UNIVERSIDADE FEDERAL DO RIO DE JANEIRO – UFRJ

INSTITUTO DE ECONOMIA - IE

PROGRAMA DE PÓS-GRADUAÇÃO EM POLÍTICAS PÚBLICAS, ESTRATÉGIAS E DESENVOLVIMENTO - PPED

ELBA CRISTINA LIMA REGO

HOW TECHNOLOGICAL CATCHING UP MATTERS TO ECONOMIC DEVELOPMENT TODAY

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Tese de Doutorado apresentada ao Instituto de Economia da Universidade do Rio de Janeiro como parte dos requisitos necessários para a obtenção do grau de Doutor em Ciências, em Políticas Públicas, Estratégias e Desenvolvimento.

Orientadora: Professora Ana Célia Castro

Co-orientador: Professor Mario Possas

Rio de Janeiro

2014

Rego, Elba Cristina Lima
R343 How technological catching up matters to economic development today / Elba Cristina Lima Rego ; Orientadora: Ana Célia Castro ; Co-orientador: Mario Possas – Rio de Janeiro, 2014.
166 p.

Tese de doutorado -- (Instituto de Economia, Universidade Federal do Rio de Janeiro, 2014).

1. Inovações tecnológicas - Tese. 2. Inovação - Tese. 3. Desenvolvimento econômico - Tese 4. Catch up - Tese 5. Catching up - Tese I. Castro, Ana Célia (Orient.) II. Possas, Mario (Co-

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Tese submetida ao Programa de Pós-Graduação em Políticas Públicas, Estratégias e Desenvolvimento – PPED, como parte dos requisitos necessários para a obtenção do grau de Doutor em Políticas Públicas, Instituições e Desenvolvimento.

Tese aprovada em 25/11/2014

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To
My parents, Maria and Evandro,
With all my love

Para
Meus pais, Maria e Evandro,
Com todo meu amor

ACKNOWLEDGMENTS

Rabbi Nilton Bonder says that there are long-short and short-long paths to reach a destination, noting that long paths may lead us faster to our goal than apparent short paths. The route that I took to accomplish my doctoral project, however, is inserted in another category: a long-long path. My long hike through winding and labyrinthine paths had many setbacks and new beginnings. In many moments, reaching the destination seemed an unattainable goal, like a mirage in the desert. While on this journey, or during the layovers, the learning was vast. Some lessons have already fulfilled their role, but others became durable, precious tacit knowledge.

At the end of my journey to the completion of my doctoral project, I want to express my gratitude especially to:

My supervisors Ana Celia Castro and Mario Possas, who provided me a valuable overall guidance and specific recommendations. They were the compasses that not only pointed north, but, as a modern GPS, showed me how to reach it. They read my texts cautiously, separating the chaff from the wheat and thus making room for new ideas. Working together in a complementary way, they gave me the exact measurement of the difference that makes for real supervision. I am also grateful to Ana Célia – to whom I greatly admire by the unique ability to conceive, organize and make projects come true – for having persistently contributed for and with solutions in critical moments along the way.

My friends Lee Pegler, Professor of the International Institute of Social Studies, at the Hague, The Netherlands, and Geraldo Biasoto, Professor of the Institute of Economics of the UNICAMP, Campinas, who made useful comments and suggestions. Biasoto helped me at the last minute to finally decide where to put a rambling discussion of key importance to the dissertation, the place of which had changed a number of times.

Professor Luc Soete, Rector of Maastricht University in The Netherlands, who some years ago put me in contact with many authors and texts that provided the theoretical background for this work. I also thank him for making my participation possible in two courses on technological and innovation issues organized by the

European DIMETIC Doctoral Summer School. The first one in 2005 at MERIT (now UNU-MERIT - The United Nations University – Maastricht Economic and Social Research Institute on Innovation and Technology) at Maastricht; and the second in 2006 at the University Louis Pasteur, in Strasbourg, France. My regards also go to my professors (many of them in my bibliographic references) and colleagues.

Professors and fellows at PPED, as well as to Professor Renata La Rovere, the Program's coordinator, for all her understanding and support.

My dear friend Selmo Aronovich, managing-deputy director of the Financial Division of the Brazilian Development Bank (BNDES), whom I much admire and appreciate. Much thanks for supporting my leave from my activities at BNDES to I finally conclude this work and for allowing me to do so within the office. Most of all, I thank him for the lasting friendship, which I greatly value, and for being a reference of effectiveness and integrity both at work and in personal relationships.

Leonor Chaves, who has actively listened, supported and encouraged me, especially in times when encouragement was needed.

Julia Granato, my sister-friend, whose friendship and uplifting presence in my life, both in moments of joy and difficulty, I great appreciate.

My dear fellows from the Dharma Group, especially Joana, Fabiane, Vidal, Claudia, Eliane, Daniela, Ruy, Debora, Fernanda, Rui and Mariana, who refresh me and bring joy to my spirit in our wonderful weekly and other meetings.

Geraldo, Felipe and Patricia, from the Taizé-Rio Group and also my dear fellows in a contemplative journey that invigorates and strengthens me. I extend my thanks to Brothers Bruno, Cristovão and Rodolfo the Community of Taizé-Alagoinhas, for the loving support and amazing example of selfless service.

Ricky Toledano, who promptly and efficiently reviewed this dissertation and made its text clearer and more fluid, work that was much appreciate.

Colleagues at the BNDES's Financial Division – Letícia, Ricardo, Sabrina, Luciana, Paula and Andréa – whose proximity and background noise in my surroundings allowed me to keep my sense of belonging (and sanity) during my lonely work in the last months. Also a special thanks to Letícia França and George

Ramos, who helped in the last minute to format the final text and comply with other requirements.

My grandmothers Honória and Francelina, strong and remarkable women, who showed me the importance of education since the very beginning.

My uncle Antonio, who instigated and fed my intellectual curiosity also in my early ages.

My siblings, Evandro, Eduardo, Eliana and Daniela, and my nephew Rodrigo, whose love and partnership makes all difference in my life.

My daughter Brenda, my dearest, who has given countless opportunities to remodel and improve myself on daily basis. Many times, she disputed and won over my time with this study, but she allowed me to work harder on the weekends leading to the last stretch, even if reluctantly, and for which I am very grateful.

My mom, Maria Cardoso, and my dad, Evandro, paramount reference of uprightness and perseverance in my life, and whose unconditional love still sustain me. For them I direct my greatest gratitude with all my love.

“No past experience, however rich, and no historical research, however thorough, can save the living generation the creative task of finding their own answers and shaping their own future”.

Alexander Gerschenkron

ABSTRACT

REGO, Elba Cristina Lima. **How Technological Catching up Matters Economic to Development Today.** 166 p. Rio de Janeiro, 2014. PhD/Doctoral Dissertation (Public Policies, Strategy and Development Doctoral Program). Instituto de Economia, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil.

The present dissertation, which approaches development as a catching up issue, analyzes the critical role of technological change and innovations for the developing countries willing to narrow or close their gap with the most advanced economies. In this study, catching up is defined as a process in which a developing country narrows its technological gap in some key sectors, using the leading countries as a model but also innovating, with significant increases in productivity, growth rates and income, which results in a narrowing of its economic gap. The dissertation´s main arguments are that technological change and innovations have become not only a prerequisite to catch up in broad sense, but the very essence of catch up today, which increasingly relies on the ability of countries behind the technological frontiers to build up scientific and technological capabilities to absorb new technologies and innovate locally. The dissertation is organized in an introduction, three chapters and concluding remarks. The first and more conceptual chapter revisits theoretical and empirical contributions grounded in the catching-up approach. Although focusing on technological aspects, the chapter also calls attention to other critical elements to catch up, such as institutions, state intervention and finance. The second chapter discusses the catching-up experiences of Japan and East Asian, especially those of Korea and Taiwan. The third chapter analyses changing conditions in the international scenario associated with the emergence of the WTO and the resurgence of China as major international player, which put challenges but also open new opportunities behind the technological and economic frontier.

Key words: catching up, catch up, technological change, innovation, economic development

RESUMO

REGO, Elba Cristina Lima. **How Technological Catching up Matters to Economic Development Today.** 166 p. Rio de Janeiro, 2014. Tese de Doutorado. (Doutorado em Ciências, em Políticas Públicas, Instituições e Desenvolvimento). Instituto de Economia, Universidade Federal do Rio de Janeiro. Brasil

A presente tese, que aborda o desenvolvimento como uma questão de *catching up*, analisa o papel crítico das mudanças tecnológicas e das inovações para os países em desenvolvimento que desejam reduzir ou fechar o seu *gap* tecnológico e econômico com relação às economias mais avançadas. Neste estudo, *catching up* é definido como um processo no qual um país em desenvolvimento reduz o seu gap tecnológico em alguns setores chave, usando os países líderes como modelo e também inovando, com aumentos significativos de produtividade, taxas de crescimento e renda, que resultam em redução de seu gap econômico. Os principais argumentos da tese são de que a mudança tecnológica (i.e, a introdução de novas tecnologias) e a inovação tornaram-se não apenas um pré-requisito, mas a própria essência do *catching up*, que depende cada vez mais da capacidade dos países atrás das fronteiras tecnológica e econômica desenvolverem competências científicas e tecnológicas para adaptar e adotar novas tecnologias, e inovar localmente. A tese possui uma introdução, três capítulos e conclusão. O primeiro capítulo, revisita contribuições teóricas e empíricas fundamentadas na abordagem do *catching up*. Embora priorize os aspectos tecnológicos e a inovação, o capítulo também chama a atenção para outros elementos críticos para o *catching up*, como as instituições, a intervenção do Estado e o financiamento. O segundo capítulo analisa as experiências de *catching up* do Japão e do Leste Asiático, especialmente as da Coréia e de Taiwan. O terceiro capítulo examina as mudanças no cenário internacional associadas à emergência da Organização Mundial do Comércio (OMC) e ao ressurgimento da China como grande *player* internacional, que colocam desafios, mas também sinalizam novas oportunidades para países atrás das fronteiras tecnológica e econômica que querem fazer o *catching up*.

Palavras-chave: *catching up, catch up,* technological change, innovation, economic development, mudança tecnológica, inovação

Acronyms and Abbreviations

IT Information Technologies

ICT Information and Communication Technologies

USSR Union of Soviet Socialist Republics

BRICS countries Brazil, Russia, India, China and South Africa

CPC Communist Party of China

ECLA United Nations Economic Commission for Latin America

EU European Union

FDI Foreign Direct Investment

GATT General Agreement on Investment

GDP Gross Domestic Product

IMF International Monetary Fund

IPR intellectual property rights

MCN Multinational Corporation

NIS National Innovation System

R&D Research and Development

S&T Science and Technology

SCM WTO's Agreement on Subsidy and Countervailing Measures

SOEs State owned enterprises

TRIPS WTO's Agreement Trade Related Intellectual Property Rights

UN United Nations

US United States

MITI Ministry for Trade and Industry (Japan)

MOST Ministry of Science and Technology (CHINA)

WTO World Trade Organization

UNIDO United Nations Industrial Development Organization

OECD Organisation for Economic Co-operation and Development

UK United Kingdom

WW II World War II

CAF Development Bank of Latin America (originally Corporación Andina de Fomento)

IDFC International Development Financial Club

KfW German Development Bank

JDB Japan Development Bank JDB

HCI Heavy and Chemical Industry Plan (Korea)

NIEs Newly Industrialized Economies

NSC National Science Council (Taiwan)

ITRI Industrial Technology Research (Taiwan)

ERSO Electronics Research and Services Organization

KIET Korea Institute for Electronic Technology

OEM Original Equipment Manufacturers

SMEs Small and Medium Enterprises

HIV Human Immunodeficiency Virus

AIDS Acquired Immunodeficiency Syndrome

TVEs Township-Village Enterprises TVEs

SASAC State-owned Assets Supervision and Administration Commission (China)

CO_2 Carbon Dioxide

SUMMARY

INTRODUCTION

Why have some nations succeeded in attaining high levels of economic and human development while others, despite all development strategies already adopted, still continue very far from the socio-economic frontier? What explains the differences among countries and regions in terms of wealth, productivity and welfare? What are the key elements for developing economies to succeed in catching-up with the more advanced economies today?

Since the early days of economics as a separate field of study, a huge amount of literature has addressed these questions, explaining the origin of nation's wealth and how progress can be attained. Over time, different approaches have proposed many interpretations and prescribed a plenty of policies for countries to succeed, often conflicting with one another. In fact, socio-economic progress is a multidimensional issue, contingent upon a myriad of changing factors, such as capital accumulation, knowledge, technology, institutions, culture, politics, behavior, values and conditions in the international arena. Thus it comes as no surprise that economists and other experts have different ideas about what development is about and how it can be achieved.

According to Irma Adelman (1998)[1], shifts in theories about underdevelopment and policy prescriptions to attain economic progress are dependent on many elements, such as learning; changes in ideology, international environment and domestic institutions; emergence of constraints and new aspirations; technological breakthroughs and how the culture of Economics evolves. The greater availability and better quality of data on development and growth make it possible to check the validity of some propositions with a certain degree of accuracy, as well as the formulation of new approaches with a higher degree of adherence to the reality. The emergence of new ideologies usually implies the reformulation of old theories and policy prescriptions in accordance with the values of the elite in power. Technological breakthroughs and institutional innovations solve old problems and put new challenges; close old roads and give birth to new opportunities. Structural socio-

[1] Adelman, Irma (2001) – Fallacies in Development Theory and Their Implications for Policy. In G.M. Meier and J.E. Stiglitz (editors), *Frontiers of Development Economics*, World Bank and Oxford University Press, pp. 103-134.

economic shifts associated to the development process itself demand new institutions, change the nature of constraints that a country has to face and forge new social aspirations. Yet the principles that structure the rhetoric of Economics also affect how the determinants of change are integrated into theories and models (Adelman, 1998).

Despite all interpretations, recommendations and changes along the way, most countries are still doing badly in terms of progress and well-being. The prosperity gap between nations is widening[2] and even the more advanced ones have to strive harder not to get worse off. In addition, drastic changes in political, technological, financial, regulatory and competition conditions in the international scenario have rendered some development strategies, which worked quite well in the past, ineffective or prohibited; thus, new development instruments are necessary. These new circumstances helps to explain the renewed interest in development studies and why questions concerning how socio-economic progress can be accomplished, how countries significantly behind the technological and economic frontier can catch up, and even what the critical factors are today for countries that are behind the technological and economic catch up with the more advanced economies remain crucial and should be addressed more than ever.

Just as it was in the past, there is still neither an easy nor a general answer to these questions that fits all countries. The current developing and least developed nations are very heterogeneous in terms of population, size, economic and social structure, geography and capabilities. Many of them pursued development strategies after World War II, but they were unable to sustain a consistent growth trajectory that enabled them to narrow their economic gap with advanced countries, or at least to reduce poverty and inequalities substantially. Some countries have already reached a diversified and complex economic structure while many others have a limited division of labor and are specialized in activities with diminishing returns (Reinert, 2005).

[2] According to Landes (1998), in about 250 years, the difference in income per capita between richest the poorest countries increased from roughly 5:1 to 400:1.

Nelson *et al*. (2005)[3] point out that any attempt to answer the questions above - "how can countries that are significantly behind the technological and economic frontier catch up?" and "what are nowadays the critical factors to catch up?" - involves studying the past, analyzing the present and looking into the future. Looking backward is as crucial as looking forward (Winters and Yusuf, 2007), which means not only seeing what those that succeeded in reaching the socio-economic frontiers did, but also learning from the mistakes of countries that did not succeed or only did so partially. Analyzing the present involves taking into account the changing conditions in the international economic arena and looking at what countries that seem to be on their way to catching-up, such as China, are doing. Looking into the future includes prospecting trends and examining emergent elements.

That said, the objective of this study, which approaches development as a catching-up issue associated with technological change and innovation, is to examine the critical elements for developing economies to narrow their gap with the more advanced economies by addressing the following inquiries:

1) How can we revisit the catching-up approach in light of the knowledge economy and the experiences of countries that have succeeded in narrowing their gap with the more advanced economies in the last decades?

2) What seem to be the critical factors for catching-up today and what is the role of knowledge and technological catching-up in attaining a higher level of development?

3) What can countries behind the economic and technological frontier still learn from the experience of economies that succeeded in forging ahead (especially Asian economies) or are on their way to do so (case of China), through the lens of the catching up approach?

[3] NELSON, R. *at al* (2005) – A Program of Study of the Process Involved in Technological and economic Catch up. Draft.

Dissertation Structure

This thesis comprises the present introduction, three chapters and a conclusion.

1) The first chapter revisits theoretical and empirical contributions grounded in the catching-up approach, focusing on technological aspects, but also to other critical elements to catch up
2) The second chapter discusses the catching-up experiences of Japan, Korea and Taiwan (East Asia) through the lens of the review done in the first chapter and other empirical studies.
3) The third chapter analyses changing conditions in the international scenario associated with the emergence of the WTO and the resurgence of China as major international player. Emphasis is given to the rules protecting intellectual property rights and to some aspects of China's ongoing catch-up that have challenged established consensus about development and catching-up, as well as indicated new possibilities for countries willing to catch up.
4) Conclusion

I - DEVELOPMENT AS A CATCHING UP ISSUE

The main goal of this first and conceptual chapter is to review some theoretical and empirical contributions of the tradition that approaches development as a catching up issue, associated with technological change and innovations. Since the late 1990s, this tradition has been reinvigorated by studies emphasizing that countries behind the technological and economic frontier need to develop inner capabilities to innovate in order to catch up with the more advanced economies and occasionally forge ahead.

The chapter starts by overviewing influential propositions and policy prescriptions of classical development economics and market-friendly theories on development, with the purpose of making a clear difference between the catching-up approach and other perspectives about growth and development. This overview will be useful to the discussion on concrete experiences of catching-up held in the second chapter. Afterwards, Gerschenkron's and Abramovitz's contributions are discussed, as well as new-Schumpeterian studies, examining concepts such as functional substitutes (Gerschenkron, 1962[4]), social capabilities and technological congruence (Abramovitz, 1986[5], 1989[6] and 1994[7]; Abramovitz and David, 1995), windows of opportunity (originally by Perez and Soete, 1988[8]), technological capabilities and national innovation systems (originally by Freeman, 1974; diffused by Lundvall, 1992 Nelson, 1993[9], and then by many others). The selected studies combine both theory and historical evidence, raising useful elements to the understanding of the catching-up processes in different contexts.

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[4] Gerschenkron, Alexander (1962) – *Economic Backwardness in Historical Perspective*, Harvard University Press.

[5] Abramovitz, Moses (1986). Catching-Up, Forging Ahead, and Falling Behind. Journal of Economic History, vol. 46, no2, p.385-406.

[6] Abramovitz, Moses (1989) – Thinking About Growth. In Thinking About Growth and other Chapters on Economic Growth and Welfare. Cambridge, England: Cambridge University Press.

[7] Abramovitz, Moses (1994) - The Origins of the PostwarPost-war Catch-up and Convergence Boom; In J. Fagerberg, B. Verspagen and N. von Tunzelmann (editors), The Dynamics of Trade, Technology and Growth. Aldershot: Edward Elgar.

[8] Perez, C. and Soete, L. (1988), 'Catching up in technology: entry barriers and windows of opportunity', in G. Dosi, C. Freeman, R.R. Nelson, G. Silverberg and L. Soete (eds), *Technical Change and Economic Theory*, London: Pinter, pp. 458-479.

[9] NELSON, R. (ed.) (1993), *National Innovation Systems. A Comparative Analysis*, Oxford University Press, New York/Oxford.

1.1. The Classical Development Economics

Prosperity was the main concern of Economics until the late 19th century, when Marginalist/Neoclassical theories focusing on resource allocation gained popularity. Neoclassical growth theories emerged in the early 20th century, proposing single equations to explain the growth performance of all countries. The exogenous neoclassical growth models (*e.g.* Solow's model), associated with these theories, predicted that growth rates and income per capita would converge among countries, since the tendency of diminishing returns on capital and the consequential fall in the rate of return on investment would lead investors to move from advanced to backward countries. In other words, the exogenous neoclassical growth models forecasted that "under otherwise similar circumstances, investment in poor countries (that is, those with little capital) would be more profitable than in the richer ones, and so the former would enjoy higher investment and faster economic growth than the latter" (UNIDO, 2005[10], p. 9). Besides the hypothesis of diminishing returns, this result relied on two other assumptions: the exogenous character of technological change and the equal access to the same set of technological knowledge by all countries (UNIDO, 2005).

Economic prosperity came back to the stage during the Great Depression in the 1930s, but it was only after the Keynesian revolution and World War II that development in a broader sense really appeared as an attractive and separated field of Economics. This resurgence occurred thanks to the socio-economic challenges faced by many countries and the resulting priority conferred to economic progress by their governments. On the one hand, Europe and Japan faced the challenge of reconstructing what was destroyed by the war, which demanded a huge coordination of decisions and it was something that could not be expected from markets. On the other hand, governments in the newly-independent nations that emerged after the post-1945 decolonization of Asia and Africa, and also in the already independent Latin American countries, were called upon to modernize their traditional (and primarily agricultural) societies through industrialization and urbanization, both

[10] UNIDO (2005) - *Industrial Development Report 2005, Capability building for catching-up: Historical, empirical and policy dimensions*. United Nations, Vienna.

considered pre-conditions for increasing productivity and income per capita (Fine, 2006[11]). In the post-war period, former colonies were on their own, facing great challenges and in need of policy advice on development.

As a new branch of economics, Development Economics had many background influences, such as the Keynesian revolution, the Soviet planning experience, national economic policies during the Great Depression, planning practice during the wartime and the Marshall Plan for recovery of Western Europe and Japan after the war (Meier and Dudley, 1984[12]). Meier and Dudley (1984) point out that the Keynesian revolution had a strong influence on development economics, for raising alternative arguments to orthodox economics and conferring a larger role to the public sector. In doing so, Keynesianism paved the way for unconventional approaches to economic problems and provided a case for discretionary national economic actions to promote capital accumulation and industrialization through planning (Meier and Dudley, 1984). Unlike the neoclassical approach, the so-called "Classical" Development Economics acknowledged that both underdevelopment and development had multiple causations and tried to understand the peculiarities of backward or underdeveloped countries[13] in Asia, Latin America and Africa, as well as to understand under which conditions economic growth could be generated.

According to Meier (2001)[14], the first generation of development economists "was visionary and dedicated to grand theories and general strategies."[15] They attempted to shed light on the understanding of the differences among countries in terms of growth rates and economic development, as well as to investigate ways through which underdeveloped countries could overcome poverty. Initially, the

[11] Fine, Ben (2005) – New Growth Theory: More Problem than Solution. In K.S., Jomo and Fine Ben (2005) – The New Development Economics After the Washington Consensus. Tulika Books, pp. 68-86.

[12] Meier, Gerald M. and Seers, Dudley (Ed.) (1984) Pioneers in Development, Washington, World Bank, volume 1.

[13] The peripheral economies (to use the Raúl Prebisch's terminology) were called "rude and barbarous" in the 18th century; backward in the 19th century; underdeveloped in the prewar period; laggard, less developed countries, developing economies or poor countries after WW II (Meier & Dudley, 1984). Since the 1990s, some of them have been labeled emergent economies.

[14] Meier, Gerald (2001) – The old Generation of Development Economists and the New. In Gerald Meier and Joseph Stiglitz (editors), Frontiers of Development Economics, pp. 13-50. World Bank and Oxford University Press.

[15] Among the pioneers of the classical development theory in the late 1940s and 1950s were Eugene Staley, Kurt Mandelbaum, Paul Rosenstein-Rodan, Ragnar Nurske, Arthur Lewis, Raul Prebisch and Albert Hirschman.

pioneers of economic development used to focus on growth and identify economic development with industrialization, meaning the introduction of manufacturing industries in agricultural economies. Later, their concerns about development were expanded beyond economic growth and productivity, to encompass equity, income distribution and other social issues. However, the basis of development remained - as at the beginning of economics - the generation of economic wealth, considered a synonym for progress and precondition to life improvement.

