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National Innovation Systems:
Lessons from East Asia to Latin America.
Case studies of Costa Rica and Chile

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ABSTRACT

Over the last two decades, the concept of National Innovation Systems (NIS) has been increasingly used as an approach to explain the competitive advantage of nations. Economists and policymakers consider that by evaluating NIS the major causes of the disproportioned economic growth between developed and developing countries can be understood. Also, it is believed that adequate policies and institutions to reduce these disproportions can be formulated by using NIS as a conceptual framework.

East Asia and Latin America have been constantly compared in their economic growth, mainly because after World War II Latin American countries had several advantages over East Asian countries and now the situation is totally reversed.

The aims of this paper are: 1) to identify innovation trends in Latin America and Caribbean countries (Costa Rica and Chile) that compared with trends in East Asian countries (HPAEs), can help to explain at some degree the low development in LAC region, and 2) to provide some guidelines for the formulation of policies to improve the innovation systems in LAC countries.

To achieve the paper's aims we will do case studies of Costa Rica and Chile, analyzing Costa Rican and Chilean organizations' involvement on S&T and innovation activities (linkages, roles, etc.) as well as assessing data and indicators of innovation performance (education, R&D expenditure, etc.) of these two countries.

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Introduction

Latin America and the Caribbean region (LAC) consists of 34 countries and 12 territories, around 534 million people live within this region, three-quarters of the population live in and around cities making LAC the most urbanized region in the developing world (World Bank, 2004). This region is also characterized by its deep wealth inequalities: almost one-third of the population live in poverty.

LAC has an incredible regional identity as well as a strong homogeneity, sharing historical, language and cultural features. Spanish and Portuguese are the main languages spoken in the region; English, French and some 400 indigenous languages are some of the others languages spoken in LAC.

The region is currently facing a strong economic recovery after a period of low growth, most of the LAC countries are expected to grow about 4% or higher in 2004, compared with less than 2% annual per capita growth rate during the 1990s up to 2002 (World Bank, 2004). Unfortunately, the economic recession across the region has not only increased the development gap between LAC and the more advanced countries but also between LAC and the East Asian countries (NICs), which two decades ago were approximately in a similar development level.

From Import Substitution Policies to Open-Economy Policies.

After World War II, almost all governments in LAC introduced import substitution policies[1] intended to accelerate industrial growth by the production of manufactured goods for the local markets.

The import substitution policies were not successful in transforming Latin American countries into exporters of manufactured goods. Latin American industries could not compete effectively in international markets and were not able to produce the foreign capital needed to finance the development of technology and new products.

[1] **Import substitution** is a trade and economic policy based on the premise that a country should attempt to substitute products which it imports (mostly finished goods) with locally produced substitutes. This usually involves government subsidies and high tariff barriers to protect local industries and hence import substitution policies are not favored by advocates of absolute free trade. In addition import substitution typically advocates an overvalued currency to allow easier purchase of foreign goods and capital controls. (Wikipedia, 2004).

However, import substitution policies are not the only cause for what is known as *the lost decade* but they can be considered as a major contributing factor. It is well understood that the increase on the price of oil created a difficult situation for LAC countries. Thus, "the import substitution polices deserve the blame, for making a bad situation worse" (Baier et. al., 2003).

In the 1990s, Latin American countries moved away from these policies of protectionism (high protective barriers such as trade quotas, tariffs, etc.), to market-determined, open economies; LAC countries replaced their trade barriers for regional trade agreements such as the North American Free Trade Agreement (NAFTA), Mercosur among others.

Concerns in Latin America and the Caribbean.

Macroeconomic problems have been relatively controlled in almost all of the Latin American and the Caribbean countries and the mechanisms that once protected the industrial sector in this region have been dismantled. However, economic growth in Latin America has been very slow. Many policymakers in the region are asking: what is the problem? and whether they should continue with the current economic model?.

Latin America can be classified as a medium-income region. In 2000, it occupies the fifth place worldwide in terms of per capita income, behind the developed countries, Southeast Asia, the Middle East and Eastern Europe. Only the countries of the rest of Asia and Africa are below it. (Inter-American Development Bank, 2000).

But, the major concern about Latin America's pattern of economic development is the way income is distributed, some Latin American countries are among those with the worst income distribution in the world.

Also Latin America faces the problem of competitiveness. In the 2001 edition of the Global Competitiveness Report, most Latin American economies ranked very low by international comparison, and what most concerns is that some Latin American economies have competitiveness indicators much lower than what would be expected. This problem of competitiveness is a potential threat to the economic growth of the region.

LAC currently has two major needs to decrease its low level of innovation: 1) to create and/or strengthen R&D institutions in the public sector, encouraging them to follow applicable activities to the country's development needs; and 2) to develop an environment that supports the private sector to engage in R&D activities (Velho, 2004)

Possible lessons from East Asian Countries.

East Asia and Latin America have been constantly compared in their economic growth, mainly because after World War II Latin American countries had several advantages over East Asian countries and now the situation is totally reversed.

Then, Latin American countries can learn from East Asian countries how they were able to succeed over negative circumstances. Particularly, East Asian countries can teach to Latin American economies how they changed their economies' structures form agriculture industries to manufacturing industries.

Due to some similarities between these two regions such as late industrialization start, high levels of poverty (at least in the past in East Asia) among others, East Asian countries are the perfect model for Latin America to obtain best practices in economic development and innovation progress.

Methodology and Scope of the research.

The aims of this paper are: 1) to identify innovation trends in Latin America and Caribbean countries (Costa Rica and Chile) that compared with trends in East Asian countries (HPAEs), can help to explain at some degree the low development in LAC region, and 2) to provide some guidelines for the formulation of policies to improve the innovation systems in LAC countries.

To achieve the paper's aims we will do case studies of Costa Rica and Chile, analyzing Costa Rican and Chilean organizations' involvement on S&T and innovation activities (linkages, roles, etc.) as well as assessing data and indicators of innovation performance (education, R&D expenditure, etc.) of these two countries. We consider that it would be more useful for policy making purposes, if we provide a cross-case analysis of Costa Rica and Chile with some of the high-performing Asian Economies (HPAEs) in a separate section of the paper.

Costa Rica and Chile were selected as case studies for this paper because they have had a huge economic success within their regions during the last decade and it is presumed that this is related with their reforms in Science and Technology policy among other reforms (macroeconomic, educational, institutional).

Costa Rica has been specially successful in attracting high-tech and middle-tech foreign companies-investments, that goes beyond of the typical "maquiladora" phenomena (just manufacturing processes); Costa Rica is involved in the processes of testing, designing

and creating technology. In the other hand, Chile has been very economically successful within its region.

The paper is based on quantitative and qualitative information collected from multiple sources. The quantitative data comes primarily form international databases on S&T indicators as UNESCO, Institute for Statistics and the Red of IberoAmerican Indicators of S&T, World Bank, International Monetary Fund, Inter-American Development Bank, government agencies in each country and other sources. The qualitative information was collected from government agencies, documents and reports as well as from international organizations and through a literature search of S&T publications.

The second section of the paper develops the concept of National Innovation Systems and discusses the relation between innovation and economic growth. The third section introduces some insights from the HPAEs innovation systems and some theories explaining the “East Asian Miracle”. The fourth and fifth sections are the case studies of Chile and Costa Rica respectively. In each section the NIS of each country is analyzed extensively as well as their economic and political performances. The sixth section is the cross-case analysis of the Costa Rican and Chilean innovations systems with the HPAEs innovation systems. The final and concluding section sums up the main issues identified in the paper and set some policy recommendations for policymaking in LAC countries regarding their national innovation systems.

National Innovation Systems

Over the last two decades, the concept of National Innovation Systems (NIS) has been increasingly used as an approach to explain the competitive advantage of nations. Economists and policymakers consider that by evaluating NIS the major causes of the disproportioned economic growth between developed and developing countries can be understood. Also, it is believed that adequate policies and institutions to reduce these disproportions can be formulated by using NIS as a conceptual framework.

The concept of national innovation system.

A national innovation system can be seen as "a subsystem of the national economy in which various organizations and institutions interact and influence each other in the carrying out of innovative activity" (Balzat & Hanusch, 2003).

The NIS approach analyzes the process of innovation in a more comprehensive manner than just using benchmarks (number of patents, number of new products created, etc.); this approach covers from private and public institutions' activities in R&D up to other factors of innovation such as: learning processes, incentive mechanisms, interactions among different actors, etc.

Balzat (2002) concludes that a definition of national innovation system should contain and emphasize at least three crucial things:

1. the consideration of the entire innovative process;
2. the analysis of various main actors involved in these processes (plus the linkages between them); and
3. the institutional set-up serving as a framework for economic action.

The theories around the innovative process have gradually extended their focus and complexity: from individual firms to the environment in which firms operate and the national system of regulations, institutions, human capital and government programs (Niosi et al, 1993).

Although, there is not a single general accepted definition of a national system of innovation (Box-1), the majority of researchers on this concept agree that what is important is the web of interactions; their definitions stress the importance of understanding the linkages among the actors involved in innovation to improve technology performance.

