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1. Introduction.

For more than three decades now Latin American countries have introduced market-oriented structural reforms, opening up their economies to foreign competition, de-regulating markets, and privatising economic activities. These policy reforms involved a major departure from the policy regime that prevailed in the region during the immediate post war period. The new policies –together with the rapid process of globalisation of the world economy that obtained throughout the 1990's– induced a major transformation of the social, economic and institutional environment of each one of the countries in the region, as a result of which Latin American economies have undergone major changes in production structure, international competitiveness, institutions and technological capabilities.

Modern Growth Theory is not particularly well equipped for these issues. Said theory is specified in terms of an equilibrium algorithm, in which changes in institutions and in the structure of the economy, macro-to-micro interactions, the co-evolution of economic, institutional and technological forces and the process of creation and destruction of institutional and technological capabilities that obtains during the process of economic development can not be adequately studied.[2]

New sectors of economic activity have emerged in Latin America during the 1990's, while many 'old' activities have been gradually phased out. Labour expulsion has taken place both from manufacturing and agriculture. Open unemployment and informality have increased in most countries in the region. Different forms of capital intensive, computer-based production technologies have been brought on board by the larger firms in the economy displacing 'old' – more labour intensive - technologies and forms of production organization. ´Large´ firms have managed to reduce their degree of vertical integration and rely now more strongly on external outsourcing, both of production technology as well as of intermediate parts and components. On

[1] Jorge Katz, University of Chile. An initial version of this paper has been published by ECLAC´s REVIEW in Santiago de Chile in August 2006.

[2] The inadequacy of neoclassical lens for the examination of development processes was frequently brought up by Sanjaya in many articles and conferences. In 2003, for example, he wrote: (Received economic theory)…¨assumes that firms in developing countries operate with full knowledge of all technologies: they are on a universal, well-specified and well-behaved production function. Given the right market prices for inputs and outputs, they pick the technology appropriated to national factor endowments. By definition, all firms in an industry facing the same prices choose the same technologies. There are no tacit elements in the transfer, no learning costs and no need to adapt. All firms immediately use technology with the same efficiency.. According to this argument there is no meaningful technological activity in countries which use existing technology. …There is no need to build the capability to use new technology¨ (S.Lall, Technology and industrial development in an era of globalization. In: (Ed. Ha-Joon Chang, Rethinking Development Economics. Anthem Press, 2003. Pags.277-297.

the other hand, as a result of imperfect access to local capital markets or due to insufficient ´in house´ technological capabilities, most SMEs have not adapted well to the new rules of the game and have lagged behind in terms of technological and organizational upgrading. Thousands of them were forced to exit the market during the adjustment process - estimates being that around 8 thousand SMEs closed down in Chile and more than 12 thousand did so in Argentina during the 1980´s. The large majority of those that remained in business found themselves lagging behind 'large' firms as far as productivity growth and innovation are concerned.

After long years of market-oriented reforms, average labour productivity in Latin America continues to be in the range of 20-50% of that attained by the US, with Argentina and Chile in the upper part of the spectrum, and Ecuador, Paraguay and Bolivia in the lower one. On the other hand, the labour productivity gap between ´large´ and ´small´ firms in the economy has increased sharply in the course of time.

Summarizing: market-oriented reforms and the process of globalization of the world economy triggered off a major process of institutional and technological transformation throughout Latin America. The nature of competition has changed dramatically in most production activities, with business concentration and foreign ownership having expanded fast in many industries. External sources of technology and production know how have gained prominence in the production structure while domestic knowledge-generation activities and national innovation systems have remained frail and still mostly uncoordinated pieces of social machinery, scarcely significant at the time of supporting local innovation efforts and the inception of new production activities and technologies in the economy.

Even though the reforms have not delivered what was a priori expected from them in terms of an across-the-board process of economic upgrading it is nevertheless true that in each and every country in the region a (small) modern sector of economic activity has been erected as a result of the change in policy regime. Such sector covers, say, 40% of GDP in the richest countries in the region, and not much more than 10% in the poorest ones. It includes new production activities which were not present just a few years back (or were performed using less modern production technologies), including: a) natural resource processing industries which have now incorporated ´state-of-the-art´ technologies – such as genetically modified soy beans and vegetable oil production in Argentina, pulp and paper production and salmon farming in Chile, fresh flowers in Colombia, and many others. b) high productivity service industries including banks, telecoms, energy and tourism; and c) a few technology intensive manufacturing activities, such as airplanes design and construction in Brazil (A.Goldstein, 2005), or the assembly - in ´state-of-the-art´ plants, relying mostly on imported parts and components as well as on foreign-designed production organization routines - of vehicles and electronic equipment in Mexico.

The (small) fraction of society that belongs in the modern part of the economy is paid well above average and has gradually developed consumption patterns comparable to those exhibited by the large majority of the citizens in more developed industrial nations. For the individuals belonging in this segment of society the question as to whether or not 'convergence' with more developed industrial countries will ever take place constitutes a rhetoric question, insofar as their life style is indeed quite similar (and in many cases better) to the one attained by the average citizen of, say, Spain or Italy. On the other hand, however, deeper and more

intractable forms of social and economic exclusion have emerged in society, higher levels of informality now prevail, and more vindictive social relations -resulting from a growing climate of frustration and despair – have become widespread in most countries, making political governance increasingly difficult to attain.

In this paper I shall examine how the inception of new production activities has affected economic, institutional and technological forces in various countries and industries in the region. I shall use as examples three sectors in which the region has strongly gained in international competitiveness in recent years, i.e. salmon farming in Chile, genetically modified soy bean and vegetable oil production in Argentina and fresh flower production in Colombia. While metalworking activities and the production of capital goods have lagged behind in terms of international competitiveness and technological dynamism, the above mentioned sectors constitute the basis of the new pattern of production specialization Argentina, Chile and Colombia presently exhibit in the world economy. We notice here that this is the consequence of the co-evolution of economic, institutional and technological forces that have come together during the process of structural change.

