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UNDERSTANDING FIRM PERFORMANCE: THE CASE OF DEVELOPING COUNTRIES'S FIRMS THAT COMPETE INTERNATIONALLY IN TECHNOLOGICALLY ADVANCED INDUSTRIES

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UNDERSTANDING FIRM PERFORMANCE:

The Case of Developing Countries's Firms that Compete Internationally In Technologically Advanced Industries

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Abstract

Insights from industrial organization, Schumpeterian innovation, and economic development theories are used to try to explain firm behavior in cases of successful acquisition of advanced technological assets and inte-national trade competitiveness by Asian and Latin-american countries at an intermediate level of industrial and technological development. The role of the state as innovador as well as the importance of alternative forms of organization emerge as the most salient findings.

Key words: Enterprise, innovation, industrialization, technology, developing countries, industrial organization, institutions, public sector.

JEL classification: O14, O31, O32, O33, O38, L20, L60, L63.

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Introduction

This paper is concerned with a narrow subset of the overall question of understanding the behavior of the firm: how to reckon with the performance of firms in developing countries that possess advanced technological assets and use them to compete in international markets?

Relying on cases analyzed in Teitel (2006) we apply insights from the industrial organization, economic development and innovation literature, to contrast actual performance with the received theory of the firm. In particular, we rely on Schumpeter's (1934, 1950) views about the innovating entrepreneur, notions of structural impediments present in developing countries (specially institutional and skills constraints), as well as a conceptualization of technological and industrial development as evolutionary processes occurring at firm, sector and country levels (see Teitel, 1987).

It will be our contention that neither the traditional conception of private entrepreneurship, nor the received theory of the firm, are very useful to understand the accomplishments of a number of firms in countries at a relatively low level of industrial and technological development that have nevertheless managed to compete in technologically advanced industries with major enterprises based in highly industrialized countries.

In attempting to explain these apparently paradoxical findings we shall be guided by reference to three key factors: **skills, institutions and policies**. It seems intuitively clear that such factors do not operate independently or in isolation from one another. Thus without their requisite skilled manpower, institutions cannot work and policies cannot be implemented. However, in principle, lack of skills can be

remedied at any time through short and long term educational and training policies, including, inter-alia, the necessary institutional build up. Similarly, policies will have little chance of being implemented in the absence of a minimum institutional infrastructure. Nevertheless, without disregarding the extent and nature of their interactions, it will be useful, for analytical purposes, to examine these factors individually.

According to the theory of the firm the main economic justification for its the existence of firms resides in their ability to lower transaction costs by internalizing a number of operational and coordinating activities otherwise performed by multiple actors external to the enterprise (see, for example, Hirshleifer, 1984). Could we then anticipate that acquiring advanced technological capabilities and international competitiveness in the production of new, sophisticated, products and services, in a developing country milieu, falls within the purview of private firm decision-making? Or do such undertakings demanding innovative entrepreneurship not necessarily require private sector firm structures?

The paper is organized as follows: Part I contains the case evidence, Part II describes the effects of such factors as policies, institutions and skills, Part III contrasts the findings with precepts from the literature on innovation and entrepreneurship, industrial organization, and economic development. The paper closes with a brief section of summary and conclusions.

I.Case Evidence

A. Nuclear Engineering in Argentina: In the Beginning There Was an Institution

Acquisition of Argentina's technological capability in nuclear reactor engineering took place in the National Atomic Energy Commission, (NAEC), preceding the creation of INVAP, a joint, federal-state public firm spinned off by the NAEC. Additional technical and engineering skills were obtained via R&D and fellowship programs instituted by the National Council for Scientific and Technological Research (CONICET), and learning-by-doing during the construction of Argentina's first atomic power plants.

It could however be argued that in the marketing of its technological capabilities, including participating in international tenders in competition with firms from industrialized countries, INVAP has benefitted from its access to entrepreneurial autonomy. This is perhaps best exemplified by its recent success in winning a major contract to construct a research nuclear reactor in Australia.