Most pioneers saw capital accumulation as the crux of economic progress (in Maurice Dobb´s terminology) and massive state planning as the key tool to surpass deficiencies of market mechanisms in reallocation of production factors in the course of industrialization processes through import substitution strategies.[16] For them, the role of the state should be to promote rapid development by coordinating and supporting private investments, as well as by investing directly in infrastructure and heavy industries.[17] This way, the state would contribute to the achievement of national objectives in terms of per capita income growth and the improvement of the population's living standards. Many development economists supported mercantilist trade policies, advocating the protection of infant industries in initial phases of import substitution industrialization, in association with selective export promotion (Adelman, 1999).

Despite the consensus, classical development economics was far from being a homogeneous body. In fact, it was marked by strong debates and controversies about "balanced growth versus unbalanced growth, industrialization versus agriculture, import substitution versus export promotion, planning versus reliance on the market price system" (Meier and Dudley, 1984, p. 22). Some development economists did not consider comprehensive planning indispensable, neither foreign aid nor huge investments in physical capital. Others paid more attention to

[16] Often development economists were enthusiastic about planning experiences in the Soviet Union during the 1930s and in the reconstruction process of Europe under auspices of the Marshall Plan, as well as with the constitution of welfare states in many European countries.

[17] For Arthur W. Lewis (1954), for instance, the structural problems of underdeveloped economies could not be overcome without strong state coordination, which assured a balanced growth of various sectors, a *sine qua non* condition to the economy as whole grow. Lewis was, along with Theodore Schultz, awarded with the Nobel Prize in Economics in 1979.

economies of scale and circular causation, whereas others, like Lewis (1954), focused on dualism (Krugman, 1995[18]).

In a work published in 1954, Arthur Lewis discussed the idea of a dual economy in a poor country by using a theoretical explanatory model to describe intrinsic problems of underdevelopment and explain patterns of growth in countries in general. Hirschman (1968)[19], conversely, believed that development could happen without dualism, but argued that industrialization should be forcefully sequential. In Hirschman´s view, the big technological gap with advanced countries would make industrialization of late-latecomers a 'tightly' staged process of import substitution, beginning with the manufacturing of final consumer goods to domestic markets and then moving on to intermediate goods and equipment through backward linkage effects (Hirschman, 1968). For Hirschman (1968), it would be possible to go into export specialization in manufactured goods only after import substitution has advanced to some degree.

There were also disagreements among development theorists over the nature of policies needed to take a country out of a low-level income or poverty trap and to enhance conditions for growth. Some authors, such as Rosenstein Rodan (1953)[20], emphasized the role of a coordinated and broad investment program. Hirschman considered that the best policy to get out the poverty trap was initially to foster a few key sectors with strong backward and forward linkages, which would push other industries through the "doorway" of profitability. Afterwards the country should invest in other sectors to correct possible disequilibria caused by investments in the target sectors and, in this manner, achieve a "balanced growth".

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[18] Krugman, Paul (1995) - *The Fall and Rise of Development Economics. In: Paul Krugman, Development, Geography, and Economic Theory*. Cambridge, MA: MIT, pp. 1-29.

[19] Hirschman, Albert (1958) - *The Strategy of Economic Development,* (New Haven, Conn.: Yale University Press).

[20] Rosenstein-Rodan, Paul (1943) - Problems of Industrialization of Eastern and South-Eastern Europe. In The Economic Journal, Vol 53, pp. 202-211.

1.1.2 United Nations and the Latin American perspective on development

The United Nations bodies and regional commissions played an important role in the understanding of underdevelopment and design of development policies. In 1951, at least two reports written by groups of experts under the United Nations sponsorship directly addressed the particularities of developing countries and examined which obstacles had to be overcome and which factors had to be provided to promote development (Meier and Dudley, 1984).[21] In these reports and other United Nations papers, it was argued that underdeveloped countries should set up planning and coordinating bodies to correct market deficiencies and build development programs. This explains why development programs, national planning bodies, and industrial development institutions soon flourished throughout the world.

The most well-known of the UN Commissions was the Economic Commission for Latin America (ECLA), established in 1948 and based in Santiago, Chile. The ECLA produced a large body of studies on Latin American economies, planning, development policies and economic integration (Meier and Dudley, 1984). The Commission, which gathered some of the best Latin-American development experts, provided new interpretations of underdevelopment, practical tools to project sectoral domestic demand and import capacity, estimates for savings and capital-output ratios, and investment criteria and input-output analyses for Latin American economies (Meier and Dudley, 1984).

In some manner, ECLA's economists answered the calls of development economists from advanced countries like Gunnar Myrdal, who instigated the new generation of economists in backward countries to create a body of thought more realistic and relevant for the problems of their countries and abandon the prescriptions of mainstream economics (Meier and Dudley, 1984). In Myrdal's words:

[21] The report *Measures for the Economic Development of Under-Developed Countries* (United Nations, 1951a) emphasized the necessity of focusing on physical capital accumulation and called attention to the existence of labor surplus in underdeveloped countries. The report *Measures for International Economic Stability* (United Nations, 1951b) proposed the adoption of specific international actions for reducing the vulnerability of underdeveloped economies to fluctuations in trade volumes and prices of primary products, stimulating flows of international capital and enhancing sound development programs. The gap between available resources and requirements in terms of investment would be closed through foreign aid.

> *In this epoch of the Great Awakening, it would be pathetic if the young economists in the underdeveloped countries got caught in the predilections of the economic thinking in the advanced countries, which are hampering the scholars there in their efforts to be rational but would be almost deadening to the intellectual strivings of those in the underdeveloped countries. I would, instead, wish them to have the courage to throw away large structures of meaningless, irrelevant, and sometimes blatantly inadequate doctrines and theoretical approaches and to start their thinking afresh from a study of their own needs and problems. (Myrdal,1957, p. 103-104, apud Meier and Dudley, 1984, p. 20)*

ECLA's development experts contended that the peculiarities of underdeveloped Latin American countries demanded a new theoretical framework to support their industrialization through import substitution. Given the structural and peripheral insertion of those countries in the world system as exporters of primary goods, their industrialization would follow different stages and produce different results.

Departing from the critique of classical comparative advantage theory, the Prebisch's hypothesis (also called Prebisch-Singer hypothesis) stated that there was a tendency for the terms of trade between the producers of primary and manufactured goods to deteriorate over time, which could be explained by the existence of structural differences between labor markets in the center and in the periphery of capitalism, as well as by the lower elasticity of demand for primary goods. Thus, the specialization in primary goods would imply a transfer of income from poor agricultural and mining economies to industrial countries (Bresser Pereira, 2000[22]) and structural external imbalances in the latter. To break this trend, it was imperative to increase productivity and foster economic growth by spurring industrialization in the Latin American countries through import substitution policies. Generally speaking, state activism should play a critical role in the planning process, enhancing a more efficient allocation of resources than that provided by markets, promoting capital accumulation, protecting infant industries and investing directly through public companies.

[22] Bresser Pereira, Luiz Carlos (2000) – *After Structuralism, a Development Alternative for Latin America.* In http//:www.bresserpereira.ecn.br.

This hypothesis of a deterioration tendency in the terms of trade was much criticized, but, according to Bresser Pereira, "the 'best' outcome that orthodox economists were able to pull off against Prebisch's thesis was that the terms of trade among developed and developing countries would have been constant in the long run" (Bresser Pereira, 2000, p. 5).

One of the most prominent ECLA economists was Celso Furtado, who made an important contribution to the design of the development strategy adopted in Brazil during the 1950s and 1960s. He saw development as a process of industrial modernization and construction of a wage-based economy. Contrary to what had happened in advanced economies, in which changes in the productive forces and consumption patterns were articulated and moved in the same direction, Furtado stated that there was an uneven assimilation of advanced technologies in underdeveloped countries, which absorbed innovation in consumption patterns without the adoption of more efficient productive processes (Furtado, 1973[23]).

In Furtado's view, development would involve changing the economic structure (by reducing external dependence and internal heterogeneity) and increasing the social homogeneity. In this sense, development could be understood as a process through which all members of society would progressively satisfy their needs for shelter, food and access to clean water, sanitation, health care, education and cultural goods (Furtado, 1992). According to Bielschowsky (1998[24]), Celso Furtado was among the ECLA intellectuals who most looked at understanding the historical context of the Latin American countries.

Over time ECLA thought evolved and became more sophisticated, taking into account the new historical circumstances, while keeping the idea that economic growth and the diffusion of technical progress would assume different characteristics from those of developed countries (Bielschowsky, 1998). Contrary to the critics of ECLA, Bielschowsky (1998) commented that the Commission placed an importance on promoting exports – and not only import substitution – since its very beginning

[23] Furtado, Celso – *O Mito do Desenvolvimento*. Rio de Janeiro, Paz e Terra, 1973.

[24] Bielschowsky, R. (1998) - *Evolución de las ideas de la CEPAL. In CEPAL. Cincuenta años de pensamiento en la Cepal* – textos seleccionados. Santiago: Cepal/Fondo

and mainly from the 1960s onwards. Indeed, the institution played an important role in two initiatives in this regard.[25]

Despite the Commission also stressing the importance of export promotion, its image is predominately associated with the prescription of planning and the protection of infant industries within the context of import substitution policies. ECLA economists certainly gave an immeasurable contribution to the understanding of the Latin American peculiarities; the design of development policies more appropriate for local reality; and technical support, planning and project building. The Commission, however, was not able to help Latin American countries to move forward and outward, and thereby take earlier advantage of the new IT technologies and industries, with production, distribution and competition patterns quite different from those of the mature industries. Many countries remained trapped in import-substitution policies and closed in their own domestic markets, adopting protective measures without setting compliance requirements or phasing out schemes to boost emerging industries. Asian economies, as we will see later, took a different route, targeting both emerging technologies and foreign markets early. They also invested massively in education.

1.2 Development as a natural result of market-friendly policies

By the late 1960s and early 1970s, the thesis of the classical development economics started to lose prestige both in the academic arena and on the political front. In fact, with the end of the post-war economic boom[26], the unsatisfactory results of many countries that pursued development strategies and macroeconomic imbalances across advanced countries contributed to radically shift the previous state-friendly picture. Doubts about the ability of strong states to promote growth

[25] The Commission took part in the creation of the Latin America Association of Free Trade (ALALC, in the Spanish and Portuguese acronym), which aimed to diversify exports of Latin America countries through intra-regional trade. It was believed that the Latin America common market would provide gains of scale, facilitating the import substitutive process (Bielschowsky, 1998). The other initiative, which produced more immediate fruits and had Prebisch as the protagonist, was the creation of United Nations Conference on Trade and Development (UNCTAD), to promote the integration of developing countries into the world economy.

[26] Post-war economic boom ends in the early 1970s with the collapse of the Bretton Woods System, international oil shocks and the stock market crash in the US.

through planning and coordination in underdeveloped countries became stronger with the growing evidence of deficiencies in industrial programming and planning in a broad sense (Meier, 2001).

According to Wade (2003)[27], three types of critiques were made regarding state activism: a) import substituting industrialization policies during 1950s and 1960s produced inefficient industries, demanding constant subsidies, without reaching international competitiveness; b) government pervasiveness created considerable 'rent-seeking', diverting economic agent efforts from productive activities to lobbying for getting more government subsidies and protection; and c) some of the most successful latecomer countries attained a remarkable industrial performance by adopting outward-oriented models, pushed by market incentives and a strong private sector. In sum, state activism supported rent-seeking and distorted markets; provoked a wasteful use of resources; kept industries inefficient and non-competitive; and encouraged corruption.

For the supporters of market-oriented reforms, state activism had generated more extensive and detrimental distortions than the market failures that government interventions intended to correct. Accordingly, the remedy to correct market distortions caused by such interventions was to withdraw the state from the economy. In the neoclassical perspective, governments should restrict their activities to a) preserving the macroeconomic stability; b) providing physical infrastructure; c) supplying public goods, such as education, basic research, defense and national security, law, and environmental protection; d) correcting price distortions related to market failures; e) and improving income redistribution (Wade, 2003).

One of the main arguments regarding state intervention was that governments should basically remove distortions in the market of factors of production to get prices right and an appropriate allocation of resources across sectors; encourage the adoption of suitable technologies; and foster capital accumulation. The emphasis of mainstream economics on hypothetical economic equilibria and optimization succeeded once more in dominating the economic arena. It was the so-called new-liberal counterrevolution of the late 1970s and 1980s, which gave birth to a new

[27] Wade, Robert Hunter (2003) - *Governing the market: economic theory and the role of government in East Asian industrialization 2nd*, Princeton University Press, New Jersey, USA.

generation of development economists, postulating new methodologies, interpretations and policy prescriptions.

Instead of broad theories and visionary models, they preferred to investigate the microeconomic aspects of the development process and target specific policies. According to the new ideology, labeled the Washington Consensus[28], nothing more than reducing the state economic role and strictly applying the basic principles of standard economic analyses would be necessary to induce growth. Macroeconomic conditions and market incentives by themselves would improve the efficiency of the economy. Hence, in order to grow, it would be enough to get prices, property rights, institutions, competitiveness, and governance right. All these "right things" were to be achieved through privatization, fiscal discipline, market–determined interest and exchange rates, trade liberalization and deregulation.[29]

This perspective became more influential in the 1980s, when development lost popularity in the most renowned Economics schools, where it was treated as a secondary issue. Many departments of Economics in important universities in the United States and Great Britain stopped offering courses in Development Economics, arguing that it would suffice to train students in core disciplines such as microeconomics, macroeconomics and econometrics. As Chang (2003)[30] notes, actually for some mainstream economists, development economics should not exist as a specific branch, separated from the 'Economics-as-a-universal-science' and with its own assumptions and methodologies. The same universal theoretical principles and policies would fit all countries, no matter their level of development.[31]

Development quickly came to be viewed as the result of sound macroeconomic policies and free markets. Indeed, the so-called Washington

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[28] The term Washington Consensus was coined by John Williamson in 1989, originally in reference to the policy prescriptions recommended by Washington-based institutions, such as the IMF, World Bank and the U.S. Treasury Department, to the Latin American countries that faced debt crises in the 1980s. Later on the term acquired a more general use, being employed, under protest of its creator, to designate a broad set of policies believed to be neo-liberals or market fundamentalist.

[29] Recently more emphasis has been given to 'right institutions' for the well-functioning of markets. According to Fagerberg and Srholec (2005), this more 'institutionalist' perspective is also called a 'market-friendly' approach and its main contestant has been the knowledge-based perspective, which emphasizes the crucial role of a country's capacity to use and create knowledge to succeed in catching up.

[30] Chang, Ha-Joon (Editor) (2003) - Rethinking Development Economics. London, Anthen Press.

[31] Heterodox theoretical and empirical studies continued to be done, but at the margin of the predominant thinking.

Consensus not only brought to the forefront new economic prescriptions but also a new understanding about development itself, which was supposed to be achieved (exclusively) through market mechanisms and negligible state intervention.

In industrialized countries, the emergence of the new prescriptions coincided with a period of slowdown and turbulence – recession, trade restrictions, interest rate hikes, currency devaluations, and unemployment. In the early 1980s, this scenario contributed to trigger a huge debt crisis in Latin American countries, which provoked serious balance of payment constraints and other macroeconomic problems. In consequence, these countries had to shift their priorities from development toward the achievement of external balance (Adelman, 1999), ending in a very long and costly recession and/or stagnation.

The administrations of Ronald Reagan (USA) and Margaret Thatcher (UK) strengthened the World Bank and the International Monetary Fund (IMF). Both institutions defined the terms of the "market versus state" debate, supporting the former (Fine, 2006[32]). With the debt crisis of 1982, the IMF made its concessional loans contingent upon the adoption of liberalization programs, which became broader and stricter in the 1990s. In practice, both institutions endorsed the applicability of universal policy prescriptions to all countries, without giving the necessary attention to their particularities (Adelman, 1999). Once the pendulum moved toward free trade, deregulation and the minimal state, development policies were put aside or neglected.

Although many critiques have correctly pointed out absences, failures, excesses and the negative side effects of the absolute economic powers conferred to states in the post-war period, moving the pendulum radically towards market fundamentalism left almost no room for governance and institutions. It produced some costly results in terms of economic performance, industrial development and social indicators.[33] These consequences were experienced by many countries that rapidly and indiscriminately liberated their domestic markets, strictly pursuing the

[32] Fine, Ben (2006) – New Growth Theory: More Problem than Solution. In K.S., Jomo and Fine Ben (2006) – The New Development Economics after the Washington Consensus. Tulika Books, p. 68-86.

[33] The 1980s were considered a lost decade to Latin American countries. According to ECLAC, during the 80s, GDP grew only 1.3 per cent on average in Latin America; the income per capita fell 0.8 per cent. The PIB per capita grew only 1.1 percent in average between 1990 and 1999. Poverty and indigence levels increased from 40.5 percent in 1980 to 48.3 percent in 1990, and in 2000 was still higher (42.5 percentage) than in 1980.

prescriptions of mainstream economics or combining them with homemade polices. Furthermore, some countries (like Argentina) dismantled institutions that supported their development, which resulted in a decline of productive investments. The market-oriented reforms of the 1980s and 1990s, however, were usually judged by the extension of liberalization, deregulation and privatization achieved rather than by their effects on firms, industries, production, the economy as a whole and the social indicators. Eventually, poor economic performance and deterioration of social indicators throughout the developing world generated a crisis of legitimacy for their major sponsors (like the World Bank and the IMF), and also disseminated pessimism with regard to human emancipation through economic progress.

1.3 Resurgence of development in the 1990s

In the 1990s, development resurged and progressively broader perspectives about the subject began to regain prestige both in the academy and on the political front, due to the poor performance of the countries that strictly followed the prescriptions of the so-called Washington Consensus; the growing concerns about climate change and environmental depletion; the great visibility of some development thinkers (such as Amartya Sen and Joseph Stiglitz); and the impressive performance of Asian economies using different policies. The initial interest in theoretical models that produced self-sustaining and endogenous technological progress gave way to studies that tried to examine concrete experiences of economic growth and determinants of economic performance (Rodrik, 2003[34]). The notion of sustainable development also started to gain popularity.[35]

[34] Rodrik, Dani (2003) – Introduction – What do we learn from countries narratives? In Rodrik, Dani (editor) (2003) – In the Search of Prosperity: Analytic Narratives on Economics Growth. Princeton University Press.

[35] The term sustainable development was first used in 1983 in the framework of the United Nations World Commission on Environment and Development, chaired by Mrs. Gro Harlem Brundtland, then the Prime Minister of Norway. The concept of sustainable development was widely publicized and became known during the UN Conference on Environment and Development (so-called Eco-92 or Rio-92) in 1992, when were signed the Agenda 21 and numerous agreements on biodiversity, climate, forests, desertification, access and use of natural resources in level global. Over time more dimensions were added to the definition of sustainability, such as social sustainability, political sustainability, financial sustainability, cultural sustainability, and so on. As Herman Daly (2006) commented the "term had acquired such vogue that everyone felt that their favorite cause had to be a

Since the emergence of new development approaches and the re-invigoration of old ones, more emphasis has been given to technological change, institutions, governance and environmental issues. One of the approaches that got revisited in the 1990s was a 1960s tradition of thinking of economic development as a matter of catching up associated with technological change and institution building. This tradition is examined in the next section. More emphasis will be given to technological aspects.

1.4 Development as a catching up issue

The notion of development as a catching up issue is not new and the term was often used as a synonym of convergence, just as the first generation of neoclassical growth models had done. These models focused on capital accumulation and predicted the convergence of growth performance and income per capita among countries. The neoclassical growth models also sustained that the growth rates of backward countries would tend to decline as their convergence towards the more advanced countries proceeded.

This section discusses alternative approaches to catch up, starting with a conceptual discussion and then examining in more detail selected contributions of the above mentioned tradition of thinking of development as a catching-up issue associated with innovation and technological change. Although Torstein Veblen (1915)[36] had already approached the matter, the inauguration of this tradition is usually credited to the economic historian Alexander Gerschenkron, who stated in the 1960s that catching up is far from being an automatic result of capital accumulation. Since Gerschenkron's original contribution, efforts have been made to identify the critical factors to catch up, analyze the economic determinants of technological change and understand its role in economic development, with different emphasis and concepts of catching up in mind.[37]

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part of the definition or else be implicitly condemned to oblivion". The problem is, as Daly (2006) also noted, that "any definition that excludes nothing is a worthless definition".

[36] Thorstein Veblen (1915) - *Imperial Germany and the industrial revolution.* New York: Macmillan.

[37] One of lacks of the literature on catching-up is the absence in many studies of clear definitions about the concept.

1.4.1 What catching up is about

In Gerschenkron´s perspective, catching up is understood as a process of narrowing the economic gap between backward and advanced countries through rapid industrialization and structural economic changes, encompassing technological modernization, institutional innovations and shifts in management and labor force behaviors. Abramovitz, who studied macroeconomic aspects of catching-up processes, contended what he called the general (neoclassical) hypothesis on catching up and developed the concepts of social capabilities and technological congruence. According to that hypothesis, “rates of productivity growth across countries in any period would be an inverse function of their initial level of productivity, and national levels of productivity would converge towards the leader’s” (Abramovitz, 1986). The author argued that such convergence is not something automatic and that a country´s potential for catching up is related to its technological congruence and social capability, emphasizing that the realization of such potential is contingent upon many factors. Similarly to neoclassical models, however, Abramovitz seemed to treat convergence and catching up as the same thing.

Contrarily, in Fagerberg and Godinho’s view, catching up and convergence should be considered distinct issues, although they partially overlap. For them, ‘“catch-up’ relates to the ability of a single country to narrow the gap in productivity and income per capita vis-à-vis a leader country”; while ‘convergence’ “refers to a trend towards a reduction of overall differences in productivity and income in the world as a whole.” (Fagerberg and Godinho, 2003[38], p. 6).

Neo-Schumpeterian perspectives and evolutionary theories of technology change define catching up as the process through which developing counties narrow their technological gap (and then the economic gap) with the more advanced economies, emphasizing the key role of innovation. They have added important elements to the understanding of catching up processes, the identification of its

[38] Fagerberg, J. and Godinho, M. - 2003. Innovation and catching-up, Working paper nr. 24/2003. Centre for Technology, innovation and culture. University of Oslo, Norway.

determinants and the formulation of development polices, as part of an effort to build a theory of technological change.

In this study catching up is understood in a narrow and in a broad sense. In a narrow sense, it refers to a process in which a developing country narrows its technological gap with the leading countries in some key sectors (technological catch up), using the leaders as a model, and also innovating; in a broad sense, it refers to a process in which a developing country narrows its gap in productivity and income with leading countries (economic catch up), via a technological catch up.

As Odaginri, Goto, Sunami and Nelson (2011, p. 2)[39] note, both meanings of catching up are interconnected, since economic catch up requires a technological catch up, especially today when many industrial sectors have become technology-intensive. Whether in a narrow or in a broad perspective, catching up processes always have a sectoral dimension and rely on structural changes in key sectors, with impacts on the rest of economy.

Although economic development involves intentional efforts by backward countries to catch up with the more advanced economies that serve, to some extent, as a model, each country must find its own way of doing things, according to local circumstances, as Gerschenkron (1962), Malerba and Nelson (2011)[40], among others, had stressed. In other words, economic development entails innovation, meaning both the introduction of practices and products already in use in other countries and the introduction of practices and products developed locally – a process which requires intensive learning and many kinds of capabilities, such as technological, organizational and managerial capabilities.

While recognizing that the catching up process is a complex and multidimensional phenomenon, in which knowledge and the use of new technologies per se are insufficient to achieve progress, this study gives more emphasis on the technological and innovative dimension of catching up. In retrospect, it is important to point out the crucial role that technological change has played in successful catching

[39] Odagiri, Hiroyuki; Goto, Akira; Atsushi Sunami and Nelson, R. (2011). Introduction. In Odagiri, Hiroyuki; Goto, Akira; Atsushi Sunami and Nelson, R. (2011) (editors) - *Intellectual Property Rights, Development, and Catch Up: An International Comparative Study*. Oxford University Press.