II. STRUCTURAL CHANGE AND ECONOMIC DEVELOPMENT. UNDERLYING CONCEPTUAL ISSUES.

In the classical tradition – brought back during the past few decades by authors such as S. Kusnetz and M. Abramovitz, and also by evolutionary economists such as R. Nelson, S. Winter, P. Saviotti or J.L.Gaffard – the process of economic development is described as strongly associated to changes in the structure of the economy. In Smith and Ricardo structural change obtains from more ´roundaboutness´ in the economy and from increasing returns to scale which result from specialization. A growing economy is one that becomes more complex and sophisticated through time by the creation of new sectors of economic activity and the entry of new, more knowledge-intensive, forms of production organization. Concomitantly, new institutions, skills, and learning processes develop in the economy and diffuse in the social structure. It is such process that induced Kusnetz and Abramovitz to differentiate between the ´immediate´ and the ´ultimate´ sources of economic growth. An expanding capital/labour ratio – resulting from a higher rate of savings and investment – is seen as an ´immediate´ source of growth, while learning, the accumulation of domestic technological capabilities, institutional changes and the improvement of production organization capabilities are regarded as the ´ultimate´ sources of economic and social development. They constitute hidden ´forces´ which operate beneath the surface. The fact that we do not normally measure them –in many cases we do not even know how to do it– does not really mean that they are not present and constitute the essence of what development is all about.

Given the above, it becomes apparent that the long term performance of any one economy should not be described exclusively in macro terms – as it normally is– but rather as the outcome of the interaction between the macro and the micro and the co-evolution of economic, institutional and technological forces that co-evolve during the process of economic development. Furthermore, economic growth should not be thought as exclusively resulting from the adequate management of the so-called macro ´fundamentals´ of the economy, but also as the outcome of a more complex process of social transformation which involves in a very major way

changes in institutions, in the division of labour, learning processes and the expansion of production organization capabilities. Of course adequate macro management constitutes a fundamental component of the process – some people might even think of it as a *sine qua non* condition - but it is rather myopic to believe that it constitutes a sufficient condition for a successful process to obtain. Structural change might even take place within a volatile macro environment, as it has been the case in Latin America in the past few decades. Evidence to that effect will be discussed later on in the paper.

Many of the above mentioned changes in the ´ultimate´ sources of growth come together in the process of inception of new activities in the economy. As production capacity expands, learning processes are triggered off and new institutions –in the sense of intangible long term habits and patterns of social interaction among economic agents – emerge. Furthermore, the inception of new activities is associated to numerous market and non-market forms of interaction among firms and between them and other organizations in society such as universities, engineering associations, government regulatory bodies, municipal authorities, and so forth. Intermediate input suppliers, engineering firms and service providers tend to develop, gradually ´clustering´ into an increasingly stronger production organization fabric. The process is paved with ubiquitous externalities which conventional market analysis does not capture well.

Contrary to modern growth theory which takes the production structure as given and looks at its expansion through time, like if it were an expanding balloon - using A.Harberger´s illuminating metaphor (Harberger, 1988) in which the relative size of each part of the structure does not change as the size of the balloon increases - we notice that changes in the structure of production constitute a major component of the process of development. It is the change in the production structure that allows for more ´roundaboutness´, specialization and productivity growth, as well as for the gradual expansion of more knowledge intensive production activities, including the production of capital goods and the provision of engineering services.

It is important to notice that the inception of a new activity in the economy normally takes place in response to innovative quasi-rents. It is not part of what we would describe as the behaviour of firms under equilibrium conditions. In fact, quite on the contrary, innovation normally derives from the expectation of above normal profits and involves pushing the economy out of its equilibrium growth path. As from this perspective, an initial crucial question is where would these above average rents come from? After such question has been answered and a new industry has been incepted in the economy we can expect the activity to become more ´contested´ through time as a result of new entry, which is attracted by the perception of above average rents being captured by firms first entering the industry. In other words, market structure and behaviour are bound endogenously to change as the process unfolds, with innovation rents being eroded as the maturity cycle of the activity proceeds. As the process unfolds new forms of interaction can be expected to develop among firms and between them and other organizations in the economy. This dynamic sequence does not need to follow a unique pattern. There is not a ´one-size-fits-all´ universal model of production organization which could adequately accommodate the variety of possible real life situations. Variety and the co-evolution of economic, institutional and technological forces constitute the essence of the process we are talking about. There are quite different forms of capitalism throughout the world, each one with its own development path and process of institutional functioning. (P.Saviotti and A.Pyka, 2004,

a and b)

In some cases the dynamic agent motorising the inception of a new activity in the economy is a multinational corporation that plays a major role transferring technology, opening up external markets, training domestic labour and subcontractors and upgrading domestic engineering practices. In other cases such role is played by family-owned SMEs or by large domestic conglomerates, both public and/or private. The dynamics of the industrial organization model developing in each case, and the learning path firms and public sector regulatory bodies follow through time, is bound to be different, and highly ´country-specific´. . So are also the forms of ´clustering´ and interaction between ´large´ and ´small´ firms in the economy and the subcontracting practices that emerge in the process.[3]

The State, far from being a neutral agent to the process, is frequently an active one, through its regulatory agencies, financial institutions, universities and municipal authorities, many of which provide public goods, coordinate processes of market and institutional functioning, helping to develop domestic organization and technological capabilities that support the inception of new activities in the economy.

The above mentioned inter-country differences in the way new sectors are being incepted in the economy, how innovative quasi-rents induced the process and the role the public sector played in each case ´putting the wheels in motion´, is clearly documented in the East Asian Miracle Study the World Bank undertook in Korea, Taiwan, Singapore and Hong Kong in the 1980´s. The studies found that Korea was, mostly, a story of large cheabols and high business concentration, while Taiwan 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 MNCs bringing a whole new dynamics into the economy. In all three cases, however, a significant amount of public sector intervention was involved, creating markets, institutions and domestic technological capabilities in support of the inception of new export-oriented sectors. It was the public sector that undertook the effort of coordinating firms and public sector R&D labs and it was also the public sector the one that made available the funding and public goods that were needed to accelerate the process of internationalization of the new entrants. In other words, the link between Schumpeterian quasi-rents, public sector intervention and the inception of new, export-oriented production activities (and firms) was clearly documented by the above mentioned study. It is fair to recall here that at the time the East Asian Miracle Study came out a large number of colleagues doing research work on development economics were already familiar with the above ideas through Sanjaya´s writings in numerous books and papers.

