Research and Statistics Branch

working paper 02/2008

Structural change, domestic capabilities and economic development

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

RESEARCH AND STATISTICS BRANCH
WORKING PAPER 02/2008

Structural change, domestic capabilities and economic development

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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna, 2008

Acknowledgements

The author acknowledges the support provided by UNIDO to participate in the First Annual Conference of the Sanjaya Lall Programme for Technology and Management for Development "Confronting the Challenge of Technology for Development: Experiences from the BRICS", University of Oxford, 29-30 May 2008. This paper elaborates on an initial draft presented in Geneva, in 2007, at a conference organized by UNCTAD in honour of Professor Sanjaya Lall.

Jaime Moll de Alba was responsible for backstopping the support provided by UNIDO to the participant as well as the production of the paper. Robert Cox was responsible for stylistic revision and Griselda Sanz for graphic design.

Introduction

For more than three decades, Latin American countries have introduced market-oriented structural reforms, opening their economies to foreign competition, deregulating markets and privatizing economic activities. These policy reforms have involved a major departure in macroeconomic policy regime from the one that prevailed in the region during the immediate post-war period. The new policies—together with the rapid process of globalization of the world economy throughout the 1990s—induced a major transformation of the social, economic and institutional environment of each country in the region. As a result, Latin American economies have gone through major changes in institutions, production structure, international competitiveness and technological capabilities.

Modern growth theory is not equipped for the examination of these issues. Said theory is specified in terms of an equilibrium algorithm, in which changes in institutions and in the structure of the economy, as well as macro-to-micro interactions are left mostly unexplored.

New sectors of economic activity have emerged in Latin America during the 1990s, while many former activities have been gradually phased out. Different forms of capital intensive, computer-based production technologies have been brought on board by the larger firms in the economy displacing older, more labour-intensive technologies and forms of production organization. Large firms have managed to reduce their degree of vertical integration and rely more on external outsourcing of production technology as well as of product licences. The proportion of imported parts and components in production content has increased considerably. On the other hand, most small and medium sized enterprises (SMEs) have not managed to adapt, with their contribution to gross domestic product (GDP) having declined in the transition to a more open, de-regulated economy. Thousands of them have closed during the adjustment process, with estimates at 8,000 in Chile and more than 12,000 in Argentina, during the 1980s.

After more than two decades of market-oriented reforms, average labour productivity in Latin America continues to be in the order of 20-40 per cent of that attained in the United

States, with Argentina and Chile at the upper end and Ecuador, Paraguay and Bolivia at the lower. On the other hand, the labour productivity gap between large and small firms has increased sharply in the past two decades.

In short, market-oriented reforms and globalization of the world economy have brought about major institutional and technological transformation of Latin American countries. The nature of competition has changed in most production activities, with business concentration and foreign ownership having expanded rapidly in most industries. External sources of technology and production know how have gained prominence in the production structure. On the other hand, domestic knowledge-generation activities and national innovation systems have remained marginal in the process of structural transformation. They still behave as uncoordinated and somewhat marginal pieces of social machinery, scarcely integrated into the long-term development process of local production activities. Domestic research and development (R&D) continues to be a small fraction of what it is in more developed industrial societies, and it is still mostly carried out by public sector laboratories and public universities. Very little R&D comes from private firms.

In spite of this, it is nonetheless true that in every country in the region a small, modern sector of economic activity has emerged during the past two decades. It comprises around one third of GDP in the richest countries in the region and not much more than ten per cent in the poorest ones. It includes new production activities not present in the economy a few years ago or, if present, in the form of much less sophisticated production organization processes, including: (a) natural resource processing activities that are now performed using automated, state-of-the-art production facilities, such as in the case of genetically-modified soy beans and vegetable oil in Argentina, pulp and paper production and salmon farming in Chile and fresh flower production in Colombia; (b) high productivity service industries including banks, telecoms, energy and tourism; and (c) a few technology-intensive manufacturing activities, such as aircraft design and construction in Brazil (A. Goldstein, 2005).

The small segment of society that belongs in the modern section of the economy is paid well above average wages and has gradually developed consumption patterns similar to

those exhibited by the large majority of the citizens in more industrially developed nations. For them, the question as to whether convergence with more developed nations will ever take place appears rhetorical, insofar as their life style is similar to, and in many cases better than the one attained by the average citizen of, say, Madrid or Rome. On the other hand, however, deeper and more intractable forms of social and economic exclusion have emerged, higher levels of informality in labour markets now prevail, and more difficult social relations—resulting from a growing climate of frustration and despair—have become widespread, making political governance increasingly difficult.

In this paper, I shall examine how the inception of new production activities has affected the economic, institutional and technological landscape of various countries and industries in the region. I shall use salmon farming in Chile and genetically-modified soy bean and vegetable oil in Argentina as examples of two industries in which the region has strongly gained in international competitiveness in recent years. In both countries, metalworking and the production of capital goods have contracted after trade liberalization, while natural resource processing activities have expanded rapidly and now constitute a major part of the new pattern of production specialization for both countries. Such structural transformation has involved the co-evolution of economic, institutional and technological forces, which came together during the growth process. Neoclassical growth models are not useful to study situations of this sort.

