. The National Institute of Secondary School Teachers was founded in 1904 in Buenos Aires following Prussian educational models. Between 1904 and 1913, some twenty foreign teachers were hired for this school, almost all of them German (Babini, 1954). Vocational training was provided by some technical institutions. The earliest industrial studies began in 1898 when an industrial department directed by engineer Otto Krause was added to the Secondary School of Commerce in Buenos Aires. The department later became the National Industrial School, known by the name of its first director and crucial in the development of technical education.

In the early decades of the twentieth century, there was a new social demand for technical rigour and its corresponding specialization. Already dozens of graduates in medicine, law and engineering occupied positions in a society that was becoming more complex. Individuals with scientific education were rapidly assimilated into the state bureaucracy. An incipient scientific market had emerged. Agricultural experimental stations, the modernization of cities and ports, etc., were clear manifestations of progress and industrialization. The entrance of science into the public arena at this early stage of institutionalization meant its increasing dependence upon public administration. The state was the main patron of research and educational programmes in the universities and remaining knowledge institutions.

Since the turn of the century, the governments of most countries in Western Europe and the United States competed in the field of scientific relations as they did in many other more mundane fronts. All created similar agencies and all chose Buenos Aires as their main point of entry into Latin America. France founded the Alliance Francaise for cultural diffusion and the Instituto Francés de Buenos Aires (1921) (later known as the Institut de l'Université de Paris à Buenos Aires), although the political interest of French authorities did not satisfy the expectations of Argentine demands and the financial means of the institute were always meagre (Petitjean, 1989, 1992).

In the scientific and cultural fronts, the United States began to participate actively in Latin America since the First Pan-American Scientific Congress which took place in Santiago de Chile as part of a broader strategy to consolidate its dominant position in all the domains of inter-American relations in the early century (Sagasti and Pavez, 1988). Let it be known that in Buenos Aires, one year later, on the occasion of the Fourth International Conference of American States, it would manage to have it reorganized as a Pan-American Union with functions of a commercial bureau in Washington.[16] In connection with science in Argentina, the United States would become more active in the following stage, largely through individual universities and private foundations, among which were the Rockefeller Foundation that supported medical education and the physiological research led by Bernardo Houssay (Cueto, 1991, 1994), and the Guggenheim Foundation that gave fellowships to scholars like Salomón Horowitz, who was crucial in the development of vegetal genetics in Argentina and Venezuela (Vessuri, 1992).

Bose's premature death in 1911 did not end German influence in the La Plata project. Between 1913 and 1926, Richard Gans, who before going to America had been assistant to Nobel Prize winner Ferdinand Braun and had made a brilliant career in Tübingen and Strasbourg, supervised the first six theses in physics defended in an Argentine university, and he persuaded students to publish in German journals. Gans' most distinguished Argentine pupil, Enrique Gaviola, received a doctoral degree from Berlin in 1926. Gaviola also studied in Göttingen, Johns Hopkins, Carnegie Institution and Caltech. In those places he worked with von Laue, Planck, Meitner, Einstein, Hilbert, Courant, Born, Franck and other giants of modern physics (Bernaola and Grünfeld, 1989).

Spain too in this stage reinforced its links with Argentina. The Institución Cultural Española, created in 1914, was the result of an initiative of the Spanish colony in Argentina in 1912 to honour the memory of the Spanish scholar Marcelino Menéndez y Pelayo. The aims of the association were to make known and to diffuse in Argentina the scientific and literary work produced in Spain, through a chair that would be occupied by Spanish

intellectuals in the Universidad de Buenos Aires, and the development of other activities directly related to the intellectual exchange between Spain and Argentina (Roca and Sanchez, 1990). Among the occupants of the chair were Ramón Menéndez Pidal (1914), José Ortega y Gasset (1916), Julio Rey Pastor (1917), Augusto Pi i Sunyer (1919) and Esteban Terradas (1927), who exerted great influence upon the local intellectual milieu. When the Civil War brought havoc in Spain, a considerable number of Spanish intellectuals fled to Argentina and other Latin American countries, making crucial contributions to the institutionalization of science and culture locally.[17] Italy contributed a significant number of teachers in the institutions of higher education and research laboratories. A distinguished one was mathematician Beppo Levi, a pupil of Tullio Levi-Civita, the creator of tensorial calculus, who settled down in Rosario (Babini, 1954). We still lack a global study of the Italian contribution to the formation of the Argentine scientific community.

National Soul Searching: 1916–1945

The world of intellectuals and scientists changed rapidly in the inter-War period, stirred by renewed ideological currents resulting from the dominant spiritual uneasiness in Europe after the First World War and developments in some countries, above all Russia and Italy.[18] Workers strikes and student revolts constituted the backcloth of the deep transformation in Argentine society. There was the emergence of the communist and socialist parties. A revitalization of Catholic thought was also visible, specially in the apology of religious education. Confusion in a world undergoing great political and economic transformation and redefinition of the locus of knowledge and culture with regard to the state were matters of concern for the elite of writers, artists and scientists who wanted to elucidate national features.

The intellectual field not only became more autonomous and differentiated vis-à-vis other social domains, it added to its periphery individuals of immigratory origin from the outlying *barrios* and a culture in transition in comparison to the more homogeneous elite 'culture' that had characterized Argentina until the *novecientos*. Intellectual production grew significantly. The emergence of a middle class, concerned with national problems, created a whole new market for the Argentine author, stimulating the expansion of the publishing industry. The 'new' emerged as hegemonic value. The intellectual vanguard completed the 'modernist' movement of the first cultural nationalism of the 1880s, producing a 'peripheral modernity' (Sarlo, 1988).

An awareness of the remoteness of the Argentine periphery was densely and complexly assimilated. The universality postulated in, for example, Borges' *Historia universal de la infamia* was the one he cultivated all his

life: by situating himself with cunning at the margins, in the foldings, in the dark zones of the central histories, this *rioplatense* sought what he believed was the only possible universality to which he could aspire. I cannot help comparing this with the attitude of Argentine Nobel Prize winner biochemist Luis Leloir, as recounted by Cereijido (1990). He thought it inconvenient to work on fashionable topics, for the number of publications involved was too high and, even though one might be willing, it would be impossible to read them all. In his opinion, one should choose forgotten topics, for 'any', if analyzed deeply and cleverly questioned, would become a little window into the unknown, and then it was up to one's ability to be able to make an important contribution.