It is well accepted now that a linear approach to conceptualize the complex interactions in an innovation system is very limited because the innovative process goes beyond policies that merely relied on "technology push", "aimed strengthening science and engineering education in the nascent universities", or on locally generated "demand pull" for scientific and technological research (Mytelka, 2001). Rather, it is considered by many scholars that the success in economic and technological development is associated with the capacity that a nation has to acquire, absorb and disseminate modern technologies (Feinson, 2003).

The development of the National Innovation System approach.

The idea of "innovation systems" can be tracked back to List (1841) (Freeman, 1995). List stressed the relevance of knowledge, the links between scientific institutions and productive sector and foreign technologies for economic development. (Alcorta & Peres, 1998).

More recently, research on NIS has gained new emphasis. The NIS approach was introduced in the late 1980s (Freeman (1987), Dosi et al. (1988)) and since then it has evolved (Lundvall (1992), Nelson (1993), Edquist (1997)). Freeman (1987) was the first to use the concept to help describe and interpret the performance of Japan over the post-war period (Archibugi D. et. al., 1999).

The innovation literature was reviewed by Edquist (1997), he tried to identify the different elements and perspectives as well as the similarities of the various approaches. The author outlined nine common characteristics of the systems of innovation approach: 1) innovation and learning; 2) their holistic and interdisciplinary nature; 3) the natural inclusion of a historical perspective; 4) differences between systems and non-optimality; 5) their emphasis on interdependence and non-linearity; 6) the incorporation of product technologies and organizational innovations; 7) the central role of institutions in the systems of innovation approach; 8) their conceptually diffuse nature; and 9) the focus of the systems of innovation literature on conceptual constructs rather than on a more deeply rooted theoretical framework (Archibugi D. et. al., 1999).

The relationship between innovation and economic growth.

Usually, innovations are defined as: the introduction of new or improved products, production techniques, discovery of new market and the use of new input factors (Schumpeter, 1934 cited in Balzat, 2002). Innovation can lead to economic growth in many ways, such as the expansion of a firm's market shares in domestic and international markets and its revenues by the introduction of a new product to the

market; firms' efficiency can be increased by initiating new manufacturing processes or by re-arranging the organization of production methods, resulting in lower product prices and/or higher profits to firms (Balzat, 2002). However, innovations are not the only force of economic growth: other subsystems of the national economy such as legal systems, financial systems, tax systems, etc. influence the innovation system and interact with it. (Graph-1).

At present, economic activities are more knowledge-based, the success of enterprises, and even of national economies as a whole, is defined by the effectiveness of gathering and utilizing information (technology and innovation). The OECD (1997) considered that "investment in knowledge, such as research and development, education and training, and innovative work approaches are key factors for economic growth".

National Innovation Systems in Developing Countries.

More and more developing countries are putting extra emphasis to understand their NIS with the aim of increasing their innovative and technological capacities. Noteworthy, that the role of the innovation systems in developing economies is not the same as it is in developed economies. NIS in developed countries serves to maintain or improve an already established level of competitiveness and growth, whereas in developing countries the NIS has the task of catching up (Feinson, 2003). Therefore, it is expected that the application of the NIS concept in developing countries would not be the same as it is in developed countries.

Edquist (2001) presents the concept of Systems of Innovation for Development (SID), which is a different NIS approach to the one taken in developed economies. The author highlights four main areas where SID differs from NIS:

1. Product innovations are more important than process innovations because of the effect on the product structure;
2. Incremental innovations are more important and attainable than radical ones;
3. Absorptions (diffusions) are more important than development of innovations that are new to the world;
4. Innovations in low and medium technology sectors are more attainable than those in high technology systems.

Considering the historical context where developed nations are technological leaders and developing economies followers, the absorptive capacity of the last one is very important in the process of innovation. Developing countries can obtain technology by contracting or setting agreements with firms, universities, labs, etc. in developed

countries; then, in developing economies the focus shifts from innovation to learning process.

Viotti (2002) argues that learning in developing economies can be defined as “the process of technical change achieved by diffusion (in the perspective of technology absorption) and incremental innovation. In other words, learning is the absorption of already existing techniques, i.e., the absorption of innovations produced elsewhere, and the generation of improvements in the vicinity of acquired techniques”.

Insights from high-performing Asian economies.

From 1965 to 1990 East Asia grew faster than any other region in the world (World Bank, 1993). This phenomenon is attributable to the extraordinary growth of eight high-performing Asian economies (HPAEs) within this region: Japan, the "tigers" (Korea, Singapore, Taiwan), China and the newly industrializing economies (NiEs) Indonesia, Malaysia and Thailand (World Bank, 1993).

The HPAEs grew twice as faster than the rest of East Asia, almost three times faster than Latin America and South Asia and five times faster than Sub-Sahann Africa (World Bank, 1993). From 1960 to 1985, real income per capita increased more than four times in Japan and the Four Tigers and more than double in the NiEs (World Bank, 1993). Amazed by this phenomenon, the economists and policymakers around the world started to look at this region and its dynamics trying to understand how the HPAEs achieved this growth and what lessons can be learned for policies in other developing countries.

There are different theories trying to explain the "East Asian Miracle"; Nelson & Pack (1999) divided these theories in: the accumulation and assimilation theories. *The accumulation theories* point out the role of capital investments in moving the HPAEs' economies along their production functions. What lies behind rapid development, according to these theories, is very high investment rates. (Young, 1993; Krugman, 1994).

The assimilation theories based on how the HPAEs economies went throughout entrepreneurship, innovation and learning before they could master the new technologies they were adopting from more advanced industrial nations. Investment in human and physical capital is an important part in these theories, but does not fully explain the "East Asian Miracle". The assimilation theories emphasize innovation and learning, rather than just marshalling. (Pack & Westphal, 1986; Kim, 1997; Nelson & Pack, 1999).

The East Asian Miracle Report from the World Bank

The World Bank published in 1993 its report: "The East Asian Miracle". The report demonstrated and explained the performance of the HPAEs countries in achieving their extraordinary economic success. One of the principal conclusions from this report is that although the HPAEs did have some fundamental characteristics in common at the beginning of their development, it is questionable to talk about a single Asian model. In

this report from the World Bank, it identifies six factors that explain the East Asian economic success:

1. Macro-economic stability, low inflation and competitive rates of exchange;
2. Building human capital;
3. Effective and secure financial systems;
4. Limiting price distortions;
5. Absorption of foreign technology, and
6. Limiting the bias against agriculture.

From Imitation to Innovation.

From 1960s to 1970s, the rapid industrialization in East Asia was based on reverse engineering of existing foreign technologies, these processes do not require specialized investment in R&D. Trial and error and try-again learning processes were necessary to achieve satisfactory results (Kim & Nelson, 2000).

After gaining experience and mastering the foreign technologies, the HPAEs moved to the next stage of industrialization characterized by skilled-labor intensive industries. (Graph-2). During the 1980s and the 1990s, East Asian countries moved up to skilled labor and technology intensive industries, "they intensified the diffusion of technologies and the rapid improvements in process and product technologies and increasingly relied on their own design and engineering capabilities as well as on R&D efforts" (Cardoza, 1999).

Overview of National Innovation Systems of the HPAEs.

The high-performing Asian economies have different characteristics even when they are geographically close. Thus, their national innovation systems are diverse as well. However, there are some common features across these countries such as the existence of a policy document or a section in a broader development vision, accentuating the role of innovation. (European Trend Chart on Innovation, 2004).

- .**China.** Over the last two decades, China has totally transformed its economy by establishing a market-oriented model. The Chinese economy has achieved an amazing growth rate, almost double-digit growth (World Bank, 2004). In fact it is considered that China has made the largest single contribution to global poverty reduction in the last 20 years. The Chinese transformation has improved the dynamism of its rural and urban economies.

Chinese innovation capacity, even when initially was very low, is growing very fast: the government has increased its efforts to advance in R&D and innovation. However, according with the Global competitiveness report, Chinese NIS seems to be weak: its linkages are poor, there are many actors for research and some for innovation but they

do not interact with each other. China still depends on foreign supply of advanced industrial technologies and this can lead China to a very risky position if domestic technological capability is not developed. (European Trend Chart on Innovation, 2004).

- **Indonesia.** The World Bank (2004) considers that Indonesia achieved an outstanding economic development until the Asian economic crisis, it considered this economy to be among the best performing East Asian economies. Indonesia grew at a rate of 7.1 % between 1985 and 1995.

Indonesia experiences technological dependency on developed countries. The government decided to industrialize the country because it was considered the fastest way to stimulate economic growth. Noteworthy, the government currently is trying to change the country's dependence on technology from developed countries by developing national science and technology. The principal actor in Indonesia's system is the Ministry of Research and Technology (RISTEK).

- **Japan** is considered one of the most advanced countries in the world in terms of R&D inputs and outputs (European trend chart of innovation, 2004). It is economically well-developed and from 1960 to 1990 the country experienced a spectacular growth. The productive sector plays a dominant role in innovation and one of the major drivers of Japanese competitiveness is its innovation policy, which is characterized by its long term scope. Government intervention for the promotion of innovation and technology transfer is a constant characteristic of the Japanese system.