The recent inception of industries such as salmon farming in Chile, genetically-modified soy bean and vegetable oil in Argentina, or fresh flowers in Colombia, exhibits many interesting similarities with the above, starting from the fact that in all three cases economic, institutional and technological forces can be identified underlying the process of structural transformation..

[3] Lall´s early insights in this field – derived from the comparison of the development process of Korea, Taiwan and Singapore – are quite remarkable. He perceived well before the East Asian Miracle Study by the World Bank the fact that the Korean case was more an scenario of large domestic chebols inducing – with goverment support - the structural transformation of the economy, while such role was played by local SMEs in Taiwan and by domestic subsidiaries of large transnational corporations in Singapore.

Interestingly enough, an adequate macro environment was not necessarily a sine qua non condition for this to happen. It certainly helped, but it was not a sufficient condition.. 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 Fundacion Chile, which in the early stages of industry inception created the basic technology and gradually transferred it to numerous local SMEs, the expansion of soy bean and vegetable oil production in Argentina was motorized by large MNCs – Monsanto and others - induced by the expected innovative quasi-rents thereby involved. The macroeconomic environment underlying these cases was not necessarily close to some form of equilibrium, but the expected innovation rents induced firms to expand their production and export activities in any case, and they successfully did so in a short period of time..

In the initial years of industry inception growth was determined by the rate at which new production capacity could be erected (Saviotti and Gaffard, 2003). New firms entered the industry, building up new plants, hiring labour, developing subcontractors and so forth. They made decisions on the basis of expected profits, which basically depended on a large potential market being there for them to cater for, and on the global and sector-specific institutional environment in which they find themselves operating. Opportunity and appropriability were major forces motorizing microeconomic behaviour . The expectation of above average returns on investment induced the expansion of production capacity, but the rate at which such capacity could come on stream was mostly conditioned by the availability of financial resources, production know how, trained labour and country-and-sector-specific institutional and regulatory circumstances.

The entry of new firms to the industry gradually turned all three of these industries more competitive, with the rate of expansion of the sector becoming more determined by forces coming from the demand side, rather than from the supply side as before. We show in our next section that the above ´stylized´ description of the dynamics of new industry inception describes fairly well the process of expansion of salmon farming in Chile, genetically modified soy bean and vegetable oil in Argentina, and fresh flowers in Colombia. The available information indicates that from inception to maturity the previously mentioned cases used the best part of two decades. All three of them are now mature oligopolies strongly inserted in world markets.

Turning now to the macro impact of the above mentioned issues, we argue here that the long term performance of the economy should be expected to be positively related to the rate of inception of new activities and more sophisticated firms to the production structure, and to the impact such process has upon the creation of institutions and social capabilities. ´Old´ industries need to be phased out while new ones are being created. When the rate of inception of new activities is high we could expect the dynamics of the development process to be high and, contrariwise, if such rate slows down the global development process could be expected to slow down. Saviotti and Pyka put this as follows: ¨A faster rate of growth of variety would lead to faster economic development¨ (Saviotti and Pyka, 2004, pag.4). Each individual new activity could be expected gradually to run into diminishing returns, but the global performance of the economy could be thought to be positively correlated with the rate at which new production activities are incepted in the economy.

III. STRUCTURAL CHANGE, THE EMPIRICAL EVIDENCE.

Table 1 provides empirical evidence on the process of structural transformation of the Argentine, Brazilian, Chilean, Colombian and Mexican economies for the period 1970-2002. It also presents an index of ´structural transformation´ (ICE) measuring how much the manufacturing sector of each one of these countries changed when comparing 1970 with 1996, 2000 and 2002.[4] The taxonomy hereby utilized to classify manufacturing activities is closely linked with the one Sanjaya used for many years trying to reflect the unit factor content of different industries and their ´technological intensity´. Sectors are classified as being more natural resource intensive, engineering intensive or low skill labour intensive. While Sanjaya used for this purpose UNIDO data, we have in this case employed ECLAC´s PADI programme and software to carry out much the same cross-country ´appreciative´ comparisons.

[4] The figures presented in the table have been calculated using ECLAC´s PADI program and software. Thanks are due to Mr. G. Stumpo and to Ms .J.Marincovic from the DDPE Division at ECLAC for providing me access to the data and helping me with the calculations.

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, referente year 1970.

I. Engineering intensive industries. (excluding automobiles) CIIU 381,382,383,385;

II Automobiles. (CIIU 384)

III+IV. Natural Resource intensive industries. Foodstuffs, beverages and tobacco (CIIU 311,313,314); resources processing industries (CIIU, 341, 351, 354, 355, 356, 371, 372)

V. Labor intensive industries (CIIU 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 suffered a major transformation in the direction of natural resource processing and food production activities. Contrariwise, metalworking industries producing machinery and equipment contracted in relative terms in the cases of Argentina, Chile and Colombia, but not so in the case of Brazil where metalworking industries maintained an expanding participation in manufacturing production throughout the period. The vehicle industry – a heavily protected metalworking activity - lost participation in Argentina and Chile.

In order to illuminate further the above mentioned structural transformation in favor of natural resource processing activities we have undertaken three individual case studies which help us to understand more thoroughly the process. These case studies refer to genetically modified soy bean and vegetable oil production in Argentina, salmon farming in Chile and fresh flower production in Colombia.

The process of structural transformation went in a completely different direction in the case of Mexico (and in the Central American economies) where ´in bond´ assembly industries – ´maquiladoras´ - have gained participation within manufacturing activities. These industries employ ´state-of-the-art´ foreign-designed production facilities, imported intermediate inputs and local cheap, low skilled, labor, for the assembly of computers, TV sets, VCRs (video cassette recorders) and garments. Such production aims, mostly, to the US market. Very little domestic engineering content can be found underlying these production activities, being product designs as well as production and organization technologies and logistics brought almost entirely from abroad.