[40] Malerba, Franco and Nelson, Richard (2011) - Learning and catching up in different sectoral systems: evidence from six industries. *Industrial and Corporate Change* 6, 1645-1676.

up experiences since the 19th century, despite most growth and development theories giving, until recently, more emphasis to capital accumulation and considering technical progress an exogenous variable [41] (UNIDO, 2005; Odaginri, Goto, Sunami and Nelson (2011)

1.4.2 The Gerschenkronian approach

The first version of Gerschenkron's proposition on the catching up of backward countries appeared in an article entitled 'Economic Backwardness in Historical Perspective', which was prepared for a Conference in Chicago in 1951 and published later in the Journal Economic Development and Cultural Change (Fishlow, 2003[42]). In this article, and afterwards in his book of the same title (published in 1962 and reedited in 1966), Gerschenkron discussed the catching up of continental European countries with Britain through rapid industrialization in the late half of the 19th century, especially focusing on the German and Russian cases.

Gerschenkron treated development and industrialization as synonyms and considered them a catching-up issue, associated with the introduction of modern techniques and institutional innovations. He disagreed with interpretations that advocated for the uniqueness of development paths and that gave more emphasis on the differences among countries than the common elements of catching up experiences (Shin, 1996), showing how late industrialization may vary. His main proposition is that the development of backward countries tends to be fundamentally different from that of advanced countries, both with respect to the speed of the process and the productive and organizational structures of new industries.

Gerschenkron also disagreed with those that overemphasized the prerequisites to catch up, and he pointed out that missing requirements may emerge in response to specific needs and demands as the development process progresses

[41] The neoclassical theory of growth and the classical theory of development, for instance, even though differing in many assumptions, associated differences in growth rate to capital accumulation and differences in income and productivity to accumulated capital per worker.

[42] Fishlow, Albert - "Review of Alexander Gerschenkron, Economic Backwardness in Historical Perspective: A Book of Essay Chapters." EH.Net Economic History Services, Feb 14 2003. URL: http://eh.net/bookreviews/library/fishlow

-- although he stated that there was no guarantee that the appropriate institutions or other required conditions would necessarily or automatically appear when needed. For him, the level of backwardness of a country affects its development strategy, but does not indicate its success or failure in catching up. If a country has natural resources and had already removed certain institutional obstacles (such as slavery in Russia), the opportunities associated with industrialization are proportional to its degree of backwardness (Zonenschein, 2006[43]).

Gerschenkron noted that some elements that were crucial in Britain's industrialization were lacking when industrial development started in backward continental European countries in the 19th century. Based on these catching up experiences, his theory contends that the existence of a more advanced economy (Britain at that time) enables countries that are behind to start their industrialization processes by using the more advanced country as a source of technical assistance, skilled labor and capital goods (Gerschenkron, 1962).

In his book, Gerschenkron remarks that the catching up of backward countries involves both imitation and innovation, requiring a lot of effort. Although the development of latecomers usually starts by employing the technological and institutional backlog developed by leading countries, "in every instance of industrialization, imitation of the evolution in advanced countries appears in combination with different, indigenously determined elements" (Gerschenkron, 1962, p. 26). Innovation, in his view, refers to the creation of original institutional arrangements, which works as functional substitutes for structures and institutions of the more advanced countries (Shin, 1996[44]). In the catching up processes of continental Europe in the 19th century, the creation of new and original institutions - adapted to the local conditions, the degree of backwardness and the technological trend - played a role as crucial as borrowed technologies and imitation of England's practices. In many cases, the new institutions were created during the catching up process, and not prior to its beginning. Thus, Gerschenkron preferred to call attention to the variety of responses to challenges placed by the development process, instead of focusing on pre-conditions for catching up.

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[43] Zonenschain, Claudia N. (2006) - O caso chinês na perspectiva do "*catch-up*" e das instituições substitutas. UFRRJ, Tese de Doutorado.

In the 19th century, the most important institutional innovations, according to Gerschenkron, were related to the financing of industrialization. The industrial investment banks were one of the new instruments created by countries such as France, Germany and Italy to finance long-run investments in large-scale industrial plants and infrastructure (construction of railroad, ports, drill mines, and improvements in the cities). They appeared in the 1840s-1850s in France and Belgium to finance railroad building and quickly extending their support to other manufacturing industries (Shin, 1996). However, it was in Germany that banks played a crucial role in the industrialization, as compared to England's industrialization (financed by what Karl Marx called primitive accumulation), in which the banking system was not so important. In fact, Germany was the paragon of the universal bank, which combined long- and short-run activities, in close connection with industrial enterprises. The German banks acted as entrepreneurs, identifying technological trends and new business opportunities.

Gerschenkron stressed that industrialization (or catching up in a broader sense) is a difficult, arduous and expensive process, but that obstacles are important elements of success, since small challenges do not create any response, as Arnold Toynbee (a British Historian) argued. Or, in other words, a nation needs to be challenged both internally and externally to advance. Nonetheless, Gerschenkron noted that it was only when the process started at a large scale that the tension between pre-industrialization conditions and expected benefits became strong enough for European countries to overcome the obstacles and liberate the necessary forces for industrial progress. The author also remarked that, as industrialization may generate certain undesirable non-economic effects, a great delay in industrial development may create sufficient time for the emergence and intensification of social tensions, which can hamper the process. Challenges and obstacles make the presence of an original development ideology fundamental, which becomes more important the more backward the country is.[45] In Gerschenkron´s words:

[45] The Brazilian industrialization experience during the Juscelino Kubitischek government in the late 1950s-early 1960s is a very good example of the importance of such ideology. The ideology of progress, synthesized in the slogan "fifty years in five", conquered hearts and minds, increased the self-esteem and self-confidence of people, stimulating the creativity in different arenas. One of most innovative and important musical movement in Brazil – the *Bossa Nova* – emerged in that time.

> *To break through the barriers of stagnation in a backward country, to ignite the imaginations of men, and to place their energies in the service of economic development, a stronger medicine is needed than the promise of better allocation of resources or even of the lower price of bread. Under such conditions even the businessman, even the classical daringan innovating entrepreneur, needs a more powerful stimulus than the prospect of high profits. What is needed to remove the mountains of routine and prejudice is faith – faith, in words of Saint-Simon, that the golden age lays not behind but ahead of mankind…In a backward country the great and sudden industrialization effort calls for a New Deal in emotions. (Gerschenkron, 1962, p. 24-25*).

Unlike the common view about the abundance of labor in backward countries, Gerschenkron contended that the supply of the required work force to catch up is scarce, since new technologies demand skills that workers from traditional activities do not have. Gerschenkron's argument is more valid today than ever, since the so-called knowledge economy is very demanding in terms of skills and capabilities, which in most cases is rare in the work force of backward countries. Gerschenkron also underscored the importance of targeting the most modern technologies due to their dynamic backward and forward effects on the economy as whole.

Some authors argue that he did put excessive emphasis on capital goods industries and large-scale industrial plants, arguing that many backward countries could not do the same thing. Hirschman, for instance, points out that, in the 19th century, latecomers were able to base their catching up on the introduction of large-scale capital good industries because they were already engaged in the production of equipment and therefore did not face a big technological gap. It would have enabled them to embark on the 'newly emerging dynamic industrial sector' (Hirschman, 1968).

For Hirschman, latecomers with a much bigger technological gap (or a higher degree of backwardness) should follow a tightly sequential industrialization process, starting with manufacturing final consumer goods, and then moving on to intermediate goods and machinery. His point was that there would be a threshold to follow the Gerschenkron pattern. Countries with a large technological delay could not "jump" directly into the production of capital goods. Their industrialization should be gradual and sequential. Hirschman based his formulations about late late-

industrializations in the experience of Latin American countries, traditionally exporters of agricultural products to advanced economies. The author seems to be right about the accumulation of certain capabilities to undertake a more ambitious catching up strategy, but some qualifications are needed, as we will soon see.

Other authors are less comfortable with Gerschenkron's emphasis on large industrial plants, contending that it was not something feasible for late- latecomers due to the required scale of markets. This argument seems also to be valid to some extent. Generally speaking, in the 19th century the threshold to start industrialization processes by targeting capital goods industries was likely not only related to the existence of technological capabilities – to use a neo-Schumpeterian concept – in the production of equipment, but also to the markets' sizes and the endowment of raw materials.

But what is Gerschenkron's main argument? Is it about targeting new and the most dynamic technologies, focusing on capital goods industries, or prioritizing large-scale plants?

It appears that Gerschenkron emphasized the importance of targeting industries based on modern technologies and talked about focusing on large-scale capital goods industries because in the late 19th century breakthrough technologies emerged in the machinery sector and were associated with large plants. His insistence on the capital goods sector was contingent upon the historic context that he observed at the time. This view is in line with Fargerberg and Godinho's interpretation. They believed that Gerschenkron considered it crucial for European latecomers to target the more progressive and dynamic industries because of their high potential returns and strong modernization pressures on the rest of the economy (Fargerberg and Godinho, 2003). In fact, Gerschenkron (1962) said literally: "it was largely by application of the most modern and efficient techniques that backward countries could hope to achieve success, particularly if their industrialization proceeded in the face of competition from the advanced country" (Gerschenkron, 1962, p. 9)

Many important technological trajectories that emerged over the 20th century were based on large-scale plants. However, it is worth noting that throughout most of that century, the relative stability of the technological trend in heavy industries

enabled some backward countries with big markets or export-oriented to focus on some segments of large-scale heavy industries from the very beginning of their import substitution industrialization processes. Brazil, for instance, before starting its sequential import substitution strategy in the 1950s, as recommended by development economists, invested in steel and other heavy industries. The country pursued an industrialization strategy based on final durable consumer goods and, in the 1970s, re-directed its efforts to the development of capital goods industries. The former Soviet Union, China and India, which were also very distant from the technological frontier, also developed heavy industries in the post-war period. Korea, again a very backward country, quickly targeted capital industries very early.

Gerschenkron's insights are still valid today if we take the essence of his arguments instead of reading them literally or from a narrow historical perspective. He paid attention to elements for succeeding in catching up that have acquired even greater importance in the last few decades, such as institutional innovations and the introduction of modern technologies; although he neither explicitly spoke about the importance of endogenous technological innovations nor the need for building technological capabilities, as do the neo-Schumpeterians.

1.4.3 Technological congruence and social capabilities by Abramovitz

Abramowitz's ideas about catching-up processes were first developed in the paper *Catching-up, Forging Ahead and Falling Behind* (1986)[46] and his starting point was the catching-up experience of Western European economies with United States after World War II. Abramovitz contested what he called the simple version of the catching up or convergence hypothesis, which predicts that the bigger the technological and productivity gap between the leader and follower, the larger the potential of the latter for fast growth in productivity. He stated that the simple version of the catching up hypothesis needed qualifications. Backward countries can potentially grow faster than the more advanced ones only if they have technological congruence and social capabilities sufficiently developed to successfully exploit

[46] Abramovitz, Moses (1986). Catching-Up, Forging Ahead, and Falling Behind. *Journal of Economic History*, vol. 46, n°2, p.385-406.

technologies already in use in leading countries (Abramovitz, 1986, 1989[47] and 1994[48]).

The concept of technological congruence refers to the compliance level of available natural resources, supply factors, technical capabilities, market scales and consumer demands in the laggard country "to those required by the technologies and organizational arrangements that have emerged in the leading country or countries" (Abramovitz and David, 1995[49]). In the short run, limitations in technological congruence may render it extremely difficult for laggard countries to adapt to and adopt the current practice of the leaders. These difficulties, however, are not constant and can be reduced over time, during the catching up process.

The concept of social capability refers to:

> *"[the]countries levels of general education and technological competence, the commercial, industrial and financial institutions that bear on their abilities to finance and operate modern, large scale business, and the political and social characteristics that influence the risks, the incentives and the personal rewards of economic activity" (Abramovitz, 1994, p. 25)*.

The concept also includes long-term policies, social attitudes towards wealth and growth, incentives and opportunities. Abramovitz remarked that institutional and human capital elements of social capability could only be developed slowly. Over time, there is a two-way interaction between the social capabilities demanded by technological best practices and the development of such capabilities.

Abramovitz emphasized that some elements of a country's social capabilities, such as the level of education and existing institutional arrangements, restrain its choice of technology, but that such constraints may decline when the country learns to change and improve its institutional arrangements. Concerning institutions, he also stressed the importance of government's stability and effectiveness; managerial and

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[47] Abramovitz, Moses (1989). Thinking About Growth. *In Thinking About Growth and other Chapters on Economic Growth and Welfare*. Cambridge, England: Cambridge University Press.

[48] Abramovitz, Moses (1994). The Origins of the Post-war Catch-up and Convergence Boom; In J. Fagerberg, B. Verspagen and N. von Tunzelmann (editors), *The Dynamics of Trade, Technology and Growth.* Aldershot: Edward Elgar.

[49] Abramovitz, Moses and David, Paul (1995) - Convergence and Deferred Catch-up Productivity Leadership and the Waning of American Exceptionalism. Draft prepared for publication as Chapter 1 in Growth and Development: The Economics of the 21st Century, edited by Ralph Landau, Timothy Taylor, and Gavin Wright, Stanford CA: Stanford University Press, 1995.

organizational experience with large-scale enterprise; and the presence of financial institutions and markets to mobilize capital for individual firms.

If it is true that technological congruence and social capabilities determine a country's potential for catching up, as noted by Abramovitz, its ability to realize that potential in a certain period of time is driven by factors associated with the international environment and how the country responds to challenges set forth by the catching up process. The first group of realization factors comprises elements that affect the access to knowledge and the ability of laggard countries to learn about, appraise and acquire the more advanced methods used in leading countries, as well as the necessary devices and rights to use that knowledge for commercial purposes (Abramovitz, 1986, Abramovitz and David, 1995).

Externally, access to knowledge depends upon the channels of knowledge diffusion, such as vehicles of international technology communication, knowledge facilities, licenses, multinational companies, international trade and direct investments. Internally, to use "borrowed" technologies, local firms need technical competence to recognize, evaluate and adapt it to their own conditions and needs, as well as legal, managerial and marketing skills (Abramovitz, 1994). In general, a country's ability to adapt and exploit borrowed technologies depends not only on the availability of the required skills and technical capabilities to deal with new technologies, but also on the ability of workers to learn new jobs and routines and respond to new opportunities in different places (Abramovitz, 1994).

The second set of factors includes conditions that either enhance or obstruct structural changes in the composition of the output and the mobility of resources (distribution of workforce and geographical location of industries and population), since aggregated productivity growth tends to change industrial and occupational structures in the long run. The third set of factors refers to macroeconomic and monetary conditions, which impact the effective demand, the capital cost, investment expenditures, return on investments and risks associated with them. These conditions are necessary, but not sufficient *per se* to enhance capital accumulation and the expansion of demand.

According to Abramovitz (1986), catching up tends to be a self-limiting process, but this tendency can be reduced or overcome for limited periods at least.

Improvements in social capabilities during the process of catching up may enable followers to keep going fast and forge ahead of the leader. Abramovitz and David (1995) use the concepts of technological congruence and social capabilities to explain differences in terms of economic performance among countries, as well as to explain why Europe, an old center of technological progress, was able to catch up with the United States (which forged ahead in the second half of the 19th century after catching up with England) only after World War II. According to them, it was the congruence between the US socio-economic characteristics and the path of the technological progress that enabled the country to attain and maintain productivity leadership until the post war. In other words, the United States had better social capabilities and technological congruence than European countries, whose deficiencies in technological congruence and social capability prevented them from fully exploiting large-scale technologies. In contrast to the United States, most European countries had difficulties in adapting their capabilities (in terms of education, institutional and organizational arrangements, for instance) to the requirements of modern large-scale technologies, explaining their delay in catching up with the leader. To different degrees, those countries had deficiencies with regard to levels of general and technical education. [50]

Abramovitz stressed that the higher the social capabilities of followers, the higher is their ability to compete in new markets and displace old established industries of the leader countries, whose survival depends upon subsidies and protectionist measures (Abramovitz, 1986). Competitive pressures may be an incentive for research and innovation as well as an excuse for protection. He added that countries that succeed in their catching up processes quite often challenge the older leaders at the technological frontier. In fact, as the technological gap falls, the direction of knowledge transfer may change in some domains, and the old laggard countries may become leaders in particular branches and sources of new knowledge

[50] According to Fagerberg and Srholec (2005), Europe, especially Germany, led science-based industries until the interwar period in the 20th century, but during the World War II, the United States succeeded in forging ahead in this area. In fact, the U.S. firms started to catch up in science-based industries in the beginning of the 20th century, supported by new technical universities and business schools, with whom such industries were closely connected. This movement toward Science and R&D was reinforced during the World War II and the Cold War, thanks to the substantial public investments in defense. In the post war period, the European countries were able to narrow their productivity gap with the United States by adopting (in many cases through imitation) technologies already employed over there because they increased their technological congruence and improved their social capabilities.

to the countries that they had followed before (Abramovitz, 1986). In this case, the country not only reaches the current frontier (catching up), but forges ahead, surpassing previous leaders.

Unlike Gerschenkron, who does not adhere to the theses of general preconditions to catch up and who shows that many requirements are created in the process of development itself, Abramovitz seems to see social capabilities and technical congruence as something that should be almost totally present or developed before the catching up process starts. Although the two concepts are very interesting, they are vast and complex, encompassing practically all elements that influence growth. Therefore, to say that a country did not succeed in catching up because it missed the necessary social capabilities and technological congruence sounds like a vague (or ad hoc) rationalization, made only after results are known. Yet, successful and concrete experiences in catching up have shown a great variety in terms of the initial level of backwardness and paths taken. In many cases, the necessary conditions were built in the process itself. However, it is true that more competences are required in advance in order to catch up today and that perhaps broad concepts, such as social capabilities, can serve as better proxy of such requirements in many circumstances than concepts looking at specific capabilities.

1.4.4 Catching up in neo-Schumpeterian perspectives

Evolutionary/Neo-Schumpeterian approaches, which are focused on technology and technological change, tend to see catching up as a process of narrowing the technological gap in some key sectors, initially through technology transfer and then through innovation. Many scholars associated with these approaches have added important elements to the understanding of catching up processes, the identification of its determinants and the formulation of development polices, as part of an effort to build a theory of technological change. The concepts of natural trajectories of technical change (Nelson and Winter, 1977[51]), technological

[51] Nelson, R. and Winter, S. (1977). In Search of a Useful Theory of Innovation. In Research Policy. vol 5. pp. 36-78.

paradigms and technological trajectories (Dosi, 1982[52]), techno-economic paradigms (Freeman and Perez, 1988[53]), windows of opportunities (Perez and Soete, 1988) and absorptive capacity (Cohen and Levinthal, 1990[54]) were developed in order to understand the role of technological change in catching up processes. Motivated by Schumpeter's emphasis on the generation and diffusion of innovation, and more concerned with technological change processes, neo-Schumpeterians also forged the concept of technological capabilities and national innovation systems (NIS), which affect the intensity and the direction of the learning process. Both concepts will be discussed later on in this chapter.

In the evolutionary and Neo-Schumpeterian views, economic catching up requires a technological catching up and its crucial element is technological learning, which goes beyond mastering productive techniques to include ways of organizing, coordinating and managing activities -- representing a kind of learning that is more difficult to develop, even though it represents an essential part of the catching up processes (Malerba and Nelson, 2011[55]; Nelson et al, 2005). For this reason, Evolutionary/Neo-Schumpeterians approaches have accurately studied technology issues and how the emergence of new technologies influences the latecomers' possibilities of technological catching up. The introduction of new technologies is seen in this perspective as a costly and risky process, which demands endogenous technology investments, skills and complex capabilities to absorb and adopt what comes from more advanced countries.

Moreover, an effective catching up process cannot be reached simply by accessing foreign knowledge and using imported technologies. In fact, capability building is necessary to participate in the generation and improvement of technologies, which means being able to act as imitators as much as innovators of new products or processes (Perez and Soete, 1988). Another aspect is that the

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[52] Dosi, G. (1982) – 'Technological paradigms and technological trajectories: a suggested interpretation of the determinants and directions of technical change'. In Research Policy, vol. II, no. 3, June.

[53] Freeman, C., Perez, C., 1988. 'Structural crisis of adjustment, business cycles and investment behaviour'. In: G. Dosi, C. Freeman, R.R. Nelson, G. Silverberg and L. Soete (eds), *Technical Change and Economic Theory*, London: Pinter.

[54] Cohen, W. M. and Levinthal, D. A. (1990) – Absorptive Capacity: A New perspective on Learning and Innovation. Administrative Science Quarterly, 35(1), 128-152.

[55] Malerba, Franco and Nelson, Richard (2011) - Learning and catching up in different sectoral systems: evidence from six industries. Industrial and corporate change 6, 1645-1676.

conditions for catching-up have become more restrictive over time, demanding more technological capabilities and innovative efforts of countries struggling to reduce the technological gap with more advanced countries. Actually, in the 1980s and 1990s the accumulation of technological capabilities and specialization in services became more relevant for catching up than capital accumulation and a sufficient manufacturing base, factors that counted more in the past, according to Fagerberg and Verspagen (2002). These authors note that these changes in the conditions for catching up "may be a reflection of the radical technological change in the last decades, with ICT based solutions substituting earlier mechanical and electromechanical ones, and the derived change in the demand for skills and infrastructure" (Fagerberg and Verspagen, 2002, p. 17).

According to Perez and Soete (1988), a deeper understanding of the technological issues that sustain the process of development is necessary, which means taking into account the ways that technologies evolve and diffuse, as well as the conditions in which a process of effective technological catching up can happen. They criticize the approaches that try to understand technological change as a more or less continuous and cumulative unidirectional process, which, in practice, is to see development as "a race along a fixed track, where the catching up will be merely a question of relative speed" (Perez and Soete, 1988, p. 460). Of course, speed is an important aspect, but Perez and Soete note that there are many examples of successful overtaking based on running in a new direction. Actually, technological change is "a disruptive process with changes in direction and deep structural transformations" (Perez and Soete, 1988, p. 460), as Gerschenkron (1966) had already called attention to.

Evolutionary/Neo-Schumpeterian scholars have shown that technology cannot be straightforwardly transferred from leading to backward countries through capital goods. In fact, developing countries absorb neither passively nor easily foreign technologies through importation and imitation, since technology, defined as knowledge[56], can only be partially codified and transmitted. As Nelson (Nelson et al,

[56] In Alice Amsden's view, "knowledge is possibly the most precious of all assets. The knowledge needed to compete in world markets, as distinct from factual information, comprises unique skills, sui generis capabilities, novel product concepts and idiosyncratic production systems. Because knowledge is proprietary and firms specific, it is anything but universally available and free." Amsden, Alice H. (2001, preface).

1997) states, technological advancement is not a fortuitous process: it depends upon both supply side factors, such as the mechanisms of diffusion from leading to backward countries (like international trade, foreign direct investment, technical know-how and technology transfer), and demand side factors, such as the absorptive and adaptive capacity of recipient countries. It is a risky and costly process that involves deliberation, learning and adaptation, both for forerunners and latecomers. Technological knowledge is only partially codified in blueprints and other documents. What is sold is codified knowledge (Amsden, 2001), and it is not enough to master imported technologies. Much of the necessary knowledge to use and adapt new technologies is tacit and requires permanent learning and skillful entrepreneurship, which demands that firms learn to do things they did not do before (Nelson et al, 1997; Amsden, 2001).

Recognizing the dependence on previous knowledge to use imported technologies, Neo-Schumpeterians developed the concept of absorptive capacity, defined as “the ability of a firm to recognize the value of new, external information, assimilate it and apply it to commercial ends” (Cohen and Levinthal, 1990). The concept refers also to the ability to create new knowledge and acknowledge that the competences to assimilate existing knowledge and create new knowledge are connected.[57]

The requirements to catch up in terms of knowledge and technological infrastructure go beyond the capabilities of individual firms. Actually, the ability of developing country firms to access and use available sources of codified knowledge relies not only on their own competences, but also on collective skills and capabilities. For this reason, neo-Schumpeterian researchers have put emphasis on the concepts of technological capability (starting with Rosemberg, 1982), national systems of innovation-NSI (starting with Freeman,1982), and Bengt-Ake Lundvall (1992), Nelson (1993); and sectoral systems of innovation (Malebra, 1999).