The military-instigated government (G) policy of assigning priority to the acquisition of atomic power capabilities obviously came first, and it resulted in the creation of a relatively strong institution, the NAEC, with sufficient resources and autonomy to pursue its assigned objective. The G further contributed by embarking in a series of investments in nuclear power plants to diversify the country's energy supply sources. NAEC's lobbying for domestic participation in the construction of the first atomic power plants won G support and was instrumental in acquiring local engineering and construction capabilities while supplying parts and equipment to the foreign builders.

Needless to say, acquisition of the nuclear engineering skills required a thorough understanding

of atomic physics, an incipient but relatively good quality specialization among physics and chemistry students in Argentine universities at that time[1]. The acquisition of advanced nuclear engineering skills was enhanced by a program of scholarships abroad implemented with CONICET's support. The NAEC also received technical assistance through the regional metallurgy program administered by the Organization of American States (OAS).

In this case, the original entrepreneurial motivation did not arise from a private firm, nor was such a type of organizational structure responsible for the acquisition of technological assets and their underlying skills. The innovation-investment sequence seems to have started with G policy (P), leading to institutional (I) build up and then skills (S) acquisition and further institutional creation, or change. Schematically: P - I - S - I .....

B. <u>Aeronautical Industry in Brazil: Public Design and Market Building Regulation</u>

Development of a domestic aerospace industry in Brazil took initially the form of the creation of a public firm, EMBRAER, that acquired private partners much later, and, remarkably, has recently gone public at a time when major aircraft firms in industrialized countries seem to be unable to compete internationally without G subsidies. EMBRAER also managed to enter partnership agreements with major public and private aeronautical firms to complement its technical assets, including the joint design and construction of new civilian and military aircraft models.

G support continued to be critical for EMBRAER's success all along. First, by protecting the firm from foreign competition in the domestic market. Then, by earmarking a portion of public defense

[1] *Indirect evidence of the quality of their training was the ability of Argentine graduates to obtain work in atomic laboratories and universities in Europe and the USA at a time when such openings were badly lacking in the country.*

procurement for EMBRAER, and, more recently, by providing export financing subsidies that allowed it to compete abroad. Public support was also critical in securing its initial commuter aircraft design.

EMBRAER succeeded in the US market with its first commuter plane, the Bandeirante, whose design it obtained from a public research institute (CTA) which also collaborated with the firm in successive plane development. With a seat configuration for 19 passengers, EMBRAER aptly capitalized on a US air-transport regulation requiring a flight assistant in commuter planes with 20 passengers or more, thus helping regional airlines to lower their operating costs.

The process of EMBRAER's creation seems to have followed the sequence: G policy launching the industry-firm, concomitant institutional development of aeronautical infrastructure, followed by the acquisition of skills, and further policy support in domestic and foreign markets: P - I - S - P ....

In both cases above, public entrepreneurial motivation seems to have originated with the military who influenced governmental decision-making when those initiatives had a critical need for financial and political support. While their success apparently validated the vision of the initial supporters, it is hard to imagine that such initiatives could garner similar support in the present trade and technology global environment (see, for example, Teitel, 2005, pp. 458-59).

C. Korean Designed Digital Telephony Switches: Public R&D to Leapfrog Technology

For successful R&D to develop their own national digital switching system (TDX), Koreans relied on public entrepreneurial leadership. This was the more remarkable in view of the fact that, although in limited scale, local producers were already manufacturing such equipment locally, and that, following Japan's example, Korean industrial and technological landscape was (and is) dominated by very large conglomerates. Moreover, the scheme was audacious in that it sought to leapfrog the

analogue phase and jump to digital technology for which little knowledge or experience existed in the country. Also in the best Korean (Japanese inspired) tradition foreign investment participation was initially avoided.

Distinguishing this experience is the fact that no enterprise structure was established, with the project being managed by a G ministry and involving a national sectorial research institute (first the KTRI and then the ETRI), the prospective main customer, (the public telephone agency), as well as some conglomerates attracted by the expectation of large future sales (and profits), if the project were to succeed. However, private interests did not play the key entrepreneurial, or coordinating, role, which fell to the G. Once the digital switches were successfully designed the consortium R&D project structure was abandoned.