The index of structural change reported in the Table also provides an interesting story in and for itself. It shows that the Chilean economy was the one that attained the fastest pace of structural transformation during the period 1970-1996. This indicates that the inception of new production activities in the economy was indeed much stronger in Chile than anywhere else in the region. If our previous argument is correct – i.e. that new activities induce the expansion of new institutions and production and technological capabilities in the economy – we find here a likely explanation as to why Chile attained a better overall growth and institutional performance than the rest of Latin America during the above mentioned period.

We also notice that the index of structural change fell in Chile in the late 1990´s and early 2000´s. at a time in which the dynamism of the Chilean economy slowed down considerably. This suggests that the Chilean process of structural change might have reached a ´plateau´ in the late 1990´s, opening up a new major issue for further future research.

We argued before that it is at the sector and firm level that the impact of the inception of new production activities in the economy becomes all the more noticeable. Macroeconomic lens tend to suppress the major economic, institutional and technological forces that come together at the micro level as new activities open up in the economy.. We

now present three short case studies to illustrate the above. We then draw several general lessons from the evidence to be now examined.

GM soy beans and vegetable oil production in Argentina

The production of genetically-modified (GM) primary products started in the world in the mid-1990´s. By 2002 there were nearly 60 million has under cultivation world-wide, being soy beans and maize by far the two more important crops involved in the transition from conventional to genetically-modified versions of the products. Argentina has now well above 15 million has under cultivation of GM soy beans, representing as much as 90% of total local soy beans production. The country is second to the US in the production of GM soy beans and vegetable oil.

The transition from ´conventional´ to GM soy beans involved a major transformation both in production organization and in institutions in Argentina. The impact relates both to agricultural as well as to manufacturing activities. It has also affected domestic technological efforts both in the private and public sectors of the economy, in particular, the relationship between firms, universities and public sector labs, as we shall now see.

As far as the agricultural sector is concerned we notice that ´cero tillage´ (*siembra directa*), and ´contract agriculture´ (*agricultura de contratos*) now dominate the scene, with the ´traditional´ farmer being relegated to the back seat as far as production organization decisions are concerned. Such role has been taken over by large independent subcontractors that take responsibility both for financing and production planning and organization. Production is now undertaken under the form of risk-contracts with financial intermediaries and banks advancing the funding for each new annual agricultural campaign. The technology package –seeds, fertilizers, herbicides– used by subcontracting companies belong to large multinational corporations – Monsanto, and a few others [5] - establishing a clear difference with the pattern that prevailed previously, during the ´green revolution´ period in the 1960´s - when agricultural technology was basically a ´public good´ disseminated by public sector agricultural agencies like INTA . Technological change during the green revolution was strongly related to mechanical improvements in machinery and equipment as well as to fertilizers. Contrary to the above technological change in GM soy beans is more related to genetic manipulation and biotechnological advances in the seed industry, an activity which is basically controlled by just a few large multinational corporations, with just a few local firms participating in the trade.

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 40%

[5] It is interesting that in the case of the RR (Roundup Ready) 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 alternative as a result of the low level of confidence Monsanto had in the functioning of the Argentine legal system protecting intellectual property rights. Monsanto seems currently to be searching for new ways of enforcing its legal rights on the RR technology, retaliating Argentina internationally for alleged patent violation. See Ablin and Paz, op. cit., September 2000. page 8.

of the seeds used in any given agricultural campaign are ´retained´ seeds from the previous campaign (the so-called ´bolsa blanca´) which are being sold as unauthorized versions, violating property rights on the technology. Monsanto failed to patent its technology for GM soy beans 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, and is presently trying to implement retaliatory policies against the local producers that violate its intellectual property rights. Concomitantly with the above we also notice that the ´cero tillage´ model of production organization is having a major impact upon the local pattern of land utilization. As the soil does not need to be prepared from one campaign to the next there is sufficient time for an additional crop to be obtained from the same land throughout the year. This has a positive effect upon land productivity, but many specialists argue that it has a negative impact upon the rate of soil depletion, an issue which is still the subject of hot debate among local agronomists and biologists.

Also major economic and institutional changes can also be found when we look at the manufacturing side of the industry, i.e. vegetable oil production out of GM soy beans. Highly capital intensive new ´state-of-the art´ plants have been erected during the 1990´s for such purpose. These are catalytic production facilities in which labour productivity is ten fold higher than in ´old´ manufacturing plants operating in Argentina in the 1970´s and 1980´s. A new and more complex set of skills is needed to operate these new plants. On the other hand, the new processing technology is highly biased in a labour-saving direction as very few unskilled workers are now needed at the shop floor level to operate the plant. Furthermore, vegetable oil production in Argentina is a highly concentrated activity dominated by a few large local conglomerates and foreign firms. A large number of M&A cases obtained during the 1990´s significantly expanding the degree of foreign control over the industry..

Recent studies indicate that the expansion of the GM soy bean industry has brought about a significant expansion in biotechnological activities locally performed. (Bisang et al 2006). Some 80 firms have been identified in the Argentine biotechnological sector, which produces not just GM seeds and agrochemicals, but also pharmaceuticals and food products of various sorts. Only 20 of these 80 firms are directly engaged in the production of GM seeds, but technological cross fertilization and externalities do not seem to be negligible.

These 80 companies have annual sales of biotechnological products of around U$S 350 million dollars. They employ nearly 5.000 people and carry out annual exports for around U$S 52 million. They spend close to 5 % of sales in R&D activities – nearly U$S 18 million – employing nearly 600 persons to that effect. Approximately 80% of these firms are local SMEs. A number of these firms maintain an active process of interaction with public sector agencies funding research and development activities in the biotechnological field.

In addition to the above we notice that the production of GM soy bean and vegetable oil opens up many new institutional and economic questions which Argentina will need to face in the forthcoming future. Among them, issues of traceability, labelling and human health protection, enforcement of intellectual property rights (IPRs), university-industry relations, funding of R&D efforts and so forth. There is no ´national policy´ to the

subject – as many other countries in the world have - but the need for a more pro-active public programme in the field is becoming increasingly clear at present.