[57] Developing an inner capability to innovate locally also requires combining capability-building policies and openness to international trade, investments and technologies. One of the challenges that candidate-countries to catch up face is how to calibrate this openness with capability-building policies in an international scenario quite different of that which prevailed in 1970s and 1970s, when the East Asian economies caught up (UNIDO, 2005), characterized today by stronger IPRs, knowledge-intensive technologies, the prohibition of export subsidies and great competition.

1.4.4.1 Technological capabilities and National Innovation Systems

Technological capabilities comprise the ability to develop new goods, services and production processes (Fagerberg and Srholec, 2005). The accumulation of technological capabilities makes the process of assimilation and improvement of imported technologies easier, in the same way that the accumulation of social capabilities does in the Abramovitz's perspective.

The concept of NIS was originally proposed by Christopher Freeman, and diffused by Richard Nelson and Bengt-AkeLundvall in the early 1990s, and has been enriched over time by the contributions of authors like Pattel and Pavitt, Metcalfe and others. In essence, the NIS refers to the network of people and institutions involved, in some way, in the importation, production, modification, diffusion and absorption of new knowledge and technologies at the national level. The main argument here is that a country's innovation and technological performance rely on the complex interaction among actors in the system that is comprised of researchers, firms, universities, government research institutions and others. Their interaction - producing, distributing and applying different types of knowledge - can assume the form of joint research, personnel exchanges, cross-patenting and purchase of equipment, among many others (OECD, 1997[58]).

The NIS approach focuses on flows of knowledge (instead of the measurement of knowledge investments) and reflects the growing attention devoted to its economic role, as do the use of systemic methodologies to study technology development (OECD, 1997). Actually, innovation results from the complex relationships among an increasing number of institutions with different kinds of expertise in the process of knowledge production and diffusion. The success of companies and national economies as a whole relies on their ability in gathering and applying knowledge from these institutions.

Knowledge can flow through many channels in a NIS, such as interactions among companies, universities and public research institutions; diffusion of

[58] OECD (1997) – *National Innovation System.*

knowledge and technology to firms; and the movement of personnel. Knowledge flows are structured differently among countries and also vary in weight for different actors, institutions and interactions with the production system. Macroeconomic and specific policies can facilitate or block the flow of knowledge.

One of the most important interactions is that among companies, which may involve R&D collaborations and strategic technical alliances. Another significant connection is between the public and private research sectors – public research institutes and public universities on one side and private companies and universities on the other. Government-supported research provides basic knowledge to industry, serves “as an overall repository of scientific and technical knowledge in specific fields” and also makes new methods, tools and skills available (OECD, 1997). The role of the public research sector as a source of knowledge for industry varies across NIS. The correction of systemic failures may involve the improvement of interactions between actors and institutions to facilitate the production, diffusion and absorption of knowledge at a national level.

The NIS approach emphasizes the importance of enhancing joint research activities and other technical collaborations among companies and public sector institutions; promoting innovation networking; developing innovative clusters; and designing more efficient flows, interactions and partnerships within the system. The purpose is to increase the ability of companies to acquire knowledge and technology, to absorb and adapt the techniques to their needs, and also to develop their innovative capabilities and performance.

The NIS influences the innovative performance of firms and thus the country´s innovative and technological performance. As the technological path a country takes is influenced by the connections that characterize the NIS, a better understanding of how it works helps policy makers identify leverage points, recognize systemic failures and better design technology and innovation policies to boost innovative activities and competitiveness of industry and the economy as a whole (OCDE, 1997).

UNIDO (2005) notes that the main constraint in implementing catching-up policies today is the national capability to manage the simultaneous development of domestic knowledge, business innovation and policy/governance of the national innovation system. It involves stimulating innovative development on the supply side

and the demand side, as well through the formulation of the adequate framework and incentives, including subsidies for innovative activities in a broader sense, which are not prevented by the WTO rules, as will be explained later.

Lundvall (2005)[59] warns that the concept of NIS "has been both used and abused", and that although policy makers sometimes discussed it, NIS is neglected in practice. A broader discussion about the complexities involved in NIS (as well in sectoral systems of innovation), although of much relevance, goes beyond the scope of this thesis.

1.4.4.2 Knowledge, technological capabilities and education

Knowledge has become more complex in terms of previous knowledge and skills, and investments in emergent or more promising technologies have become more costly or financially unaffordable by most developing countries. A set of skills and a physical and social infrastructure are required to search, identify, evaluate alternative sources, assimilate and adapt imported knowledge and technologies, and then innovate locally (UNIDO, 2005). The effectiveness of an organization in mastering the inflow of codified knowledge and become an innovator depends on the existing tacit knowledge and collective competences in science and technology, in the organization and in the NIS (UNIDO, 2005).

As the stock of codified knowledge grows, its use requires an expressive increase in a number of capabilities and tacit knowledge. The complexity of the necessary capabilities varies across sectors. Some sectors (such as pharmaceuticals) rely more on scientific knowledge. In other sectors (such as iron and steel), the use of new knowledge and technologies demands much more than access to technical blueprints (UNIDO, 2005).

Building indigenous capabilities in science and technology depends on trained scientists and engineers; it also demands more R&D activities by local firms, especially if taking into account the constraints placed by by international trade and IPR rules to access codified knowledge. R&D activities demand an appropriate

[59] Lundvall, B.-Å., (2007) - National Innovation Systems - Analytical Concept and Development Tool. Industry and Innovation. Volume 14, Issue 1, 2007.

institutional context that is related to the formulation and implementation of pro-innovation policies in developing countries, which makes necessary an understanding of the function of competition and industrial policies in the innovation process. According to Nelson *et al* (2005), the importance of the scientific underpinnings of technology and the constraints to access codified knowledge, as placed by international trade and IPR, reinforce the role of research in universities and public laboratories as part of the institutional structure needed for successful catch-up. Local universities and public laboratories may have an important function in training scientists and engineers, mastering and tailoring the technologies and organizational forms of advanced countries for local needs, and conducting research.

As Fargerberg and Godinho (2003) state, the key role of education for development cannot be stressed enough, since,

> *"compared to the situation three or four decades ago, the progressive technologies have become less 'congruent' with the economic conditions (and, particularly, skill-based and R&D infrastructure) that prevail in many developing countries. (...) today only countries that have invested massively in the formation of skills and R&D infrastructure seem to be able to catch-up (while those that haven't fall further behind)." (Fargerberg and Godinho, 2003, p. 42)*

Mazzoleni and Nelson (2006)[60] address in more detail the role of research in domestic universities and public laboratories in the catching up processes, which according to them, is more important today than it was in the 20th century. They stress that practices that need to be mastered involve both "physical technologies" (embodied in physical hardware and materials) and what Nelson and Sampat (2001)[61] call "social" technologies, or technologies embodied in organizations, laws, public policies, customs, norms and so on. The effective operation of many physical technologies demands the implementation of several social technologies.

[60] Mazzoleni, R. and Nelson, Richard (2005) - The Roles of Research at Universities and Public Labs in Economic Catch-up. August, 2005. LEM Working Papers Series.

[61] NELSON, Richard R. and SAMPAT, Bhaven N. (2001) - *Making Sense of Institutions as a Factor Shaping Economic Performance*. Journal of Economic Behavior and Organization, 44:31–54.

A study conducted by Fagerberg and Srholec (2005)[62], which provides very useful insight on development issues, confirms the centrality of knowledge for success in catching up today. The authors evaluate the real importance of a set of capabilities considered critical for catching up in the literature through an empirical model that takes into account data for 29 different variables from 135 countries between 1990 and 2002. These factors are knowledge, openness to technology/knowledge from abroad, development of the financial system, quality of governance and degree of democracy.[63] They found a strong statistical relationship between the level and evolution of GDP per capita, and the level and evolution of knowledge. Countries that succeeded in catching up have invested strongly in the creation of knowledge capabilities, as measured by indicators like skilled labor force (highly-educated workers), R&D activities, scientific publications, and ISO certifications, as well as information and communication technologies (ICT) infrastructure.

But Fagerberg and Srholec (2005) also found that knowledge needs to be supported by an adequate financial system and good governance. In fact, it is the efficient management of these three dimensions of development that makes the difference in catching up. The potential for low-income economies to grow faster than the rich ones exists, but it is counteracted by better financial conditions, better governance and faster increase of knowledge in the more affluent countries. For this reason the variation in GDP per capita between rich and poor economies is growing rather than declining (Fagerberg and Srholec, 2005).

The increasing recognition of the necessity for a domestic knowledge system to decode and use codified information, however, contrasts with the recent reduction in science and technology (S&T) efforts in competence building in developing countries (UNIDO, 2005).[64] Moreover, there is a tendency to concentrate efforts on basic science because it is cheaper than investing in applied S&T development. This trend explains why some Latin America countries make a higher contribution to the

[62] FAGERBERG, J. and SRHOLEC, Martin (2005) – *Catching up: What are the Critical Factors for Success?* Background paper for the UNIDO World Industrial Development Report. Preliminary Version.

[63] The Fagerberg and Srholec (2005) study was one of the background paper of the UNIDO Report on Capabilities Building for Catching up (2005).

[64] According to UNIDO (2005), Brazil and Costa Rica would be exception. Out of Latin America, R&D as percentage of GDP has increased in China, India, and Uganda.

world's basic science "compared to their local R&D effort, without significant spillovers to innovative activity"[65] (UNIDO, 2005).

Indeed, recent research has shown that successful catching up experiences since the emergence of science-based industries – such as chemical and electric equipment – in the 19th century have been associated with the expansion of higher education, especially in science and engineering (UNIDO, 2005).[66] Overtime, the role of universities and public research in catching up evolved: besides supplying a well-educated and trained workforce, these institutions do basic research, and provide assistance to domestic firms and other technology services.

However, only investing in the preparation of engineers and scientists or R&D labs (supply side) is not enough. There is no innovation or economic transformation without an increase in the demand for knowledge by the private sector since the locus of innovation is the firm, whose role it is to transform creative ideas into innovative products and processes, submit innovations to market test and diffuse them. Ultimately, it is the market that creates incentives for firms to demand the resources for innovation or not. Actually, matching the supply and demand sides of innovation resources requires firms feel the need to innovate and that both private and public sectors work together from the early stages of IS building. (UNIDO, 2005).[67]

An effective relationship between university and industry often relies on the degree of responsiveness of the educational curricula and activities to the emergence of new technology fields or sectors (UNIDO, 2005). This usually involves

[65] That is, for instance, the case of Brazil.

[66] Fagerberg and Godinho (2004) found a positive correlation between tertiary enrollment and per capita income. The emergence of science-base technologies changed views about the role to be played by universities. Training programs in engineering and industrial technology grew in number in Europa and US in the 19th, inspired by the German example. In the US, however, more emphasis was given to practical problem-solving and industrial practice. In the late 19th century, the enrollment in basic education increased in continental Europe, but the access to university education remained restricted in comparison to what happened in the US. In fact, by 1870 the university enrollment rates in the United States were between two and three times those of European countries (UNIDO, 2005).

[67] Innovations and their diffusion may also be fostered or hampered by technical standards, which may enhance efficiency, reduce costs and prices, cut demand-side search information costs, increase the potential market, mitigate market risk, but may also circumscribe product variety and the user's scope of alternatives. Here also regulation by government bodies is necessary, to protect the users and avoid that technological development be limited by existing technologies or by diffusion of new technologies with a lower potential to improvement. It demands that policy makers be able to foresee technological change and make decisions accordingly and timely (UNIDO, 2005). For more details about the role of formal and technical standards in catching-up today, see UNIDO (2005).

building effective networks between academic institutions, technical and vocational training, research institutes, technical associations and industry. Increases in quantity, however, are not a guarantee of competence building, since a growing supply of engineers and scientists alone is insufficient to enhance the development of technological capabilities if their skills are not demanded. Creating an effective technological infrastructure, especially during the early phase of industrial development, involves setting complementary policies and institutions that are necessary to enhance the interaction between industry and academia, and also the skill formation through in-firm training or training programs contracted from vocational schools (UNIDO, 2005).

In sum, access to knowledge does not mean technological progress, which depends on mastering and applying new knowledge, as well as creating new knowledge. In general, there is no certainty if any commercially useful result will be produced. There is also the danger of knowledge obsolescence and loss of markets to competitors. Previous success cases and the perception of technological opportunities help to build a competitive environment that encourages firms to make technological investment to enlarge or protect their markets. But, as the real opportunities are not known in advance, in a less competitive environment firms may prefer to get more of existing products and technologies. In such situations, only new competitors can motivate them to search for improvement and explore new possibilities of technological advancement (Abramovitz, 1986).

1.4.4.3 Windows of opportunity to catch up

An influential contribution to the caching up approach associated with the neo-Schumpeterian perspective was proposed by Perez and Soete (1988) in the late 1980s, in the paper *Catching up in Technology: entry barrier and windows of opportunity*, in which the interaction between technological path and the potential for catching up, given the costs of entry for latecomers during technological transitions, is discussed.

Perez and Soete (1988) offer an analytical scheme based on the cost of entry in different phases of a product life cycle and, additionally, in different phases of a

cycle of a technology system, exploring under what conditions catching up is more likely. The product life cycle describes the development of a product from innovation to its introduction in the market, and unto its extinction, as postulated by Vernon in 1966[68]. Technology systems are understood as elements of techno-economic paradigms, according to Freeman and Perez´s taxonomy[69]. Within a techno-economic paradigm, technologies change incrementally. As technologies mature and the production techniques become more standardized, a window of opportunity is open to less developed countries, due to their comparative advantages in terms of lower labor costs. But, for Perez and Soete, it does not represent a real opportunity to catch up for latecomers because mature technologies are less dynamic, and "this choice implies clear risk of getting 'fixed' in a low wage, low growth, development pattern. (Perez, 1988, p. 459)"

According to the authors, real windows of opportunity for latecomers appear during the birth of new techno-economic paradigms, generating and diffusing new types of knowledge, skills and experience, and also creating a favorable environment for easy entry. Techno-economic paradigm shifts affect technology systems that evolved and matured under the previous paradigm. It implies that countries and firms that have accumulated advantages in the old system face high costs to get rid of past experiences and externalities (associated to mature technologies), and acquire new ones. Newcomers with the relevant new knowledge and skills "are lighter and faster" because they do not carry the onus of capital stocks and institutions of the previous paradigm. For these reasons, Perez and Soete (1988) contend that periods of paradigm shift have historically enabled some countries to catch up and even forge ahead of previous leaders: such was the case with the United States, which caught up with England in the second industrial revolution; and with East-Asian countries

[68] R. Vernon (1966) - International Investment and International Trade in the Product Cycle. *Quarterly Journal of Economics* 80, pp.190-207. Vernon argues that during its life, a product demands different types of inputs, such as knowledge and labor skills. Vernon built his model based on the internationalization patterns of US companies, postulating that these companies would initially develop, produce and sell new products at home. As the production techniques became more standardized, manufacturing could be transferred to less developed countries, with low labor costs.

[69] Freeman, C. and Perez, C. (1988) - "Structural crises of adjustment: business cycles and investment behavior". In Dosi, G. et al (editors) - Technical Change and Economic Theory, Pinter Publishers, London.

that caught up with the United States (at least in some sectors) at the beginning of the information technology revolution.

In the Perez and Soete's view, conditions are more favorable for lagging countries to catch up during paradigm shifts for two sets of reasons:

a) Everybody is learning – designers, plant engineers, management, workers, distributors and consumers. Much of the required knowledge is public and available at universities. Many of the required skills are created in practice. It is only with the evolution of the system that the new knowledge and skills tend to become increasingly private.

b) A temporary window of opportunity is open "with low thresholds of entry where it matters most" for those with a reasonable level of productive capacity, locational advantages and enough supply of skilled human resources in new technologies.

Perez and Soete state that catching up involves being in a position to take advantage of temporary windows of opportunity created by technological transitions. Developing countries that are able to take advantage of this kind of opportunity have probably attained this position through decades of efforts, with some success at mastering mature technologies. Although early entry into new technological systems is crucial, it is not a sufficient ingredient for a successful process of catching up. Problems will emerge if the endogenous generation of knowledge and skills is not enough to remain in business with the evolution of the system. In fact, being able to take advantage of new opportunities and favorable conditions require the ability to recognize them, the competence and creativity to formulate an adequate strategy, and the social and political conditions to "carry it ahead". The socio-institutional framework at the international level is also important. Moreover, the self-sustainability of the growth process demands constant technological effort, a growing flow of investments and the creation of synergies.

As discussed in the section on Gerschenkron's contribution, some authors are quite skeptical about whether today there is a real window of opportunity in the first phase of new technology. Hikino and Amsden (1994) argue that, conversely to Perez and Soete's view, the technological gap between advanced and developing countries would tend to become larger with the emergence of breakthrough technologies –

protected by the new intellectual property rights (IPR) system and other mechanisms of appropriation that make access to such technologies more expensive. And yet, knowledge itself has become more complex in terms of previous knowledge and skills, as well as in investments in emergent or more promising technologies that are costly or financially unaffordable by most developing countries.

The arguments about the current difficulty to access and master new technologies are valid, but we need to be cautious about criticisms that overemphasize the constraints posed by technological entry barriers if we want to avoid a certain technological determinism that leaves no room for latecomers to catch up with leaders. To say that there is a window of opportunity does not mean that every laggard country can pass through it. As Perez and Soete point out, a country needs to have the conditions to take advantage of the situation or, put in other words, it needs to possess certain technological capabilities to adapt and adopt, and then become an innovator later on.

Studies on specific technologies conducted by neo-Schumpeterians have shown the presence of niche markets for laggard countries even when high entry barriers are present (Shin, 1996). Moreover, leaders have historically not succeeded over time in their intents to prevent or control technology transfer. They can make it more difficult, but not stop it. Yet difficulties associated with technological trends and entry barriers may be overcome by the creation of original institutions, as emphasized by Gerschenkron, even though it is not an easy task.

Another critique of Perez and Soete's analysis is that they seem to consider the institutional system dependent on the technological system, while one observes that institutions can change and be adapted in response to new technological constraints and demands. Institutions may also be created in advance to take advantage of new technological opportunities or to prospect technological trends (Shin, 1998). In fact, in the process of catching up, the technological path and technological barriers are as important as the strategy adopted by latecomers to face technological and other constraints. And, as we saw in Gerschenkron's analysis, the creation of original institutional arrangements may allow a country to overcome its initial limitations in terms of capabilities.

1.5. Institutions, state and finance

The dissemination of science-based and information technologies, the consequent growing importance of knowledge for a country's performance and competitiveness, and the more restricted international IPR rules create challenges that go beyond the competences of firms and markets, especially in developing countries. In these countries, the creation of capabilities in science and technology demands, more than in advanced nations, proactive states, adequate financial instruments and proper institutional arrangements, aspects that will be addressed in this section.

1.5.1 Institutions

Institutions are considered essential for development by much of the literature on growth, and the catching up approach is not an exception. In a narrow sense, institutions refer to rules and norms. In a broader sense, they also involve organizations and other collaborative activities (Fargerberg and Srholec, 2005). According to Hodgson (2014), "Institutions are the long-lasting systems of established and rooted social rules that structure social interaction." Chang and Evans (2005)[70], see institutions "as devices which *enable* the achievement of goals requiring supra-individual coordination and, which are *constitutive* of the interests and worldviews of economic actors".[71]

But, what are the required institutional arrangements for both growth and catching up?

As Gerschenkron had stressed, successful catching-up experiences have been associated not only with the adoption by laggard countries of existing practices in leading countries, but also with innovation, particularly institutional innovations.

[70] Chang, H.-J. and P. Evans (2005), 'The Role of Institutions in Economic Change', in G. Dymski and S. de Paula (eds), *Reimagining Growth*, London, Zed Press, pp. 99–129.

[71] Chang and Evans (2005), criticize both the mainstream economists and the so-called New Institutional Economists (Douglas North and, Oliver Williamson among others) for seeing institutions basically as constraints, neglecting their other dimensions.

Even though Gerschenkron had given more emphasis to the role of institutions in allocation of scarce financial resources in late industrialization processes, his analysis had also shown the importance of non-market coordinating mechanisms in the mobilization of other scarce resources to support the new business, such as skilled labor, knowledge, and managerial capacity. Taking Gerschenkron's proposition in a broader perspective, one can say that an important role of institutions in catching up processes is to mobilize and provide scarce resources in general, such as capital, technical and managerial competences and knowledge.

Institutional learning may reduce the time necessary to build the appropriate institutions, but learning does not simply mean replication of institutions used or in use in more advanced economies (Shin, 1996). In fact, institutional learning is about creating institutions that perform similar functions to those performed by entrepreneurs and institutions in advanced countries, while tailored according to the country's degree of backwardness, technology features and the challenges put by the international scenario. Although laggard countries can take advantage of the successful institutional experiences of leading countries, institutions must be, to some extent, embedded in the country's socio-economic structure to work properly and effectively (Evans, 2005).

Actually, development can be attained with different institutional arrangements, both economic and political. There is no institutional arrangement that matches all countries or stages of development, as Gerschenkron (1966), Adelman (1998), Shin (1998) and Niosi (2002), among others, have pointed out and empirical studies have shown. Moreover, as Gerschenkron also remarked, appropriate institutions do not necessarily need to be created in advance; they may be designed in the course of the catching up process. However, institutions need to be adapted as the development evolves in order to support the economic demands, thereby transforming the initial growth impulse into sustained economic growth (Adelman, 1998). Some institutions are good for stimulating economic growth but inappropriate for its continuation. As they become dysfunctional in generating economic development, institutions and policies have to shift selectively – e.g., institutions engaged in import substitution promotion probably are not good for fostering international competitiveness and export. Generally, success in diversification demands the creation of new institutional arrangements (Reinert, 2006).

Furthermore, some types of institutions fit very well at a given moment in a particular environment, but may not be efficient or effective for all or forever (Niosi, 2002). Over time they may become a burden if they remain locked onto characteristics that did well in the past but are inappropriate for the new historical circumstances. Institutional arrangements for a middle-income country can be much more demanding than for a low income one. There are situations in which inefficiencies reinforce each other and are very hard to correct. Countries that succeeded in catching up developed institutions equipped to promote capability building and technological change. Today, increasing requirements in terms of knowledge and technological capabilities make such institutions more important than ever. The introduction of new institutional arrangements and regulations in the international scenario also demands the creation of institutions or the restructuration of existing ones to deal with so many obligations, patterns requirements and new challenges.

Creating good institutions, however, it is not enough. They need to work in a systemic way, entailing the mobilization of resources and the diffusion of knowledge and innovations throughout the economy. Analyzing the emergence of the biotech industry in the US, Coriat, Orsi and Weinstein (2002) showed how the diffusion of new technologies and the constitution of new industries might be an outcome of institutional changes, such as rules on IPR and new financial arrangements. In their words, “institutional changes introduced in different domains and at different levels of the American NSI (namely in IP regime and in the financing of innovation) matched ones with the others, in such way that finally opened for the agents new opportunities” (Coriat, Orsi and Weinstein, 2002, p. 27).

According to the authors, these new institutional “complementarities” resulted from decisions made by public authorities and agencies in charge of regulations, due to emergent property of the innovation system in which the actors interacted. Changes in IPR rules allowed the patent of basic research outcome publicly funded and of living forms, and although very controversial, created new markets; financial innovations such as venture capital provided funds to start up innovative firms.

1.5.2 State

The state matters for catching-up and its role naturally evolves as development proceeds and also as the conditions in the environment to catch up change. Over time and worldwide, states have created markets or substituted inadequate ones, and played an active role in physical capital accumulation, human capital formation and technological change, with diverse degrees of success. Historically, the state's first economic role was to unify regions and markets, build up political and socio-economic institutions, set rules and regulations, provide basic infrastructure, facilitate transactions, remove barriers to the mobility of labor, and pursue economic progress.

Governments had active participations in the industrial revolution in Britain (18th century) and in the industrialization of the United States, France, Germany, Italy, Japan, Russia, and Spain in the 19th and 20th, by fostering private investments or investing directly, protecting inefficient infant industries, providing financial funds, setting rules of the game, improving education, expanding the infrastructure or creating markets. The state was also important in the development of small economies in Europe, such as Belgium, Denmark, the Netherlands, Sweden, and Switzerland – countries that exhibit high living standards and equitable income distribution today.