This initiative was also G inspired, starting with a policy to harness R&D resources to develop and produce Korean designed switches which would allow them to leapfrog the analogue phase and jump to a digital system when the country's telecommunication network was still in an embryonic stage. Relying on domestic technical institutions and skills, a major R&D project was launched, supported, and coordinated by G institutions. It generated the envisaged designs for digital switches which were later on successfully manufactured and exported, with additional skills being learned in the process. Thus the sequence followed seems to have been: P - I - S ....

D. <u>Taiwanese Made Computers: Developing Country Expatriates Supplying MNCs.</u>

The story of ACER's creation and development falls more clearly within the traditional conceptual purview of the private sector firm and its coordinating advantages. Nevertheless, it can be argued that when settling back in Taiwan from their respective sojourns abroad, the founding engineers brought with them some of the assets crucial to their future success. Namely, their advanced training and

the experience of having worked in major information technology (IT) firms for which, upon returning, they started to do subcontracting work producing lower cost equivalents of foreign-designed computers and their parts. Additional technical assets were also acquired as a result of cooperating with their foreign clients and other international firms.

Later on, through its own R&D capabilities, ACER was also able to modify existing chip designs, as well as to design its own, improved versions, of new chips earning several patents in the process. Moreover, it also succeeded in selling products under its own brand name besides those produced for its multinational clients.

ACER was able to capitalize on the skills and contacts acquired by its founders while working for major IT firms. The key to this contractual or "institutional" arrangement resided in their ability to use similar, highly efficient, manufacturing and management techniques, in a lower cost environment. Moreover, skill creation and enhancement also took place leading to their own "chip" designs. They were also successful in marketing a substantial share of output under their own brand name.

Thus we are in the presence of a sequence: S - I - P..., where in this case the P (policy) refers to internal, private firm, policies, and not to public ones. In fact, ACER seems to have taken no advantage from significant Taiwanese G initiatives to support SMEs firms in the S&T area, including a major "science" park and consortia set up to help with the financing of R&D projects.

II. Factors, their Effects and Interactions

A. Policies

These include all G interventions that result, directly, or implicitly, in changes in market prices or quantities. In Argentina their first effect was in favoring nuclear energy as a source of power. While the armed forces original motivation may have been acquiring a strategic, subcontinental, lead in the development of nuclear arms, strong diplomatic pressure by major international powers resulted in the channeling of this potential towards peaceful applications such as domestic power generation and research reactor engineering.

The nuclear power policy took its most important and effective embodiment in the creation of a leading institution, the National Atomic Energy Commission (NAEC), which was entrusted with becoming the main depository of the scientific knowledge and technical skills that the development of atomic energy sources in the country would require. Moreover, once the construction of nuclear power plants was approved, the NAEC sought, and obtained, contractual clauses to permit a degree of "un-packing" of the design and construction technologies, as well as training of its personnel and procurement participation by local industry. Thus policies for the acquisition of knowledge, and learning-by-doing, were also implemented by the G through NAEC's initiatives.

Supplementary policies to enhance the basic scientific and engineering skills of Argentine physicists, chemists and engineers were carried out via another institution, the CONACYT (now CONICET), that financed local R&D projects and fellowships abroad. The G later also supported export of research and training reactors via capital goods export financing schemes.

In Brazil there was similarly a G desire to develop a local aerospace industry to attain both a

measure of national independence in the provision of training aircraft for the armed forces, as well as commuter planes for the potentially large aero-transport domestic market. Defense considerations were also important given the vastness of the country and the lack of roads or other transportation means which made many remote areas only accessible by plane. However, it would be hard to argue that the G foresaw the development of an enterprise, or industry, that would become one of the largest exporters and foreign exchange earners for the country.

Creation and growth of the enterprise were also favored by the design and other technical support it obtained from nearby public aeronautical R&D facilities, particularly the Center of Aeronautical Technology (CTA), which provided it with the design of its first commuter jet plane, successful in the domestic market, and later on in the US.