Salmon farming in Chile[6].

The process through which international competitiveness was attained by the Chilean salmon farming industry covers the best part of two decades, 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 production organization and international marketing practices. As a result of the cumulative impact of said changes Chile gradually acquired 'world-class' status as one of the three major salmon farming countries in the world, side by side with Norway and Scotland. One third of the world demand for fresh salmon is now catered by Chilean based companies.

Salmon farming in Chile can be described as having evolved through three quite different 'stages´. In each one of these stages the actors and the problems they had to deal with changed quite significantly. There is first an inception 'stage' in which salmon farming was successfully introduced and adapted to the Chilean environment, almost entirely starting from imported genetic material. This is a stage in which trial and error and learning appear as major factors explaining both individual firm behavior and the starting-up of a new industry. 'Teething' problems were proverbial during that period, both at the individual firm and industry level. The Chilean government played an important role during these years through the action of Corfo and Fundacion Chile. There is then a second 'stage' in which the industry rapidly increased in size and complexity with the entry to the market of many intermediate input suppliers, service-firms, and the building up of a strong sector-specific industrial ´cluster´. The role of the Public Sector changed significantly during this period, taking a step back as a pro-active dynamic agent inducing the inception of a new production activity in the economy and substituting it by an active role on the regulatory front.

The sector finally evolved into a third stage in which a major transformation in industrial structure obtained through M&A (Mergers and Acquisitions), changes in plant ownership, foreign direct investment and a rapid process of internationalization.

[6] This section is based on a previous paper of the present 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 14.000; 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 the short period of less than twenty years Chilean salmon exports –almost entirely cultivated salmon– increased from less than US$50 million in 1989 to around US$2000 million in 2006. Salmon exports now account for close to 5% of Chilean total exports. From an almost negligible participation in the world's production of salmon -2% in 1987– Chile's share in world salmon production reached nearly one third of the total in recent years. A large number of economic, technological, and institutional forces have been involved in the process..

Public organizations, foreign companies and a large number of SMEs participated in the early years of industry inception. Although there was a clear public sector involvement in the industry right from the beginning, it is also clear that a new vintage of Chilean entrepreneurs emerged in association with salmon farming and became the driving force behind the wheel. Regulatory and sanitary activities –such as fishing and cultivation permits, monitoring environmental impact, controlling salmon eggs imports, and so forth– are adequately performed by government agencies such as Sernapesca, Conama and others. The required legal infrastructure supporting the above activities was set in place in the late 1970´s and during the 1980's and was considerably improved thereafter complying with ´world class´ practices. (*Acuanoticias*, November 1997).

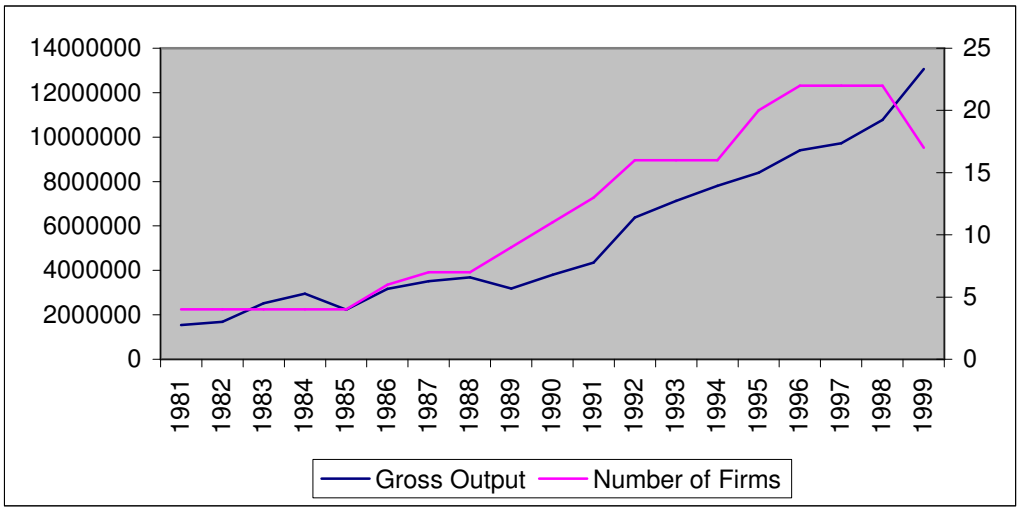
Production practices in the early years of industry inception were quasi-artisan and mostly based on imported genetic material. Salmon food, a major component of salmon farming costs, was still daily prepared by each company on the basis of fresh raw materials. The conversion rate from salmon food to the finished product was more than 3:1 i.e. three kilograms of fresh food per kilogram of salmon. This is more than three times the input/output coefficient the industry exhibits today, suggesting that major productivity improvements have been attained and also that learning processes have been quite substantial at the individual firm level. (*Acuanoticias*, July 1997, page 24). Many examples of this sort can be cited, in relation to cultivation tanks, vaccines, final product processing and so forth. (*Acuanoticias*, April/May 1998, page 12).

It is in the late 1990's that the Chilean salmon farming sector attains many of its present features of a 'mature' oligopoly.[7] World prices for salmon fell significantly in the second half of the 1990's getting closer to the industry's long term unit production costs. Unit gross margins contracted, as competition increased and the markets for salmon became more 'contested'. 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 bigger, much more capital intensive and technologically more sophisticated. On the other hand, business concentration increased quite significantly.