The Japanese innovation system is characterized by its dense infrastructure and a strong cooperation between government and industries. However, Small and Medium Enterprises (SMEs) were less integrated to the system. As a response to this disconnection, the government started a process of transformation towards a policy where SMEs are considered as the source of entrepreneurship and innovation (The SME Basic Law in 1999) (Motohashi, 2002).

- **Korea.** In 2003 the Korean economy performed lower than most of the regional economies, the country's GDP grew by only 3.1 % (World Bank, 2004). This situation was primarily provoked by a series of negative shocks such as the serious of household debt problems and persistent weakness in domestic demand. It is expected that this year the Korean economy would grow around 5.3%.

Korea started formulating science and technology policies in the late 60's, with the creation of the Korea Institute of Science and Technology and the Ministry of Science and Technology (MOST) (European Trend Chart on Innovation, 2004). The Korean innovation system was first based on a catch-up model and on a strategy oriented to technological widening rather than deepening. This may explain to some degree the Korean low innovative capacity index.

At present, Korea has increased its R&D efforts and its private sector has taken up these efforts from the government. The present development model intends to raise the national R&D capacity to the level of G-8 countries and to strengthen strategic technologies and regional innovation clusters (European Trend Chart on Innovation, 2004).

- **Malaysia** has sustained a rapid economic growth during the last 30 years (World Bank, 2004). The country has also been successful in limiting high poverty rates and reducing income inequalities. As a result of the Malaysians' strong commitment to growth, this economy has achieved a more equitable distribution of wealth and has created a conflict-free environment even tough the presence of numerous ethnic groups within the country.

The Malaysian government is now putting more effort in improving the innovative process in the country. In 2003 the National Innovation Center, under the Ministry of Science, Technology and Innovation, was established with the aim of expanding the economic and social returns by commercializing Intellectual Property derived from R&D in Malaysia. (MOSTE, 2004).

- **Singapore.** Recently, Singapore has had to adapt to additional challenges after the 1997 Asian financial crisis, such as the global economic slowdown in 2001, the outbreak of Severe Acute Respiratory Syndrome (SARS) among others. During 2002 and 2003 Singapore's economy grew very slow, though 2004 offers a better scenario. Singapore's engines for growth are manufacturing and services sectors, and the country is largely reliable in other economies.

Nevertheless, Singapore is a high developed country with a successful free-market economy, a notable open and corruption-free environment, stable prices and one with the highest per capita GDPs in the world. (European Trend Chart on Innovation, 2004). Currently, the government in Singapore orients its efforts to new knowledge-driven clusters and promotes the vision of an "intelligent island". Also, the government has

increased R&D expenditures and encourages the creation of the Singapore Science Park in order to enhance the country's capability for technological production (European Trend Chart on Innovation, 2004).

- **Taiwan.** During the last decade the Taiwanese economy was one of the strongest economies in East Asia with a 8% average growth of GDP. Unfortunately, since 1998 Taiwan has been suffering a slow down growth. The Taiwanese economy is highly dependable on other economies, almost 50 % of its GDP derived directly or indirectly from exports (European Trend Chart on Innovation, 2004)

Taiwan faces a challenge for further growth: its limited innovation capabilities. The government recognizes this situation and its trying to address this problem with a massive intervention. The country has a successful cluster innovation environment but fails in innovation linkages. The Taiwanese system is characterized by a traditional government intervention

- **Thailand** has changed its economic structure from an agriculture-based economy to an economy based on the industrial sector, particularly manufacturing. The percentage of the agriculture sector in GDP has reduced from almost 40% in the 1960s to approximately 10% in the late 1990s (ADB, 2004).

According with the National Science and Technology Development Agency (NSTDA), private firms, government and universities have the main roles in shaping Thailand's NIS. In 2000, a study done by the World Bank concludes that only a small minority of large subsidiaries of Transnational Corporations, large domestic firms and SMEs have resources for R&D, while the majority of the firms in Thailand are struggling with increasing their design and engineering capability.

Thai government actions and policies regarding S&T development are characterized by: 1) No coherent and articulated innovation policies; 2) Policies to promote industrial technology development are not given high priority and virtually not incorporated in industrial, trade, and investment policies; 3) Unlike in other HPAEs, there have been virtually no selective industrial policies to promote targeted industries/clusters and no reciprocity for state subsidies; 4) Government has focused its efforts on carrying out technology development activities (mostly R&D) for industry by public institutions rather than supporting technological development within industrial firms; and 5) There is an obvious imbalance between S&T organizations and economic organizations related to technology development (Intarakumnerd,, et. al., 2000).

The Chilean National Innovation System

Chile has experienced a considerable economic growth in recent decades using policies such as attracting foreign capital, privatizing state-owned companies and committing to trade liberalization (open economy). Chileans also opted for political stability through regulatory transparency and high levels of human capital (education) to improve their welfare. However, the major competitive weakness of the country today is its relative lack of ability to innovate and adopt technological change. (Vial and Cornelius, 2001).Therefore, even with Chile's economic achievements, the country faces a challenge for developing science & technology.

Overview of the Economic Performance of Chile.

The economic performance of Chile has been exceptional in Latin American in recent years (Inter- American Development Bank, 2001). During the 1990's the average annual rate of GDP growth was 6.5% (World Bank, 2004) and the inflation was reduced to its lowest level in 50 years reducing to 2.5% in 2002 (World Bank, 2004). During the 1990's Chile decreased its poverty level from 38.6% (1990) to 17% (2003) (World Bank, 2004).

In the late 1980's structural reforms were carried out in Chile and they were consolidated in the 1990's, these reforms made possible the subsequently growth and stability of the Chilean economy. The introduction of an exchange rate regime and open economic policy were the key features of this trend.

A policy of unilateral liberalization has been followed by Chile. Currently the country has a total non-discriminatory foreign investment regime and an efficient system of custom tariffs (a single rate of 6% in 2003). However this policy of integration has not barred Chile from negotiating preferential trade agreements with some countries. Chile has agreements with Canada (1997) and U.S. (2003) among other countries and is member of MERCOSUR as well as participant of the APEC Forum (Chilean Ministry of Economy, 2004).

The structure of the Chilean economy is not following the tendency of the developed economies. (Table-1). Agriculture is still a very high percentage of the Chilean GDP and it increases steadily; the level of the industrial sector is maintained primarily by the mining industry (Copper) and manufacturing shows a trend towards losing importance on the industrial sector.

One of the most competitive sectors of the Chilean economy is agriculture. The world recognizes fruit and wine products from Chile as being very successful in international markets. This is an indication of the capacity of the Chilean producers in using new technology in the production processes. In fact, the strengths in Chilean applied research lie in agriculture, forestry and fisheries (Mullin et. al., 2000).

In Chile, the services sector is quite modern and competitive, and it accounts for more than the 50% of the Chilean GDP. Communications and transportation industries are more technology-intensive than many manufacturing industries. The progress of the Telecommunications sector in Chile has been remarkable, in less than 10 years this sector has provided modern, fast and efficient means of communication. Chile shows an impressive technological advance as user of technology, although the country is not a *producer* of technology (World Bank, 2000).

Overview of the Political Performance of Chile.

During the 20th Century Chile benefited from a stable political system that to some extent is possible to consider as an essential democratic system, although the radical break in Chilean political institutions in 1973 by the Pinochet's coup against the government of Allende.

Chile is considered a latecomer in terms of democratization (Bertelsmann Foundation, 2004) since it became the last country in Latin America to return to democracy (except Cuba), which makes a disparity with the fact that the country has been a pioneer in open-market economy.

Over the past years Chile has gone on making progress towards democracy, as the Pinochet's inherited institutions lose power and become weaker. However, military's autonomy and the institution of designated senators are still present in the Chilean system. One of the most successful achievements of democracy in Chile, is in the area of humans rights where violations have decreased drastically since the end of the dictatorship period, the Judicial system is now stronger and more consolidated. Also the system of checks and balances among the different branches of government (executive, parliament and judiciary) has been improved by a reform in the Supreme Court. Constitutional consensus is still missing, even though the efficiency of the government is fairly high and stability is maintained.

The current president of Chile, Mr. Ricardo Lagos, was elected in January 2000. President Lagos is a socialist, a moderate one with a social-democratic orientation. He is the first socialist since Allende in occupying the presidency of Chile. Despite the

economic crisis faced by Chile in 1998-1999, the country was able to continue its political and economic transformation in a remarkable way. President Lagos has done a good job considering that he suffered the consequences of the externally-induced economic crisis. However, some tasks in the areas of political participation and securing the social and long-term sustainability of Chile's economic development are pending to be addressed.

Chilean innovation performance.

Science and technology have played an important role in the Chilean governmental plans and programs since the 1990s: in 2000, when Mr. Ricardo Lagos accepted the Chilean presidency, he assured that the budget for Scientific and Technological Research would be increased from 0.6% to 1% of the GDP. So far, efforts from the public and private sector are being made to attain this goal. The budget for Science, Technology and Innovation in the 2001 was of approx. US$ 500,000 Millions (CONYCIT, 2004).

However, the Chilean innovation performance is not first-rated and it lies behind the East Asian economies (HPAEs) which have used policies in R&D for increasing their economic sectors and understood R&D importance. On the other hand, Chile is currently trying to catch up with this trend by the creation of new policies and programs such as "Gobierno en Marcha".