After the World War II, the governmental economic activism was accepted throughout the world for the sake of development and equity, and supported, in different degrees, by most economic theories. Active states were widely justified in the post-war reconstruction of Europe and Japan, and similarly in the industrialization of Latin American and Asian countries, many of them newly independent and very behind the economic and technological frontiers. There was a certain consensus that some economic and social goals could not be attained exclusively through market mechanisms.

The public sector was the main agent of industrialization in Asia and Latin America, with different degrees of success. In some countries, the state assumed functions performed by private entrepreneurs and institutions in the more developed countries during their industrialization processes, working as their functional

substitutes. Advised and supported by the United Nations Commission for Latin America (ECLA), Latin American governments set planning and coordinating bodies to correct market deficiencies and design development strategies based on import substitution policies. Moreover, they directly assumed investments in heavy industries and infrastructure, and also protected infant industries through overall guidance, tariffs and credit facilities.

It was in Asia, however, as will be seen in the second chapter, where the so-called developmental state emerged and promoted the rapid industrialization of many economies through planning and active industrial policies, in combination with market mechanisms. In Japan, the state coordinated and supported strategic investment in the domestic and foreign markets, providing financial resources, protection to local companies and other incentives. In the East Asian economies, governments followed the Japanese example, targeting emerging technologies, guiding and supporting private investments, providing physical and legal infrastructure, and fostering the development of social and technological capabilities through high investments in education.

Since the 1990s, from the intense debate confronting state and markets, it has emerged distinct proposals and concrete experiences of relationship between both. In the academic front, although extremisms remain, more balanced views have rejected the false dichotomy that opposes states and market mechanisms. Emphases have been given to the state activism in specific domains such as investments in human capital and infrastructure, acquisition of technology, regulatory and competition policies, institution building, capability improvement and governance, beyond the preservation of the macroeconomic stability.

In the knowledge-driven economy, states have been called upon to assume new functions, besides adopting “sound” macroeconomic and horizontal policies (education, tax incentives, financing), creating the necessary infrastructure, investing in basic research and setting rules and regulations, as Mariana Mazucatto (2011)[72] states in the so-called pamphlet *The Entrepreneurial State*. The author argues that to foster economic growth-enhancing innovations, a “far more proactive role is required” from states than the Keynesian demand management. In her view, it is necessary a

[72] Mazzucato, M. (2011) – *The Entrepreneurial State* – Demos, London.

target, leading and entrepreneurial state in Schumpeterian sense, able to take risks, set a vision for strategic change, create new technological opportunities, make the necessary investments, foster a decentralized network to enhance risky research and facilitate the dynamic process of its development and commercialization.

Mazzucato emphasizes the key role that the state has historically played in leading innovation in many industries and fostering economic growth in different situations, especially in the United States. Differently from what mainstream economics says, she adds, most risks in innovative activities in the US have been taken by the public sector instead of private companies or venture capital funds. In the US, the government has enhanced innovation from the early stages of research up to commercialization of its results, taking risks that the private capital do not want to take or cannot afford for surpassing in its horizon of decisions. Supported by many studies by Peter Block and others, Mazzucato shows that an expressive number of key innovations imputed to the dynamism of markets – such as personal computers and the internet - are indeed the result of public sector choices that created new products and associated markets.

By investing in the most uncertain and riskiest areas, states have enhanced technological change and been the source of innovation and engine of growth in advanced economies and economies in their way to catch up. Over time, these states have actively created new markets and corrected “network failures”, instead of simply fix market failures. In Mazzucato’s words:

> *“…the role of the government, in the most successful economies, has gone way beyond creating the right infrastructure and setting the rules. It is a leading agent in achieving the type of innovative breakthroughs that allow companies, and economies, to grow, not just by creating the ‘conditions’ that enable innovation. Rather the state can proactively create strategy around a new high growth area before the potential is understood by the business community (from the internet to nanotechnology), funding the most uncertain phase of the research that the private sector is too risk-averse to engage with, seeking and commissioning further developments, and often even overseeing the commercialisation process. In this sense it has played an important entrepreneurial role*.” *(Mazzucato, 2011, p. 18-19)*

If in developed countries states had and continue to have a crucial role in leading industrial development, in developing countries they are called upon to be an even more proactive actor in capability building and in the development of strategies

to enhance technological progress and innovations, looking beyond the private sector horizon. In this regard, it is crucial its actuation to strengthen the interactions in the national knowledge system, in order to foster the flow of knowledge across the economy and innovative activities, through universities, research institutions, public banks and regulatory agency. Yet, states also play a role in enhancing the competition in the economy to compel the private sector to invest in innovation and technological improvement. Without the active participation of the private sector in the process, no catch up is possible.

1.5.3 Finance

As it is well known, financing is a key element for catching up. In Britain, the Industrial Revolution in the 18th century was financed by the so-called primitive accumulation. In the industrialization of late-coming countries in the 19th century, the required financial resources to finance their catching up with Britain came from investment banks in Germany and in other European countries and from self-financing (and capital markets, later) in the United States. In countries with a higher degree of backwardness, such as Russia in the 19th century, the state played a more crucial role in financing industrial development. In Japan and East Asia, as will be seen in the second chapter, this function was carried out by the government and business groups, which performed the role of the capital markets in the advanced economies. In the industrialization of Latin American countries, international markets, foreign direct investment and public institutions provided the funding for modernizing their traditional agricultural economies.

The importance today of many financial instruments that were created in the past cannot be underestimated, but the new science base and IT technologies demand new and original financial arrangements. Some countries have been more successful than others in designing non-conventional financial instruments, such as venture capital funds, while others that have tried to “borrow” institutions developed in leading nations have failed or succeeded only partially. This seems to confirm that financial arrangements, like other institutional instruments, need to be embedded in the local socio-structure to some extent.

Even apparently successful instruments have limitations in financing new sectors. Venture capital funds, for instance, tend to support projects with returns forecasted to three to five years, which is not enough to allow innovation in emerging sectors such as biotechnologies and green technologies, according to Mazzucato (2011). The author states that this short-term bias is overtime detrimental to long scientific exploration and emergent business. Moreover they tend to overemphasize patents, producing patents of little values that are not conductive to the increment of innovations.

Innovation-driven technologies reinforce the importance of public institutions, such as development banks, in supporting investments in more promising and risky new businesses (such as biotechnology and green technologies), which otherwise would not take place. However, providing funds to innovation is useless if the private sector is not compelled by competition to innovate. Brazil, for instance, has created many kinds of financial instruments to foster innovation, but investments by private companies in innovative activities are still kept low and funds unused.[73]

Besides having an active role in financing basic research, innovations, and emerging sectors, governments in developing countries still need to be involved with the financial support of investments in infrastructure and some mature sectors and technologies. The reason is the scarcity of long-term financial resources in the domestic banking system and international markets. On the one hand, long-term financial institutions are underdeveloped or inexistent in most developing countries. On the other hand, the current international financial scenario is characterized by scarce long-term funds to finance investments and infrastructure (a problem especially for the poorest countries), as well as by a high instability due to the predominance of short-term capital flows and consequent volatility of capital markets. Even solid economies can be affected by financial turbulence and speculative waves, or regional financial crisis, as in the 1990s (speculative waves against European and

[73] The discussion about what compels companies to innovate is crucial but goes beyond the scope of this thesis. In the case of Brazil, Mario Possas, co-supervisor of this study, suggests that the explanation to the private companies´ low propensity to innovate should be searched in the competitive conditions. Brazilian private companies that operate basically in the domestic market do not see investments in innovation as a necessary means to become more competitive. The companies that invest in R&D and are involved in technological alliances are those export-driven, such as Embraer, the competitive Brazilian aircraft manufacturer. For some empirical evidence, see Kannebley Jr *et alii* (2004), and Dosi *et alii* (2014).

East Asian currencies) or global crisis, as in 2008 (a broader financial crisis caused by the US *subprime*).

Moreover, international financial markets may put more restrictions on than give options to backward countries for reducing the maneuver of policy makers in the management of macroeconomic policies.

The 2008 financial crisis reinforced the importance of national and regional development institutions for developing countries, to finance infrastructure and other investments, and also to act as a countercyclical instrument in times of financial turbulence. Developing countries have already realized the need of strengthening or building up development banks and are taking many concrete initiatives in this regard, both individually and as a group. Here we will give some illustrative examples. At the national level, one observes that countries from Latina America, Africa and even from Asia have shown great interest in knowing how the Brazilian Development Bank (BNDES), one of the world´s largest public development institutions, works and in some cases demanded its cooperation to create or restructure national development banks. At the regional level, efforts have been done to make more effective existing regional development institutions, like CAF[74], or to create new ones, like Banco del Sur[75] and the BRICS Development Bank[76]. Other initiative worth mentioning was the creation of the International Development

[74] Created in 1970 as a small sub-regional institution by the then five members of the Andean Pact (now Andean Community), CAF was restructured in the last two decades and became a regional development bank sponsored by 18 countries of Latin America, The Caribbean, and Europe, as well as 14 private bank. It provides credit lines, non-reimbursable resources, and technical and financial support in structuring of projects of public and private sectors of Latin America. With headquarters in Caracas, Venezuela, CAF has representative offices in Buenos Aires, La Paz, Brasilia, Bogota, Quito, Madrid, Mexico D.F, Panama City, Asuncion, Lima, Montevideo and Port of Spain.

[75] Regional Financial Institution newly created by members of the Union of South America Nations – UNASUR - to finance infrastructure and social projects in the region. It is expected that the bank starts its operation in 2015, with a capital of USD 7 billion, subscribed by Argentina, Brazil, Bolivia, Ecuador, Paraguay, Uruguay and Venezuela.

[76] The BRICS Development Bank is the multilateral development bank newly created by the BRICS states (Brazil, Russia, India, China and South Africa) as an alternative to the World Bank and International Monetary Fund. With headquarters in Shanghai, China, and USD 50 billion as initial capital, the bank will finance infrastructure and sustainable development projects (like the World Bank). In addition, a Contingent Reserve Arrangement, with USD 100 billion as initial capital, will provide assistance to members in financial difficulty (like the IMF). In the new institution, all members will have the same voting power, unlike the World Bank and the IMF, in which the quota assigned to members determines their voting power. Devised to reflect the countries relative size in the global economy as measured by GDP, these quotas have not been changed for many years in order to reflect the growing contribution of emerging economies to the global GDP.

Financial Club - IDFC, a network of national and sub-regional development banks from developing and developed countries.[77]

These initiatives are supposed to help their sponsors to address the major obstacles to finance development today and reflect their dissatisfaction with an international financial environment dominated by multilateral financial institutions controlled by the US and short-term private capital markets

1.6. Concluding remarks

For a long time, economists considered capital accumulation as the main explanatory factor for the differences in terms of growth and productivity performance among countries.[78] Early neoclassical analysis of technology saw technological change as an exogenous variable to the economy and result of advances in sciences and techniques, without economic motives or incentives. In the 1960s and 1970s, the endogenous character of the technological change progressively began to be recognized and many theoretical approaches and models looked for identifying its economic determinants and role in economic development. In these models, new technologies were supposed to flow easily from leaders to backwards. While countries in the technological frontier faced high risks and costs to develop new technologies, backward countries were regarded uniquely as passive importers of technologies embodied in equipment and machinery, without practically any role in the technology generation. It was supposed that firms in laggard countries could learn how to use imported technology by reading the technical information contained in blueprint material and employ new equipment as efficiently as firms in the countries in which they were developed, incurring only costs of purchasing new products and technologies.

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[77] Created in 2010, under the sponsorship of the German KfW, the IDFC joins 20 financial development institutions from all regions and also intends to strengthen the influence of their through cooperation and sharing of best practice experiences in strategic issues of mutual interest, such as climate finance, infrastructure finance, social development, poverty reduction, green banking and innovation finance.

[78] Schumpeter emphasised the importance of generation and diffusion of technology to the economic development in the first half of the twentieth century, but his ideas were not very influential among mainstream economists, perhaps because, to some extent, of the difficulties at that time to put them in mathematical formulae.

In this first intent of bringing technology inside, local conditions – such as capabilities, institutions and infrastructure – seemed to have little importance to the absorption of new techniques. Even the more sophisticated endogenous growth models that took into account the role of trade and technology to the development of backward countries used to keep the assumption about their passive role, regarding them merely as importers and imitators of technologies developed in advanced countries.

Technological progress was also object of attention of classical development economics in the 1950s and 1960s. Most classical development theorists believed that technologies developed in more advanced countries could be absorbed by backward countries through capital accumulation. Although emphasizing the difficulties in the diffusion of technical progress from advanced to developing countries, development theorists from Latin America (mainly those based on ECLA) did not accurately study the process of technology transfer or how the emergence of new technologies influenced the latecomers' possibilities of technological catching up.

Also in 1960s, but following a different path, the economic historian Alexander Gerschenkron inaugurated a new tradition of thinking of development as a catching up process associated with technological change and (institutional) innovations, which came to be known as the catching up approach. Gerschenkron showed that the catching up of backward countries – meaning the reduction of the economic gap with leading countries through rapid industrial modernization - involves both imitation and innovation, and requires a lot of efforts. Innovation, in his view, consists in the creation of original institutional arrangements, which he sees as functional substitutes for the structures and institutions of the more advanced countries. In general, instead of focusing on the preconditions for catching up, Gerschenkron preferred to call attention to the variety of responses to challenges put by the development process. He also stressed the importance of targeting the most modern technologies due to their dynamic backward and forward effects to the economy as whole.

Since the Gerschenkron's contribution, efforts have been made to identify the economic determinants of technological change and understanding its role in catching up processes. In the search of critical factors to catch up, Moses Abramovitz

developed the concepts of social capabilities and technological congruence. He also emphasized that access to knowledge does not mean technological progress, which depends on mastering and applying new knowledge, and on creating new knowledge. In their quest to understand technological change and how technologies evolve, Neo-Schumpeterians forged the concepts of natural trajectories of technical change, technological paradigms and technological trajectories, techno-economic paradigms, windows of opportunities, technological capabilities and national innovation systems.

Generally, one of the basic premises of the catching up approach rooted in the Schumpeter´s perspective is that in order to narrow the technological and economic gap with the more advanced nations, a country needs not only accessing and mastering imported knowledge and technologies, but also needs to develop an inner ability to innovate technologically and institutionally. It relies on supply side factors, such as mechanisms of diffusion from leading to backward countries (like international trade, foreign direct investment, technical know-how and technology transfer) - and equally on demand side factors, such as the absorptive and adaptive capacity. In fact, technological advance is far of being a fortuitous process. It is a risky process that involves deliberation, learning and adaptation, both for forerunners and latecomers. The perception of development or catching up as a natural consequence of capital flows from developed countries to backward countries was never confirmed by empirical evidence.

Technological knowledge is only partially codified in blueprints and other documents. Much of the necessary knowledge to use and adapt the new technologies is tacit and requires permanent learning and skillful entrepreneurship. It demands that firms learn to do things that they were not able to do before, supported by the innovation system they are connected with. Theoretical and empirical studies have shown that catching-up increasingly relies on the ability of countries behind the technological frontiers to adopt and adapt imported technologies, and to develop new technologies that depend upon the acquisition of technological capabilities, technological infrastructure and an efficient NIS.

The increasing importance of knowledge to catch up is confirmed by empirical studies that examine its role in successful catching up experiences since the late 19th

century. They show that the critical role of knowledge to development is not something new, although only more recently this had been recognized by a larger spectrum of growth and development theories. Knowledge, however, needs to be supported by proper financial conditions and good governance. In this scenario, states had and continue to have a key role to play.

II - THE SUN RISES[79] AND TIGERS CATCH UP: JAPAN AND EAST ASIA CATCHING UP

Europe and the United States concentrated most of the world's industrial activity until the end of the 1950s. The impressive economic performances of Japan in the 1960s, East Asian countries from 1970s onwards, and more recently of China and India have contributed to shift dramatically this scenario, questioning established development theories and providing new development models for developing countries.

Asian economies comprise a broad range of ethnic groups, cultures, religions, languages and sizes, with different resource endowments. There are large and populous countries such as India and China, and small city-states such as Singapore. Some of them export oil and natural gas (like Indonesia and Malaysia) and other are extremely dependent on imports of oil and other natural resources. Asian countries differ also politically – many of them have or had strong authoritarian regimes, while others (like India) have consolidated democratic regimes. This diversity, and also differences in terms of initial conditions, explains why the economic development of Asia has varied greatly among countries since the World War II, despite many elements in common.

The departure point of the so-called Asian Miracle was the catching up of Japan, which experienced sustained and unprecedented growth rates in the first post-war decades. Other Asian economies, departing from higher degrees of backwardness, attempted to pursue the Japanese route by following different strategies and some of them also experienced remarkable results in terms of socio-economic development. The first ones were South Korea, Singapore, Hong-Kong and Taiwan (East Asia), followed by Thailand, Indonesia and Malaysia (Southeast Asia), and more recently by China and India (South Asia), and Vietnam (Southeast Asia).

In this chapter, we examine the main features of catching up experiences of Japan and East Asian economies, focusing especially on the Korean and Taiwanese

[79] Japan is often called the "Land of the Rising Sun" because the words for Japan in the Japanese languages - Nippon and Nihon - mean "sun-origin".

cases, the most successful catching-up experience in the second half of the 20th century. We do so in the light of the theoretical contributions overviewed in the first chapter and of other empirically-based studies. We believe that empirical and theoretical perspectives cannot encompass all the complexity of the reality if taken separately. Together, however, they may help us to better understand why few countries have succeeded in reaching socioeconomic progress whereas the majority still continues to struggle in moving ahead.

2.1 Japan's catch up

The starting point of the Japanese catch up was the so-called Meiji-Restoration (1868-1912), under which Japan adopted many European and American customs and institutions, as well as their technologies. The explicit purpose of the regime was to strengthen the country's economy (by catching-up with advanced Western economies) and the military power of the state, which at that time was challenged by Western empires. The slogan of the day was "a rich society and a strong army" (Fukoku-Kyohei), a goal to be achieved through industrial development (Shokusan-Kogyo). Therefore, similarly to what happened in Russia in the 19th century, the engine of the Japanese industrialization was a military concern (Shin, 1996).

The public sector played a vital role in the process of modernization and industrialization of Japan, particularly in its initial phase. Among other things, the government modernized the legal system, the physical infrastructure and the educational system; it expanded and improved transport networks, promoted land and financial sector reforms, initiated new businesses in industries considered strategically important and sent students and educators to be trained in the United States and Europe. In fact, acquiring knowledge and creating a higher education system were seen as crucial to catch up with advanced western economies. Japan made a huge effort to develop a system of higher education between 1870 and 1920, taken as model institutions from Germany, UK and the USA, and succeeded in catching up with these countries regarding students' enrolment by the 1920s. Universities, colleges and research centers were founded - often oriented towards

mathematics, engineering, applied sciences, technology and foreign languages - and a large number of foreign professors and researchers were invited to work there. According to the UNIDO report (2005), the transfer of students and scholars enhanced the development of a national academic system, which attained a standard equivalent to those of most advanced European economies within 50 years.

Influenced by German and British experiences, the Japanese government also set complementary policies and public research institutions to support research activities carried out by the private sector, both in agriculture and industry. This support tended to increase as the access to imported technologies started to be restricted by foreign companies (UNIDO, 2005).

Gradually private initiatives and the cooperation between public and private actors grew in importance, especially with the emergence of the family-owned business groups, known as *zaibatsus*. Until the World War I, these groupings were engaged predominantly with food processing and textiles, the dominant industries of the time in Japan. During the war, heavy industries emerged as leading sectors and the Japanese economy experienced a rapid transformation (Fargerberg and Godinho, 2003). It is worth noting that during the wartime period Japan was already a developed society with regard to many socio-economic indicators, such as income per capita and education. According to Sen (2003), the levels of these two indicators were higher than the world average on the eve of the Japanese catching up. Generally speaking, Japan was technologically behind, but was not a socially backward country (Abramovitz, 1986).

The power structure of the Japanese society changed deeply with the defeat of Japan in the World War II. The dismantlement of two out of the three contending powers in society – the military and the zaibatsus – gave room for the emergence of new business groups called keiretsus, as well as for the re-empowerment of the bureaucracy, which resumed the leadership of Japan's catching up with the more advanced West countries. Prohibited from having an army, the Japanese state channeled all national resources and efforts to enhance the nation's economic development. Shin (1996) remarks that due to restrictions imposed by the war winners, economic development became the only alternative for the Japanese state to promote its national prestige, which enabled the emergence of the so-called

developmental state in the country. The concept of developmental state was first proposed by Johnson in 1982 in a study about Japan, in which he described the combination of state planning with market mechanisms. The term was adopted by other authors, such as Alice Amsden in studies on Korea and Robert Wade in studies on Taiwan. Peter Evans and Ha-Joon Chang contributed to generalize the concept (Bastian, 2008)

The exact role of such developmental state in the Japan's economic growth after the war is controversial. Mainstream economists have argued that the government only pre-paved the way for private investments. However, even though (given the moderate backwardness of Japan) the private sector had been more risk-taking after the war than during the Meiji Restoration, evidence seems to show that the state activism was crucial and, according to Fagerberg and Godinho (2003, p.16), "contributed significantly to gear the attention of private business to catch-up with the West".

The government supported the catching up of the private sector by providing overall guidance; selective tariff protection and credit facilities; selecting firms for controlled imports and exploitation of foreign technologies; arranging the necessary industrial combinations to the proper scale of operations; reducing the risky investments in innovation; and, in general, by coordinating research projects. The coordination of such projects also aimed to save resources by avoiding redundant research and mitigating global risks of heading into wrong directions via the division of specializations (Shin, 1996).

To foster Japan's industrial development, the Japanese government built an original institutional framework adapted to local conditions, the country's degree of backwardness and the path for technological progress. This institutional framework worked as a functional substitute, in Gerschenkron's perspective, of existing institutional arrangements in forerunner countries (Shin, 1996). Whereas the investment bank was one of the main functional substitutes (or innovative arrangements) for the catching up processes of continental Europe during the 19th century, the Ministry for Trade and Industry (MITI) played this role in the Japanese catching up after the WW II whereby it supported private industrial investments through many channels and instruments. The MITI, which was the leading and

coordinating state agent in the economic arena, initially directed its attention to iron, steel, aluminum, automobile, and shipbuilding industries.

Rather than simply assist the development of labor-intensive mature industries to supply the domestic market, the MITI decided to promote also the most dynamic and high technology industries, such as oil-refining, machinery and electronics, in which “income is high, technological progress is rapid, and labor productivity rises fast” and make them competitive in the world economy (OECD 1972, apud Wade, 2003, p. 25). Even when the MITI supported already established industries, such as iron and steel, it stimulated the adoption and/or development of new technologies, instead of fostering the absorption of mature technologies. Initially the MITI resisted supporting the ambitious plans of the iron and steel private sectors since it did not consider them exporting industries, but later changed its position and included the building of an integrated production system for both industries in the list of priorities with the steel export boom in 1955.

According to Shin (1996), the most distinctive characteristic of the Japan’s catching up in the iron and steel industries was their very early insertion in the global production and markets, when compared to what happened in the United States, where the development of such industries was enhanced by and directed to the immense and rapidly growing domestic market. In effect, the backward and forward linkages of the Japanese industry with global markets were what made possible the concentration of a huge iron and steel production capacity in Japan.

Contrarily to the US and European countries, according to Shin (1996, p. 96), “Japan imported raw materials from all over the world, established plants big enough to exploit economies of scale on the global level and exported its products to the world markets.” Until the Japanese catching up, all the major world steel producers had based their production on domestic raw materials, including the exporting countries. Japanese companies had to engage in exporting to pay for imported raw materials and used the increased production capacity in order to take advantage of economies of scale. These economies played a key role in the enhancement of the Japanese international competitiveness.

In Shin’s view, the institutional pattern of Japanese catching-up in the iron and steel industries fits Gerschenkron’s moderate backwardness approach (Shin, 1996).

In fact, by the end of the war, Japan had already heavy industries and possessed experienced managers and engineers, well-trained workers, and technological and organizational capabilities to exploit the new technologies of the time. The country constraints were derived from the scarcity of financial resources and restrictions imposed by international circumstances. The funds necessary for investment were provided at great extent by the keiretsu system and the state, which facilitated the 'over borrowing' of Japanese companies. However, unlike what occurred in Germany, where investment banks provided finance and controlled the industry, in Japan the coordination mechanism operated within the keiretsu system, without any private effective inter-keiretsu coordination. The support that Japan received from the US in the context of the Cold War was important.