The coming to power of the multi-class and multi-national Radical Civic Union Party in 1916 inaugurated a democratic experiment which, despite its limitations—particularly the inability to alter the socio-economic structure—allowed to a large extent the political democratization of the country (Rock, 1975). The 1930 revolution meant a return to power of the conservative forces and the re-establishment of a regime with a clear oligarchic profile. In general, the years until 1943, known as 'the infamous decade', were characterized by a combination of electoral fraud, open corruption and naked violence. Transformations in the university setting were seen as belonging to the democratic experiment and, therefore, the universities became one of the key arenas where political ideas were fought out. Since then, the public university and the scientific activity it lodged suffered the instability of political government interventions, dismissal of teachers, purges of students, censorships and the subordination to immediate practical ends of political domination or conservation of certain historical situations, in alternation with shorter periods of strenuous reconstructive attempts.

However, the history of science and of the university to which it was closely associated for a long time cannot be reduced to political history. The more visible universities continued to grow, with faster rhythm than until then. Most of the current faculty installations were built during the 1930s and 1940s to house students which already numbered tens of thousands. But less visible science was also making progress. Precisely in those conflicting years some of the research centres began to bear their most valuable fruits, while the coexistence of research and teaching in the university became more common.

In 1919, Houssay founded the Instituto de Fisiología at UBA's Faculty of Medicine, becoming its first director. The Institute imparted theoretical and practical teaching of physiology, biochemistry and biophysics for the Schools of Medicine, Dentistry and Pharmacy. Between 1919 and 1939, 216 authors published 1,037 works in Argentine and foreign journals, and other publications (Instituto de Fisiología, 1941). In the late 1930s, the Institute was in its apogee. Houssay had culminated his work on the

hypophysis function; the hypertension group (Braun Menéndez, Fasciolo, Leloir, Muñoz and Taquini) competed vigorously—and successfully—with North American researchers for priority in the discovery of angiotensin;[19] Leloir and Muñoz isolated for the first time sub-cellular particles capable of realizing the oxidative phosphorylation; Foglia was making rapid progress in his work on rat diabetes; Cicardo made observations about nervous transmission, cronaxia, the influence of adrenal cortex and the biological function of the potassium ion; Orías was doing brilliant work on heart noises. Young people who would later make significant contributions to science, like G. Weber and A. Stoppani, were starting their careers as research assistants. A number of clinicians ascribed to the Institute also developed intensive research activity (Vessuri, 1991). The Institute was in fact a graduate school of physiology and biochemistry which has been unsurpassed in Latin America.

Also through Houssay's initiative the Sociedad Argentina de Biología was created in 1920s, with affiliates in Rosario and Córdoba cities, which published the *Revista de la Sociedad Argentina de Biología*. In 1934, the Sociedad Argentina para el Progreso de las Ciencias came into being, with funds to support research and to grant scholarships. Bernardo Houssay was its president until 1949. The Association published the journal *Ciencia e Investigación* and already in 1937 proposed the creation of a national council for scientific and technological research, that would come to fruition only twenty years later.

In the agricultural sciences, the teaching of genetics began in La Plata in 1915 with Miguel Fernández, who had got a doctoral degree in Germany. Also, since the beginning of the century, A. Birabén and A. Gallardo had been carrying out studies dealing with heredity and wheat improvement at the Agronomical and Veterinary Institute of Santa Catalina in Buenos Aires province, close to La Plata. Around 1930, the first immunological studies were produced under the direction of the German Wilhelm Rudorf. Among Fernández's pupils were Salomón Horowitz and Francisco Alberto Sáez. The three were responsible for the development of genetics until 1947, when they were forced to emigrate. Horowitz directed the first institute of genetics that functioned in Argentina since 1929, where a good portion of the best plant breeders of Argentina were trained, and since 1934 taught genetics at the Faculty of Exact and Natural Sciences. Among his contributions were those dealing with a constant wheat–rye hybrid, heredity to locust resistance in bitter corn, sugar increase in corn and the genetic determination of the sex of papaya (Mazoti and Hunziker, 1976). His Argentine story ended in 1947 when, being dean of the Agronomy Faculty at UBA, he was forced to emigrate to Venezuela where he created the Venezuelan school of vegetal genetics (Vessuri, 1992). In 1944, the Instituto de Fitotecnia was created in Castelar, depending on the Ministry of Agriculture. There, some researchers continued the Rudorf school: Vallega,

Cenoz and Favret. When the National Institute of Agricultural Technology (INTA) was created in 1957, the Instituto de Fitotecnia became the Department of Genetics, and under the leadership of Favret produced important innovations in corn genetics (Bercovich and Katz, 1990).

The ups and downs of agricultural scientific research are reflected in the course of agricultural productivity in the country. If from the end of the nineteenth century to the beginning of the Second World War agricultural production in the pampas had an important growth, with features similar and productivity levels comparable to those in the large North American prairies, state 'deaccummulation' in the agricultural sector became particularly critical in the 1930s and 1940s. While the United States and Canada witnessed a second era of spectacular growth in production, thanks to the massive adoption of new technologies, in the Argentine pampas technical progress was paralyzed for lack of government and social interest, production stagnated and even receded for two decades until it resumed growth in the 1960s (Sábato, 1981; Brasky, 1988).

Since the late 1930s, another outstanding figure, Enrique Gaviola, back in the country after his successful years abroad, practically single-handedly tried to start the study of physics, astronomy, mathematics and chemistry in Argentina. He founded the Argentine Physical Society in 1942, abrogated for the creation of a National Research Council, tackled the problem of university education in Argentina and the absolute necessity of sending students abroad by the dozens. By 1945, just before the assumption of the new Perón government, a project of his was being discussed for the creation of a private university in which the best Argentine scientists would be involved. Disagreements in emphasis between Gaviola and Braun Menéndez led to a halt in the discussion (Mariscotti, 1985). When taking into account the relationships between government (that is, Perón) and local physics (that is, Richter and his fusion project),[20] the double tragedy of Gaviola and Argentina acquires a sadder tone. An exceptionally talented researcher, Gaviola's solitary labours found an unresponsive, short-sighted milieu, rocked by political strife and daily frustrations, which ignored his efforts and eroded his work. His seed met fallow ground (Bernaola and Grünfeld, 1989).