Chile has accomplished good results in areas such as: mathematics, materials science, physics, oceanography, cell biology, and biotechnology, and has created and consolidated centers of excellence employing multidisciplinary researchers to investigate around these areas.

Most of the scientific research in Chile is done by universities, followed by the governmental institutions (primarily pubic research institutes). Noteworthy, is the new trend in Chilean industries to support more scientific and technological activities during the last years. Industries are financing research and creating their own laboratories and institutions.

Innovation governance systems.

The Chilean innovation system is generally directed by governmental institutions, which deal with scientific research, technological development, innovation process and technology transfer at different stages. Though, the main problem with the Chilean innovation system is that the government does not seem to have a strong and

coordinated policy for the development of national S&T capacity and resource allocation (Mullin et. al., 2000)

The Chilean National Council for Science and Technology (CONICYT) and the Presidential Advisory Commission on Scientific Matters are the principal government institutions responsible for the development of S&T policies and grants distribution (Holm-Nielsen and Agapitova, 2002).

CONICYT defines and implements the national science policy. Also this council is "designed to advise the President of the Republic on the planning of scientific and technological development." (Chilean Decree, 1971).

The Presidential Advisory Commission on Scientific Matters is a counseling bureau, responsible of some activities on the national science agenda; this bureau does not deal with engineering and technology and has limited resources for its functions, resulting in a restricted ability to develop and commission policy studies (Holm-Nielsen and Agapitova, 2002).

Other actor of the Chilean NIS is the Ministry of Economics, which is in charge of the innovation and development policy and works closed with CONICYT as well as collaborates with other governmental agencies and private corporations in various innovative programs (CONICYT, 2004).

"Fundacion Chile" is an important actor in the Chilean innovation system. This organization is a private, non-profit institution, created by the government of Chile and ITT Corporation (U.S.) in 1976. Its activities included: increasing the competitiveness of human resources in Chile, increasing the competitiveness of Chilean production and service sectors, promoting and developing high impact innovations, technology transfer and management. "Fundacion Chile" plays a major role: creating technology businesses through strategic alliance and facilitating the innovation linkage with local universities and institutions, national enterprises and research institutes and foreign technology-based companies.

"Fundacion Chile" wants to be recognized as the leading technology institution in Chile. It has participated in projects outside of Chile: Denmark, El Salvador, Venezuela, Colombia, Trinidad & Tobago, Ecuador, Brazil, Sao Tome & Principe, Peru, Uruguay, Indonesia, Mozambique, Bolivia, Argentina, Mexico, Guatemala, England, Costa Rica, Egypt, Panama and New Zealand. Its most frequent international clients are privately

owned companies in the agriculture, forestry and aquaculture sectors; local, regional or national public agencies and International institutions (Fundacion Chile, 2004).

Numerous conflicts of interest between the Chilean institutions involved in research financing have emerged due to the weak government policy framework and inconsistency of organizational structure. Also, the lack of a strong agency in charge of S&T policies in the Chilean innovation system has resulted in an intricate decision-making system in the matter of science, technology and innovation (Mullin et. al. 2000)

Innovation policy making and delivery structure.

Chile, as some of the East Asian countries, has a long history of government intervention to promote innovation and technology. This country has achieved a considerable technological development within its region by constant government initiatives to establish a systematic S&T policy. Since the 1990s the Chilean government has implemented different programs and plans in the area of S&T: "Science and Technology Program" (1992-1995), "Technological Innovation Program" (1996-2000) and "Chile Innova" (2001-2005).

In general, Chilean S&T policies are characterized for not giving protection or privilege to any specific sector: the Chilean government has mainly focused on broad science policies and less on technology policies, leaving the innovation process without much attention.

However, more recently the Chilean government has put more consideration into technological development to improve its competitiveness and has implemented a variety of programs such as: The Science and Technology program (BID-I); The Technology Innovation Program; The production promotion program (SERCOTEC), and Millennium Science Initiative Project.

The CONICYT acts as the coordinating entity that works jointly with the other institutions and agencies, to promote and strengthen scientific and technological research. Also, it is in charge of the training of human resources, the development of new areas of knowledge and productive innovation, by administrating at the national level the allocation of public resources to S&T.

Innovation Networks

The Chilean government has strengthened the capacity of the country for research and promoted publication as means of disseminating research. Nevertheless, the innovation process is still disconnected form the use of knowledge due to academic interests and narrow disciplinary approaches to research (Mullin et. al., 2000). In addition, the little coordination among research performers aggravates the problem of linkages on the Chilean innovation system.

Although most of the scientific research in Chile is done by the academic sector, a sense of competition between universities and technological institutes exists. This situation is the result of the vague way of public financing of research activities: these academic institutions see each other as competitors rather than partners. (Holm-Nielsen and Agapitova, 2002).

The collaboration between the private sector and research organizations in Chile is still limited, noteworthy that the Chilean industries have been more participative during the last years in the process of innovation and R&D.

Currently, some universities are starting to open offices to assist researchers with the process of technology transfer (commercialization, negotiation with potential clients, etc.). This initiative has had some positive result such as an increment of firms benefited by innovation from universities and public research institutes. However, most firms in Chile still report that the principal source of new ideas is their own personnel (Melo, 2001).

The Chilean government has placed a lot of emphasis on generating knowledge but none at all on its diffusion (Holm-Nielsen and Agapitova, 2002), and the Chilean innovation system fails particularly in supporting SME.

Chilean expenditure on Science, Technology and Innovation.

More resources have been allocated to the generation and diffusion of knowledge in Chile. A part of these resources is used in innovation (R&D) and other important part is used in design, marketing, training and financial and organizational change of the process of innovation (Graph-3)

From 1990-1999 the Chilean government contributed for over 75% of the national R&D expenditure of this period. (Graph - 4), foreign investors also contributed to R&D in Chile with approximately 7% during the 1990s. Noteworthy, the Foreign investment in Chilean

R&D expenditures is the highest in Latin America and some authors attributed it to the favorable environment created by the government of Chile (RICyT, 2000)

In Chile, the private sector is identified as not been strongly involved in funding R&D. Mullin et. al. (2000) concluded that this phenomenon could be due to either: " the lack of integration of Chilean science into an overall innovation framework, and/or the dependence of the economy on the export of raw materials".

Until 1990, the private sector saw scientific development as a state's responsibility and its contribution in the R&D expenditure was extremely restricted (Holm-Nielsen and Agapitova, 2002).

The Costa Rican National Innovation System

Overview of the economic performance of Costa Rica.

During the last 20 years Costa Rica has experienced an uneven economic growth of around 4.7% annual average GDP, representing a significant progress to the Country even when in some years Costa Rica suffered economic crisis. In 2000-2001 Costa Rican economy went through a decline due to the world recession; however in the last year, Cost Rica grew at a healthy 5.6% GDP and it has a high living standard compared with its Central American neighbors, with a per capita income of about U.S. $4,200, and an unemployment rate of 6.7% (U.S. Department of State, 2004).

The public sector's debt of Costa Rica has increased significantly over the past five years. In 2003 it reached 55% of GDP and borrowing rose sharply as the government took advantage of favorable market conditions to pre-finance some of its 2004 needs. Reliance on short-term debt and the use of foreign-currency debt in the domestic market are characteristics of the Costa Rican economy. (International Monetary Fund, 2004).

Competitiveness needs to be strengthened in Costa Rica. Even when the level of the real exchange rate appears adequate, high relative unit labor costs and a decline in Costa Rica's market share suggests that external competitiveness should be reinforced. This is a very important issue for Costa Rica given the implementation of CAFTA, the growing competition from East Asia and the expiration of the Multi-Fiber Arrangement in 2005 (International Monetary Fund, 2004)

Costa Rican government enhances an open economy approach and in early 2004 reached a free-trade agreement with the United States and other Central American countries (CAFTA). With this agreement Costa Rica will combine the benefits that enjoyed under the Caribbean Basin Initiative and include a gradual removal of state monopolies in telecommunication and insurance. Costa Rica also concluded a free-trade agreement with the Caribbean countries (CARICOM) in 2004 (International Monetary Fund, 2004).

Overview of the political performance of Costa Rica

Political stability has characterized Costa Rica for a long time due to its governmental system that operates principally by agreement. Costa Rican system is based on a democratic tradition with a history of consultation and consensus-building. Democracy in Costa Rica is also the source of tremendous pride that brags about having more

teachers than policemen and not having a standing army since 1948 (Government of Costa Rica, 2004).

Costa Rica is placed near of the top in the governance indicators, which is a clear demonstration of its democratic values. For Voice and Accountability, a measure of the extent of citizen participation in government, Costa Rica is first among its region. Second place in absence of corruption and in effective government occupied the third place. Costa Rica, Chile and Uruguay are tied in first place for public trust in state institutions. However the voters abstention rate in Costa Rica has rose significantly in the last two presidential elections (18.9% in 1994, 30% in 1998 and 31.2% in 2002) (Kaufmann, et. al., 2002) (Inter-American Development Bank, 2003).