2. Structural change and economic development: conceptual issues

In the classical tradition revived by authors such as S. Kusnetz and M. Abramovitz and, in more recent times by R. Nelson and S. Winter, M. Amendola, J. L. Gaffard, P. Saviotti and others the process of economic development is strongly associated with changes in the structure of the economy. In A. Smith, structural change is the result of more roundaboutness in production processes and increasing returns to scale resulting from production specialization. A growing economy is one that becomes more complex and sophisticated through time, with creation of new sectors of economic activity and the entry of new, more knowledge-intensive firms into the economy. *Pari passu* with the above, new institutions, skills and learning processes develop and economic agents build up new forms

of interdependencies. It is to such process that M. Abramovitz refers to as ultimate sources of economic growth. An expanding capital:labour ratio is seen as an immediate source of growth. Learning, accumulation of domestic technological capabilities, institutional changes and development of a more dense network of interacting economic agents are thought as the real determinants of economic and social change. Many of these forces are not easy to quantify, but, nonetheless, they constitute the essence of development.

With these considerations in mind, it becomes apparent that the long-term performance of the economy should not be described exclusively in macro terms, and that a great deal of attention needs to be given to micro and institutional changes that occur during the process of economic development. Economic growth should be thought as the result of a complex process of change, which involves, in a profound way, new institutions, learning processes and creation of social capabilities. While adequate macro management constitutes a *sine qua non* condition it seems overly simplistic to believe that it constitutes a sufficient condition for a successful process of social change to obtain.

Many of the above-mentioned changes in the ultimate sources of growth come together with the inception of new production activities in the economy. As new activities emerge and production capacity expands, learning processes take place and new institutions and forms of social interaction among agents in the economy develop. The emergence of new activities is associated with numerous market and non-market forms of interaction both among firms and between them and other organizations such as universities, engineering associations, government regulatory bodies and municipal authorities, many of which do not operate on the basis of conventional market rules. The process is surrounded by externalities and synergies that conventional market analysis is simply blind to incorporate. The functioning of any given production structure involves much more than market driven exchanges among firms, individuals and public sector agencies.

Contrary to modern growth theory, which takes the production structure as given and describes its growth through time as if it were an expanding balloon—using A. Harberger´s inspired metaphor (Harberger, 1988) in which the relative size of each part of the structure does not change as the size of the balloon increases—changes in the structure of the

economy constitute a major element. Such change allows for more diversity and productivity growth, as well as for gradual expansion of more knowledge-intensive production activities, including production of capital goods and provision of engineering services.

The inception of a new activity in the economy normally occurs as a response to an above average rate of return on capital. In other words, it is an out-of-equilibrium response involving the introduction of new products, new production processes or new forms of production organization in the economy. As innovation takes place and monopoly rents are captured by the innovator imitators could be expected to follow, attracted by the above average profits. Market structure and behaviour are bound endogenously to change as the life cycle of the activity unfolds. This dynamic process does not follow a single and universal pattern. There is not a one-size-fits-all model that can adequately suit all possible real-life situations. Variety and the co-evolution of economic, institutional and technological forces constitute the essence of what happens. The dynamics of the industrial organization model that develops and the learning path that firms and public sector regulatory bodies follow in each case are bound to differ significantly.

Far from being a neutral agent to the process, the state should be conceived as an active participant through its regulatory agencies, financial institutions, universities and municipal authorities, many of which provide public goods, coordinate processes of market and institutional functioning and help to develop organizational and technological capabilities that support the inception of new activities in the economy.

This was documented in the East Asian miracle study, which the World Bank carried out in the Republic of Korea, Taiwan Province of China, Singapore and Hong Kong Special Administrative Region of China in the 1980s. The Bank found that the Republic of Korea was, mostly, a story of large cheabols and high business concentration, while Taiwan Province of China was more a case of SMEs operating in a quite different production organization environment. On the other hand, Singapore was more a case of large multinational corporations (MNCs) bringing entirely new dynamics into the economy. In all three countries, however, a significant amount of public sector intervention was

involved creating markets, institutions and domestic technological capabilities in support of the introduction of new export-oriented activities. It was the public sector that undertook the effort of coordinating firms and public sector R&D laboratories, as well as made available the funding and public goods needed to accelerate the process of internationalization of the new firms. In other words, the link between Schumpeterian quasi-rents, public sector intervention and the opening-up of new, export-oriented production activities was clearly documented in the above-mentioned study. At that time, development economists such as A. Amsdem, L. Westphal and S. Teitel were already familiar with the findings that the World Bank was reluctantly reporting. Sanjaya Lall was certainly a pioneer among those that understood well in advance of the Bank what was involved.