The well-known Argentine psychoanalytic movement had local roots, although its articulation with the International Psychoanalytic Association occurred after the Spanish psychoanalyst Angel Garma, who was trained at the psychoanalyst institute in Berlin, migrated to Argentina in 1938 fleeing from the Spanish Civil War. Garma and the Argentine Celes Cárcamo, who had travelled to Paris, joined a pre-existing local group led by Arnaldo Rascosky and Enrique Pichón Riviere (Balán, 1991). Some time later, Marie Langer, who had received psychoanalytic training in Vienna, joined them. Due to the bad international reputation of the country, based on the advancement of right-wing governments in the 1930s which hindered the

reception of refugees, Argentina attracted only a minimal portion of the forced intellectual European exile before and during the Second World War. Different from many other professions, the psychoanalysts discovered soon that it was possible to prosper at the margins: nobody interfered with private work in the consulting office nor with the scientific endeavour of a civilian entity such as the Argentina Psychoanalytic Association (APA), which was careful of not calling public attention and not breaking the rules of the game established by the Peronista regime. Psychoanalysis has been the liberal profession par excellence.

The Years of Developmentalism: 1945–1976[21]

The world economic collapse at the beginning of the 1930s forced Argentina to abandon its previous pattern of economic development based on the expansion of cereals and meat production and turn to import-substitution industrialization. Owing to strong state support, by 1946 there were approximately 85,000 industrial establishments with almost 900,000 workers. In 1958, industry represented approximately one-third of the GDP. By then the manufacturing industry became the main purchaser of technology. Easy manufacturing needs could be met by domestic technology, but most capital goods and core technologies had to be imported.

During the Peronista government, state emphasis centred on technological development. In 1945, the Technological Institute of the Department of Industry and Commerce was created; in 1951 the Argentine Antarctic Institute, followed by the Armed Forces Centre for Scientific and Technical Research (CITEFA) three years later. In the ensuing government, official attention was given to the development of the scientific domain, being influenced by juridical–institutional European models (particularly France) for the organization of the S&T sector. Thus, the Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET) was created to coordinate, orient and promote scientific and technological research, and to advise the national government on such matters. It fulfilled only the role of scientific promoter, mainly through the instauration of the Carrera del Investigador Científico (1960), which gave stability and continuity to the research endeavour, imposing norms of rigour and quality that were in general accepted by all succeeding administrations. Yet it failed as an advisory body because the government at the highest decision making level had not established objectives as to the role of S&T in social and economic enterprises. In the end, research policy was based on the needs and objectives of the scientists themselves, the interests of the armed forces in security-oriented research and goals of the Ministry of Education. Public S&T institutions were the outcome of personal initiative and they remained relatively autonomous, deciding on programmes and their

implementation based on their own prerogatives.[22] The lack of coordination was almost complete.

Although there was a large increase in the number of researchers and university students throughout the decade, the developments of S&T (besides the Atomic Energy Authority—CNEA) reflected a clear lack of concern with domestic R&D. The share of R&D in the GDP fluctuated between 0.31 and 0.33 per cent. Only small fractions of public expenditures for R&D were devoted to the industrial sector, and these decreased with time. Even in the late 1950s, when the state sought to fuel the substitution process by actively promoting capital goods, domestic technology was not an issue. Industries in the dynamic consumer goods sectors, such as electrical machinery, automobiles and petrochemicals, grew much faster than the national technological capacity to supply industry's demands. The National Institute of Industrial Technology (INTI) was created in 1957 on the basis of a frustrated antecedent like the Technological Institute of the Ministry of Industry and Commerce established in 1945. Financed by a 0.25 per cent tax applicable to all bank credits to industry, its aim was to provide technological services to industry through a network of laboratories and research centres and promote and support the development of research in industry. INTI was also supposed to provide industry with financial aid, but it did not have enough financial capacity to operate with autonomy. It did not have any planning power for the industrial sector (Oszlak et al., 1982). In the 1960s, it grew and diversified excessively, becoming bureaucratized and inefficient (Valeiras, 1989).

These developments coincided with the internationalization of big American companies. Argentina called on the multinationals, and they responded—at least for some years. Technological laissez-faire was embraced by decision makers at high levels of government and industry. Yet, despite the fact that the industrialization pattern adopted did not foster dynamic R&D systems, notwithstanding the blows against higher education, the strength of the modernization ideal helped university and governmental research to acquire momentum in some areas, particularly since the late 1950s. In 1945, with the consolidation of the military regime after the 1943 coup d'état, the new government entered the university as a defeated plaza and treated it accordingly. Despite official rhetoric to the contrary, the problems of the university sector became aggravated: a poorly paid professorate, laboratories without equipments, deficient installations and libraries without resources had to look after the unrestricted entry of new students in conditions of open demagogy. Incapable of defining its own objectives in the university domain, Peronism, which had begun by looking at the university as a political problem, ended ten years later visualizing it in police terms. The sacrifice of the university was thus useless to its own executioners (Halperiín Donghi, 1962). Ironically, when Houssay received the Nobel Prize for physiology in 1947,[23] he was no longer on the staff of

the institute he had founded twenty-eight years earlier. Separated from his post by the Peronista regime on a technicality, he and Braun Menéndez founded, thanks to local private patronage, the Instituto de Biología y Medicina Experimental in 1943 (Foglia, 1980).[24] In 1947, another private science institution, the Fundación Campomar, was founded for research on biochemistry by a brilliant group of young biochemists who were the second generation of the Houssay tradition.[25] In his diary, H.M. Miller, regional director of the Rockefeller Foundation Natural Science Programme, recorded that they had 'discovered, identified and determined the structure of two coenzymes, which no group of enzyme chemists in the US had done'.[26] It may be mentioned that some years later, in 1970, its founding director, Luis Leloir, received the Nobel Prize for chemistry for work in the field of carbohydrate metabolism.