In May 2002 a new administration headed by Abel Pacheco de la Espriella took the executive office. President Pacheco remains popular after 2 years in office, his term expires in May 2006; however the government does not have a majority in congress, which results in a lot of negotiation to pass any legislation. The legislative branch is unicameral: Legislative Assembly (57 seats); members are elected by direct popular vote to serve four-year terms.

Costa Rican innovation performance.

Costa Rica decided to focus its policy on three industry clusters: information technology, environmental sciences and applied technology for the agricultural and forestry sectors. Therefore the government has developed a consistent approach around these three clusters with the purpose of having a stronger competitive advantage.

Today you can see the economic benefits of the Costa Rican approach: besides the Intel Plant, there is a considerable number of local software companies in Costa Rica and the country is recognized globally as a leader in environmental issues and eco-tourism. Also Costa Rica has highly respected research centers like the ITCR and the Tropical Agricultural Center for Research and Higher Education (CATIE), which have a very productive relationship with local industry.

Costa Rica's innovation linkage index, 4.5 (World Economic Forum, 2004) in 2003, is ranked in third place within Latin America and the Caribbean region, just after Chile and Brazil. In its region's context this is a very good perspective, however compared with East Asian countries Costa Rica is below most of them. For instance Thailand, which is considered as a country with starting innovation policies within its region, is ranked 45 in innovation linkage and Costa Rica is 46 (World Economic Forum, 2004). The Costa

Rican government is not surprised with its low innovation linkage index because they correlate this index with their null number of patents and with their low R&D expenditure.

Innovation governance systems.

Costa Rican government has been fully committed to the process of developing science and technology. It has shown a strong cooperation with the private sector, specially with big industries (Intel, Procter & Gamble) to enhance the development of S&T in the country. This approach is very similar to the one followed by Japan, although the Costa Rican system is less complex and dense. Today the Costa Rican government is putting more stress in integrating SMEs to the NIS, this situation is due to the necessity of the country to create an internal market.

For instance, the fact that the Costa Rican government was eager and prepared to invest in training (education) to meet Intel's skill needs, and following Singapore's approach, went further and involved Intel Human Resources staff in designing the training and infrastructure programs (Spar, 1997), shows an example of government's dedication to increase the level of science and technology in the country.

Innovation policy making and delivery structure.

The Ministry of Science and Technology (MICIT) is responsible for implement the S& T policies in Costa Rica. Currently, MICIT is running the National Program of Science and Technology (2002 - 2006), which aims to promote the development of researchers and human capital in diverse science fields. Also this national program seeks to attract foreign investment to increase the Costa Rican R&D expenditures.

MICIT works in collaboration with other agencies such as the National Science Academy, Productive Regional Center (CEFOF), National Council of Regents, National Council for the Scientific and Technological Research (CONICIT) and The National Center of Technology.

Innovation Networks.

Despite its low cluster innovation environment index, Costa Rica has developed a well recognized network of associations, universities and research centers around environmental sciences.

Public and Private sectors work together trying to improve Costa Rica's international position on this field, like the Costa Rican Institute of Technology (ITCR): one of the most influential research centers in the country. In the last ten years has created 10 big

research centers, with modern infrastructure and qualified researchers in fields that are supported for the development of the country (ITCR, 2004). Also, the Tropical Agricultural Center for Research and Higher Education (CATIE), is a unique regional non-profit institute devoted to research, graduate education, training and public services in America, with emphasis on Central America and the Caribbean. The Institute has three main goals: Research, Higher Education and Outreach. With approximately 500 employees and a total budget of 20 million dollars per year, it is one of the most important centers of specialization in agriculture and natural resources in the world (CATIE, 2004).

Some of the members of the Costa Rican network around environmental sciences are: Earth Council, Foundation Neotropica, National Institute of Biodiversity (INBIO), Organization of Tropical Studies (OET), The World Conservation Union (UICN), Minister of Environment and Energy and EARTH University.

The participation of non-governmental organizations in the process of innovation has been very significant in Costa Rica. The Costa Rican Investment Board (CINDE) promotes foreign investment in the country: it is a private, apolitical, non-profit organization founded in 1982 and declared of public interest by the Costa Rican government in 1984 (Costa Rican Investment Board, 2004). Even when its role is not predominantly within the innovation process, CINDE has enhanced the development of science and technology in Costa Rica by attracting companies like Intel, Roche and Baxter. CINDE is internationally recognized as an excellent advocator of Costa Rica and it works as a public relations office outside of the country.

The linkage between research centers in the Costa Rican Universities and the private sectors is very weak. The time that these centers dedicate to activities related with technology transfer is: 6.3% of their time to innovation, 11.7% R&D and 2.1% to commercialization (Ministry of Science and Technology, 2004). In the other hand the success of association between some governmental programs and the private sector is remarkable (CITA, CEFOF and CEGESTI).

Brief history of the governmental institutions of S&T in Costa Rica.

In general terms, the scientific movement has not been systematic in Costa Rica over the years. At the end of the XIX century and beginning of the XX century Costa Rica experienced scientific activity due to a significant number of foreign scientists that immigrated to this country.

Around 1950's some Costa Rican scientists did important discoveries and contributions to science, these activities were sporadic. But it was not until the 1970s when for the first time in the history of Costa Rica, a formal institution to coordinate Scientific and Technologic activities emerged: The National Council for the Scientific and Technological Research (CONICIT).

As a result of the formation of the CONICIT more collaboration and organization among scientists in different areas started. The University of Costa Rica created an office in charge of R&D. Labs, research centers and groups of researchers were formed as well.

Two major institutions were created in Costa Rica in the 1970s: The Costa Rican Institute of Technology (1971) and The National University of Costa Rica (1973), with the aim of participating in the creation of science and technology.

The Minister of Science and Technology (MICIT) was formed in the 1980s in concurrence with a project to create a law to promote the scientific and technological development in Costa Rica. This law was enacted in June,1990.
Unfortunately during the 1990's the national system of science and technology had ups and downs. In 1992, the national academy of science was created (Executive Order); during this decade MICIT's functions and responsibilities were taken by other ministers and MICIT started to lose control. However MICIT is now fully in control of the scientific and technologic activities in Costa Rica and has it own counsel.

Costa Rican and Chilean National Innovation Systems and High-Performing East Asian Economies' National Innovation Systems. Cross-Case Analysis

Why East Asian countries are growing faster than Latin American countries?. This question has been approached by several researchers. Theories trying to explain this situation have been developed using different approaches, for instance some theories try to explain the "East Asian Miracle" in contrast with Latin America's slow growth by using cultural factors; other theories take political systems as the factor that explains the success of East Asia. Nevertheless, there is not yet a general agreement about what theory may answer the initial question.

Through this paper, the theory that has been explored is the one based on technology application and innovation process as economic strategies, to explain the different economic development in East Asia and Latin America regions. The concept of National Innovation Systems (NIS) was used to describe the different scenarios in the HPAEs and in Costa Rica and Chile. Now, a cross-case analysis of the NIS of these economies will be presented trying to identify differences and similarities that facilitate explaining the economic growth of these regions.

Regional Economic Performance.

It is very clear that in aggregate East Asian Countries have done better than LAC countries; however is important to mention that Costa Rica and Malaysia had the same % of GDP growth in 2003 and that their Average GDP per capita have been very close during all the periods analyzed (Table-3). Both countries receive a considerable amount of foreign investment and both countries have high levels of exports.

Also it is worthy to point out that Taiwan and Chile had 3.3% of GDP growth in 2003, but the average GDP per capita of Malaysia was 3 times more than the Chilean average GDP per capita for the periods analyzed.

Percentage of expenditures in R&D.

The amount of financial resources that are allocated to S&T activities and to R&D, partially reflects the country's commitment to become a "knowledge society" (Velho, 2004). The LAC countries spend a very low percentage of their GDP in R&D: basically only one of them, Brazil, invests more than 1% of its GDP while Countries in East Asia spend up to 3.2% of GDP in R&D. (Tables 4 & 5).

Costa Rica and Chile invest a very low percentage in R&D of their GDPs compared with most East Asian countries, the country that is closer to their expenditure on R&D is Malaysia.

The Chilean government has an explicit policy to increase its percentage of GDP in R&D expenditures to 1%; however Costa Rica does not have clear how much and how it would increase its R&D expenditure. The Costa Rican government vaguely addresses the issue of its low expenditure on R&D and the necessity to increase it.

Expenditure by financing sector.

Chile shows a trend of a major participation of the government in financing R&D, nevertheless the private sector has been significantly involved in R&D investment. In 2002 the R&D expenditures in Chile came from the Government (68.9%), Enterprises (24.9%), Non-profit organizations (2.1%) and Foreign organizations (4.1%).

The Government of Costa Rica provides about 65% of the total investment in R&D, 25% comes from private sector and 10% from international organizations. In small industrialized countries 50-60% of R&D expenditures are financed by private sectors (Government of Costa Rica, 2004). Costa Rica and Chile could learn from Korea because this country not only increased its R&D expenditure in the 1990's but also shifted from a mainly government's funding to a private sector financing.

Singapore and Taiwan, even when they have been increasing their R&D expenditure, the government is still their principal source of investment.