The recent introduction of new industries into many Latin American economies—such as salmon farming in Chile or genetically-modified soy bean and vegetable oil in Argentina—shows many interesting similarities. In both cases, the process of structural transformation resulted from the interaction of economic, institutional and technological forces that came together during the process of growth. Moreover, macroeconomic equilibrium was not a *sine qua non* condition for these new activities to emerge in the economy, but the perception of Schumpeterian quasi-rents certainly was so. Whereas the case of salmon farming in Chile is basically a story of small family enterprises successfully coached by public sector agencies such as Corfo and Fundación Chile, which developed the basic technology and transferred it to numerous local SMEs, the expansion of soy bean and vegetable oil production in Argentina was driven by large MNCs such as Monsanto, Cargil and others. As a result, the institutional setting in which both new activities developed was significantly different, as is considered below.

In the initial years of industrial expansion, growth was fuelled by the rate at which new production capacity could be erected (Saviotti and Gaffard, 2004). New firms entered the industry building up new plants, hiring labour, developing subcontractors and so on. They made decisions on the basis of expected profits, which basically, depended on a large potential market to be exploited as well as on the sector-specific institutional environment in which they found themselves operating. Opportunity and appropriability triggered off

microeconomic behaviour. The expectation of above average returns on investment induced expansion of production capacity, but the rate at which such capacity could come on stream was mostly conditioned by availability of financial resources, production know-how, trained labour and country-and-sector-specific institutional and regulatory circumstances. While this does not imply that macroeconomic circumstances did not matter at all, they were part of a much wider set of determining forces.

The entry of new firms to the industry gradually made these industries more competitive, with the expansion of production capacity eventually becoming more determined by demand-side forces than by supply-side considerations. Available information indicates that, from inception to maturity, the life cycle of the above-mentioned sectors required nearly two decades. They both are now mature oligopolies strongly inserted into global food chains controlled by large international food companies such as Wal-Mart or Carrefour.

Turning to the macro-side of the above-mentioned processes the long-term performance of the economy is conditioned by the rate at which new activities and more sophisticated firms enter the production structure. The development of new institutions and production organizational capabilities is crucial. Old industries need to be phased out while new ones are being created. When the rate of diversification is high, the dynamics of the development process will also be so. On the contrary, if the process of structural change slows down we could expect the global economy to become less dynamic. As Saviotti and Pyka point out, "A faster rate of growth of variety would lead to faster economic development" (Saviotti and Pyka, 2004, p.4).

3. Empirical evidence concerning structural change in Latin America

Table 1 provides empirical evidence regarding the process of structural transformation of the Argentine, Brazilian, Chilean, Colombian and Mexican economies for the period 1970-2002. The table also presents an index of structural transformation (ICE) measuring how

much the manufacturing sector of each one of these countries changed by comparing 1970 with 1996, 2000 and 2002[1].

The taxonomy hereby utilized to classify manufacturing activities is similar to the one Sanjaya Lall used in many of his studies for UNIDO in the 1980s and 1990s, in trying to reflect the technological intensity of different industries. Sectors are classified here as being natural resource-intensive, engineering-intensive and low-skill labour-intensive.

Table 1. Changes in the structure of industry, 1970-1996-2000-2002

	Argentina				Brazil				Chile				Colombia				Mexico			
	1970	**1996**	**2000**	**2002**	**1970**	**1996**	**2000**	**2002**	**1970**	**1996**	**2000**	**2002**	**1970**	**1996**	**2000**	**2002**	**1970**	**1996**	**2000**	**2002**
I	13.2	9.9	8.6	6.7	16.2	25.6	26.0	26.5	11.4	10.4	10.5	10.0	12.3	10.1	8.7	9.0	12.0	14.4	16.4	15.6
II	10.9	7.2	7.4	6.1	6.8	7.3	8.3	8.9	5.5	1.9	2.3	1.9	3.0	6.5	4.9	6.5	8.4	14.6	18.8	18.6
III+IV	47.8	62.1	65.3	71.7	37.8	43.4	41.6	41.5	58.3	59.7	60.7	61.9	46.2	55.4	57.0	57.1	43.2	43.4	39.1	40.8
V	28.1	20.7	18.7	15.6	39.2	23.7	24.0	23.1	24.9	28.0	26.5	26.2	38.5	28.1	29.4	27.3	36.4	27.6	25.8	25.0
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
ICE*		14.3	18.0	25.3		18.9	32.3	27.6		40.1	27.3	33.5		19.4	29.9	30.9		17.3	22.1	22.5

Source: PADI
* Structural change index, reference year 1970.
I Engineering-intensive industries (excluding automobiles) ISIC 381,382,383,385
II Automobiles (ISIC 384)
III+IV Natural Resource intensive industries: foodstuffs, beverages and tobacco (ISIC 311, 313, 314) and resources-processing industries (ISIC 341, 351, 354, 355, 356, 371, 372)
V Labour-intensive industries (ISIC 321, 322, 323, 324, 331, 332, 342, 352, 361, 362, 369, 390).