After the fall of the Peronista regime in 1955, reconstruction of the scientific domain began.[27] The Faculty of Exact Sciences at UBA was probably the most dynamic scientific institution in the ensuing decade. Many of the most creative efforts in S&T in the last forty years have derived from one or another group incubated there in that short period which ended in the 'night of the long sticks' (*la noche de los bastones largos*), the intervention of the university and the physically brutal eviction of teachers and students of the science faculty (Vessuri, 1987; Varsavsky, 1969; Slemenson, 1970).

Around 1957, the science faculty, the home of a brilliant school of mathematics, considered the possibility of creating an institute of calculus to influence the development of applied mathematics using the resources of automatic electronic computing. The leader of this movement was Manuel Sadosky, who had done his doctoral thesis under Spanish mathematician Esteban Terradas during the latter's exile in Argentina being initiated by him into applied mathematics.[28] The work carried out by the Instituto de Cálculo (IC) in its brief existence reveals the possibilities that Argentina had to become a scientific–technological pole in Latin America in those years of nascent informatics. After the virtual disappearance of the Instituto with the military coup of 1966, Sadosky organized in Uruguay the first computing group at the Universidad de la República; and Julián Aráoz, once out of the IC, initiated the first *licenciatura* in computational sciences in Venezuela within the Department of Numerical Calculus of the Sciences Faculty at the Central University of Venezuela, directed at the time by another Argentine mathematician, Carlos Domingo, who had also participated in the Buenos Aires experience.

Among its offshoots was the aborted development of a domestic electronics project in the 1960s and 1970s. The research efforts on electronics components, digital automation and industrial electronics at the UBA's engineering faculty in the late 1950s and 1960s came to a halt with the military coup of 1966, when many scientists quit the universities (and the

country), while others went to work for multinational corporations or domestic electronics companies. Oscar Varsavsky was given a free hand by the owner of FATE, SA,[29] a private company that had made a fortune manufacturing tyres, to recruit the best electronics scientists, create FATE Electrónica, and start producing electronic calculators and printed and integrated circuits.[30] Initial success was due mainly to policies based on assimilating technology, training technicians and engineers, providing space for university researchers and producing products based on intensive R&D. The company did not use foreign licences and trademarks. Instead, it searched aggressively for non-proprietary technological information and sent technicians to study abroad. By 1975, the firm had captured more than half of Argentina's calculator market, forcing Olivetti (FATE's major competitor) into a deep crisis. The next step was computers. By 1974, a computer prototype called Serie 1000 was almost ready, but the whole project was scrapped between the end of 1975 and the March 1976 military coup. The project's ideological premise was that self-reliant development was possible and that the company could benefit from it. But the project lacked the backing of state institutions and technocrats willing or able to play a supporting role. Furthermore, Argentina lacked a systematic S&T policy and governmental awareness of the strategic relevance of producing domestic computers.

The history of atomic energy in Argentina is closely linked to the history of the CNEA, and the importance that President Perón gave to it through his support of the research work carried out by Austrian physicist Ronald Richter and his collaborators (Sábato, 1973; Mariscotti, 1985). In 1949, Perón approved a research programme to produce energy through controlled nuclear fusion. In November 1952, the High Temperatures Pilot Plant in Bariloche was closed and Richter relieved of his duties. Founded in 1951, CNEA began operations in 1953 under a military officer who, to offset the Richter fiasco, included on the staff all the better-qualified scientists, irrespective of politics—even enemies of Perón. It was another remarkable organization that attracted many capable Argentine scientists by offering good salaries, equipment and supplies for research, library facilities and opportunities for a number of the staff to go abroad on fellowships or travel grants at a time of extreme political and economic turmoil when most other scientific and technological enterprises were being suffocated by negligence and inadequate action. In 1956, it had a staff of about 400: 200 professional graduates, including thesis students, and the same number of technicians and others, a library with some 500 journals and clean laboratories, in good order and full of activity.[31]

In addition to a favourable international and domestic environment, other factors contributed to Argentina coming close to achieving its goal of nuclear autonomy during this most turbulent period of national history. The stability of institutional leadership in the CNEA (which until the 1980s

came from the Navy), and the strategic thinking of Jorge Sábato as head of the Department of Metallurgy of the CNEA since 1955, created the tradition that Argentine research reactors were to be built in Argentina. Process turned out to be more important than outcome, as CNEA scientists acquired invaluable skills and learned how to produce technology while building the reactor. Sensing that CNEA know-how would have to be applicable to domestic industry before the nuclear energy industry would have any chance of success, Sábato (with the help of an Argentine industrialist) convinced CNEA authorities to set up an institution for technology transfer, the Servicio de Asistencia Técnica para la Industria (SATI). Another critical choice was the decision to do the feasibility study on Atucha I in-house. Sábato said later: 'We did not even know what a feasibility study was, but there was the understanding that we should do it if the CNEA was to learn how to produce technology' (Sábato, 1973; Sábato et al., 1978; Adler, 1988). As expected, the study called for the active participation of domestic industry, correctly forecasting that this step would be the starting point for a nuclear energy industry. Work towards autonomy in nuclear technology continued, even when many scientists left the country during the troubled years of the second Peronist government (1973–1976) and during the dark years of the ensuing military regime.

This development was aided by the broad appeal enjoyed by nuclear energy in Argentina. The power elites (with few exceptions) viewed nuclear electricity as a boon to achieving major national goals. Turned into a 'national project' that would redeem Argentina's pride, the programme appealed to the nationalist right for strategic and prestige considerations as well as the nationalist left which applauded decreased dependency on capitalist countries. Broad consensus allowed the CNEA to insulate itself partially from intra-governmental rivalries, bureaucratic bargaining, and the political and ideological conflicts between right and left, Peronists and non-Peronists, and civilians and the military (Adler, 1987).