Human Resources: Researchers.

There is a general consent within the literature that in LAC countries exist a shortage of researchers capable of performing high quality research. In 2000, they were approx 240,000 in the region(RICYT, 2000), which is equivalent to 0.89 researchers for every 1,000 economically active people(RICYT, 2000). (Table - 6)

China, Malaysia, Chile and Costa Rica have a very close number of researchers per 1,000 employees. However, their places within the regions are quite different: while Chile and Costa Rica are above the average for LAC countries, China and Malaysia fall behind of their region averages (4.2).

The ranks of Costa Rica and Chile are not a surprise since their governments have highly invested in education and implemented programs and policies to improve the level and quality of education.

S&T Policy trends.

In practically all of the HPAEs exist an explicit policy document or a section in a broader economic development plan, accentuating the role of innovation. In comparison, Costa Rica has a explicit policy document, where the importance of innovation for the economic development of the country is stressed; this policy is well written and covers areas such as human capital development, competition, attraction of foreign investment, improvement of collaboration between universities and firms (SMEs).

However, in the case of Chile there are many policies addressing the role of innovation and consequently, there is a need for a more coherent policy framework, that allows governmental agencies to collaborate in an integrated approach.

The level of specification and sophistication of S&T policies in HPAEs is much higher than in the two Latin American countries presented.

The government role.

In HPAEs as well as in Costa Rica and Chile, government intervention is a characteristic of their NIS. However, the role of government is different among these economies.

In Costa Rica the government plays a role of "partner" of big-companies and develops policies around the necessities of the market (policies to attract foreign investment to Costa Rica). While, in Chile, the government tries to promote the creation of technology within the country by allocating resources to national projects, putting in place the necessary infrastructure for innovation, helping the private sector to develop technology, etc. In sum, the government is very proactive in trying to develop technology.

The government role in the HPAEs has been different. For instance in Japan the government tries to maintain the country's competitiveness and currently is reforming its policies and programs to improve the country's efficiency. In Taiwan the government tries to upgrade the technological capabilities of the country by using promotion instruments such as tax incentives. The case of Singapore is peculiar because the government is putting its effort to create an image of an "intelligent island" by developing indigenous science and technology capabilities.

Innovation Performance Overview – SWOT analysis.

From Strengths, Weaknesses, Opportunities and Threats analysis we can conclude that one of the weaknesses that almost all countries have is the weak or low university-industry linkages. (Tables 7 and 8). Also, it is important to highlight the fact that in some HPAEs political instability is a weakness, while in both Latin American countries political stability is a strength.

The majority of the countries analyzed are dependent on the world trade and economy, thus all of them need to work in building stronger domestic markets. Something that is very interesting is the fact that HPAEs are threaten by each other: for instance in the case of Japan the emerging of neighbor economies is an opportunity as well as a threat.

The structure of analyzed national innovation systems.

In Latin American countries the governmental agencies in charge of technology and innovation are rarely at the ministry level. In general, these agencies are under the command of the Ministry of Education or Economy, like is the case of Chile where the CONICYT is under the Ministry of Education. But very unusual is the case of Costa Rica because the country has a Ministry of Science and Technology as the agency in charge of the S&T policy in the country.

HPAEs mostly have Ministries in charge of technology and innovation, and their systems are somehow more organized than in Costa Rica and Chile. The number of actors involved in the innovation systems in HPAEs are much larger than the number of actors involved in Costa Rica and Chile.

Conclusions and Recommendations

The two Latin American countries analyzed in this paper are examples of the trend on National Innovation Systems that is currently going on in Latin America and the Caribbean region. Over the last decade, the innovation systems of these two countries have drastically evolved and even when they are still undergoing changes, they are internationally recognized as potential producers of technology and innovation.

It is clear now, that in the past the Latin American and the Caribbean countries had very different innovation systems' structures, if it can be said that they had some at all, than today. These countries basically did nothing to enhance innovation and technology within their countries. Using import substitution policies, Latin America closed its door to international trade and let national industries to exploit the markets without competitors. These policies created in Latin America a lack of entrepreneurship culture and lack of innovative capacities.

Although new policies based on open markets and democratic institutions succeeded to create a favorable scenario for economic development in Chile and Costa Rica, their scientific and technological progress has not been as good as their economic performance. In these two economies the national innovation systems remain disconnected from their economies, which indicates that Chile and Costa Rica like most countries in this region have a lot of work to do with their National Innovation Systems.

Comparing Costa Rica and Chile with some Asian countries (HPAEs), it is obvious that the Latin American and the Caribbean countries are behind of HPAEs in innovative capacities and in development of their NIS. However, some countries like Malaysia, and Thailand are optimistic examples to Latin America that even latecomers (these two countries started to develop their S&T policies and innovative capacities later than most of HPAEs) can have a technological success taking advantages of this latecomer position.

Costa Rica and Chile have taken remarkable steps and some of the findings about the current status of their innovation systems are:

- Costa Rica has made a tremendous effort to developed a national innovation system, and it is receiving now some of the benefits associated with the creation of a NIS. However, the country still has many steps head to achieve its goal of being a technology-based economy.

- Chile is considered a potential technology leader in Latin America, but the lack of organization and coherence in its S&T policy framework keeps the country from a continuous development of its innovative capabilities.

- Costa Rica has some research centers internationally recognized, however the linkage between these centers and the country's economy is missing. Costa Rica is failing in translating the knowledge produced in its research centers into economic growth. The governments in Chile and Costa Rica are not investing sufficient in R&D and in other innovative activities. Also, the private sector in both countries is not participating in R&D expenditures.

- The small number of innovation activities in Chile and Costa Rica seem to be caused by the low value recognized to innovation by the population of these two economies, their private sectors and until recently, by their governments.

- The small and medium enterprises (SMEs) do not have innovative capacity and are not connected with universities or research centers to access to licensable technologies.

The challenge today for Costa Rica and Chile is: whether they are going to be able to continue increasing their innovative capabilities?.

Costa Rica and Chile would need a new policy framework focused on innovation, in which the government takes an active role in supporting the private sector for developing and deploying new technologies, and also supporting universities and research centers in developing technologies that match with the characteristics of the market. Some policies addressing these issues are proposed:

1. Search for the best practices and tailor them to the country's characteristics. There is no need to experiment in what are the best practices for innovation and technology development. Costa Rica and Chile can go out and search for policies and programs that had worked in other countries. However, it is very important that the policies and programs that Costa Rica and Chile may take from other economies be tailored to each country's characteristics and necessities.

2. Start where other countries are now, there is no need to develop technologies from the beginning. What the HPAEs countries did in the past was obtaining technologies from developed countries and imitated them (reverse engineering).

3. In order to create technology is necessary to master previous technologies. Then, Costa Rica and Chile need to improve their human capital resources by training and educating them with the newly knowledge and technologies available.

4. A stronger S&T policy framework and an agency in charge of its implementation is necessary to be technologically successful. Both countries need to address this problem immediately, especially Chile.

5. Venture capital markets and entrepreneurial culture are key factors to increase the innovative activities in any country.

6. An increase in government expenditure on R&D. The role of government expenditure on R&D is fundamental for the development of technology in any country. In the case of HPAEs their governments invested high percentages of their GDP on R&D to foster technology and innovation and now most of them are changing to high private sector investments on R&D.

Why East Asian countries are growing faster than Latin American countries?. There may be more than one answer to this question. But, what can be concluded from this paper is that the science and technology policy-decisions that East Asian countries did after World War II shaped the economic future of these countries.

Can Latin American countries change their innovation paths and follow East Asian countries?. It would rely on the policy approach that each country takes toward the development of its national innovation system. Not all East Asian countries started at the same time to develop their innovative capacities, currently some countries in this region are considered catch-up models, and still they are very successful.

Latin American countries are still suffering the effects of the import-substitution policies adopted by their governments in the past. However, they need to move up and shift to technology-based economies, because even when the majority of the countries in Latin America are now open to international trade this may not be sufficient to grow if they do not have the ability to compete.