The figures indicate that, during the course of the past three decades, the industrial sector of Argentina, Brazil, Chile and Colombia experienced a major transformation towards natural resource processing and food production. Concurrently, metalworking industries producing machinery and equipment contracted in relative terms in Argentina, Chile and Colombia but not in Brazil, where they managed to expand their share in manufacturing production. The vehicle industry—a heavily protected metalworking activity—lost ground in Argentina and Chile but not in Brazil and Mexico.

The process of structural transformation went in a different direction in Mexico and the Central American economies where in-bond assembly industries, *maquiladoras* have gained an increased share in manufacturing. These industries use state-of-the-art foreign-

[1] The figures presented in the table have been calculated using the Economic Commission for Latin America and the Caribbean's (ECLAC) Programme for Analysis of Industrial Dynamics (PADI). Thanks are due to Mr. G. Stumpo and Ms. J. Marincovic, from the Division of Production, Productivity and Management, at ECLAC, for providing access to the data and help with the calculations.

designed production facilities, imported intermediate inputs and cheap, local unskilled labour for assembly of computers, televisions, video cassette recorders and garments.

To examine further the complexity of the process of structural transformation in favour of natural resource processing, two case studies, in Argentina and Chile, help towards an understanding of the extent to which economic, institutional and technological forces co-evolved in each case. Neoclassical theory does not provide an adequate perspective on what actually occurs in episodes of this sort. A brief summary of both case studies is presented in section 4 of the paper.

The index of structural change—indicated as ICE in the table—tells an interesting story in itself. It shows that the Chilean economy was the one that attained the fastest pace of structural transformation during the period 1970-96. This suggests that the erection of new production facilities in the economy was much more intense in Chile than elsewhere in the region. If the hypothesis that new activities induce the expansion of new institutions and technological capabilities in the economy is correct, it explains why Chile has attained a better overall growth and institutional performance than the rest of Latin America since the mid-1980s onwards.

The index of structural change fell in Chile in the late 1990s and early 2000s. The dynamism of the Chilean economy diminished considerably in the period 1998-2007. Fewer new firms and industries entered the Chilean economy in more recent years, and the rate of structural transformation slowed down considerably since the late 1990s. Although it is beyond of the scope of this paper to look into the topic in further detail, the question of how to regain a more rapid rate of expansion has become a major topic of concern in Chile in recent years. In the period 1998-2006, Chile only attained an average growth rate of GDP of four per cent per annum which is considerably lower that the 7.5 per cent the country attained in the so called golden years of its long term expansion, 1984-1997. The explanation of the slow down involves more than the contraction of the investment rate and has to do with a more complex global phenomena involving a less vibrant institutional environment and the weakening of animal spirits among Chilean entrepreneurs.

4. Economic, institutional and technological forces associated with new production activities

The previous section showed that a major process of structural transformation occurred in Latin America during the last two decades. The evidence so far presented is much too aggregated to illuminate the microeconomic details of the above mentioned process. Only individual case studies can shed light on the above, as no aggregate formal model can adequately describe the process. To this end, two short case studies illustrate the complexity of the phenomenon.

4.1. Genetically-modified soy beans and vegetable oil production in Argentina

The production of genetically-modified (GM) primary products began in the mid-1990s. By 2002, nearly 60 million acres were under cultivation worldwide, with soy beans and maize by far the two most important crops involved in the transition from conventional to genetically-modified varieties Argentina now has close to 18 million acres under cultivation of GM soy beans representing as much as 90 per cent of total local soy bean production.

The transition from conventional to GM soy beans involved a major change in organization of production and institutions in Argentina, both in the agricultural, as well as in the manufacturing sector. It has also affected domestic technological efforts in the economy, by inducing new relations between firms, universities and public-sector laboratories.

Regarding the impact on the agricultural sector, zero tillage and contract agriculture now dominate the scene. These are two major technological changes which have introduced important changes into production organization as well as in institutions. The traditional farmer is no longer the central agent charged with production decisions. His role has been taken over by large, independent subcontractors, which take responsibility both for financing and production planning and organization. Production is now undertaken in the form of risk-contracts, with financial intermediaries and banks advancing the funding for each annual agricultural season. The technology package—seeds, fertilizers and

herbicides—used by subcontracting companies belongs to large multinational corporations such as Monsanto and others[2]. This has established a clear departure from the pattern that prevailed in the 1960s during the green revolution, when agricultural technology was basically a public good disseminated by the National Institute for Agricultural Technology (INTA). Technological change during the green revolution came mostly in the form of mechanical improvements in machinery and equipment and in fertilizers. Technological change is now more related to genetics and biotechnology in the seed industry, an activity which is basically controlled by just a few large multinational corporations. Only a handful of local SMEs operate in the soy bean seed market today.