The INTA was created on the basis of two central ideas: to develop an institutional converter mechanism for the adaptation of internationally available technology as a means to increase production, and to rationalize the use of scarce technical and financial resources. Financed by a tax of 1.5 per cent on agricultural exports, it had the clear aim of refuelling the agricultural sector and redressing the effects of the 1940s' most severe crisis induced by a combination of international and domestic factors. It was organized on the basis of restructuring the services of agricultural and cattle research, and the extension and promotion work of the Ministry of Agriculture along with an extensive training programme for research and extension service staff which was developed since 1960.[32] In 1964, it opened local MSc graduate programmes within the framework of the Graduate Programme of the Inter-American Institute for Agricultural Sciences (IICA), and in 1967 the Graduate School in Agricultural Sciences (EPGCA) was

established by agreement between UBA, the Universidad Nacional de La Plata (UNLP), INTA and IICA.[33] INTA was special in the Latin American context in the sense that it managed to provide a favourable environment for professional development in research activity. The high functional concentration of the institutional model and its stability in time are linked to this. It only started to lose technical staff in 1966 and suffered a crucial loss and destabilization as a consequence of the application of the law of *prescindibilidad* sanctioned by the military regime when it came to power that year. INTA began to work on the improvement of agricultural practices, developing a body of recommendations that were already diffused in the early 1960s. All along it did research on genetics, results of which would be seen years later. The ensuing agricultural expansion was based on five crops having high degrees of technological innovation: hybrids in corn, sorghum and sunflower, exotic germ-plasm in wheat and a complex technological package in soybean. For quite some time INTA was the only official agent involved in the production of hybrids, because there was no local private enterprise activity capable of carrying it through and also because the types of corn required by the local market and ecological conditions prevented direct imports of seeds and lines from the United States. Both these elements made necessary a heavy stage of adaptive research which, of course, was carried out by the state through INTA.

Traditionally there was mutual mistrust between intellectuals and civil society organized in political parties, and thus participation of the former in public life was not a frequent feature until recent times. Distance vis-à-vis civil society was traditionally reflected in marginalization from the state, which under-utilized the social sciences considerably. Economists achieved an earlier legitimation, particularly since the 1950s, but they were not immune from entanglement with politics. An epitome of this is the case of economist Raúl Prebisch, who through the CEPAL which he inspired had less influence in Argentina than in many other countries of Latin America, although his ideas were originally developed specifically in response to his observations of Argentina. Many of his ideas and recommendations as well as those of CEPAL did not differ substantially in economic content from those of the Peronist and Frondizi governments. Yet, the meaning that these ideas acquired within the Argentine political context differed considerably because the various groups in Argentina sharing pro-industrialization and developmentalist ideas were often bitter political opponents. The story of Prebisch's influence—or lack of influence—in Argentina reveals a good deal about the role that ideas and their holders can assume in a divided and conflict-ridden society (Sikkink, 1988).

Yet, the lapse between 1955 and 1966 was decisive for the establishment of modern professional social science in Argentina, in contrast with previous traditions, although it revealed its fragility with regard to the strength which those traditions would show in the long run. The institutional base

for this renewal was the university, with the creation of the Instituto de Sociología under the direction of Gino Germani at UBA, and some time later a programme at the Catholic University and at the University of El Salvador. But the discipline did not have enough time to consolidate. The 1966 coup d' état led to the massive resignation of full-time teaching and research staff, many of whom left the country altogether. The social sciences ceased to be collective enterprises with several projects of disciplinary consolidation. For a while, the shortcomings of the university institutionalization were partly overcome by the hospitality and cooperation of official and private institutions linked to some of the social sciences, such as the Consejo Federal de Inversiones (CFI), Consejo Nacional de Desarrollo (CONADE), Instituto Di Tella (1958), and Instituto de Desarrollo Económico y Social (IDES) (1960). These and other centres created in the 1960s and 1970s and the Latin American Council for the Social Sciences (CLACSO) (1967) would help to keep alive the social sciences in a milieu that would turn openly hostile after the 1976 coup.[34]

Totalitarian Authoritarianism as a National Re-founding Experiment (1976–1983) and the Fragile Rediscovery of Democracy (1984–1989)

In the early 1970s, the style of development adopted for the previous forty years showed evident signs of exhaustion, with a pronounced deceleration of industrial growth and the economy in general. It began to be questioned by different social groups. At the beginning of 1976, with the instauration through a coup of a new military regime, such questioning assumed a radical nature and, for the first time in more than forty years, the patterns of economic administration were drastically altered. Indeed, the country witnessed an attempt at re-founding Argentine society through radical changes in its economic structure, its social base of support and the country's role in the international division of labour (Azpiazu, 1989). It involved the reversal of policies that were basic to the previous developmentalist paradigm, such as the ripening and acquisition of comparative advantages, the selective incorporation of technical progress, the strengthening of local technological capacity and the support of the scientific–technological system. Without recognizing that the national crisis, despite having local factors, was also an international crisis, the new Argentine policy adopted as central elements the generalized market liberalization and economic aperture. This was in sharp contrast with the behaviour of the advanced industrial countries, in which, in response to the crisis of the mid-1970s, the regulatory role of the state was enhanced and reinforced.

The international re-integration of the Argentine economy envisaged by the military was to take place on the basis of advantages linked to primary

production (basically the humid pampas) and to its first elaborate stages. Yet, these activities were affected by the marked exchange rate lag that turned unviable any competitive possibility (not only in the international market but also in the domestic one) of local production. The dismantling of R&D teams and of the staff of professionals of public agencies in the scientific–technological domains, the interruption of the industrial ripening processes, the abandonment of local technological efforts, and the involution in process, organization and method technologies were only some of the results that, because of their nature, projected themselves as serious conditionings for any future strategy trying to establish hierarchies for the sustained and equitable growth of the Argentine economy (Katz and Kosacoff, 1988). The re-institutionalization of the country, since the end of 1983, has had to face much more complex and heterogeneous structures and patterns of behaviour than those that had matured during the previous stage of substitution industrialization. Also, the weight of the financial valorization of capital with a clear speculative content and the implications of this for the productive sectors, particularly the industrial one, meant a qualitative change, difficult to revert, relative to the situation of the early 1970s (Azpiazu, 1989).