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Appendix

Box-1
Definitions of National Innovation Systems

"The network of institutions in the public- and private-sectors whose activities and interactions initiate, import, modify and diffuse new technologies" (Freeman, 1987)

"The elements and relationships which interact in the production, diffusion and use of new, and economically useful knowledge... and are either located within or rooted inside the borders of a nation state" (Lundvall, 1992)

"The set of institutions whose interactions determine the innovative performance of national firms" (Nelson and Rosenberg, 1993)

"The national system of innovation is constituted by the institutions and economic structures affecting the rate and direction of technological change in the society" (Edquist and Lundvall, 1993)

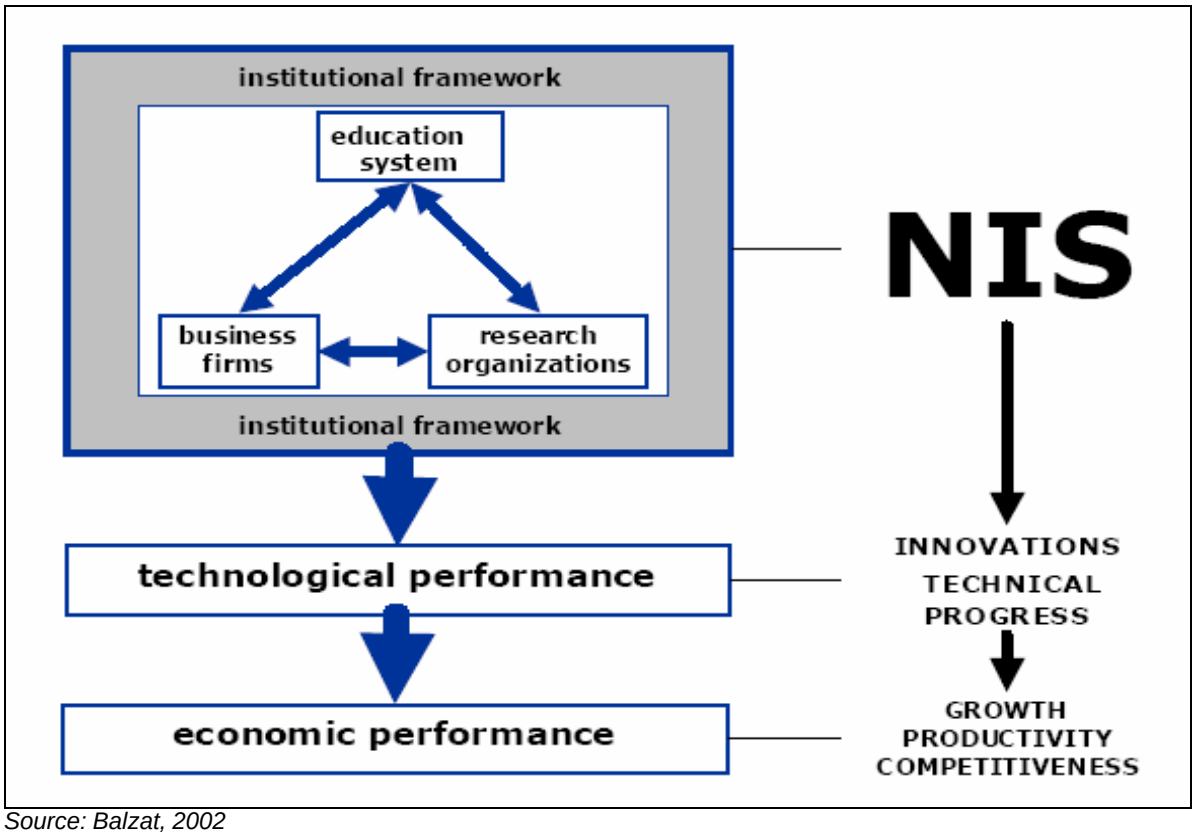
"A national system of innovation is the system of interacting private and public firms (either large or small), universities, and government agencies aiming at the production of science and technology within national borders. Interaction among these units may be technical, commercial, legal, social, and financial, in as much as the goal of the interaction is the development, protection, financing or regulation of new science and technology" (Niosi et al., 1993)

"The national institutions, their incentive structures and their competencies, that determine the rate and direction of technological learning (or the volume and composition of change generating activities) in a country" (Patel and Pavitt, 1994)

"That set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provides the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artifacts which define new technologies" (Metcalfe, 1995)

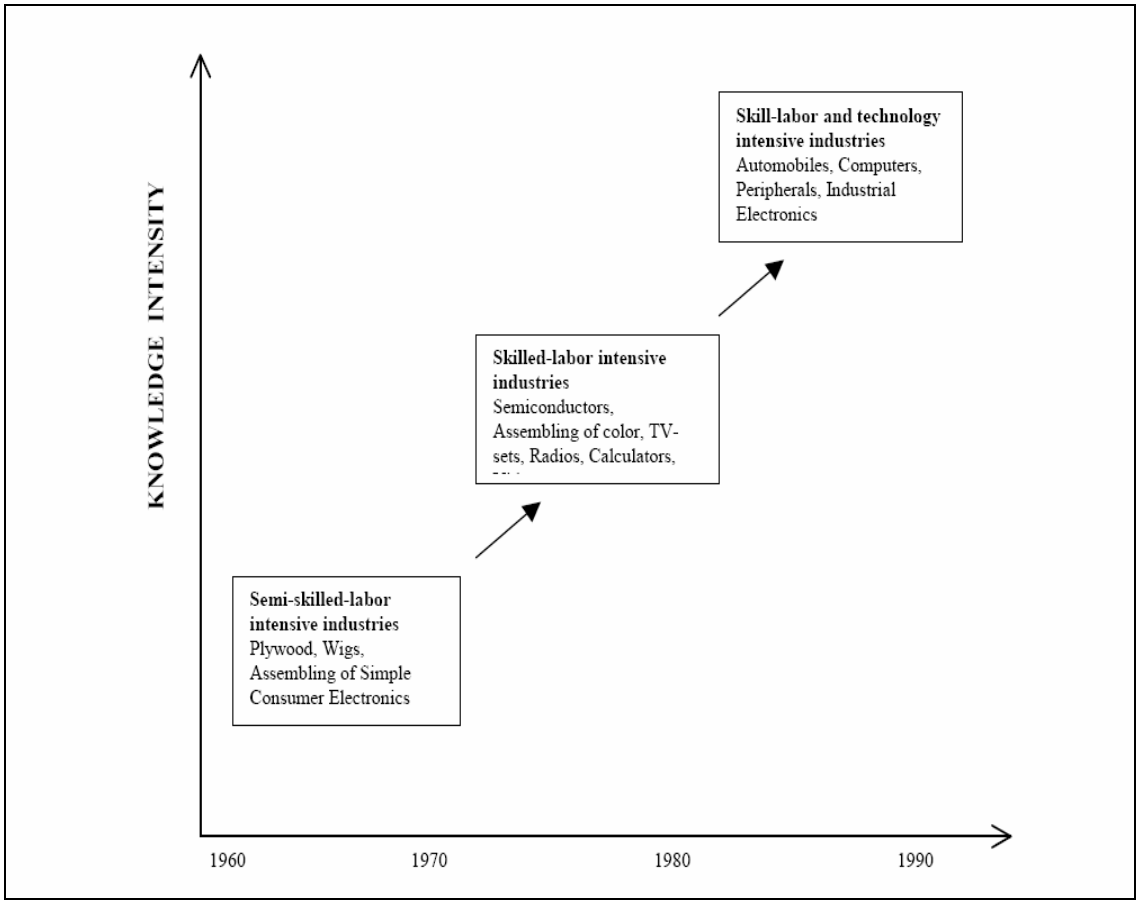
Source: Niosi, 2002

Graph-1. The significance of a national innovation system for economic success.



Source: Balzat, 2002

Graph-2. Technological Trajectory in East Asia



Source: Cardoza, 1999.

Table-1. Chilean economic structure as percentage of GDP

Sector	1980	1990	1999	2000
Agriculture	7.3	8.7	11.6	11.4
Industry	37.4	41.5	36.8	37.5
Manufacturing	21.5	19.6	17.4	17.4
Services	55.3	49.8	51.7	51.0

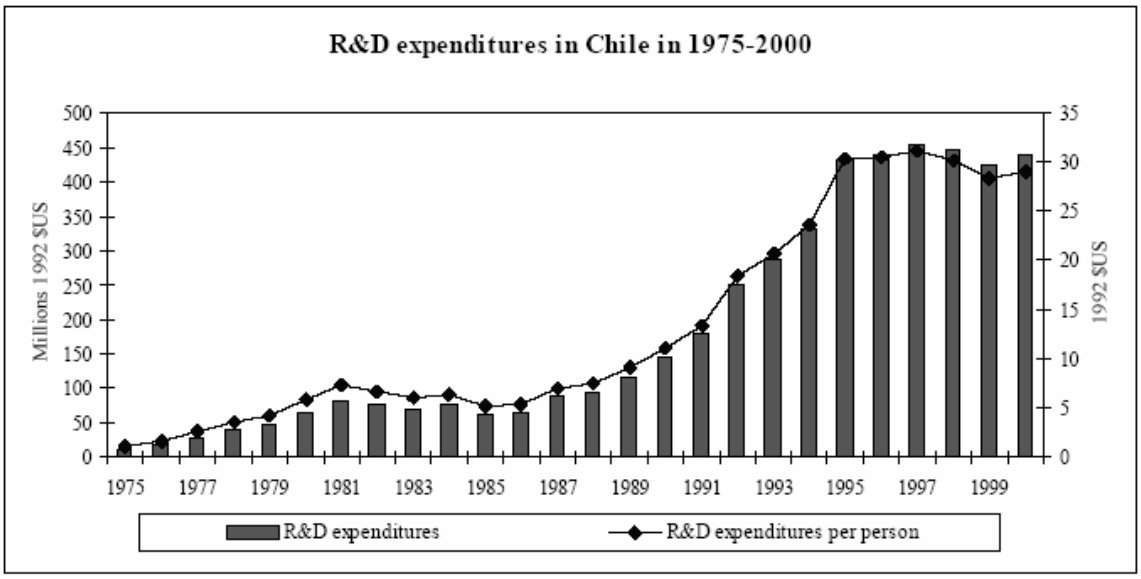
Source: World Bank and OECD.