The G supported EMBRAER by protecting the domestic market from foreign imports of similar commuter planes. Moreover, it also favored the firm as a supplier of training planes for the Brazilian armed forces. Later on, the G provided critical financial subsidies for EMBRAER's exports that allowed the firm to compete with well established manufacturers in developed countries. Through FINEP/BNDE supported programs the G also favored R&D work carried out by EMBRAER.

In Korea the G provided the initial inspiration and entrepreneurial vision to create a domestic R&D capacity to design digital telephony switching equipment and thus help the country to leapfrog the analogue stage in telephone communications. While in envisaging the provision of the public good of indigenous switch design the G exhibited Schumpeterian innovative attributes, this did not directly lead to the creation of any specific firm but just to coordination of a major R&D project.

Thus similarly to the Argentine and Brazilian cases, initial policy support was based on pursuing

a public good: nationalism as embodied in technical and economic autonomy (see Johnson, 1967, ch. III), which could hardly be perceived and adopted as such by the private sector. The managerial role was then assigned to a G Ministry which assumed the coordination of the various participants: technical research institutes, future producers, and future major domestic client. Once the switching equipment was successfully designed and produced, the G saw to it that it would be adopted domestically and later on also provided export promotion policies for its dissemination abroad. It is also worthwhile noting that the G supported a policy of domestic knowledge creation with minimum foreign participation via the importation of technology or capital.

In ACER's case, policies refer to strategic decisions adopted by the firm since the G had no role in its inception or development. Critical to its success were decisions as to how much to produce for their clients under their internationally recognized names vis a vis output sold under ACER's own brand name. Similarly, initial dependence on technology mostly provided by their customers, was eventually supplemented by own R&D that resulted in significant modifications of existing computer chips as well as the design of some new chips of their own. A measure of their R&D success are the patents that some of their major international customers have been willing to license from ACER.

B. Institutions

Different types of institutions have been of significant importance in the cases reviewed. Our take on "institutions" in this paper is quite general in nature. Given the existence of transaction costs and limitations to the flow of information among key reasons for market failures, institutions are the name given to all sort of industrial organization arrangements, including at one extreme the enterprise and at the other the market(s) in which it operates.

As noted above, in Argentina's quest for nuclear power knowledge and its application, a public

agency (NAEC) became the key institutional depository of the scientific and technical knowledge required to operate as well as to design research and training atomic reactors for domestic use and later export. In fact, there was no initial attempt to create an enterprise the spinning off of INVAP being a much later step taken to facilitate the marketing of the acquired technical assets in domestic and foreign markets.

For Brazil's objective of acquiring an autonomous aeronautical capacity, the (public) enterprise was the institution of choice, but with the support of complementary institutions. This was particularly important initially, when EMBRAER relied on the CTA for the design of its first commuter plane, the Bandeirante. Other institutions played also an important role, particularly R&D programs supported by the BNDE.

As a public enterprise, with a tiny private minority, EMBRAER, was able to achieve significant breakthroughs in both the technical and commercial areas. It also exhibited flexibility in its ability to arrange partnerships with major foreign aircraft manufacturers which were important to acquire new technologies and to share in new plane design and development. In its recent, and more mature phase, EMBRAER was able to go to the stock market and become a largely private, publicly listed, firm, which competes with firms from major industrialized countries in the international market for regional jets.

For Korea's objective to acquire an autonomous research and design capacity in the digital telephony switching equipment field, the institutional solution was not to create a firm, but to organize an R&D consortium coordinated by a G agency. Among the major institutions participating, besides the telecommunications ministry, were the Korean Telecommunications Research Institute (KTRI) (later replaced by the Electric Technological Research Institute (ETRI)), Korean Telecom, as well as various

local private producers.

Thus the R&D project was the arena in which transaction costs had to be lowered via efficient coordination. Later on, when the design objective had been achieved, the G withdrew from the scene and let the manufacturing firms organize production to supply domestic and eventually foreign markets. It could be argued that the key objective was to attain the technological asset that consisted in the R&D design and capability to manufacture digital telephony switches to be incorporated in local and foreign central telephony stations[2].