The difficulty of engaging in an aggressive technological transformation became particularly serious in view of the problem of external debt. As expressed by Ferrer (1987), since the 1950s until the mid-1970s, the economy had grown at a 4 per cent annual rate and domestic fixed investment represented about 22 per cent of the GDP. Although the country was far from achieving conditions of self-sustained growth and dynamic integration into the world system, it had considerable freedom to manoeuvre and to decide the orientation of its development and technological change. In the 1980s, on the contrary, while the GDP was at the same level as in the mid-1970s, the per capita product was 20 per cent lower and domestic fixed investments hardly represented 13 per cent of the GDP. At the same time, the country had lost its freedom to manoeuvre and decide the priorities of its development, and external creditors had acquired an unprecedented influence in resource allotments. From 1981 to 1986, Argentina paid US $30,000 million in profits and interests, of which creditors refinanced 10,000 million. The largest part, US $20,000 million was paid with internal resources, that is, with the superavit of the commercial balance and with reserves. Despite this extraordinary effort, the external debt increased by more than US $20,000 million between 1980 and 1986. This transfer of resources absorbed 40 per cent of the exports of the period.

When the military coup of 1976 completed the task of dismantling the universities that had started in the previous coup of 1966, exodus, death or '*prescindibilidad*' affected massive numbers of teachers and students. Illegality reached persons, researchers, theories, ideological orientations—indeed entire disciplines. This was perhaps the most severe blow in a series

of authoritarian experiences, which left deeply distorted the public university institution. In the process, all areas of knowledge were affected.

The intervention in the universities meant, besides its devastating short-term effects of expulsion and marginalization of those scientists committed to modernization schemes, longer-term effects which would lead to new organizational forms of research. These were basically geared to removing research from the university domain and exercising a political– ideological control over these actvities, which was impossible to do in academic institutions. The power of CONICET grew together with a very substantial increase in its budget, which was intensively applied to the expansion and strengthening of what came to be called the 'system of institutes'; by 1983 there were 116 institutes depending on CONICET and seven regional centres aimed at scientific geographical decentralization. On the return of democracy, investigation of irregularities in the use of funds granted to the institutes and research programmes that proliferated in the 1976–1983 period resulted in a protracted legal cause and in the elaboration of a subsidies regime favouring transparency in its handling, both as regards officials and beneficiaries of the system (Valeiras, 1989). The traditional scientific promotion subsidy mechanism was perfected since 1984 by means of the creation of the Projects of Research and Development (PID), where proposals approved were to be subsidized for three years; a complementary system was implanted to support projects for one year—the Annual Research Projects (PIA). Both programmes were conceived as policy instruments aimed at directly supporting the researchers and reducing significantly the role of organizational superstructures.

During 1987, CONICET financed a total of 2,275 fellowships in the country and 130 fellowships abroad in addition to maintaining the members of the Researcher's Career Programme, which in 1988 included 2,212 members, and the Research Technician and Support Staff Career Programme, which had 2,667 persons. Yet, a survey carried out by CONICET in 1988 gave a total of 19,111 persons devoted to scientific and technological activities. The exact and natural sciences prevailed, with notable weight of the basic sciences. In terms of numbers, this disciplinary grouping grew by 76.4 per cent between 1969 and 1982, and again by 21 per cent until 1988, well above the average for both periods (52.8 and 4.4 per cent respectively). By 1988, there was a partial recovery of the universities, which came to have 56.7 per cent of the scientific–technical staff (Albornoz, 1989).

Perhaps the most novel aspect of the actions in the last few years was the addition of the technological linking promotion function to CONICET through the Office of Technology Transfer. One hundred and thirty-one technological linkage agreements were signed between 1984 and 1988, while another ninety-four were carried out by units depending on CONICET and other institutions, signed only by other institutions. These figures acquire more meaning if one takes into account the economic crisis and the relatively small amount of money invested by private firms, mostly small and medium sized; it was evident that a considerable number of risk

activities emerged without practically any state incentive. CONICET, without investing any additional money, began to optimize the use of resources of the scientific system.

The social sciences, identified by the military regime in the 1976–1983 period with subversive ideological penetration of the university, suffered the most direct attacks. They survived, reduced to a minimal expression in terms of numbers of active practitioners in precarious independent (that is, private) research centres which, in order to survive, adopted a 'catacomb mentality', including a low profile, little diffusion of their work, very restricted research topics and complete dependence on foreign funds (Vessuri, 1990; Brunner and Barrios, 1987). Towards the end of this very dark period, the delegitimated and marginalized social sciences oriented themselves towards a democratic discourse, built from the position of the defeated. Democracy came to be seen more as a hope than as a problem. Instead of a future radical transformation of society, the aftermath of the authoritarian experience led to a defence of the democratic tradition. The new conceptual apparatus moved to problems of political development, governability, public choice, institutional reconstructive reform, critique of the state and other topics common in the research agenda of foreign funding agencies and in intellectual centres in the developed countries. In a society like the Argentinian one, deeply disturbed, whose political history is characterized by situations of catastrophic tie and reciprocal veto, the idea of pacts and strategies of bargaining and governability constitute important innovations. Of course, concern for the reconstruction of the social tissue responded to the legacy of devastating dictatorships, but it was also influenced by neo-liberal claims towards the dissolution of the state.[35]

With the reinstauration of democracy, official and para-official foundations grew significantly, serving as communication channels for new ideas, and foreign foundations as funding agents and co-sponsors of new ventures increased. By contrast to the proverbial historical conflicts of intellectuals, technicians, professionals and even certain groups of bureaucrats with political parties, in the 1980s intellectuals entered strongly, not only into government circles as advisers and speech-writers (the Esmeralda group, for instance) but also in executive functions. Two important ministries, economy and foreign relations, were commanded by social scientists coming from independent private research centres, and a considerable number operated in pockets of the political administration (Passalacqua, 1989). A certain trend became visible towards the transfer of party power to sources of authority not belonging to any party and above them, the substitution of party representatives by experts in political posts, justifying it in terms of the 'technical' nature of decisions.