Table-2. Structure of the Chilean Manufacturing Sector – 2000

Sector	Contribution in total manufacturing (%)
Low-technology Industries	**56.09**
Food Products	30.4
Textiles, Leather and Footwear	9.8
Wood Products	4.8
Paper, Printing and Publishing	11.0
Medium-low-technology Industries	**26.4**
Metals	6.7
Petrochemicals	10.9
Non-Metallic Mineral Products	3.6
Fabricated Metal Products and Other Manufacturing	5.2
Knowledge-based Industries	**17.6**
Chemicals	12.0
Machinery and Transport Equipment	5.4
Professional & scientific equipment	0.2
Total Manufacturing	**100.0**

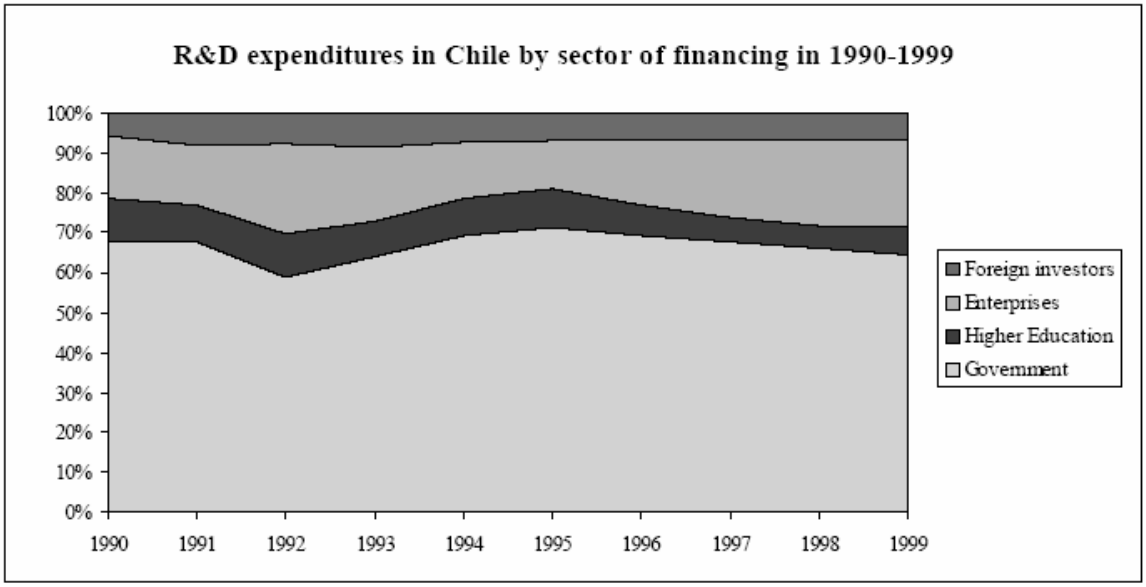
Source: National Institute of Statistics (2000)

Graph – 3. R&D expenditures in Chile



Source: National Institute of Statistics (2004)

Graph - 4. R&D expenditures in Chile by sector of financing.



Source: Holm-Nielsen and Agapitova, 2002.

Table – 3. GDP: growth and average in East Asian and
Latin America and the Caribbean countries.

Country	GDP Growth (annual %)				Average GDP per capita (current US$)		
	2000	2001	2002	2003	1990-1994	1995-1999	2000-2003
East Asian Countries							
China	8	7.5	8.3	9.1	412	704	963
India	5.4	3.9	5	7.2	335	412	482
Indonesia	4.9	3.5	3.7	4.1	774	882	786
Japan	2.8	0.4	-0.3	2.5	31,307	35,995	33,771
Korea	8.5	3.8	7	3.1	7,768	10,394	11,294
Malaysia	8.9	0.3	4.1	5.3	3,078	4,084	3,885
Singapore	9.7	-1.9	2.2	1.1	16,143	23,524	21,638
Taiwan	5.9	-2.2	3.6	3.3	9,797	12,792	12,863
Thailand	4.8	2.1	5.4	6.8	1,926	2,435	2,007
Latin America and Caribeean Countries							
Argentina	-0.8	-4.4	-10.9	8.8	6,285	7,877	5,216
Brazil	4.4	1.3	1.9	-0.2	2,874	4,465	3,036
Chile	4.5	3.4	2.2	3.3	3,288	5,241	4,569
Colombia	2.9	1.4	1.6	3.7	1,643	2,404	1,878
Costa Rica	1.8	1	2.9	5.6	2,578	3,594	4,118
Mexico	6.6	-0.2	0.8	1.3	4,072	4,079	6,192
Uruguay	-1.4	-3.4	-11	2.5	4,196	6,446	4,612
Venezuela	3.7	3.4	-8.9	-7.6	2,741	3,817	4,327

Source: International Monetary Fund (2004)

Table – 4. High-performing Asian Economies

Country	*GERD/ GDP 2002 (%) **
China	1.3
India	0.8
Indonesia	0.05
Japan	3.2
Korea	2.7
Malaysia	0.4
Singapore	2.2
Taiwan	2.2
Thailand	0.3

National Sources or IMD Yearbook

* or more recent year available

Table – 5. Latin American and The Caribbean Countries

Country	*Exp R&D/ GDP* **2002 (%) ***
Argentina	0.39
Brazil	1.04
Chile	0.57
Colombia	0.10
Costa Rica	0.39
Mexico	0.40
Uruguay	0.22

Source: RICYT.

* or more recent year available

Table – 6. HPAEs & LAC: number of researchers.

Country	Researchers FTE per 1,000 empl. 2002*
China	1.1
India	0.8
Indonesia	0.5
Japan	13.6
Korea	4.9
Malaysia	1.5
Singapore	8.3
Taiwan	6.4
Thailand	0.4
Chile	1.2
Costa Rica	1.5

* or more recent year available

Table – 7. Innovation Performance Overview – SWOT analysis.

Country	Strengths	Weakness
China	• Spectacular Economic Growth. • Increasing R&D inputs. • Improving Human capital resources.	• Low initial position. • High share of traditional agricultural production. • Regional disparities.
Indonesia	• Market size. • Natural resources. • A shy start of emphasis on innovation-based dev. policies.	• Political instability. • Lack of infrastructure. • Weak university-industry linkages.
Japan	• Highly performing R&D infrastructure. • Sufficient resources for innovation. • Strong SME base	• Weakly performing economy in the last year. • Problems of corporate government in the kereitsu system. • Weak university-industry links
Korea	• High economic growth. • Increasing R&D support. • Well designed long term innovation policy.	• Flexibility of education system. • Governance of large enterprises. • Regional imbalances.
Malaysia	• Rapid economic growth. • Inward investment. • Infrastructure in electronics production and applications.	• Low initial position. • Low R&D capabilities. • Weak university-industry linkages.
Singapore	• Corruption free-environment. • High quality of institutional set up. • Good macroeconomic performance	• Low efficiency of locally controlled companies.
Taiwan	• Good innovation governance. • High level of patents in USPO. • Innovative core of SMEs.	• Political instability. • Low university-industry interaction. • Lack of well-established large companies.
Thailand	• Recent development. • Tourist economy.	• Lack of infrastructure. • Lack of innovation infrastructure.
Chile	• Recent economic growth. Natural resources. • Improving human capital resources. • Recent, political stability.	• Low R&D investment. • Lack of well-established innovation governance. • SMEs have low capability for innovative activities.
Costa Rica	• Highly qualified human capital. • Political Stability. • Transparency in government • Good education system.	• Low R&D investment. • Weak university-industry linkages. • Technological dependence.

Source: HPAEs data from European Trend Chart on Innovation (2004). Latin American countries own source.

Table – 8. Innovation Performance Overview – SWOT analysis.

Country	Opportunities	Threats
China	• New entrepreneurial class. • Broader economic cooperation	• Dependence on world trade increase. • Emerging neighbor economies.
Indonesia	• Growth within the region.	• Emerging neighbor economies.
Japan	• FDI and innovation collaboration with emerging "giant" economies in its region. • University, laboratories and other liberalizing reforms.	• Increasing international competition. • Aging population. • Challenges from the emerging economies in the region.
Korea	• Political commitment to R&D and innovation. • Overall growth in the region. • Cooperation and potential reunification with North Korea	• Competition from China and India. • Globalization pressures.
Malaysia	• Growth in the region. • International cooperation	• Emerging neighbor economies. • Dependence on world economy.
Singapore	• Increasing foreign direct investment. • Increasing international cooperation.	• Catching-up from neighbor economies. • Dependence of world economy.
Taiwan	• Access to new markets. • New innovation policy and shift of development model. • A future good cooperation model with China.	• Export-led model • Catching-up from neighbor economies. • Potential conflict with China.
Thailand	• Growth in the region. • Opening up of its economy.	• Emerging neighbor countries.
Chile	• International cooperation.	• Potential political problems in neighbor economies.
Costa Rica	• New trade agreement with U.S. • Increasing foreign investment.	• Dependence on world economy • Export-led model.

Source: HPAEs data from European Trend Chart on Innovation (2004). Latin American countries own source.