In Taiwan, instead, a private firm was the institutional arrangement used to internalize the newly acquired IT knowledge and experience of its founders, as well as the contacts made while working with major IT firms abroad.

C. Skills

In all cases a specific, advanced, technological asset was attained that constituted a basis for success in international competitive markets. Mastery of those advanced technologies required a gamut of technical and engineering skills. Acquisition of those skills was made possible by a variety of policy and institutional arrangements.

In Argentina, engineering skills for the design and construction of nuclear research reactors required a scientific grounding in atomic physics plus the chemistry of nuclear reactions and specialized metallurgy for radiation containment vessels, etc. The basic principles of those disciplines were imparted

[2] *In this sense the Korean achievement is in some ways similar to the Argentine acquisition of technological capabilities in the nuclear engineering field, since INVAP, the firm spinned off from NAEC, was more in the nature of an afterthought and mostly to facilitate marketing undertakings.*

in local universities while a good deal of applied technical knowledge was acquired by on-the-job-training and learning-by-doing. Instrumental was also a program of fellowships for study abroad instituted by the NAEC with the support of the CONICET.

The NAEC was also responsible for negotiating contracts with foreign constructors of the atomic energy power plants ATUCHA I and II that allowed for learning-by-doing of its personnel during the execution of those investment projects, as well as the granting of preferential procurement allowances for domestic industry. While all those skills were accumulated in the NAEC, and to some extent among local suppliers, the creation of INVAP facilitated their application and marketing in international undertakings.

Engineering and design skills were also acquired locally by EMBRAER, but with significant help from public aeronautical research institutes, in particular CTA, that provided the design of its first commuter plane. Additional advanced technologies were acquired via partnership agreements with international aerospace companies. Firm R&D projects were supported by BNDE financed programs.

In Korea's case, the new technology was acquired via a G sponsored and coordinated R&D project. Engineering and technical skills were, for the most part, locally available and were successfully harnessed to attain the desired digital switch design (TDX). The project was started at the KTRI and later on transferred to the ETRI with these institutes providing technical leadership. Once achieved, the design was implemented by local manufacturers for both domestic and export applications.

ACER brought the computer manufacturing technology to Taiwan via the expatriation of a group of local engineers who trained and worked abroad for major IT firms. Their skills were the result of local education plus experience working abroad. Imported technologies were further enhanced by

own R&D leading to several international patents.

Table 1 shows schematically the role played by the three key factors (policies, institutions, and skills), as well as the various levels at which they operated in the four cases reviewed.

Table 1. Contributing Factors in the Acquisition of Advanced Technological Assets

Factor	Nuclear Eng. (Argentina)	Aircraft (Brazil)	Dig. Telephony (Korea)	Computers (Taiwan)
Policy, 1st level	Regional nuclear preeminence	Promot. national aeronaut. industry	Promotion of indig. telephony equip. design	Wholly private initiative
Policy, 2nd level	Favoring nuclear power	Protecting local industry	Sponsoring local acquisition of equipment designed	General G support of S&T infrastructure
Policy, 3rd level	Preferential procurement, Xs promotion	Financial subsidies for Xs.	Xs promotion	___
Institutions 1st level	Key institutional structure: NAEC	Key structure: public firm, EMBRAER	Key structure: national R&D consortium	Private enterprise
Institutions, 2nd level	Spin off subsidiary structure: INVAP	Main support inst. for R&D: CTA	Main support. institut: telecom. ministry	Long term supply contracts with MNCs
Institutions, 3rd level	Support institution: CONICET	R&D projects supported by FINEP/BNDE	R&D institutions: KTRI and ETRI	____
Skills, lst level	Basic scientific and eng. skills: local universities	Basic aeronaut. engineer.: local universities	Basic elect. eng. skills in local universities	Basic elect. eng. skills in local universities
Skills, 2nd level	Main ground for specializ.: NAEC	Local R&D projects	Local R&D projects	Technol. know-how provided by

				clients
Skills, 3rd level	Partic. in power plant constr. and training abroad	Partners. agreem. for advanced technologies	Foreign agreements for specific technologies	Own R&D

III. A Conceptual Framework?

As stated initially, we can look at the evidence through three different lenses, or economic thinking perspectives: entrepreneurship and innovation as conceived by Schumpeter, institutional theories of industrial organization, and theories of economic development.