In the years of the military 'process', the emigration of the scientific, technical and professional cadres was very significant, adding to the problems of repression and marginalization. The abrupt application of the new model of economic opening since 1976 resulted in the breaking up of the

industrial and technological systems and the devastating interruption of the ripening process in sophisticated industries like electronics, leading, among other things, to the significant growth of unemployment specially in the best qualified and better paid jobs—scientists, technologists, professionals and qualified workers (Azpiazu et al., 1988). From being an immigration settler country, by 1984 Argentina had a total stock of expatriates numbering 547,000 individuals, a considerable figure if the average educational level of the stock is taken into account as well as the fact of the considerable proportion of professionals and technicians it involved (Lattes, 1986).

Inadequate funding of higher education has persisted for several decades. While between 1960 and 1990 the total student population grew at a 5.9 per cent annual rate, public funding diminished during the same period at a 1.5 per cent yearly rate. The combined result was a substantial and sustained reduction of the expenditure per student, which passed from an annual average of US $1,800 in 1963 to US $225 in 1989—an average annual rate of reduction of 7.5 per cent. Higher education expenditure also diminished relative to secondary education to the point that at present there is no difference between the two levels. This situation has inevitably had an effect on the quality of higher education and scientific endeavour as a whole, in view of the close interface between science and higher education.[36] A recent study has found that professional schools suffered the impact more in the form of government and funding strategies in national (public) universities—these schools have the lowest level of teaching staff in terms of the proportion of full-time teachers. Instead, in the 'academic' schools, such as the science faculties, the teaching staff remains above the norm, although they are under-utilized as seen by the low levels of supplementary expenditure to that of staff (Gertel, 1991).

Since the 1970s, INTA's role diminished gradually as dynamic private firms began to competitively provide the market with corn seed. Also, the appearance of hybrid sorghums ten years after the corn hybrids, which involved an easy ecological adaptation of North American varieties, as well as of sunflower allowed the direct importation of foreign public technologies without the local public sector having to do any major adaptation work. This task was already carried out by private firms, be it subsidiaries of multinational companies or national enterprises through licensing (Gutierrez, 1988). However, the peculiar dynamism of these new sets of institutional social actors, together with the deterioration of the public sector, the reduction of financial resources for research and the lag in the production of innovations, have produced a negative effect upon the national capability to produce an appropriate technological change in the agricultural sector. A fundamental change is required, both qualitative and quantitative, in the nature of the demand of technology for agricultural production, with deep implications for the research system, as much from the point of view of the

type of technology to be investigated as from the point of view of the necessary availability of resources and specialists in order to carry it through.

Conclusions

Science is an activity carried out by individual and group practitioners—the scientists—in specific settings—the laboratories—whose results are communicated to other practitioners like themselves and to other audiences. The Argentine case exemplifies nicely the problems of the transition of knowledge from private to public non-science spaces. Behind the narrative of the process of growth of a scientific community in this developing country, my purpose has been to present historical evidence that suggests how the relationships between science and its audiences can be illuminated by cases of individual scientists and disciplines at different points in time. A variety of experimental, representational and discursive strategies have been shown to be implicated in the creation of a public authority for scientific knowledge. Thus, I have considered how Ameghino managed the transition from his totally marginal position to the leadership of the National Museum of Natural History in Buenos Aires; how Houssay, practically self-taught in experimental science, achieved the maximum consecration of the scientific profession by getting the Nobel Prize while staying in Argentina despite adverse conditions and building an experimental school internationally renowned for its technical quality; or how Sábato, another self-taught scientist, managed to stir the imagination of other scientists and technicians as well as of industrialists and politicians to define a national strategic project such as that of nuclear energy.

Why, independent of their scientific quality, have some of these scientists been successful in their transition to the public stage while others have not? Adler's thesis of intellectual 'guerrillas' offers a possible explanation for some of the cases. He refers to those individual scientists, technologists and economists with authority in domestic and international forums who were able to use state power to mobilize the practical experience of scientific and technological development and its industrial applications. When their views were akin to those of the political elites, they had only to show the way—as in the case of the nuclear industry—shaping collective beliefs and expectations within state institutions and at policy making levels. In other cases, however, their ideological motivations differed from those of the ideological context of ideas indirectly in trying to bring about the desired end by using their technocratic and persuasive skills. More often, they failed to have their ideas carried through. One of the most unfortunate instances of national waste of capacities is that of the relationship of the government with physicist Gaviola.

In general terms, the problem is one of producing a reasonable account of the process of the emergence of a scientific community in a particular society, which enables scientific work to be related to the aims and resources of its practitioners and to the structure of constraints within which it finds itself. All knowledge production comprises an inseparable compound of both types of elements. Precisely what stands out in the Argentine case is the frustrating coexistence of a disproportionate amount of will, imagination, creativeness, and skills and techniques found in individual scientists to probe the natural world, and the unfavourable socio-political factors beyond their control that they encountered as soon as they began to be seen as a menace to the status quo (whatever the domain in question).

Notes

1. The migration of non-natives was the main component of population growth until 1935, making this city a very special case (Recchini de Lattes, 1971).
2. There were many manifestations of the 'peril' involved in the 'invasion of immigrant students that would later invade society as professionals' competing with those who in the past had dominated professional activity without rivals (see for example, Pueyrredón, in *La Nación*, 1904, as quoted in Halperín, 1962: 118–19).
3. I will show in the next sections that low salaries, continued political and economic instability, and frequent persecution and repression have contributed to the emigration of a good portion of scientists and engineers and discouraged the scientific vocation among the young in recent decades.
4. Yet, since the First World War and particularly since the 1920s, there were clear signals of the exhaustion of a development style which for half a century had relied exclusively on the agricultural rent of the humid pampas. The international 1930s' crisis implied the final demise of that accumulation model.
5. See the papers included in Platt and Di Tella (1985). For other references to Argentine development in comparative perspective see Korol's 1991 review paper.
6. For a recent review of different explanations of the Argentine agricultural stagnation from 1944 to 1960, see Barsky (1988).
7. One of the men that best expressed in his own life the complex tissue of such a dense and invigorating epoch was naturalist E. Holmberg (see Montserrat, 1974).
8. For a description of Gould's activity in Argentina, see Echarri (1970).
9. Ameghino published two works that evidenced his precocious maturity: 'La formacion pampeana' and 'La antigüedad del hombre en el Plata'. In 1882, he organized his ideas about transformation in a conference entitled 'A la memoria de Darwin', and two years later he did the same with his views about the general problem of evolutionism in his *Filogenia* (1884), whose content he defined as the transformist classificatory principles based on natural laws and mathematical proportions (See Ameghino, 1935; Romero, 1965).
10. The Argentine University Reform Movement inspired the leaders of great popular movements in the region, from Haya de la Torre to Fidel Castro, while in Argentina the extra-university repercussion was practically non-existent. Among the historical reasons adduced to explain this is that in Argentina the popular masses had a more complex structure than in the countries where reformist ideas had political success. A good portion of the urban masses with which the students had more direct contact had already found political and union organizations that channelled their interests. Also, different from

most Latin American countries subjected to military dictatorships, in Argentina a democratic experiment had begun in 1916, whose failure was not envisaged yet (Halperín Donghi, 1962).