Shin (1996) also remarks the strong competition for market shares and new markets among the keiretsus, as well as the MITI's efforts to mitigate overcapacity problems in the 1950s, by controlling their investments and sales. Due to keiretsus' resistance to government regulation, the MITI changed its strategy and stimulated cartelization and mergers in order to get the same results.

The development trajectory of the electronics sectors, which successfully caught up with the U.S. industries in the late 1970s, was quite different from that of the iron and steel industries, and especially from that of the semiconductor industry. Export markets gave the overall direction of the semiconductor sector development, although the beginning of the process had been more domestic-market based, in comparison with the experience of East Asian countries. While the iron and steel sectors were already mature and established industries, the semiconductor was an emergent industry, characterized by rapid process and product innovations, and a greater linkage impact over the economy as whole.

In Japan, the keiretsu groups involved in semiconductors were vertically-integrated electronic manufacturers, with backward and forward linkages with consumer electronics, computer, and other IT products. It was the electronics industry itself that provided a stable demand for the semiconductors' production and made them profitable (Shin, 1996). The vertically integrated electronics companies had access to low cost capital and other government benefits. After succeeding in the production of final consumer electronics goods and in a narrow segment of

semiconductors, Japanese corporations started moving to more complex products and technologies. A similar strategy would be adopted by Korea later on.

Japan was able to pursue a very ambitious catching up strategy from the very beginning of the semiconductor and computer industries in the post wartime because the country had already accumulated technological and organizational capabilities (Shin, 1996), or social capabilities in the Abramovitz's terminology. Its success can be attributed both to the risk-taking behavior of firms and also to the state activism, which supported Japanese companies until they became competitive in the domestic market and internationally. The starting-point of the state's participation in Japanese IT technologies varied across the electronics industry. In some cases, such as in the semiconductors, private companies initiated their own catching up; in others, such as in the computer industry, the state intervention was important from the beginning.

The state support to the electronic industry was particularly important from the 1970s onwards, even though the government identified the electronic sector as strategic since the late 1960s. The government policy first focused on import-substitution and then on export promotion – a path of development that, in Shin's view, was not available to Korea, which had to adopt export promotion and import-substitution policies simultaneously (Shin, 1996).

The Japanese government played a crucial role by reducing uncertainties and enhancing investments. Its support involved the control of technology transfer and the U.S. companies' direct investments, research project coordination, protective measures and credit facilities. Japan's protectionism restrained the US firms' access to license their technologies to the Japanese market.

2.1.1 Remarks on the Japan's catch- up

Amartya Sen (2000) contends that the Japanese economic development was enhanced by the human resource development associated with social opportunities, particularly in basic education. In effect, the pervasive and efficient Japanese educational system endued the industrial system with high-quality human resources and was one of the pillars of Japan's catching up.

The Japan's development has been interpreted as a Schumpeterian process of creative destruction. In fact, an important element in the Japanese catch-up was the very rapid and orderly process of structural change through which old industries were replaced by technologically more progressive ones, with growing product differentiation and continuous improvements associated with learning. Since the beginning of the postwar period, Japan set the goal of establishing a broad-ranging industrial structure and developing a diversified manufacturing system, updated technologically, although Takeuchi, Shimada and Itami (1997) contend that the focus on latest technologies of the time was in part fortuitous. Whether a process partially fortuitous or completely intended, the fact is that Japan knew how to take advantage of the favorable economic and geo-political circumstances after World War II, characterized by the Cold War, as well as of the technological trends of the time, in order to catch up.

Grabowski (1999) also argues that the rapid technical change in Japan was more an outcome of the incorporation of innovations into the economic activity through a process of learning by doing than the result of deliberate investments in research and development, as had been previously seen in England. In this process, Japanese conglomerates combined the exploitation of economies of scale and the development of flexible plants, in which products are tailored according to the end-users' needs. In fact, the very rapid catching-up of Japan towards Western productivity levels involved important organizational innovations (e.g. the introduction of the "just in time system") that resulted in improvements in productivity and efficiency. These innovations, diffused with a lag to the established leader (the U.S.) and other countries, totally transformed many industries at the world level. In other words, Japanese firms not only reached the technological frontier (caught up), but also forged ahead, defining a new frontier in some sectors.

Initially, most of the Japanese growth was inward-oriented, with domestic demand pushed by increasing incomes. Once Japanese firms acquired competitiveness in the domestic market (highly protected), they started to exploit foreign markets, targeting the demand for high tech products in the most advanced countries. The domestic market, however, remained protected to enable local firms to improve their technological capabilities – the U.S. companies had access to the Japanese market exclusively by licensing their technology to Japanese firms whose

investments were considered strategic by the state. Although firstly inward-oriented, Japan knew very early to take advantage of the insertion in global markets.

As a whole, the Japan's catching up process was largely self-financed, even though the US financial support in the context of the cold war (through the Marshal Plan, for instance) had been fundamental in the beginning of the Japanese economic recovery. Part of capital needs for the keiretsu investments was supplied by the state, which had a direct participation not only in the process of technological development and investment coordination, but also in financing Japan's catching up.

In fact, the Japan Development Bank (JDB) was one of the major financial instruments of the government's industrial policy, coordinating cooperative loans to target industries and affecting the allocation of credit by private banks to the industrial sector (Fargerberg and Godinho, 2003). Moreover, the Ministry of Finance controlled the level and the structure of the banks' interest rates, as well as influenced their decisions on credit allocation, which made the Japanese financial system very effective in collecting savings and transfer them to industrial conglomerates. The easy money provided by the banking system, in association with the keiretsu system and integrated manufacturers, enabled the private companies to maintain high and stable investment rates.

Steel and shipbuilding industries were the first to reach the productivity frontier; the next ones were the automobile and electronics (Fargerberg and Godinho, 2003). Regarding electronics industries, the Japanese catch up was more significant in the capital-intensive segment of semiconductor industry. Most Japanese semiconductor producers took advantage of the horizontal keiretsu grouping, benefiting from their keiretsu banks. The major players were integrated electronics manufactures, with business also in consumer electronics, computer and telecommunication. Some of them became independent vertical keiretsus, articulated through backward and forward linkages. This close integration allowed them to "exploit the synergy between the sectors better than their US counterparts", whose vertical integration was prohibited by the US antitrust law (Shin, 1996, p. 121). One of the synergies was the systemic user-producer relation. The main incentive to improve the Japanese semiconductor technology came from the computer sector, which demanded more complex ICTs. The internal market provided a stable demand

for new products and allowed them to get more rapid returns on their investments. The integrated industries had a priority access to low-cost capital, tax incentives and other benefits granted to other divisions of the group.

In synthesis, Japan's catching up involved both imitation and innovation. The developmental state played a key role by offering general guidance and selective protection and by mitigating risks associated with investments in innovation and investments in general. This work was done by MITI, the main institutional innovation of the Japanese catching up. The MITI supported the import substitution in the mature industries, as well as enhanced the export drive of the emergent IT industries, allowing them to take advantage of global production and marketing networks. Both import substitution and export promotion policies generate dynamic effects on economy as whole, producing an equitable development path through which most part of population could improve their standard of living. As the result, Japanese industries were able to catch up with their more advanced counterparts abroad and eventually to forge ahead, defining a new technological frontier.

After successfully catching up in many sectors, Japanese corporations adopted aggressive strategies to become more globalized and competitive. They rapidly expanded their investments overseas, looking to reduce production costs and increase market shares due to the limited scale of domestic markets. These investments tended to be clustered geographically in some regions – initially in the East Asia, and later in the Southeast Asia, regions with lower labor costs. The tendency to delocalization became stronger throughout the 1990s with the high yen.

When the Japanese economy entered into a stage of maturity, and the high rates of growth vanished, increase exports to maintain production became an obsession for the Japanese corporations. In the context of the strong yen, the Japanese industry started to search tirelessly to raise productivity, improve quality and cut costs to preserve their international competitiveness. The success of this strategy - translated into huge trade surplus - generated many trade frictions with the main Japanese commercial partners, especially the US. The persistent low dynamism of domestic demand, the losses associates with the financial bubbles of the 1980s, and the external pressures to open Japanese markets due to Japan's

high trade surplus made it clear there was the need for structural reforms in companies and changes in their predominant competition practices.

The emergence of East Asian countries and more recently of China as important competitors in the international markets clearly showed more the limits of the strategy of cutting cost and enhancing product differentiation to maintain market shares and keep pace with the leader. It also made it evident that the needed reforms went beyond the universe of firms. Apparently the educational system and many institutions which were very functional during the Japanese catch-up need to change once again change in order for the Japanese economy to better face the challenges associated with its level of maturity, the emergence of new and big players and other changing conditions in the international arena.[80]

2.2 Catching up experiences of East Asian countries

The historically unprecedented economic performance of East Asian countries over the past 50 years transformed them from backward into modern and competitive economies, able to produce high technology products and successfully compete with Europe, United States and Japan in many industrial fields.

The first East Asian economies that tried to follow the Japanese path were South Korea, Taiwan, Singapore and Hong Kong, which became known as the “four Asian tigers”, or also as the “four little dragons”. They looked at the Japanese example, but took their own way for catching up and also succeeded in achieving a rapid and equitable growth. Similarly to Japan, their catching up processes were marked by high rates of investments in human and physical capital, fast-growing productivity in agriculture and the birth rate decline (Stiglitz and Charlton, 2005). Differences in terms of strategies relied on specificities of each economy, their level of backwardness, changes in the international environment and the emergence of new technological paths (Fagerberg and Godinho, 2003).

[80] The discussion of the challenges Japan have faced after reaching the economic and technological frontier goes beyond the scope of this study.

A number of different theories have tried to explain the so-called East Asian Miracle, which surpassed that of Japan. As in the Japanese case, there is a controversy about the critical factors to the East Asian successful catching up processes, particularly regarding the role of the state and market mechanisms.

In the next sections, the critical elements of the so-called East Asian Miracle will be examined, in light of the Korean and Taiwanese catching up experiences, focusing on the technological aspects. In order to highlight the specificities of East Asian catching up experiences, they are compared with those of Southeast Asia and Latin America economies.

2.2.1 Korea and Taiwan's roads to catch up

Korea and Taiwan[81] were very far from the economic and technological frontier when they started their development process in the 1960s. Korea, for instance, had an income per capita of about USD 880, smaller than those of many sub-Saharan African countries (Grabowski, 1999). Both economies succeeded in narrowing their socio-economic gap with more advanced ones, adopting different combination of policies. Most of their output and productivity increment is attributed to the accumulation of physical and human capital. Investments in human capital allowed a more effective use of the imported technology embodied in the machinery and equipment. Korea and Taiwan depended heavily on foreign finance: Korea, in the form of lending; Taiwan, in the form of foreign direct investment (FDI).

Differences between both economies in terms of catching-up strategies and product specialization can be explained by their historical background and specific conditions in the eve of the spurt of industrialization (Grabowski, 1999; Shin, 1996).

[81] South Korea and Taiwan were controlled by Japan until the end of World War II. South Korea remained under the Japanese rule from 1910 to 1945; and Taiwan, from 1895 to 1945. South Korea is the part of the old Korea that remained under the US influence after the division of the country in two in the cold war context. In 1949, led by Chiang Kai-Shek, Chinese Nationalists occupied Taiwan, after they lost the civil war to the Communists in Mainland China. Singapore and Hong Kong were for long time British colonies. The former became an independent state-city in 1965, after being part of Malaysia for two years. Hong Kong was part of the British Empire from 1842 until 1997, when its sovereignty was transferred to China. Since then, the island is a Special Administrative Region of China, but keeps its autonomy, with its own legal system, currency (Hong Kong dollar), police force and trade policy.

Given their historical and economic peculiarities, while Korea's government enhanced concentration and the development of large groups - the chaebols - public policies in Taiwan encouraged the dissemination of relatively small firms, which carried out most of the investments. The island concentrated its efforts in the production of components, which were more labor-intensive, taking advantage of the flexibility of its small firms. Such strategy raised the investment rates from about 10 percent of GDP in the 1950s to over than 30 percent in the late 1970s. The Taiwanese government support comprised tax holiday, financing and other incentives. One of the key elements of the Taiwan catching-up was the promotion of entrepreneurship, due to its impacts on the innovative activity, a result of the close association between public research labs and start-ups.

In Korea, the military regime elected industrial development as a strategic endeavor for economic, political and geopolitical reasons, in order to: a) solve the country chronic balance of payments constraints; b) legitimize the non-democratic regime; and c) make Korea a military power with certain independence from foreign resources and technologies, as well as from the US military influence (Shin, 1996). Conversely to Taiwan, and as Japan had done, the country concentrated its efforts on large domestic conglomerates and embarked in an industrialization process based on the development of heavy and chemical industries – industries that demand high investment in facilities - and also on the mass production of final consumer goods.

The chaebols were the Korean counterpart of the Japanese keiretsu. They appeared in the early 1950s, but only became prominent in the 1970s with the Heavy and Chemical Industry (HCI) plan, the state's program to foster the development of chemical and heavy industries through import substitution measures. Initially the chaebols were not strong enough to launch by themselves large-scale investments, being dependent on the state capital mobilization. In fact, given the degree of the backwardness of Korea, it was the state that guided the chaebols' investments – initially, in heavy and chemical industries, and then in electronics in the 1980s.

In the case of heavy industries, particularly of iron and steel, the catching up strategy followed by Korea was very similar to that of Japan, although it had demanded a greater state participation. As the private sector could not assume the

large-scale investments required, the government created the state enterprise POSCO in the late 1960s, which, with the establishment of a chemical complex, was the starting-point of Korea's ambitious industrialization program of the 1970s. POSCO was conceived as a key instrument of the export promotion´s framework, and its role was to provide inputs to other industries at lower prices than foreign suppliers did and export directly at least thirty per cent of its production. The funds for its initial investments could not be obtained in international markets neither in multilateral institutions as the World Bank, which refused to support the project. Then, the Korean government started the company by negotiating loans with Japan Export-Import Bank and changing the usage of an important portion of reparations paid by the Japanese government, which involved concessions to Japan (Shin, 1996).

Whereas Japan embarked in a broader catching up strategy in many segments of the electronics industry, Korea, a country with a higher level of backwardness, started its process by assembling simpler labor-intensive consumer electronics, moving progressively to more technologically complex processes and products as the industrial development proceeded. At the beginning, the state strategy was based both on import substitution policies, which reserved the domestic market for local producers, and export promotion. Although some segments of the electronics industry had strong linkage with the domestic demand, others were developed exclusively to export.

Initially the Korean electronics industry was characterized by a dual structure: a segment linked to the domestic demand, and other 'enclave' segments directed to export (Shin, 1996). The latter were associated to foreign direct investments and networks of international specialization, without a strong connection with the domestic market. One of the more prominent examples of fostering an 'enclave' segment was the development of the semiconductor industry from the mid-1960s. Until the beginning of the 1980s, Korea was basically an assembly site for multinational electronics companies, and Shin argues that its weak forward linkages with industries like computer and telecommunications explain the high degree of export orientation of semiconductors. Moreover, the internal market was insufficient for Korea to exploit economies of scale and produce competitive goods.

The Korean catching up in the semiconductor industry was the result of high investments in R&D (from the 1980s), carried out by the chaebols with the state's support. In fact, rather than wait for comparative advantages to emerge naturally, the Korean government created them by concentrating resources in a few groups, adopting an import substitution strategy and directing incentives to export (Grabowski, 1999). One key means of acquiring advanced technologies by Korean companies was the establishment of outposts at Silicon Valley by taking over small US firms.

The chaebols concentrated their investments in a narrow segment of the semiconductor sector, i.e., the development through learning by doing of competitive memories, the DRAMs. First, they invested mostly in facilities and only later in R&D. The specialization was possible because the characteristics of the electronics industry, such as the possibility of fragmenting production in different sites with gains in economic efficiency.

According to Grabowski (1999), governments of Korea and Taiwan did not always adopt detailed development plans. Instead, they often acted pragmatically, going with "what worked and dropping what did not. Thus there was a dialectical interaction process between policy makers and society, more so in Taiwan than in Korea." Adelman (1999) and Grabowski (1999) point out that both governments exhibited high levels of autonomy regarding small groups' interests and were strongly committed to development. Generally speaking, they implemented a two-way policy, protecting infant industries in the domestic market and promoting their competitiveness by exposing them to competition in international markets with the support of export marketing institutions. Adelman stresses that they both "combined selective protection in successively higher industries with selective liberalization in earlier industrial specialties" (Adelman, 1999, p. 120). The selected industries were supported through quotas, tariffs, and subsidies. Financial resources were provided to them at below market interest rates, since the government controlled the banking system via ownership or having significant influence (Grabowski, 1999).

The public sector was the actor that organized and enhanced the well-functioning of the markets by building the physical and institutional infrastructure, correcting their failures, choosing industries for development, ensuring saving and

technology and promoting stability, investment and competition (Stiglitz and Charlton, 2005). For Adelman (1999), possible market distortions associated with state interventions were limited by the subordination of subsidies to the export performance of their beneficiaries.

The two economies and other East Asian countries took advantage of the import demand from OECD countries, and also of shifts in the technology cycles and competition strategies of large multinational companies. The segmentation of production of electronics, often spatially separated to gain efficiency and save costs, and different requirements in terms of capital and skills across each segment led these companies to search for lower wages. East Asia economies had the merit of perceiving the windows of opportunity opened by the global production networks associated with the emergence of information technologies and globalization.

Both economies invested heavily in education, and the increase in the supply of university graduates was so impressive that it temporarily surpassed their capacity to create job opportunities for them in the academic system and industry, especially in science and engineering. Many of them emigrated in search of job opportunities or to continue their education abroad. The government tried to restrain the brain drain, but without much success at the beginning. In Korea, the universities became more undergraduate teaching-oriented than research-oriented, and the university system was not able to develop a university system with strong balance between teaching and research, as other countries did (UNIDO, 2005). Overtime, job opportunities were created, stopping the brain drain.

2.2.2 Critical factors to the East Asia success

Many studies conducted by individual academics and institutions (such as the World Bank) have tried to explain the success of East Asian economies in catching up, stressing the role of market friendly policies, state activism (or developmental state), export-oriented strategies, high investments in education and concentrated investments in the most dynamic technologies. Other explanations impute the East Asian success to their cultural heritage, particularly Confucian tradition and other features of “Asian ethics which encourage hard work, loyalty, and diligence” (James,

Naya and Meyer, 1989, p. 16). There are also those that remark the importance of the US support due to the cold war and the presence of many fortuitous circumstances in the world economy, such as the large foreign aid and growing openness of markets to manufactured goods. As in the case of Japan´s catching up after the defeat in the World War II, the U.S. aid in the context of the Cold War also contributed to strengthen the states in Korea and Taiwan and to the success of their policy in promoting socio-economic development.

Certainly all these elements matter and none of them alone explain the East Asian success, although some of them had been more determinant than others. In this section, we will initially sum up the main arguments on state activism, market friendly policies and export-oriented strategies. Then, the Korean and Taiwanese experiences will be analyzed from the perspective of the catching up approach, emphasizing technological aspects.

2.2.2.1 Market friendly policies versus state activism

The market-friendly policy approach and similar theories regarding the success of East Asian countries expound that efficient resource allocation was the principal force for growth, and that such efficiency resulted from freely functioning markets, “including closer integration of domestic product markets into international markets” (Wade, 2003 p. 29). Therefore, the East Asian economies are examples of the benefits associated with “get the prices right”, in which “right” means domestic prices aligned with international prices. (Wade, 2003).

One of the main studies that basically attributed the remarkable East Asia performance to the adoption of market-friendly policies was published by the World Bank in 1993, entitled “The East Asian Miracle: Economic Growth and Public Policy”. The origin of this study was the dissatisfaction of Japan’s government with the Bank’s emphasis on the use of free market policies in backward countries willing to grow, despite all the evidence to the contrary from the East Asian experience (Amsden, 1994). Eventually the Bank agreed to conduct broad research on East Asian growth, financed by Japan, but with the final product controlled by the top management of the institution.

The study noted that there is no single East Asian model, since East Asian economies combined policies differently, which the report classified into two broad groups: fundamentals and selective interventions. The first group included macroeconomic stability, high investments in human capital, solid financial systems, reduced price distortions and openness to foreign technologies. Selective interventions were comprised of financial repression, credit facilities, selective industrial incentives and export promotion trade policies, among others. It is also recognized that in most economies governments intervened to promote the development of selected industries systematically and through innumerous means, subsidizing credit, protecting domestic import substitutes and establishing export targets. They encouraged private investments through a broad range of instruments, including low relative prices for capital goods, subsidized interest rates, which provided limited risks for private investors who could seek tax rebates and special tariffs and exchange rate policies to keep the price of capital goods low.

Governments also created a wide range of financial institutions, among them investment banks to provide long term financing, as well as stimulated the development of bond and capital markets. The banking system was strengthened and made more accessible to a broad scope of savers, raising the level of financial savings. Additionally, education policies prioritized universal primary and secondary schooling, which enhanced rapid increases in labor force skills.

Although recognizing that government interventions through industrial, financial and trade policies played an important role in the East Asian catching up, mainly in the Northeastern economies, the World Bank report found it difficult to establish a statistical correlation between growth and specific interventions, under the argument that other economies followed the same polices without much success. Based on analytical and empirical judgments, the report affirms that states fostered growth in a higher and more equal way than otherwise would have occurred only when three prerequisites were matched: a) clear performance criteria for selective intervention and monitoring performance; b) strict cost control of intervention, preserving macroeconomic stability; and c) low price distortions. In other words, the report stated that government intervention fostered development only when rigorous criteria in terms of performance were required and monitored by government and competing firms, as well as prudent management of macroeconomic costs. These

criteria were fundamental to the achievement of two important objectives: macroeconomic stability and rapid export growth. In this analysis, performance of some economies that had not matched these criteria might have been even better if local government had “intervened less or not at all” (World Bank Report, 2003).

The document added that government interventions only made the difference by producing higher and more distributed growth in just a few economies. The report suggests that the institutional context is as crucial to the success or failure of a policy as the policy itself. This would help to understand why similar policies produce different results in different economies. In the NIEs of Southeast Asia (Indonesia, Malaysia and Thailand), government interventions would have been less pervasive and important to the economic performance than the sound macroeconomic policies. Then, the Report concluded that the experiences of Southeast economies are more relevant to other developing countries than that of Northeast Asia, which had an impressive performance in a very different international environment.

In sum, the main conclusion of the World Bank´s report is that the common element in the trajectory of high performing Asian economies was the adoption of a set of similar market-friendly policies that fostered high accumulation of physical and human capital, as well as better allocation of resources by encouraging saving and investment rates, expenditures in education, and exports. Although acknowledging that government interventions played a role in the most successful economies, the report concludes that the effect of the state intervention was residual. According to the World Bank, East Asia achieved high growth mostly by getting the basics right through sound macroeconomic policies, which provided the essential framework for private investment, whose high rates exceeded an average of 20 percent of GDP for the period 1960-1990. Therefore, the key factor to success was the government focus on macroeconomic stability, basic education, sound financial systems, and secure property rights.

In contrast with the World Bank’s view, supporters of the developmental state approach explain most of the East-Asian performance on the basis of state activism. Amsden, for instance, attributes the East Asian Miracle to micro-institutions based on a broad state intervention, which enhanced competitiveness by subsidizing learning, instead of cutting real wages, as prescribed by the World Bank policies. The author

notes that in all successful countries private investments were supported by the state in many ways, such as the provision of infrastructure, promotion of technology transfer, financing, tax rebates, public procurement and so on.

In Amsden's view, much of the East Asian government expenditures on private production run apart from the general government budget and parliamentary political process, and were under the exclusive control of the bureaucracy (Amsden, 1997[82]). Although the magnitude and composition of off-budget revenues and expenditures have varied across East Asian latecomers, generally, public spending contributed at a large extent to the fixed capital formation.