A. Innovation and Entrepreneurship

For Schumpeter, the entrepreneur and his innovating activity play the key roles in economic development. Schumpeter conceived innovation as entailing not necessarily original creativity or invention. Innovators could be imitators who introduce a product, service or process, already known and applied elsewhere, to a new market or location becoming in that way a "creator" for that environment. Entrepreneurship a la Schumpeter (see, Nelson and Winter, p. 277), is, almost by definition, a scarce commodity in developing countries. Occasionally, as we shall see, this void can be filled by G intervention, with or without private sector participation[3].

[3] *Take for example the large scale investments in the production of flat steel products and basic petrochemicals plants in Brazil during the 1960s and early 1970s. Although conventional wisdom would have predicted that given the size and growth prospects of the Brazilian economy, private capital markets would have been adequate to finance such investments, in fact they did not, with the private sector only participating in joint ventures at a later stage. Thus these projects were instead promoted and implemented by national development institutions with the cooperation of major development lending international agencies.*

Seen this way all four cases include innovations. Breaking into the atomic power field was indeed a local, and for a while, regional breakthrough in Latin America. Similarly, designing and building military training and commuter aircraft was an innovation for Brazil. In Korea's case, there was a clear innovation when they succeeded in designing their own versions of digital switching equipment and later introducing them in domestic and foreign markets. Finally, the ACER team introduced computer equipment and parts manufacturing, and later on chip designs, to the Taiwanese market, albeit initially mostly to supply foreign clients.

What differs significantly from the received notion of the innovating entrepreneur given by Schumpeter, and others, is the character it assumed in our cases. In Argentina, these were public, or political, entrepreneurs, who assumed no personal financial risk, but perhaps the political risk inherent in their pushing ahead with the acquisition of nuclear engineering capabilities. Even that danger was at times probably not perceived by them, particularly when the armed forces controlled or influenced political power. Nevertheless, it took entrepreneurship, though not necessarily of the private variety, to build institutions and provide support to the incipient nuclear engineering capabilities being developed under G protection.

For EMBRAER there was similarly a cadre of promoting public servants that pursued, together with representatives of the armed forces, the dream, if not of self-sufficiency, at least of a respectable local aircraft design and construction capability.

In Korea, G entrepreneurship was the engine of the R&D project, publicly coordinated, to develop their own version of digital telephone switches which allowed them to leapfrog the analogue phase altogether.

Finally, in the ACER case, we have an entrepreneurial effort which comes closer to the

Schumpeterian image. A team of expatriates conceived, with the cooperation of some of their prior employers, and future clients, to assemble and manufacture computer parts and equipment in a lower cost environment, but providing substantial assurances of quality and dependable supply production. The ACER team had additional innovations to their credit, such as the switch to manufacturing under their own brand name, and the carrying out of successful chip improvements and new designs.

B. Industrial Organization

New theories of industrial organization (IO) (see Williamson, 1985 and 2005), rely on an institutional conceptual foundation, and their key analytical concept is the "transaction cost". Reduction, or elimination, of transaction costs becomes the rationale for institution building, from the market to the enterprise, and including hybrid forms in between. Thus, the enterprise, and particularly its private variety, represents the lower cost solution for the coordination of multiple agents required to produce goods or services under capitalistic economic systems.

This variety of IO has moved away considerable from the traditional type which inferred "function" from market "structures" and characterized those particularly by the number of operators. Anti-monopoly efficiency solutions were predicated with the help of antitrust law (see, Scherer, 1986 for example). With technological change having eroded the notions of "natural" or technological monopoly in a number of industries, the institutional school had a new perspective to offer.