11. Where, for example, a doctoral degree in chemistry was offered already in 1905 and the Argentine Chemistry Society was founded in 1912, before those of Italy (1919), Canada (1921) and Japan (1948).
12. For his abilities as researcher and teacher, Bose was rapidly promoted as privat-docent and Nernst's assistant. In 1906, he was appointed director of the Danzig Technology Institute, a strategic point to Germanize the eastern parts of Prussia that were Polish-speaking. Precisely that experience was expected to be valuable in Argentina, considered a new cultural frontier to conquer.
13. German influence was not restricted to science. Towards 1909, German officers had reorganized the Argentine army, the Argentine navy came to depend on German wireless technology and German-led firms dominated electric facilities around Buenos Aires (Pyenson, 1984).
14. Among them, the Laboratory of Material Essays of the Ministry of Sanitary Works installed between 1901 and 1903 deserves mention.
15. Later, in 1935, the National Oil Company (YPF) inaugurated in Florencio Varela the most important laboratory of the public sector.
16. For an analysis of the differences between Pan-Americanism and Latin Americanism see Ardao (1986).
17. See Roca and Sanchez's recent book (1990) *Shipwrecked from the Civil War in Argentina* about Terradas and his profitable work at the Engineering Faculty of the Universidad de Buenos Aires, particularly in connection with aeronautical engineering.
18. For an analysis of nationalist thinking in Argentina see Navarro (1968); Zuleta (1975); and Rock (1987).
19. For the story of angiotensin see the papers by Fasciolo and by Page, both published in 1974.
20. Mariscotti, 1985, p. 26.
21. Although in Argentina the term *desarrollismo* took on a political meaning as the label of the Frondizistas, as if Rogelio Frigerio had invented the notion, I prefer to take it in the more general sense of developmentalism, which is often associated directly or indirectly with the ideas of the United Nations Economic Commission for Latin America (CEPAL in Spanish, ECLA in English) and was common for several decades in Latin America. In this sense, as recognized by Prebisch himself, the economic policy content of many of his and CEPAL's ideas and recommendations did not differ substantially from that of the economic policies of the Peronist and Frondizi governments (Sikkink, 1988).
22. Not even CONICET escaped this general trend. Founded on the personal initiative of Houssay, it stressed the natural sciences.
23. For his research on the glandular base of sugar metabolism.
24. The private patron that made possible the creation of the Institute of Biology and Experimental Medicine (IBYME) was a local entrepreneur, Juan Bautista Sauberan, to which was added a substantial contribution by the Rockefeller Foundation and the personal contribution of Braun Menéndez.
25. This time the patron was a textile manufacturer, J. Campomar.
26. See Miller (1950), Box 45.
27. All references to 1956 are from Miller (1956), unless otherwise indicated.
28. Which, like numerical calculus and mathematical logic, became one of the theoretical pillars of the digital computer. See note 13.
29. Madanes was a nationalist and Peronist supporter. This fact helps to explain the difficulties of the firm when the neo-liberal military came to power in 1976.
30. Babini (1991) explains how Humberto Ciancaglini had reached the conclusion by 1957 that the best way to prepare future electronic engineers to master digital techniques was

to start the construction of a computer in the very Department of Electronics at the engineering faculty and the rich set of events that this decision set in motion.

31. (*a*) Radioisotopes (eleven new short-life isotopes discovered), (*b*) analytical division, (*c*) ra technology, (*d*) physics (mass spectroscopy), (*e*) metallurgy, (*f*) biology and medicine—histology, tissue culture, hematology, biochemistry, radiobiology and electron microscopy. Other divisions included (*g*) accelerator division, in operation since 1952 (Cockcroft–Walton, of 1,200,000 volts; Philip's synchrocyclotron, which Ernest Lawrence is said to have told them to be the 'best he had ever seen' [of its class]); (*h*) heavy water separation pilot plant (Miller, 1956).
32. The training programme had the support of many international agencies, among them AIDUS Universities: Texas, Pennsylvania, Michigan; FAO-UNDP; The Ford Foundation; Rockefeller Foundation; CNRS; British Council; and the OAS–Multinational Centres Projects.
33. This school halted its activities in 1976, with the ending of the agreement between the universities and INTA (Trigo et al., 1982).
34. The Ford Foundation contributed significantly to the institutionalization of the social sciences in Argentina. It supported Germany's Instituto de Sociología in the 1950s and 1960s and Instituto Di Tella. By the time of Peronist control of Argentine universities in 1973, active investments in the country totalled some US $2 million.
35. Yet, the big problem remains one of ungovernability, as a consequence of the disproportionate number of unfulfilled demands coming in increasing numbers from civil society and the limited capacity of the economic–political system to respond to them. Posing the problem in these terms, its extreme solutions would be either the forced reduction of demands (authoritarianism) or the improvement of the public services looking for a healthier state and not its dissolution (social democracy).
36. From a financial point of view, the increase in the quality of the teaching staff is always translated in increasing educational costs. Besides, the improvement of teaching requires raising teaching requirements and qualifications, expanding library facilities, guaranteeing an adequate level of non-teaching staff for the correct use of laboratories and equipment, and updating equipment and infrastructure. In conditions of increasingly lower expenditures per teacher, as has occurred in Argentina, none of these requisites to improve the quality of teaching are satisfied.

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