Amsden contends that focus on the fundamentals supposes that economic growth is a straightforward process, conversely to what new growth theories and models suggest, in which economic growth is explained by multiple causes (Amsden, 1994). In her perspective, the Bank's mistake was to dissociate the macro basis from their micro foundations, or supporting institutions. In fact, the high saving rates in East Asia were fostered by the state, which owned all banks both in Korea and Taiwan. In the same way, exports were enhanced by favorable exchange regimes and extensive substitution policies ("tariffs and quotas on competing imports") and sophisticated export incentive systems. Consequently, "one cannot separate high investment rates from financial repression, or high export growth from import substitution or deliberate export promotion" (Amsden, 1994[83], p. 628).

In fact, the World Bank did not give a real space to heterodox interpretations (named revisionists), leaving out most contentious issues and prioritizing evidences more in line with the market-friendly approach. Instead, the report presented predominately data and analyses that support the free market-friendly policy view, keeping away works that show correlations contradicting its main thesis.

The conclusion that East Asia economies succeeded by getting prices right with minimal states derives from a narrow definition of market that overstates exchange and neglects production. This neglect, in Amsden's view, obscures the real

[82] Amsden, Alice H. (1997) Bringing production back in – Understanding government's economic role in late industrialization. World Development, Vol. 25, N°. 4, pp. 469-480. Elsevier Science Ltd

[83] Amsden, Alice H. (1994) - Why isn't the whole world experimenting with the East Asian model to develop?: Review of the East Asian miracle. In: World Development, 1994, vol. 22, issue 4, pages 627-633

government involvement in the economy in East Asia and that states supported the social construction of competitive assets (resources, skills and organizations) to overcome knowledge-based barriers by manipulating key prices (such as exchange rates, interest rates and wages) and by deliberately getting some prices “wrong” rather than try getting prices right by fostering perfect markets (Amsden, 1994).

According to Wade (2003), some evidence indicates that intentional “distortion” of some prices may support growth by changing the signals to which decentralized market agents respond, influencing their behavior. In the case of Korea and Taiwan, public policies relatively lowered the cost of investment goods, fostering accumulation, industrialization and technological development. Yet, the reduction of the technological gap with leader countries and of competitiveness in international markets have implied “a deliberate creation of ‘distortions’ in the form of firm-specific skills, knowledge-based monopolies and other types of entry barriers” (Amsden, 1997, p. 479).

Emphasizing the role of the developmental state in the Asian success does not mean dismissing the vital importance of the entrepreneurs. In fact, the state enhanced the development of a strong private sector, even in countries in which state companies invested directly in productive activities. As the World Bank report recognizes, one aspect that made difference in the most successful East Asian economies was the subordination of government interventions to rigorous performance requirements by the private firms.

Wade (2003) adds new elements to the developmental state interpretation and sets three levels of explanation to the economic performance of East Asia, being the primary causes a combination of: a) high levels of productive investment embodying newer technologies; b) more investments in key industries than would have happened without the government activism; c) exposure of many industries to competition in foreign markets. The second level of explanation is that to reach these results governments used a set of economic polices - including incentives, controls and instruments to spread risk – to govern the market process of resource allocation. These policies were carried out by specific organizations of the state and the private sector – and it is the third level of explanation.

The author states that governments guided markets by a) redistributing agricultural land in the early post-war period; b) managing the financial system and subordinating private financial capital to industrial capital; c) preserving the macroeconomic stability, focusing especially on the exchange rates, interest rates and the general level of prices; d) regulating foreign competition in the domestic market and setting priorities to scarce foreign currencies; e) promoting exports; f) enhancing technology transfer from multinational companies and building a national technology system; g) supporting selected industries through sectoral polices. (Wade, 2003)

Wade makes a distinction between sectoral policies that lead markets and those that follow markets. In the first case, the government influences the choice of products to be produced and technologies to be adopted by the use of public resources and other policy tools. In the absence of interest by private sector or of private firms themselves, the government may put its strategy in action through public enterprises. Sectoral policies follow the markets when the government accepts proposals of private firms in terms of new products and technologies, assisting them to reach their endeavors. Wade qualifies the leading and following policies by their degree of additionality. When government supports firms to do what they would have done anyway, according to the author there is a “small followership”. When the support is significant enough to affect the margin of investments, there is a “big followership”. So Wade uses the term ”big leadership” to “refer to government initiatives on a large scale enough to make a real difference to investment and production patterns in an industry, and ‘small leadership’ to refer to government initiatives which on their own carry too few resources or too little influence to make a difference” (Wade, 2003, p. 28). According to Wade, what made the difference were the government initiatives associated with the “big leadership”.

2.2.2.2 Import substitution versus export orientation: a comparison with the Latin American experience

Another stream of interpretation assigns the success East Asian economies to the adoption of export-oriented strategies, which encouraged domestic producers to export rather than sell their products on the domestic market. This stream was quite popular in the 1990s, when it became very common to compare Latin American and East Asian experiences, contending that the latter succeeded in catching up because they adopted (1970s and 1980s) export-oriented strategies and market-friendly macroeconomic policies earlier, while the former pursued import substitution paths based on the protection of infant industries for long time.

Although very appealing for its simplicity, this interpretation tells only part of the story. As Amsden (1993) points out, this explanation sees the world in terms of export-led growth versus import substitution and considers that exporting does not demand a previous period of import substitution. It supposes that domestic production just starts when the country has comparative advantage, and that this stage can be reached without subsidies or protection in the context of import substitution polices. It implies, according to Amsden (1994), seeing import substitution as an isolated event, instead of a process whose length is not easy to capture using only aggregate measures.

Unlike the views that emphasize exclusively the export-oriented aspect of the East-Asian industrialization processes, the fact is that often import substitution policies precede export-orientated strategies. In Korea, for instance, the development of heavy and chemical industry was initially oriented to the domestic market and greatly based on protective measures and concession of subsidies to infant industries. The extension and length of the protection varied according to the sector involved, being higher in strategic industries.

The early export orientation of the electronics industries seems to be more an exception than the rule if we consider the whole process, and it was at great extent connected to the productive and competitive strategies of international leading firms. Aiming to reduce costs and becoming more competitive, electronics firms located in advanced countries outsourced the assembly of final goods and/or the production of components to subcontractors in countries with lower wages. Governments of East Asian economies, and later on also of Southeast Asian countries, took advantage of this trend offering incentives to attract these companies. In doing so, they engaged

early in global production and marketing networks of electronics industries. Overtime, some of them moved from the simple assembly of products to the production of components and/or specific goods, initially by copying and eventually developing their own products and technologies.

East Asian nations performed better in the 1980s than Latin American's probably because they focused on both import substitution and exports, conversely to what the latter initially tended to do. Moreover, differently from what happened in most Latin American countries, the strong states of Korea, Taiwan and other East-Asian countries made their support to the private sector contingent upon a system of rewards and punishments according to the achievement of established goals (Grabowski, 1999; Amsden, 1997). In other words, governments in East Asia predominantly allocated subsidies and indirect support in a disciplinary way, subjecting import substitution industries to many requirements, including export performance, productivity increment, quality improvements, investments in human capital development and R&D expenditures. If the targets were not made for a good reason, the privileges were usually removed. The extent and success of such discipline varied across economies. Indeed, there were no great disparities among the former and the latter in terms of type of policies and subsidies conceded to promote rapid industrialization.

Amsden (1994) sustains that the composition of manufactured goods for export supports the thesis about the connection between export-led growth and import substitution in East Asia, arguing that the sectors that performed better were those that received more government incentives. In all countries that succeeded in export activities in East Asia, the state played a key role in the organization of production and trade expansion. Even in Thailand, the country with less government intervention (although considerable) in East Asia, the export-led industries was granted with significant government support. Thus, conversely to the views that see export as a natural and automatic result of the presence of comparative advantages, the Asian experiences show that steady efforts are required to compete effectively in world markets, which involves learning new competences, marketing, innovation and entrepreneurship, for which the assistance of specialized export institutions and foreign partners is crucial.

The export-led orientation became stronger in East Asia in 1980s, after the second oil shock and the beginning of the debt crisis that engorged many developing countries. This re-orientation enabled the region to resume growth and boosted manufactured exports. The conversion of import substitution industries in exporters relieved pressure on the balance of payments and stimulated the raise of investment rates in the economy as a whole, and reduced the dependence of East Asian countries on foreign borrowing.

As it is known, Latin-American countries were traditional suppliers of primary products to more advanced economies, which provided the needed foreign currencies to finance part of their imports of manufacturing goods, despite of the tendency of deterioration of the terms of trade envisaged by ECLA. Moreover, large countries like Brazil, Argentine and Mexico, had also big markets and abundant natural resources that enabled them to base their industrialization in the expansion of their domestic markets. East Asian countries, in contrast, had neither primary products to export and generate foreign currencies nor domestic markets large enough to sustain a process of inward-oriented industrialization. They also spurted their industrialization by adopting import substitution polices to promote mature industries, as the Latin America countries did, but soon had to take a step toward international markets to continue moving ahead. In doing so, they transformed a contingency in an opportunity.

Korea and Taiwan, for instance, had to search foreign markets to get strong international currencies to finance the continuation of their development process. They knew how to take advantage of the emerging electronic industries and technologies by adopting export-oriented strategies. Such strategies enhanced productivity gains in the economy as a whole, and enabled some countries to become innovators in specific segments of the electronics industry. These countries exploited opportunities in international markets, but also expanded domestic markets. The Southeast Asian countries pursued another pathway, by which they specialized in the production of goods for export, predominantly assembled, to the detriment of the development of the domestic economy and the production of intermediate goods – which explains why they did not go as further as the four tigers.

The integration of East Asian countries into the world economy was crucial to their long-term growth and it was possible because they combined direct government intervention and reliance on private entrepreneurship. The government adopted sound macroeconomic policies to, contrary to the orthodoxy, get fundamental prices "wrong" according to strategic goals. Government agencies established a closer relationship with the private sector, guiding and assisting through planning, coordination and a myriad of support mechanisms – financial, technological and managerial. The process was complex and the path to success involved difficulties and failures.

In sum, in most cases in East Asia, the outward orientation was preceded and/or accompanied by import substituting strategies. East Asian countries were also affected by the 1980's crisis, but they learned to take advantage of the changing conditions in the international trade arena, while initiating programs to liberalize imports, investments regulations and financial markets.

Box 2.1 - Import substitution policies in Latin America

Latin American economies adopted development strategies based on import substitution policies, but the protection and subsidization of local industries were usually provided without the imposition of any discipline on the capital. In contrast to the Asian economies that succeeded in catching up, the Latin American economies kept their industrialization processes inward-oriented and based on mature industries until the debt crisis of the 1980s. They neither fostered export activities as vigorously as they promoted import substitution, nor pursued attracting emerging industries and technologies. Those who tried to embark in the new and more dynamic industries did so using the same inward-oriented strategies, which were effective to mature industries but inappropriate to spark the development of industries characterized by different (and shorter) cycles of product and technology, and consequently by another logic of production, distribution and competition.

Therefore, it is not the import substitution strategy per se that explains the differences in terms of achievement between Latin American and Asian countries. Actually, the former exhibited socio-economic performances less impressive than the latter, not because they adopted import substitution policies in the early stages of industrialization, but because later on they did not take a step further, combining such policies with export oriented measures. Yet they did not design effective policies to take advantage of the windows of opportunity opened by the emergence of information technology

> industries, which were already born internationalized. Latin American economies just came to promote manufacturing exports in the 1980s, when the import substitution model collapsed and the debt crisis trapped most of them in balance of payment constraints, rampant inflation troubles, fiscal insolvency and other macroeconomic problems. In this context, the export promotion was done at the expense of real wages and domestic markets, without initially enhancing productivity.
>
> One can ask why Latin American economies neither adopted export-oriented policies nor tried to attract more dynamic industries with the same tenacity that they pursued import substitution strategies to attract mature industries. The answer to these questions may be found both in the theoretical basis of the Latin American countries' industrialization and their insertion in the world economy as exporters of primary products in the post-war period.
>
> The main intellectual inspiration and technical support to import substitution policies in the Latin American countries came from the UN Economic Commission for Latin America (ECLA). ECLA's development experts advocated that these countries, because of their position in the periphery of the world economy as suppliers of primary agricultural products and the asymmetrical diffusion of technical progress, should pursue import substitution polices to increase productivity and foster economic growth. They believed that technological progress would occur automatically through protection of infant industries.
>
> According to Bielschowsky (1998), conversely to what it is said, since its early days and mainly from the 60s onwards, the ECLA also pointed out the importance of stimulating exports, and played an important role at least in two initiatives to this regard. However, although the Commission had also stressed the importance of export promotion, the Latin American countries only moved in this direction in the 1980s, when constrained by the debt crisis and balance of payment imbalances. Perhaps the ECLA had not emphasized the importance of export promotion with the same vigor conferred to the import substitution process per se. In any case, the focus of the institution was placed in the export of goods of mature industries.

2.2.2.3 The role of investments in human capital development

Some authors attribute a great part of East Asia miracles to massive investments in basic and higher education, especially in the case of Korea, and also of Taiwan. The effort made by both economies to expand secondary and tertiary education was remarkable, investing in institutions and capabilities with little demand.

However, without an investment policy, the newly educated workforce would not find employment, and the result of education expenditures would be the increase of unemployment rates and the emigration of skilled workers (Amsden, 1994). In Amsden's view, the supply of educated people does not obey Say's Law, generating "the demand necessary to employ it" (Amsden, 1994).

Both Korea and Taiwan (two of the most educated latecomer economies) experienced brain drain and unemployment before the introduction of industrial policies in the 1950s. What really made the difference in East Asia with respect to the accumulation of human capital was the creation of employment opportunities, at some point, in parallel with the development of human resources. As many authors have stressed (Reinert, 2006, and Fageberg and Godinho, 2003, for instance), investing in human capital without changing the productive structure to absorb the skilled workers is to train people for unemployment and emigration. East Asian economies not only invested in schooling, but also managed to expand both higher technical education and employment opportunities for engineers and scientists. For them, as Fagerberg and Godinho (2003, p. 33) pointed out, "technology and educational policies were complements, not substitutes, and the ability to carry these policies out in a sustained and coordinated fashion probably explains a good deal of their economic success." In sum, investments in human capital are a necessary but not a sufficient condition for the take-off of technology-intensive industrialization (Ras, 2005).

The growth of investment rates and the continuing absorption of new skilled human resources encouraged further investments in education and training, creating a virtuous circle. The increased demand for labor and the human resource development contributed to spread the benefits of growth (James, Naya and Meier, 1989, Abramovitz, 1994).

Amartya Sen (2000)[84] argues that the investment in human capital of East Asia economies that succeed in catching up went very much beyond the expansion of education. Similarly to Japan, they enhanced the human resources development through the creation of social opportunities, investing not only in massive basic

[84] Sen, Amartya (2000) – Development as Freedom. Oxford University Press.

education, but also in health care and other spheres that affect the conditions of living, even before lifting millions out from general poverty.

2.2.2.4 East Asian Technological Catching up

Approaches rooted in evolutionary theories/Neo-Schumpeterian perspectives usually highlight the importance of the technological catching up to the success of East Asian economies. There is no question that high investment rates in physical and human capital are important to successfully catch up. But the nature of these investments matters. High physical capital accumulation per se is not sufficient to sustain a development track. In the Nelson and co-authors' view (Nelson *et alii*, 1997), what made the difference in the Asian Miracle, particularly in Korea and Taiwan, was that a significant part of capital investments embodied modern technologies and were carried out by an effective entrepreneurship. "Expansion of physical and educational capital per worker", in the words of Nelson and Howard, (1998, p. 28)[85], "is essential part of the process by which the economy incorporates modern technology into its productive structure. But, on the other hand, accumulation without assimilation yields no returns".

The technological efforts in Taiwan and Korea by firms were critical elements that enabled them to start new industries and absorb new technologies. Moreover, much of the efforts of absorption involved learning about new opportunities, improve organization and management, efforts that are not included as formal R&D investments (Nelson and Howard, 1998). In fact, it was the significant and effective innovative performance of the firms that entered into new lines of business what made saving and investment profitable (Nelson and Howard, 1998). Differently from industrialized countries, public R&D and technology were basically more involved with technology development than with applied research at the frontier of innovation (UNIDO, 2005). In Korea and Taiwan, the institutional framework for competence building and technology dissemination were set up in the 1950s, 1960s and 1970s to facilitate the industrial development. In Taiwan, it supported the creation of

[85] Nelson, Richard and Howard, Pack (1998) – *The Asian Miracle and Growth Theory*. Policy Research Working Paper 1881. The World Bank Development Research Group.

development centers for metal, chemical, mining, energy, glass, textiles and food; the setup of research unities by state companies and the creation of the National Science Council (NSC) and other institutions to promote industrial technology development - such as the Industrial Technology Research (ITRI) and the Electronic Industrial Research Centre - and the export of machinery, whole plants and IT goods. The ITRI was a key factor in the development of applied technologies for components and capital equipment and technology training in process engineering. The Electronic Industrial Research Centre (renamed Electronics Research and Services Organization, ERSO) enhanced competence-building in the industry through technology transfer and training.

In Korea, the government decided to enhance the domestic technological capability in electronics and information technology in the early 1970s, creating industry-oriented research institutes and stimulating technology transfer through licensing and consultants. The Korea Institute for Electronic Technology (KIET) was set in 1976 "to plan and coordinate semiconductor R&D, provide technical assistance to firms, assist technology transfer from abroad and conduct market research" (UNIDO, 2005, p. 51). As the chaebols expanded their in-house R&D capacity, the KIET changed its mandate and name, giving more attention to technological frontier.

As a result, both Korea and Taiwan were exporting products in the 1990s that they did not produce in the 1960s, such as electronic goods. This was possible because firms did not absorb technology passively, but instead, as Nelson *et al* (1997) state, they built technological capabilities by "first learning rudimentary processing, then improving their productivity in small ways, then engaging in innovations in process engineering and product design", through intense efforts by firms. Thus, export activities were an important "vehicle for learning" and "a way of exploiting evolving comparative advantages" (Nelson and Howard, 1998, 18).

The magnitude of changes cannot be measured or even perceived by using highly aggregated economic data alone, but rather by studying the stories from successful firms one can see the process through which they mastered new technologies and developed the necessary competencies to operate in new product fields. The story of firms, according to Nelson *et al* (1997), reveal the complexity of

this process and the changing interactions established with OECD contractors, which initially provided technical assistance and specifications for the new products manufactured by local producers named original equipment manufacturers (OEM). Case studies reported by Amsden (1989) and Hobday (1995), for instance, suggest that, rather than simply absorbing foreign technologies, usually local contractors worked actively to improve productivity and move towards more sophisticated and profitable products. At the beginning, the learning process involved reverse engineering; progressively many companies engaged in innovative efforts upon imported knowledge and some of them were able to do their own designs and later to sell products under their own brand names.

Generally speaking, firm stories show that the East Asian miracle was a process more complex than move along the production function due to the capital accumulation, involving also shifts in production function, associated with entrepreneurship and innovation (Nelson and Howard, 1998). As we saw in the first chapter, technological activities go beyond machinery and other physical devices, comprising modes of coordination and management activities, which are usually more difficult to develop, even though they represent an essential part of catching up processes (Nelson *et al*, 2005). These processes also entail deliberation and adaptation of organizational, managerial and institutional aspects of productive practices of leading countries to the local context, meaning domestic conditions, norms and values (Nelson *et al*, 2005).

It was taking into account the history of Korean and Taiwanese firms that Lee and Lim (2001)[86] and Lee (2005) built a taxonomy to explain the catching up phases followed by latecomer firms in Asia. Lee and Lim (2001) established stages of technological development and patterns of catching up, as follow.

a) Stage I - latecomers learn operational skills by operating imported equipment with support of foreign producers. This stage is characterized by duplicative imitation and path following catching up;

b) Stage II - the main feature is the acquisition of technology processes through duplicative imitation. In this stage, there is already the possibility of a skip;

[86] Lee, Keun, & Lim, C. (2001) - *Technological Regimes, Catching-up & Leapfrogging: the Findings from the Korean Industries*, Research Policy, 459-483.

c) Stage III - latecomers are able to design by imitation products or plants, usually with the help of specialized R&D firms from abroad. This phase is characterized by creative imitation and for a greater possibility of skipping the catching up process;

d) Stage IV - latecomers become able to conduct real innovation – path creating or path leading catching up.

In advanced countries, leading firms first conceive and design new products, and then develop parts and finally assembly them. Firms in late-coming countries, on the other hand, started by assembling imported parts to produce final goods, then they developed low-tech parts and afterwards they learned to design modified versions of existing products and eventually learned to create new products (Lee and Lim, 2001).

To know the level of development of a firm one has to investigate if it is assembling, making parts or designing products themselves. In fact, this methodology does not fit all sectors. In some high tech sectors, such as the aircraft industry, the leader companies are in charge of conception, design and assembly. Such was the case for automobile industries in advanced countries. At any rate, his classification is useful to understand the catching up processes of the dynamic Asian economies.

Following Lee and Lim´s taxonomy (2001), Lee (2005) identifies three patterns of catching up: a) a path-following catch up, in which latecomers take the same path of the forerunners; b) a stage-skipping catch up, where latecomers follow the path, but skip some stage to save time; and c) a path-creating catch up, in which latecomers take their own path of technological development.

The author focuses on the last two patterns, which he calls leapfrogging catch up. Leapfrogging occurs when firms in backward countries take advantage of windows of opportunity opened by new techno-economic paradigms to close their technological gap with forerunners, as pointed up by Perez and Soete (1987). According to Lee (2005)[87], even though the idea of leapfrogging had already been

[87] Lee, Keun (2005) - Making a Technological Catch-up: Barriers and Opportunities. Asia Journal of Technology Management, vol. 13:2, pp. 97-31.

considered by Gerschenkron, most of the studies on catching up have paid attention only to catch up in mature technologies.

In Lees' view, contrarily to advanced countries that usually attain higher capabilities in sectors technologies with longer cycles, leapfrogging in developing countries is more likely in sectors with rapid technological change and shorter technological cycles (case of Korean and Taiwanese firms) and became more plausible with globalization and new information technologies (Lee, 2005)[88]. Lee and Lim (2001) associate the three patterns of catching up to three stages of technological capability building by latecomer firms. Accordingly, in the stage I, latecomers learn operational skills by operating imported equipment, plants or production lines with the support of foreign producers and following blueprint instructions. The stage I is characterized by duplicative imitation and path following catching up. In the stage II, the main feature is the acquisition of technology processes through duplicative imitation. Latecomer firms become able to set up their own production unity and take responsibility for the production, learning by processing technology. In the stage III, latecomers are able to design products or plants by imitation, usually with the assistance of specialized R&D firms from abroad. This stage is characterized by creative imitation and by a chance of skipping catching up. In the stage IV, latecomers become able to conduct real innovation – path creating or path leading catching up.

Lee (2005) explores the obstacles faced by latecomer firms to acquire design capabilities. He notes that these firms do relatively well during the first stage of catching up, when they produce only goods designed by forerunner firms in factories designed by them (OEM).[89] Korea and Taiwan's domestic companies, for instance, learned by operating foreign-made plants or production lines following blueprints and guidelines established by contractors. The tacit knowledge was creating during this process of learning by processing foreign technologies, and domestic firms became able to set up their own production unities and take responsibility for the production

[88] Using an econometric model, Lee (2005) investigates which sectors tend to generate more catching up by Korean and Taiwanese firms using the number of patents registration in the USPTO. He found that Korean and Taiwanese firms acquired technological capabilities mainly in sectors characterized by short technological cycles.

[89] This taxonomy fits better to Asian countries and Mexico (with the *maquilladoras*), used as platform of export, than to other Latin America countries that pursued industrialization predominantly through import substitution.

(Lee (2005). However, more successful firms faced difficulties when forerunner firms refused to sell or license technology and designs to them, or move their production to other lower-wage sites. It was the cases of Korean *chaebols* when foreign forerunner firms (especially from Japan) stopped transferring design for them; and of Taiwanese firms, when multinational companies started to move their contracts to lower-wage countries. Lee (2005) mentions the case of Korean car makers that faced difficulties in the US market in the 1980s for lack of a good design and moved to emerging markets, such as Latin America, Eastern Europe and Southeast Asia, in order to get time to upgrade the quality of their products (case of Hyundai). This example gives an idea of the risks of trying to export brand products without a solid design capability, which is not easy to develop.