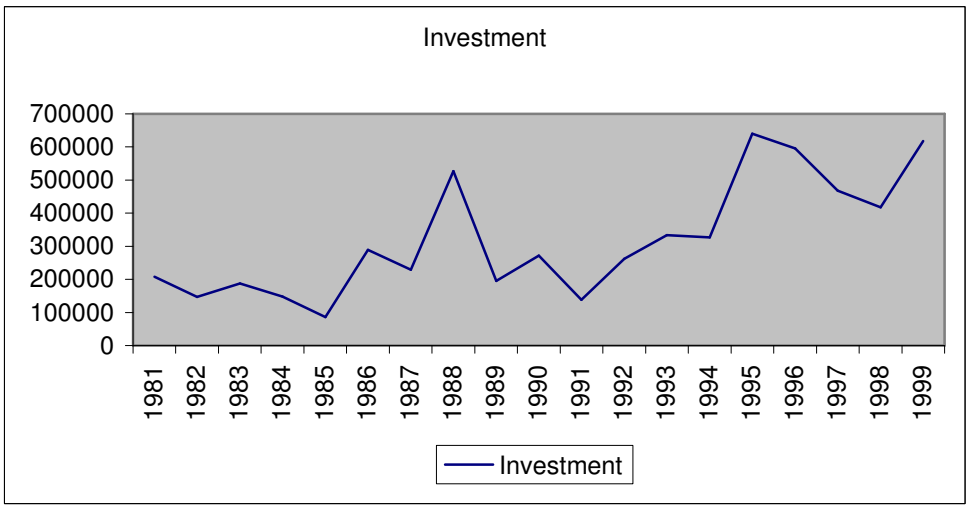
[7] What a 'mature' industry actually is, and how the notion applies to the case of salmon farming, has been made quite clear in a recent public conference by Mr. Torben Petersen, CEO of Fjord Seafood Chile, a subsidiary from the Norwegian company of the same name when he stated that 'The real maturation 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 *Acuanoticias* No. 79, 18 May 2004.

Figure 1. The Chilean salmon-farming industry, 1981–2000

a. Number of firms in the industry and their gross output



b. Investment in the industry



The number of salmon-farming companies increased until 1996, reaching a plateau in the late 1990s, and then began to decrease (figure 1a). 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 evidenced by the higher ratio of skilled to unskilled personnel. Capital deepening occurred at two different moments over the last two decades: in 1986–1989 and in the mid-1990s. With the benefit of hindsight we know that the first of these moments occurred during the industry's inception period—when many new, locally owned salmon-farming SMEs entered the industry. The second wave of investments came hand in hand with M&A that took place when large, international salmon-farming enterprises arrived in Chile in the 1990s. Many of these foreign companies joined the sector through the purchasing of small and medium-size Chilean firms.

Concentration ratios increased and the industry turned into a mature oligopoly, operating at a global scale.

c) Fresh flowers in Colombia

Exports of fresh flowers started in Colombia in a quasi-artisan fashion in the mid-1960´s. By 2004, exports amounted to nearly U$S 700 mill. annually. Nearly 400 companies –most of them SMEs– are actively engaged in this activity, providing direct employment to some 90 thousand workers. Indirect employment has been estimated in 75.000 .Close to 7 thousand has – mostly in the Bogota sabana – are now under cultivation. Colombia accounts for nearly 16% of the total world trade in fresh flowers

The Colombian fresh flower sector is gradually developing into a lively ´cluster´ of independent suppliers of hybrid seeds, herbicides and pesticides, financial and insurance services and so forth. However, much remains to be done supporting the development of ´collective action´ for the supply of ´public goods´ to the industry in terms of research and development activities into genetic engineering, the strengthening of international marketing capabilities, the legal enforcement of local trade marks and geographical denominations, and so forth. A large number of public and private organizations are presently involved in the field and new institutions and mechanisms of interaction between firms and said organizations are gradually developing. For example, as of 1996 Floraverde has been created in order to certify firms for adequate and sustainable use of water resources, herbicides, and the protection of the environment. Some 150 firms already belong in its network and as many as 60 of them have already received certification for ´good technological practices´. Although none of these firms is actually involved in formal R&D activities it is to be noted that many of them have introduced fairly advanced waste management technologies, water consumption reduction routines, and other ´state-of-the-arte´ practices. The diffusion of information and communication technologies – which is presently a major issue in the technological upgrading path of this industry – will no doubt help facilitating the achievement of network externalities associated to the provision of information concerning prices, international marketing scenarios, recent technological developments, and so forth. Knowledge-intensive SMEs developing sector-specific software for this industry should be encouraged to develop as a major contribution to the long term expansion of this industry.

IV. POLICY ISSUES.

Having so far presented three individual case studies examining the economic, institutional and technological forces that underlie the inception of new industrial activities in Argentina, Chile and Colombia, we will now try to draw some policy oriented lessons from the evidence previously reported.. For such purpose we organize our comments under four different headings: 1. Inception of new natural resource based activities and the need for domestic R&D efforts, 2. University-Industry links. 3. Natural resource processing activities and the environment, and finally, 4. Macro-to-micro interdependencies.

1. The inception of natural resource based industries and the need for local R&D activities.

In all three countries – Argentina, Chile and Colombia - the process of structural change of the past two decades has been strongly tilted in the direction of natural resource processing industries and foodstuff production.. This suggests that, as could have been a priori expected, the free functioning of market forces has naturally directed the economy towards the underlying pattern of comparative advantages characterizing all three of these economies. A large Ricardian rent was surely instrumental for the process to move in this direction. It is quite likely that this trend will continue in the medium term and that the economy of these (and other) Latin American countries will further proceed into aquaculture, forestry-based industries, mining, and agricultural activities. This poses many new questions, some of them related to the origin, adequacy and access to technology for these industries and to the impact such expansion is likely to have upon environmental protection. Are process and production organization technologies available in international technology markets suitable for the sustainable exploitation of local natural resources? How much ´location-specific´ R&D efforts are needed as a result of the idiosyncrasy of local production circumstances?

The exploitation of agricultural land, marine resources, forests and mines demands basic knowledge in disciplines such as biology, genetics, marine sciences, mineralogy, immunology and many others which provide the basic scientific underpinnings of the know how used for their sustainable exploitation.. Although part of the required scientific understanding and technological know how could be obtained from international sources, it is important to understand that there is a great deal of ´country-specificity´ attached to natural resources and that such specificity demands domestic knowledge generation and adaptation efforts, sometimes on a rather large scale. The physical, biological and ecological conditions of each production location differ strongly and so do also the machines, intermediate inputs and environmental control artifacts and technologies that are needed. In other words, the simple conceptual metaphor of a ´ready available´ ´shelf´ of production and environmental control technologies waiting to be used by domestic companies when needed would be does not appear to be the right kind of conceptual framework on the basis of which to develop a long term growth strategy in this field. Domestic research and development activities seem to be required for such purpose. Public sector R&D organizations, university-based research labs, domestic engineering firms and individual companies should interact in this area developing new country-and-location-specific artifacts, process know how and production organization technologies which would facilitate the sustainable and rational exploitation of local natural resources.