Many new institutions (habits of social behaviour) have emerged during the process of diffusion of GM soy beans in Argentina. It is believed, for example, that as much as one third of the seeds used in any given agricultural season come from the previous season, and its use violates intellectual property rights on the technology. Monsanto failed to patent its GM soy bean technology and its associated herbicides—glifosato—in Argentina, in what could be thought as a major mistake in business strategy from the part of the company. Although it is presently trying to implement retaliatory policies in Europe against Argentina for patent violation, European courts are not making room for Monsanto's case, having the demand been rejected. A significant amount of GM soy bean seeds are being smuggled from Argentina into Brazil, so the Brazilian government has been forced to accept the introduction of GM soy bean production in Brazilian territory even though it had initially rejected such a possibility.

The zero tillage model is having a major impact on the local pattern of land utilization. As the soil does not need to be prepared from one season to the next, there is time for an additional crop to be obtained from the same piece of land throughout the year. Agricultural rents have risen but many specialists believe that, in the long run, the result would be an

[2] In the case of the Roundup Ready (RR) patent, Monsanto failed to patent the technology in Argentina and opted for distributing the product through contractual arrangements with large agricultural subcontractors and distributors. It is believed that the firm opted for such an alternative as a result of the low level of confidence Monsanto had in the functioning of the Argentine legal system to protect intellectual property rights. Monsanto seems currently to be searching for new ways of enforcing its legal rights to RR technology, retaliating against Argentina internationally for alleged patent violation. See Ablin and Paz, op. cit., September 2000, p. 8.

increase in the rate of soil depletion. The expansion of soy bean production has had a negative effect on other primary products, whose production has diminished as their land is now being used for soy bean production. A similar phenomenon has occurred with forestry land having a major negative impact on the rate of environmental sustainability and desertification. These factors taken together, soy bean production has had numerous positive but also negative effects on the economy, with the net balance difficult to determine.

Major economic and institutional changes have also taken place in the manufacturing side of the GM soy bean and vegetable oil production. Highly capital-intensive new production facilities were erected during the 1990s. Labour productivity in these catalytic plants is ten times higher than in the vintage manufacturing plants Argentina had in operation in the 1970s and 1980s. A new and more complex set of skills was needed to operate these new plants, whose highly automated facilities demanded few workers. Furthermore, vegetable oil production in Argentina is a highly concentrated activity dominated by a small number of large local and foreign conglomerates.

Moreover, recent studies indicate that the expansion of the industry has had a small but not negligible impact on domestic research in the field of biotechnologies. (Bisang *et al.*, 2005). Some 80 firms have been identified producing seeds, agro-chemicals, pesticides, food additives, pharmaceuticals and food products of various sorts using biotechnological processes. Bisang *et al.* (2005) indicate that these 80 companies have annual sales of around US$350 million. They employ nearly 5,000 persons and have exports worth some US$50 million. They spend nearly five per cent of sales on R&D activities—amounting to US$18 million—and employ 600 persons in R&D. 80% of the firms are local SMEs. A number of them maintain an active pattern of interaction with public sector R&D agencies.

Finally, the rapid expansion of GM soy bean and vegetable oil production opens up many new institutional and economic questions which Argentine policy makers will have to address in the near future. Among these are issues of traceability, labelling and human health protection, enforcement of intellectual property rights (IPRs) and university-industry relations. There is no national policy for the industry but its need is increasingly clear.

4.2. Salmon farming in Chile[3]

The process through which international competitiveness was attained by the Chilean salmon farming industry covers the best part of two decades. It was a period in which many new firms—national and foreign—entered the market, sector-specific institutions and skills developed, professional management took over an originally quasi-artisan industry significantly altering organization of production and international marketing practices. As a result of the cumulative impact of these changes, Chile gradually acquired world-class status as one of the three major salmon farming nations worldwide, along with Norway and Scotland. A third of world demand for fresh salmon is now supplied by Chilean-based companies.

Salmon farming in Chile can be described as having evolved in three distinct stages. In each, the actors and problems they had to deal with changed quite significantly. There was first an inception stage in which salmon farming was successfully introduced and adapted to the Chilean environment, almost entirely from imported genetic material. This was a stage in which learning by trial and error appears as a major factor in explaining individual firm behaviour and the start-up of a new industry. Teething problems were proverbial during that period, both at firm and industry levels. The Chilean Government played an important role during these years through Corfo and Fundación Chile. In the second stage, the industry increased rapidly in size and complexity, with entry into the market of intermediate input suppliers and service firms. The role of the public sector changed significantly during this period by stepping back as a pro-active agent promoting the creation of new production capacity in the industry and taking a more active role on the regulatory front. The sector finally evolved into a third stage, in which a major transformation in industrial structure occurred through M&A, changes in plant ownership, foreign direct investment and rapid internationalization. Table 2 presents a summarized view of these stages.

[3] This section is based on a previous paper by the author written for the World Bank in 2004 (Katz, 2004).