Chosen institutional arrangements vary significantly among our cases. In Argentina, capturing the nuclear engineering technological assets was achieved under the institutional aegis of the NAEC, while marketing those assets and related capabilities was eventually shifted to INVAP a NAEC's spin off. In Brazil, although the long term aim might have been the creation of a national aircraft industry, the enterprise, albeit public, was the structure selected from the very beginning. Ownership eventually

become mostly private and EMBRAER is now publicly listed in the NYSE. For Korean nationalistic ambitions to acquire new digital telephony technologies, including design and manufacturing capabilities, the chosen structure was just a consortium of public and private entities to carry out R&D. Such an arrangement was ephemeral in nature and ended with the successful culmination of the R&D effort.

ACER adopted the private enterprise structure which must have been complemented with some kind of long term contractual assurances provided by their foreign clients as to the likelihood of continuing placing purchasing orders if quality and delivery requirements kept being met. Although ACER's case could be described as "out-sourcing", it was not the case that IT multinational producers went scouting around to find cheaper engineering and manufacturing skills to lower the cost of their computer products, but, instead, the development of a mutual, long term, commitment between ex-employees returning home and their prior employers to join forces in lowering the cost and increasing the competitiveness of their output. This set up certainly lowered the relevant transaction costs, and can be seen as an example of Williamson's (2005) characterization of hybrid structures, somewhere between the market and the enterprise.

C. Economic Development

This literature emphasizes market failures due to underdevelopment as well as the effect of externalities that incomplete or non-existent markets cannot reflect accurately (Stiglitz, 1986, ch.4). Another vein is concerned with public goods such as nationalism that play an important role, for instance, when Gs promote industrialization via import substitution and protection. (see, for example, Johnson, 1967, ch. III). Still another depicts the apparent evolutionary nature of industrial and technological development projecting an intermediate role for semi-industrialized countries. (see, Teitel, 1987).

Interestingly, both Argentina's pursuit of atomic power capabilities and Brazil's of an autonomous aircraft industry, can be seen in the light of nationalistic public goods objectives quite successfully attained by public or bureaucratic entrepreneurs.[4] Korea's case is similar, but with the additional feature of not only capturing an advanced technological asset, but of using the undertaking to leapfrog the analogue phase in telephone switching equipment.

Thus from development economics we get the notions that private entrepreneurship (and innovation) scarcity can be at times compensated by public sector interventions, and also that flexibility in institutional arrangements could be desirable when trying to acquire technological and manufacturing capabilities in new, advanced, fields.

Summary and Conclusions

Insights from Schumpeterian innovation, industrial organization, and economic development theories were used to attempt explaining firm behavior in cases of successful acquisition of advanced technological assets and international trade competitiveness by selected countries at an intermediate level of industrial and technological development. The critical role of innovator played at times by the State, as well as the existence of alternative forms of organization, emerged as the most salient general findings.

In all cases advanced technological assets were acquired in a semi-industrialized, developing country, environment.

Envisioning and carrying out innovations was done by public, or political, entrepreneurs in three

[4] *Critics of public sector interventions may of course argue that these constitute exceptions and that the rule is generally the creation of "white elephants" rather than technologically advanced competitive enterprises.*

of the four cases: nuclear engineering in Argentina, aircraft in Brazil, and digital telephony in Korea.

The institutional, or organizational, structures adopted were: In Argentina, public institutions; in Brazil, a public, later privatized, enterprise; in Korea a publicly coordinated R&D consortium, and in Taiwan a private enterprise enjoying special, long term contractual arrangements with foreign clients.

Basic scientific and engineering skills necessary for advanced technology acquisition were initially obtained in situ in all cases, supplemented by local R&D in Brazil, Korea and Taiwan, training abroad in Argentina and Taiwan, learning-by-doing in Argentina and Brazil, partnership agreements in Brazil, and know-how and other technical knowledge provided by customers in Taiwan.

Governments played significant supporting roles protecting incipient undertakings in Argentina and Brazil, coordinating R&D in Korea, and facilitating exports in Argentina, Brazil, and Korea.

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