Latin American firms have not so far shown significant interest for involving themselves in technology generation efforts aiming at the development of proprietary technologies. At variance with successful firms in other countries, Latin American firms have not until now given much indication of being interested in significantly expanding ´in house´ R&D activities nor of developing stronger links with local universities, public sector labs or engineering firms with the purpose of developing new product designs or new process technologies. Neither have they given much attention so far to environmental protection issues. Furthermore, local firms do not seem to be interested so far in exporting

'pure' forms of know how resulting from their domestic learning processes, much in the way Swedish or Finnish firms have done in the pulp and paper sector, Dutch and Scottish firms in salmon farming or dairy products, or Canadian firms in cooper refining.[8] Rather, most firms seem to satisfy themselves with a more passive behaviour in this sphere.

The lack of involvement of Latin American firms in technology generation activities and in environmental protection efforts appears, in our view, to be a deeply-rooted feature of the local production organization environment deriving, on the one hand, from lack of adequate incentives and on the other from the fragmented and inefficient public sector knowledge-generation infrastructure Latin American countries erected during the post-war period. Very little under the form of public goods and incentives can be found in the region inducing firms into technology-generation efforts, R&D expenditure[9]and environmental protection activities.

R&D expenditure has always been low in the region, usually around half a percentage point of GDP, at the most. This is between one third and one quarter of what other more advanced countries allocate for the purpose of developing new technologies. (Lugones, 2005; Ricyt, 2000). Moreover, 80% of total R&D expenditure has traditionally been carried out by the public sector in government labs and public universities.

We still know very little as to why organisations – both public and private– and institutions work well or do not do so in the field of knowledge generation and diffusion in any given country. We know, however, that markets do not perform well in this territory as a result of weak property rights, lack of qualified human capital, and many other reasons. Poor organisational design, lack of co-ordination efforts, absence of the right kind of – market and non-market– incentives, play an important role influencing lack of individual firm involvement, and country-wide inefficient behaviour, as far as technology generation and diffusion is concerned. How much a country spends on R&D activities is surely an important indicator of its commitment to science and technology matters, but even more important than expenditure itself is how efficient local R&D organizations and labs actually are in transforming resources into technologies which turn out to be useful in the production of goods and services. Institutional malfunctioning as well as an inadequate incentive regime, appear as the major reasons on account of which public sector labs and domestic sources of technology have so far played a negligible role as a source of innovation in Latin America. A long road still lies ahead until domestic firms, universities, engineering consultants, banks and government officials in general, learn how best to deal with questions of innovation and domestic technological development. How to create

[8] Contrary to the above, we should notice that exports of ´pure´ technology under the form of ´turn-key´ plants and licensing contracts where carried out by Argentine, Brazilian and Mexican metalworking firms and engineering consultants in the 1970´s and early 1980´s. Such phenomena passed unnoticed in the hype of the highly derogative criticisms the ´inward-oriented´ process of industrialization received in the 1980´s. On the topic of exports of technology from Latin America, see Katz (1982); (Llal, 1983); Amsdem (2003).

[9] ´Adaptive´ knowledge-generation activities intended for process and product improvement are being systematically performed by many Latin American firms. Although many of them involve incremental knowledge generation and changes in production organization routines, they will not normally be captured by conventional survey measuring R&D efforts at the individual company level. Expenditure and efforts of this t are normally under-reported as a result of their informal nature.

venture capital markets capable of financing innovation efforts? How to deal with would-be entrepreneurs coming from university labs? How to make innovation affordable to SMEs? What role could technological parks and incubators play in this connection?. Questions of this sort still lack a reasonable answer in most Latin American countries. They will have to be answered, however, in the forthcoming future as countries will no doubt proceed into a more intense exploitation of the rich natural resource-base they own.

2. On university–industry relations

The link between universities and industry is still in its infancy in Latin America. Institutions and incentives are very frail for these two major players of the development game to become more interested in each other. Most Latin American universities are ´teaching universities´ where little or no research is being undertaken. Very few notable exceptions to that rule can be found in the larger countries in the region, in which modern research labs and a modern research infrastructure has been gradually erected, mostly in recent years. It is the dialog between these university labs and manufacturing firms that needs to be strengthened and developed in the future, creating an atmosphere of trust and understanding that is presently lacking. Firms think of universities as ´ivory towers´ mostly connected with foreign research interests while university researchers think of firms as short term profit oriented organizations which scarcely care for the evolution of the scientific frontier underlying their specific area of involvement.. It is such climate of mistrust that needs to be overcome as part of a gradual process of mutual reassertion.

Our case studies suggest that the initial building blocks for a stronger university-industry interaction are already in place and that further public efforts in this direction might be well worth performing.

In the field of aquaculture both Fundación Chile - a sophisticated public/private knowledge generation and diffusion agency - and various local universities - the University of Chile, the Catholic University, the University of Concepción and the University of Los Lagos – currently undertake research and development efforts in the field of aquaculture, including training and research in molecular and marine biology, pharmacology, genetics, and other related scientific and technological disciplines. Some of these labs have cooperative R&D programs with salmon-farming companies as well as with producers of intermediate inputs, in areas such as vaccines and salmon food production.(El Mercurio, December 1st, 2006. ´AcuaChile se asocial con CORFO e invierten U$S 10 mill. en empresa innovativa´). Public sector agencies such as CORFO, CONYCIT and INFOP frequently act as funding agencies for R&D projects for the industry, in joint venture with university departments. Competitive bids and risk sharing contracts are normally used for such purpose. A certain overlap can be noticed between Fundación Chile and the above mentioned universities, suggesting that further coordination efforts across the Chilean aquaculture innovation system might be needed. It is interesting to notice that after nearly two decades of marginal participation in international scientific and technological academic events in aquaculture Chilean researchers are now showing a more active role, presenting papers and dissertations in international gatherings. Not very much of the above has yet

derived in domestic and international patenting efforts, yet another field in which the Chilean aquaculture sector seems to be far behind international practices.