Table 2. Evolution of salmon farming in Chile, 1960–2000					
	1960–1973	**1974–1985**	**1986–1989**	**1990–1995**	**1996–2002**
Exports (tons)	Negligible	1,000	11,000	100,000	500,000
Main products and markets		Fresh and frozen Coho salmon; trout	Coho salmon for Japanese market	Coho salmon for Japan; Atlantic salmon for United States.	Diversification of markets: United States, Asia, Latin America
Key event in marketing		Brokers buy from producers	Brokers buy from producers and wholesalers	Collective export activities	Large foreign retailers buy directly
Issues to be resolved	Transition from catch and release to cultivation tanks.	Established know-how for freshwater and need to develop saltwater aquaculture	Rapid expansion in scale of production	Development of forward (egg and smolt) and backward linkages (food, vaccines)	Environmental control systems; salmon food; production of eggs, vaccines; traceability
Government policies	Technology transfer under government cooperation; support from CORFO, ministry of agriculture	Regulation and technology from CORFO, Fundación Chile, Sernapesca, JICA, others	Provision of basic road and ports infrastructure	Missions for market research, technology for supporting industries; regulation	Missions for environmental management; sources of productivity growth
Typical type of firm in industry	External cooperation; no industry yet	Family-owned; small firms; few foreign companies	Local SMEs grow very fast	Growing presence of foreign firms	Mergers and acquisitions by foreign firms
Intermediate suppliers	Very few	High degree of vertical integration; few domestic input suppliers	Hatchery, cultivation, and final processing begin to integrate	Outsourcing expands and many new suppliers enter the market	Cluster gets stronger and service industries develop
Expected externalities			Supporting industries develop	Clustering forces become stronger	International norms and standards diffuse; GMPs and traceability
Sources of competitiveness	Natural comparative advantage	Production	Rapid expansion of number of cultivation sites and scale of plant	Mostly local quality standards	Productivity, local and international standards; ISO 9000 and 14000; traceability
Relations among actors in industry	International cooperation; proactive state participation	Public-private cooperation; CORFO, Fundación Chile	Private sector cooperative activities expand	Initial forms of globalization emerge	Full-scale globalization after M&A
Source: Based on Iizuka 2004					

In less than 20 years, Chilean salmon exports increased from less than US$50 million in 1989 to around US$2,200 million in 2006. Salmon exports now account for nearly five per cent of total Chilean exports. From a negligible participation in the world's production of salmon— two per cent in 1987—Chile now accounts for nearly one third of total world production of salmon. Considerable economic, technological and institutional forces have been involved in the process.

Public organizations, foreign companies and a large number of SMEs participated in the industry's early years. Although there was significant public sector involvement in the initial years of industry inception a new generation of Chilean entrepreneurs emerged in the 1980s and became the driving force behind the expansion of the sector. Regulatory and sanitary activities—such as fishing and cultivation permits, monitoring environmental impact and controlling salmon eggs imports—are competently carried out by government agencies such as Sernapesca and Conama. The required legal infrastructure supporting these activities, put in place in the late 1970s and during the 1980s, has been improved considerably to comply with world-class practices (Aquanoticias, November 1997).

Production practices in the industry's early years were quasi-artisanal, mostly based on imported genetic material. Salmon food, a major component of salmon farming costs, was prepared daily by each company using fresh raw materials. The conversion rate from salmon food to the finished product was more than three kilograms of fresh food to one of salmon. This is more than three times the input/output coefficient of the industry today suggesting that major productivity improvements have been attained and learning has been quite substantial at the individual firm level (Aquanoticias, July 1997, p. 24). Many examples of this sort can be cited in relation to cultivation tanks, vaccines, final product processing and the like (Aquanoticias, April/May 1998, p. 12). In the late 1990s, Chilean salmon farming developed many of its current features a mature oligopoly.[4] World prices

[4] The concept of a mature industry and how it is applicable to the case of salmon farming was enunciated at a public conference by Mr. Torben Petersen, CEO of Fjord Seafood Chile, a subsidiary of the Norwegian company of the same name, when he stated, "The real maturation process begins when we see that company actions are aimed at the markets and not at production, in other words, when salmon farming growth is determined by its market and not by its production". See *Aquanoticias* No. 79, 18 May 2004.

for salmon fell significantly in the second half of the 1990'moving closer to the industry's long-term unit production costs. As competition increased and the markets for salmon became more contested, unit gross margins contracted. The technological and competitive regime of the industry became more demanding as a result of mergers and acquisitions which, on the one hand, made the average size of firm considerably larger, much more capital intensive and technologically more sophisticated. On the other hand, business concentration increased significantly.

The number of salmon farming companies increased until 1996, reaching a plateau in the late 1990s and, then, began to decrease. Although there were fewer firms in the industry at the end of the period, the average salmon farming company was larger and more capital- and technology-intensive, as indicated by the higher ratio of skilled to unskilled personnel.

On the basis of these two case studies, it can be seen that the inception of new production activities in the economy involves a complex interaction between economic, technological and institutional forces, which come together during the process of growth. It is quite difficult to incorporate such features into a formal model of the growth process.

5. Domestic technology generation efforts in Latin America

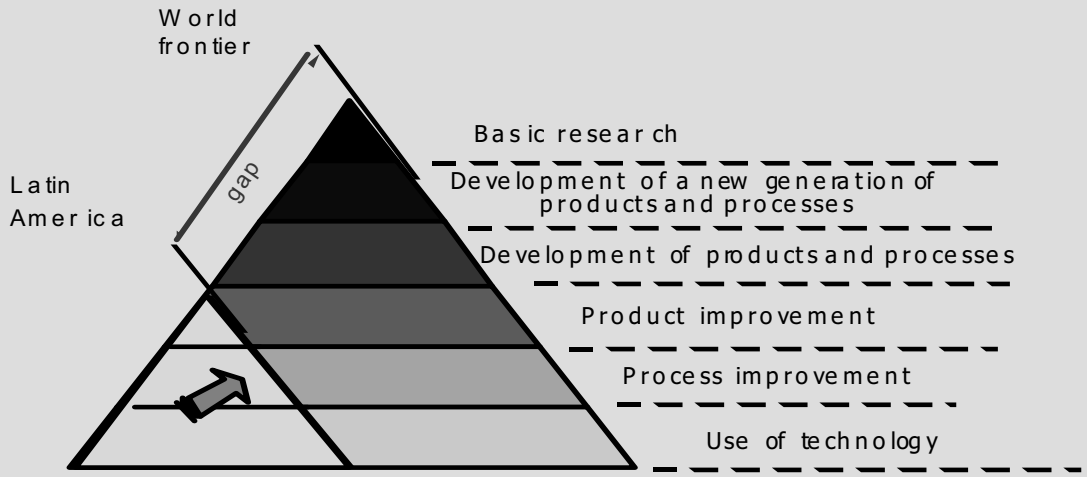
Although new production activities have emerged in Latin America during the past two decades and the modern sector of the economy has adopted state-of-the-art computer-based production technologies, firms basically rely on imported capital goods and foreign product licences, conducting very little local technological efforts. Latin American firms continue to be characterized by their low level of R&D expenditure and by their reluctance to explore the international technological frontier of their respective fields of operation.

This does not mean that Latin American firms do not generate technological knowledge as a by product of their current production activities. Many of them perform in-house´ engineering activities in order to attain product design improvements, and to upgrade production processes. Many of these knowledge generation efforts involve different forms of technological search as well as the use of pilot plants and experimental equipment. Many

involve a certain amount of technological novelty for the firm, even if the knowledge thereby attained might not be novel for the industry, let alone for the rest of the world.

Efforts of this sort usually involve spending between 0.5 and one per cent of sales in engineering activities, which should probably be measured as development following the Frascati Manual instructions. Many of these activities (which might be considered routine in more sophisticated manufacturing firms) are not necessarily routine in less advanced companies. The latter find themselves in need of generating *a novo* production capabilities other more sophisticated firms already have, as they proceed along their learning curve.

Technological capability levels attained in Latin America during the post-war endogenous growth phase



Source: Based on Hobday (1996)

In the initial stages of the learning path, firms can be thought of as engaging primarily in engineering activities related to upgrading of product designs and process engineering routines already in operation. The incremental pieces of engineering know-how that they develop are highly appropriable at the shop floor level.

The situation changes, however, when a firm decides to move into more complex, long-term research, exploring the international technological frontier. R&D expenditure increases sharply as more expensive pilot plants and experimental equipment is required. Appropriability diminishes as endeavours of this nature normally demand networking with universities, public sector laboratories, process engineering firms and the like. Intellectual property rights (IPRs) become more difficult to enforce. Firms carrying out activities of this sort usually spend ten per cent or more of their revenue on R&D activities. Long gestation periods are involved before significant new results can be obtained, and the rate of failure is frequently high.

Only a small number of firms in Latin America actually undertake R&D activities of this sort.

Distinct from firms in Finland, Israel, the Republic of Korea or Singapore, Latin American companies innovate by importing machinery and product licences from abroad, but they do not carry out their own R&D. This was the case during the inward-oriented industrialization period, in the post-war decades and continues to be so now, even after many of them have gone though a major re-structuring and modernization process.

Few Latin American firms have established their own R&D facilities or attempted to develop strong links with local universities or public-sector research and development laboratories. Rather, firms prefer to operate on the basis of imported technology, remaining in the low domestic value-added extreme of the production spectrum.