Turning now to soy bean production in Argentina we notice that many large and small firms active in the agricultural and biotechnology field maintain a lively interaction with public sector agencies and university labs funding and performing R&D activities respectively. In a recent study based on information from the Agencia Nacional de Promocion Cientifica y Tecnologica (ANPCyT), the National Council for Research (CONICET) and the National Institute for Agricultural Technology (INTA), G.Gutman shows that two major public funds support university and private firm research efforts in this field. The first one is the Fondo para la Investigacion Cientifica y Tecnologica (FONCyT) that financed – through open competitive contest – 222 research projects related to the biotechnological sector over the period 1997-2003. These research projects were carried out by universities, public labs and research institutes from CONICET and INTA and amounted to around U$S 10 million. This represents nearly 12% of the total number of research projects financed by FONCyT (3.700 totally over the same period). On the other hand, FONTAR, the public sector financial agency providing funds for research and development activities carried out in joint venture between private sector companies and public sector labs, financed 126 projects in the biotechnological area over the period 2000-2004 (out of a total of 1.528 projects) with a total expenditure of around U$S 12 million dollars. (G.Gutman, 2006). Although the figures involved are small they indicate that a dynamic ´cluster´ of knowledge creation activities organized around the biotechnologies is already under operation. Private and public agents actively interact within such cluster in a highly promising way.

We can conclude from the above evidence that small - but growing - technological links seem to be developing between industry and university labs in the natural resource processing sectors. It seems quite evident that the social rate of return on these activities is by far higher than the private rate of return, this suggesting that it is probably worth significantly expanding public expenditure in this field.

3. Environmental sustainability.

We have argued before that natural resource-based growth poses many new ´country-and-location-specific´ questions which need to be answered, in particular in areas of environmental protection and sustainability. Some natural resources are renewable others are not. The rate of depletion varies a great deal among exploitation sites. Firms are affected in their economic behavior by the cost and risk of exploration for new sources of supply, by the biological life-cycle of each production location, by the cost of preservation of the environment, by the nature of the regulatory framework and system of property rights in which the exploitation of the resource is undertaken, and so forth.

The above mentioned forces affect the planning horizon with which firms enter the activity, the long term rate of profit underlying their investment programs, and the strategy with which each firm makes decisions as to whether to stay or exit the activity.

The argument extends to the artefacts and pieces of machinery as well as to the technological know how needed for environmental protection. Each location is somewhat different and specific and the gradual adoption of world class environmental protection standards demands a great deal of research in order to develop ´tailor-made´ solutions to specific local problems. Adequate regulatory bodies and enforcement legislation as well as trained human capital from the part of the public sector are needed in order to attain a satisfactory level of compliance to the required standards in this field.

The protection of biodiversity and the extent to which the application of TRIPs-related disciplines could eventually collide with the ´national interest´ demands a great deal of expertise of a legal nature as well as a ´national´ strategy for countries to operate in an adequate fashion. (Katz,2007). Topics such as ´geographical denominations´, ´compulsory licensing´ ´parallel imports´ and ´issues of national emergency´ are becoming common jargon in this new arena of property rights related to international trade disciplines. Latin American countries still need to learn to operate according to their ´national interest´ in this area, making use of the degrees of freedom the new international institutional architecture still provides. (Roffe, 2006, Correa, 2006, Katz 2007).

4. Macro and micro interdependencies

The inception of new production activities in the economy opens up major new questions that need be examined. On the one hand, some of them are sector-specific questions of market structure and industry governance, which require consideration, antitrust and competition policies and consumer protection policies among them. On the other hand, issues more germane to aspects of macroeconomic management also emerge which need be taken care of. Let us briefly mention both of these sets of topics.

As far as market structure and performance is concerned our study of the Chilean salmon farming industry shows that in the short period of just two decades the industry moved from a highly competitive structure mostly populated by domestic SMEs to a highly concentrated oligopoly, in which fewer and much larger and sophisticated firms were involved. Although FDI was not a major force during the stat-up period of the industry it did became one in more recent times through M&As. This has significantly changed the structure and behavior of the industry. The transition involved a major increase in barriers to entry, changes in competitive behavior and the establishment of new patterns of interaction with foreign brokers and with local regulatory agencies. All of the above issues suggest that as countries move along the life-cycle of the newly incepted activities new institutions and regulatory capabilities need to be put in place in the economy. Competition and antitrust policies and consumer protection legislation seem to be high on the agenda as many forms of anticompetitive behavior seem to develop as industry matures and competition becomes significantly stronger. Latin American economies are still rather weak on this front.

Turning to macro issues associated to the inception of new production activities in the economy and the need for pro-active government policies for inducing such process, we notice that both neutral and ´sector-specific´ policy instruments could be used for such purpose. Fiscal subsidies to induce new investment in physical infrastructure as well as in the development of human capital, as well as ´sector-specific´ activities supporting the

production and distribution of public goods – marketing and technological information, industrial extensionism (involving the participation of public sector university labs), - could be used to create quasi-rents in specific niches of the economy, inducing private entrepreneurs to proceed in such direction. Many countries in the world – in particular South East Asian countries and China, but also Ireland, New Zealand or Israel are actively proceeding in this direction at present time.

It is difficult to know ex ante which policies will work well and which ones will not in any specific country. The process of inducing more knowledge generation and diffusion efforts in the economy should be thought as highly country-and-industry-specific. No ´one-size-fits-all´ policy is likely to succeed. Trial and error and a highly pragmatic approach seem unavoidable under current circumstances. . As our friend Sanjaya understood all along there are different forms of capitalism throughout the world and Latin American countries still have to find out what brand of capitalism suits better their own interests. It is only to be hoped that in the medium term they will be able to find out what local policy mix will better suits their needs in the search for a more vibrant, dynamic and equitable process of economic development.

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