Recent innovation surveys carried out in Argentina, Brazil and Chile confirm this tendency. Panel studies conducted by J. De Negri and L. Turchi (De Negri and Turchi, 2007), in Brazil, J. M. Benavente (Benavente, 2005), in Chile and F. Peirano (Peirano, 2007), G. Lugones and D. Suarez (Lugones and Suarez, 2007), in Argentina indicate the following conclusions:

- Very few industrial firms carry out R&D activities and innovative efforts. De Negri and Turchi write: "Out of 72,000 manufacturing firms of more than ten workersoperating in Brazil in 2000 only 971 indicate that they have introduced innovations and carried product differentiation efforts. In the case of Argentina, out of 11,000 firms only 413 companies belong in the group that has introduced innovations and performs product differentiation efforts."
- A similar study carried out by J. M. Benavente for Chile (Benavente, 2005) indicates that out of 6,000 firms only 450 belong in the group that have introduced innovations and carried out product differentiation efforts.
- The study by De Negri and Turchi shows that only 3,000 Brazilian firms have R&D facilities, while F. Peirano indicates that only 1,300 in Argentina report having in-house R&D and experimental equipment.

Table 3. Number and size of Brazilian and Argentine firms and their technological behaviour

	Brazil			Argentina		
Type of firm	Number of firms	Average annual sales (US$ million)	Average number of employees	Number of firms	Average annual sales (US$ million)	Average number of employees
Firms that innovate and differentiate products	971	80.61	679	413	26.76	181
Firms that produce standard goods	13,322	16.39	165	4,644	13.85	95
Low productivity firms that do not carry out technology generation efforts	55,998	0.72	36	5,661	1.35	40

Source: Table 1, op.cit., P. De Negri and L. Turchi. Number and size of Brazilian and Argentinian firms and their technological behaviour

Further findings from these studies include the following observations.

- Expenditure in R&D activities per unit of sales is significantly less in Latin American firms than in firms of developed countries.
- Latin American firms innovate by importing machinery and equipment from abroad. This pattern prevails in the three countries, Argentina, Brazil and Chile.

- R&D efforts are concentrated in a few production sectors. The study by F. Peirano indicates that R&D efforts in Argentina are concentrated in foodstuffs, chemicals and pharmaceuticals, plastics and vehicles. In the case of Brazil, it is the chemical/pharmaceutical industry, electronic and the automobile sectors that carry out R&D.
- R&D and innovation expenditure is strongly influenced by the aggregate level of economic activity. As 80 per cent of local innovation is based on the introduction of imported machinery, it seems plausible that the global level of activity affects individual firm behaviour as far as innovation is concerned. The survey, however, is actually measuring the propensity to invest in imported equipment. It makes sense to correlate this with the global cycle of the economy. A recent study by G. Bernat (Bernat, 2007), for Argentina, confirms this finding, by showing that R&D in manufacturing contracted significantly in 2001 and 2002, years in which the level of economic activity fell markedly in Argentina. A similar finding is reported by J. M. Benavente, in his study for Chile (Benavente, 2005).

In short, the available evidence concerning R&D activities in Latin America is distressing. Although local firms tend to carry out adaptive engineering at the shop-floor level to improve product designs and production processes, they do not invest in R&D activities aimed at the exploration of the international technological frontier. R&D expenditure as a proportion of sales is low, with few firms involved in long-term knowledge generation. Firms innovate by importing machinery and equipment from abroad and by acquiring foreign product licences. Only a limited number of companies have local R&D facilities and operate experimental equipment. The majority of firms produce standard products, without undertaking significant product differentiation activities. Innovative expenditure seems to be highly sensitive to the level of economic activity and not a long-term commitment from the part of local entrepreneurs.

6. Concluding remarks

Market-oriented structural reforms and the process of globalization of economic activities have brought about major changes in the Latin American economic and institutional

scenarios. Industries and institutions of the inward-oriented period of growth, 1940-70, have been gradually phased out and the economies in the region restructured to draw on their natural comparative advantages. A modern sector of economic activity has emerged in each of the Latin American countries. But far from reducing the prevailing high degree of social inequality, the process of structural change has worsened the internal gap between rich and poor segments of society.

Lack of initial entitlements—capital and education—affecting large sections of the population, insufficient provision of public goods to level the economic playing field, and different forms of market failure have prevented market-oriented structural reforms to generate the a priori expected improvements in global performance. The explanation seems to be the low level of total factor productivity attained by Latin American firms catering for local markets. In this respect, local innovation, domestic R&D activities, public-private cooperative ventures and strengthening of national innovation systems should become major components of future development strategies. Conventional neoclassical growth theory has little to teach us in this respect. It is specified in terms of an equilibrium algorithm, which does not provide much advice as to how to make an economy more productive and competitive over time. Domestic institutions play a major role in this respect. It is understandable, therefore, that a theory that lacks an adequate perception of the role country-specific institutions play in explaining innovation and productivity growth can provide little direction as to how to proceed in this field. Current research shows that there is no universal recipe and that countries should introduce a good deal of pragmatism and trial and error into their process of deregulating markets, building local technological capabilities, transforming their intellectual property rights systems and the like, rather than acritically adopting the standard advice of opening their economies to foreign competition, deregulating markets and letting market forces operate without interference. This is certainly not the lesson that rapidly emerging economies around the world seem to be teaching at the moment.

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Printed in Austria
V.08-57420—October 2008—200

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