Lee (2005) contends that firms can use these moments of design crisis as a window of opportunity to leapfrog through a stage-skipping or a path-creating catch up. The author analyses two risks or uncertainty connected to this leapfrogging strategy – the choice of the right technologies and standards among several alternatives or the creation of initial markets. The first risk can be reduced when standards are already established ("standards before markets"). The government may contribute to reduce uncertainties by identifying a promising R&D target and defining standards in advance. With regard the creation of initial markets, this endeavor was easier before WTO, when it was possible to protect national markets and use public procurement, subsidies and protective measures to promote infant industries. These mechanisms were quite important for the development of Korean automobile industry, and also in the production of digital automatic telephone switch in China, in which the government provided market protection and incentives to the adoption of local products. Without incentives or regulations for using local made products, firms will continue to buy foreign products recognized quality (Lee, 2005).

To develop technological capabilities and catching up, in house R&D activities are crucial, and it is here the government, public research institutions and consortiums may play a key role. Considering patent indicators, public research institutions were more important in Taiwan than in Korea.

Although multinational firms can be helpful in the beginning of learning process, local ownership matters in R&D activities, since such companies have no

reason or incentives to carry on technological development activities abroad. Strategic alliances are possible and can work only when the latecomer firms have higher technological capability and bargaining power. The technological capability of local firms determines the terms of the technological contracts between local and foreign firms. Yet the role of government continues to be important.

For Lee, it seems that are two or three models for catching up, at least when we think about the Asia's experience – Taiwan, Korea and maybe Singapore or China, explained as follows:

- Korean Model – process commanded by few large national owned firms (chaebols), independent from multinational companies (MNCs) in terms of production, financing and marketing (brand). In the 1970s, the government supported them to develop their own R&D activities, sometimes taking part in high risk and large-scale projects. They used foreign R&D and other MNCs as source of new knowledge through embodied technology, import, co-development and horizontal collaborations. The Chaebols were independent form each other, maintaining their own network.

- Taiwanese model – process initially commanded by a large number of national SMEs associated to MNCs in terms of financing, production and marketing (brand). In the early stage, the national SMEs used to work as subcontractors of MNCs and had the support of the government to access new knowledge. There were intense collaboration and exchange of knowledge among the firms. The economies of agglomeration allowed low transaction costs and high visibility.

2.3 Southeast Asian countries take a different road

Looking at the experiences of Southeast Asian economies is useful to better understand the critical factors for the success of the Korean and Taiwanese catching up, which will be revealed in this section. In the Southeast Asia, especially Thailand, Indonesia and Malaysia, governments also supported import substitution industries and export activities through price mechanisms (such as import tariffs, overvalued exchange rates, and low domestic food and fuel prices), tax breaks, credit facilities

and import controls. The protection embodied in the industrial policy covered from selected heavy industries to consumer goods sectors and services. Generally, subsidies were granted in exchange for compliance with certain guidelines and performance requirements.

According to Grabowski (1999), however, the industrialization in those countries was not strongly coordinated by a developmental state, but mostly by developmental entrepreneurial groups controlled by Chinese immigrants. Grabowski (1999) contends that, in the absence of strong developmental states, such business-oriented ethnic groups resolved important collective development action issues in Southeast Asia. These groups gained knowledge in business during the colonial period. After the European retreat from Asia, they invested in several productive activities and developed an extensive network with other business groups throughout Asia and Pacific, based on ethnic identification. Due to their knowledge of local markets, linkages with other national markets and ability to foster investments, these groups became the favorite partners when Japanese and Korean investors started to relocate their production of labor-intensive manufactured goods for export into Southeast Asia in 1980s and early 1990s. These investment relocations were encouraged by raises in wages in East Asia and currency appreciations and government incentives in the receiving countries. They transformed Thailand, Malaysia and Indonesia in exporters of labor-intensive manufactured goods, drastically changing the composition of their exports, which had been previously concentrated in primary products.

In contrast with Korea and Taiwan, however, the Southeast countries did not develop the necessary technological capabilities to make the transition from the production of labor-intensive manufactured goods to more sophisticated ones. The firms that succeeded in getting involved with the production of medium-term technology goods have served in most cases as an assembly base for multinational companies.

These companies have used Southeast Asian countries as a platform for export activities, with production dependent on import inputs. In fact, even domestic firms have targeted predominantly foreign markets. Thus, the development of export activities has had little backward and forward effects in the rest of economy. In

consequence, domestic markets remained underdeveloped, there was not a strong accumulation of human capital and learning processes similar to those observed in East Asia did not occur in the region (Grabowski, 1999).

Actually the development processes of Southeast Asian countries remained concentrated, at least until the end of the 20th century, in the production of low technology products and the assembly of medium technology ones. Industrialization did not create integrated markets, given the neglect of domestic markets. Their advances in schooling, health services and other social indicators (such as sanitation and treated water) were also less impressive than in East Asia.

From the mid-1990s, with the rise of labor costs in Southeast Asian countries, East Asian investors started to re-directed their investments from Southeast Asia to countries where the labor were relatively cheaper, like China and Vietnam. Beyond the increase in wages, other factors contributed to reduce the competitiveness of Southeast Asian economies as a platform to export labor-intensive goods, such as the devaluation of Chinese currency in 1990 and 1994 and the appreciation of the U.S. dollar against the yen. With the drop in competitiveness, large structural current account imbalances emerged in most of them, since they had not accumulated enough human and technological capabilities to make the transition to the production of high-tech goods.

Grabowski (1999) attributes the imbalances in Southeast Asian countries to the strategy of development based on export industries in detriment of the domestic economy and the production of intermediate goods. Problems in the current account, financed through short-term and speculative capital inflows, resulted in the financial crisis of 1997.

Conversely, advocates of the market friendly approach argue that the poorer performance of the Southeast countries is explained by the excessive state intervention in the economy.

The analyses of the trajectory of Southeast Asian countries makes the importance to succeed in catching up by combining inward and export-oriented strategies; entrepreneurship and state activism; capital accumulation and innovation; investments in education and generation of more skilled jobs; and production of labor intensive and high-tech goods (just as the East Asian economies had done) more

evident. It also highlights the crucial role of targeting more dynamic technologies and developing endogenous capacity to innovate, both institutionally and technologically.

2.4 Concluding remarks

Since the post-World War II, many Asian countries, especially in East Asia, have succeeded in sustaining fast growth and narrowing (or closing) their economic, technological and income *per capita* gap with rich Western nations. Japan was the first Asian economy to catch up economically and technologically with the US and advanced European economies. Some East Asian economies followed the Japanese example, but pursued their own strategies to get industrialized. In this chapter, the Korea and Taiwan experiences were in focus and compared with those of other countries.

A critical element of the Korean and Taiwanese trajectory to success was the combination of private entrepreneurship and state intervention: guiding, supporting and disciplining the private sector through macro and sectoral policies that enhance new institutional arrangements and technological innovations. The Korean catching up was commanded by a few large national owned firms, the chaebols, which were independent from multinational companies in terms of production, finance and marketing (brand). The Taiwanese catching was initially commanded by a large number of national small and medium enterprises (SMEs) associated to multinational companies in terms of finance, production and marketing. Both in Korea and Taiwan, the state provided general and specific guidance and support to domestic firms, facilitating the access to financial resources, technology and markets.

After initially targeting mature industries (such as heavy and chemical industries in case of Korea), the economies of Korea and Taiwan directed their efforts toward the emerging electronics industries. They began by assembling final consumer goods, but embarked in higher stages of production later on, heavily investing in a narrow range of products or processes. Korea and Taiwan accumulated physical and human capital at high rates, but such accumulation only partially explains their performances. In effect, what seems to have made a major difference was the fact that investments in physical capital embodied modern

technologies. These economies also developed an inner capacity to innovate, creating new institutions (in accordance with their background and needs) *à la* Gerschenkron, adapting import technologies and innovating technologically. As a result, they were able to catch up with advanced economies in key sectors and even to forge ahead of the leaders in some technological fields, defining new technological frontiers. Korean and Taiwanese firms took advantage of a window of opportunity to leapfrog, for which the role of government was crucial. They attained technological capabilities mainly in sectors characterized by short cycles, to the contrary of advanced countries, which do better in sectors with longer cycles.

As in the case of Japan's catch-up after their defeat in the World War II, the U.S. aid in the context of the Cold War also contributed to strengthen the states of Korea and Taiwan and to their success in promoting socio-economic development.

III - CHANGING CONDITIONS IN THE CATCH-UP ENVIRONMENT: WTO AND CHINA

In the previous chapters, we emphasized the critical role of technological change and innovation for countries behind the socio-economic frontier to catch up with the most advanced economies and occasionally forge ahead the previous leaders. In this chapter, we analyze how some changing conditions in the international environment have placed new frames, imposing constraints, creating potential new opportunities and putting new requirements for countries willing to absorb new technologies and to build up inner capabilities for innovation.

In the first part, we analyze how the World Trade Organization (WTO) rules, which prevent the use of some policies and strategies used in the past by countries that succeeded in catching up, may affect developing countries' ability to catch up today. Emphasis is given to the impact of the higher protection granted to the intellectual property rights.

In the second part, we discuss the ongoing catching up of China, whose emergence as a major trading player and investor in manufacturing and services has considerably impacted the world markets, systems and commons, changing the conditions in which other nations make their economic decisions, patterns of comparative advantages and competitiveness, and investment opportunities. The case of China is discussed in this chapter and not in the Second Chapter for two main reasons: first, because China is still in the process of catching up; second, because its impressive performance and unique way of doing things have affected the global economy and every country in a way that perhaps no other country has ever done, changing drastically the environment for catching up.

3.1 WTO

International rules on trade, investment and IPRs have shifted considerably with the creation of the WTO in 1995, imposing constraints (as it is broadly claimed) and also opening opportunities to those behind the technological and economic

frontier. The WTO was an outcome of the Uruguay Round (1986-1993), the seventh and last round of negotiations carried out under the General Agreement on Tariff and Trade (GATT), the WTO's predecessor. With the creation of the WTO, the third institutional pillar idealized in Bretton Woods to handle the international trade was built, although delayed by almost 50 years.[90]

Among the agreements with a greater impact on the developing countries are those on subsidies and countervailing measures (SCM) and intellectual property rights (TRIPS). The SCM defines two categories of subsidies: prohibited and actionable. Originally, there was a third category: non-actionable subsidies, which existed for five years, ending on 31 December 1999, and was not renewed. Prohibited subsidies are those contingent upon export targets (export subsidies) or upon the use of domestic instead of imported goods (import substitution subsidies). Among the non-actionable subsidies were those to support R&D or pre-competitive development research projects, to adapt existing facilities to new environmental requirements or to promote regional development. Since January 1, 2000, these subsidies can be actionable by other countries in the event of an adverse effect on their interests.

The differential treatment given to subsidies for pre-competitive development research was introduced in the agreement by developed countries, especially the United States, which have strongly supported R&D activities of private firms.[91] Developing countries, however, that can also benefit from this kind of subsidy, have not used it extensively. We will come back to this point.

3.1.1 The current IPR regime and its impacts on innovation and catching up

The introduction of protection to IPRs in the world trading system completely changed the rules of the game on the subject, extending and harmonizing exclusive rights at the global level. Since then, products and processes of all technological

[90] The other pillars were the International Monetary Fund (IMF) and the World Bank.

[91] For more details regarding R&D subsidies to private firms provided by the US government, see Block, Peter (2010) – US Industrial Policies, R&D, and the WTO´s Definition of Non-Actionable Subsidies. As mentioned above, these subsidies are actionable since January 1st, 2000, even though the author still continues to treat them as non-actionable subsidies.

fields can be patented, even life-forms and materials found in nature. Moreover, the increased protection goes beyond patents, being associated with several other rights, some of them new. Before TRIPS entered into force in 1995, the Paris Convention of 1883 (for industrial property) and the Bern Convention of 1886 (for copyright) were the most important international treaties on IPRs (Rego, 2000).

The Paris and Bern Conventions were of voluntary adhesion, giving freedom to their signatories to adopt IPR regimes suitable to their legal system and economic situation. With the introduction of IPR rules in the multilateral trading system, the situation changed radically. TRIPS incorporated (by reference) most provisions of the previous international treaties and established minimum standards of IPR protection to products and processes, now mandatory for all technologies (Rego, 2000). In the agreement, the rights take a number of different forms, such as copyrights and related rights (covering computer programs and data bases), patents, industrial designs, layout-designs of integrated circuits, trademarks, undisclosed information, trade secrets and geographical indications.

Before TRIPS, IPR protection differed from one country to another, generating since the 1980s permanent tensions between the United States and many countries, including other developed nations, such as France, Switzerland, Japan and Spain. TRIPS not only universalized the levels and forms of IPR protection of developed countries (especially those of the United States), but also defined surveillance mechanisms, stipulating procedures and remedies to be adopted in case of non-compliance with the established rules. Differently from the World Intellectual Property Organization (WIPO) and other international organizations, the WTO has a dispute settlement system and can legitimate trade sanctions in case of violation of rules and other commitments. The enforcement mechanism of WTO is in fact one of biggest differences introduced by the incorporation of IPR protection into the world trading system (Rego, 2000).

IPRs were incorporated to trade rules by pressure of science base sectors in developed countries, especially in the US, to allegedly to enhance innovation and knowledge diffusion. However, the debate on how intellectual property laws effectively affect innovative activities and the diffusion of their outcomes is not conclusive, with strong arguments from supporters and opponents of IPR rules.

Today, patents are considered crucial by industries whose competitiveness rest on massive R&D investments and intangible actives' accumulation. They allow innovators to charge prices above the marginal cost of production and, in doing so, to extract extra rents to finance future R&D investments. It is argued that without patent protection there are no incentives, even when benefits to society are potentially high, to companies to invest in products whose development consumes a large amount of resources but can be easily copied and sold at a lower price by imitators (Rego, 2000).

The association established between strong IPR protection and investments in new technologies and products is questionable, since excessive protection may prevent, instead of encouraging, innovative activities and the dissemination of their fruits to society. The strict protection of basic-research outcomes and other key-innovations may preclude the competitors' ability of doing new innovations at reasonable costs. Moreover, there are complaints that the current IPR laws in practice divert a growing amount of resources from the generation of new knowledge to the protection of existing knowledge and generate a plenty of patents with no real value. Yet the extended period of protection does not take into account differences in terms of product and technology among industries or the social utility of the object of patent protection (Rego, 2000). There are also other mechanisms to appropriate the results of R&D investments, such as industrial secrets, and the innovator reputation and his ability to move more rapidly in the learning curve.(Chang (2001).

In effect, the rising in patent registration does not mean necessarily more innovation, but also reflect the shifts in IPR laws and strategic reasons to apply for a patent (Mazzucato, 2011). The current IPR included among what can patented the results of public funding research, research tools and living forms. Moreover, venture capital usually takes into account the number of patent to evaluate the strategic value of a company. The final result is a plenty of patents for things that rigorously do not represent a real innovation, but prevent that others make further exploratory research that could imply scientific discoveries and innovations with real value (Mazzucato, 2011). This side effect of the excessive IPR protection affect both developed and developing countries.

TRIPS became one of the most controversial WTO agreements, largely because of its far-reaching implications for developing and least-developed countries in fields such as technology, public health, traditional knowledge, food security and biological resources. Beyond the transitional period, TRIPS agreement did not provide any type of special treatment for developing countries. Provisions in this regard were established later, after difficult negotiations, and are related to the concession of compulsory license to some countries to produce or import generic versions of medicines to selected diseases, such as AIDS (Rego, 2000). Before Trips, many countries excluded pharmaceuticals from the patent system as a whole or granted patent only for production processes.

WTO members, on the other hand, have to guarantee full protection for both pharmaceutical products and processes, which may affect the access to medicines at affordable prices in poorer countries. In the majority of these countries, governments are not able to provide subsidized medicines on a large scale and out-of-pocket payments are the most common finance mechanism to pharmaceuticals. The situation is worst in countries that almost completely depend on imports since they do not have the technical capacity to produce generic versions of patented drugs.

Although the discussions about access to medicines have gained great popularity because of the high price of anti-retrovirals (for patients with HIV) and other medicines, the impact of patent rules on public health go beyond the access to pharmaceutical products. Patenting genes and microorganisms, as in the United States and European countries, is still a controversial matter, since more and more effective treatments for several diseases have stemmed from genetic engineering. The patentability of exams for diagnosis is also contentious. Some studies have shown that these kinds of patents may retard scientific advancement and the availability to society of techniques and discoveries that may represent the difference between life and death (Rego, 2001).

Over the long run, however, the effects of the new IPR regime may be more important in terms of economic development than the increased prices of pharmaceuticals and seeds. Although restrictions for catching up go much beyond IPR rules, the challenges in this area are huge because they are mandatory and cover all technological fields; reduce the room for reverse engineering (largely used by all countries that caught up in the past) and other kinds of imitation; make the

access to new knowledge and technologies more expensive and restrictive; and potentially reduce the room for maneuvering public policies, which increases the market power of incumbent players and renders technological transfer more costly, ultimately restraining a technological catch-up. These challenges put by the IPR regime demand higher efforts and investments in innovative activities by countries behind the technological frontiers.

Therefore, the importance of creating scientific and technological capabilities and an inner ability to innovate cannot be stressed enough. And it is not a task that can be faced by individual firms in isolation, since competence building is a systemic process. Thus, as Nelson and colleagues (Nelson at al 2005) point out, the constraints placed by international trade and IPR, as well as the growing importance of the scientific underpinnings of technology, reinforce the role of research in universities and public laboratories as part of the institutional structure necessary for successful catch-up. Local firms need to learn how to do R&D on their own, increasing the importance of training and building up capabilities in advanced technologies. R&D activities require an appropriate institutional context that is related to the formulation and implementation of pro-innovation policies in developing countries, which demands an understanding of the function of competition and industrial policies in the innovation process. Thus the key role of a well-integrated National Innovation System in which strong linkages among universities, research institutions, public and private enterprises, coordinating bodies and financial institutions to foster the acquisition, production and diffusion knowledge, enhancing innovative activities.

However, as UNIDO points out, one observes a remarkable mismatch “between the increasing recognition of the need for domestic knowledge system and a quite generalized recent decline in the allocation of resources to capability building in most of the developing world” (UNIDO, 2005, p. 17). Developing countries, for instance, have not used as they could subsidies to encourage pre-competitive development research, as allowed by WTO. Many of these countries still prefer to provide incentives to the production and commercialization of goods than financing innovation, which is a riskier activity. The financial support to innovation continues low in many developing countries, even though the Agreement on Protection to

Intellectual Property Rights (TRIPS) limits and makes more expensive the access to new technologies.

3.1 Box – Trips-plus Agreements

Since WTO entered in force, many developing and least developed countries have faced great difficulties to resist to international pressures for more IPR protection and some of them have already adopted IPR laws more restrictive than Trips. These Trips-plus agreements impose additional IPR obligations to developing countries, in order to accommodate new technological advances and demands from developed countries´ enterprises and governments. Several bilateral and regional trade and investment agreements between developing and developed countries (especially with the United States) also include mutual commitments on intellectual property that go beyond WTO minimum standards (TRIPS-plus clauses), limiting or preventing the use of Trips safeguards (such as compulsory license and parallel import) and new flexibilities negotiated in and after the WTO Doha Ministerial (2001) mainly for least developed countries (Rego, 2001).

The fact is that many countries lack the capacity to defend individually their interests in face of international pressures and set IP laws in accordance with their development needs. Even though concerns about the adverse impacts of Intellectual property laws are also present in developed countries, these countries usually have sophisticated systems of competition regulation and other mechanisms to avoid that abuses in the use of monopoly rights harm the public interest. In most developing countries this is usually not the case, what makes such countries more vulnerable to unsuitable IP systems (IPR Commission, 2002).

3.1.2 Broader Implications of the WTO Rules to Developing Countries

Critics of the international trade-related rules contend that advanced countries, mainly the US, designed most of rules for the sake of their own interests. It is argued that despite of the rhetoric of free trade and globalization, many of these countries continue to adopt non-tariff protectionist measures to keep out the goods of the developing ones. In Stiglitz's view, some advanced countries adopt "two standards for what is a 'fair' or 'unfair' trade practice, one for goods produced by manufacturers

within one´s country, the other for producers outside…" (Stiglitz, 2002, p. 4). In fact, there is a disparity between what is said and done in "North".

The rules on subsidies limit the protection for infant industries and prevent the use of the export performance requirements in the context of industrial policies. The current IPR regime and the scope of patents that have been granted in advanced countries for new technologies may be an obstacle for developing countries to build up inner capabilities in science and technology

However, although international regulations and practices may prevent or limit the use of some policies and procedures applied in the past by catching-up countries, it cannot be assumed *a priori* that the new international rules of the game (especially on IPR) either render catching up extremely difficult or even impossible. Neither that such rules are the most important obstacle that catching up candidates need to overcome to succeed. Actually, changes in the institutions and policies only partly explain the shifts in the environment for catching up. As Fagerberg and Godinho pointed out, "what is a suitable policy nowadays, depends not only on the characteristics of the policies that seemed to work well in the past, but also on the economic, technological, institutional and social context today (which may be quite different from those of previous times)" (Fagerberg and Godinho, 2003, p. 41). Moreover, the room for using many old instruments still remains, and they can be combined with new ones. It is for the developing countries to identify and take advantage of the degrees of freedom in the new rules.

Even with all the restrictions to knowledge diffusion imposed by IPR and other rules, knowledge today can flow through plenty of channels and is probably more accessible than ever. Even If a hypothetical international law eliminated all kind of intellectual property rights, science and new technologies would continue inaccessible to countries without the required skills, capabilities and previous knowledge to master new knowledge and technologies.

It is a fact that certain strategies and mechanisms used by countries that succeeded in catching up in the past cannot be used any more. The reason is not only because the current developed countries are "kicking away the ladder" that they used to catch up (in List's and, more recently, Chang's terminology). In fact, changes in so many levels in the environment for catching up have made certain remedies

that worked well in the past less effective, if not a complete anachronism. Even though international regulations and practices play a very important role in the definition of policies to move ahead, the new requirements for technological progress are not less important. In any case, when new policy tools can no longer be used, whether for legal commitments or because they became dysfunctional, it is time to create new institutional arrangements to face the challenges of the time. And these challenges today demand specific policies “to build capabilities within the knowledge, business and policymaking/governance subsystems largely fall below the radar of WTO agreements”, as a 2005 UNIDO Industrial Development Report wisely indicates (UNIDO, 2005, p. xiii). In fact, the necessary efforts today go beyond “the market-based incentives or the supply of generic public goods such as macroeconomic stability, the rule of law and functioning financial markets” (UNIDO, 2005, p. xiii), as well as the sole adoption of protective measures.

The effective impacts of the current IPR regime depend upon the institutional and socio-economic characteristics of each country and its scientific and technological capabilities. They are related to factors such as: a) the country’s efforts to build social and technological capabilities, and an endogenous competence to take advantage of foreign technologies and innovate; b) the governments’ capacity to design development strategies in association with different actors, taking in account numerous alternatives and interests; c) the country’s most dynamic economic sectors and their ability to identify and take advantage of potential windows of opportunity; d) the country´s ability to take advantage of foreign direct investments (FDI) to acquire new technologies and enhance innovative activities, bargaining with foreign investors their own national boundaries. The impacts in terms of catching up seems to be potentially higher than those countries that are “in the middle of the pathway”, such as Brazil. The evaluation of specific constraints to emergent countries involves identifying the country’s economy-driving sectors and their means of appropriation – patents, secrecy, lead-times, learning curves, and complementary assets.

As we saw in the first chapter and has been emphasized by many studies, with the growing importance of science-based technologies and the enforcement of the IPR rules, catching up relies more than ever on the ability of developing countries to build technological competences and develop inner capabilities to innovate, which

places the domestic knowledge systems at the center of industrial development strategies (UNIDO, 2005).

3.2 China

Following a development path distinct of those followed previously by other successful Asian economies, China has grown fast for more than three decades by combining in a unique way central planning with market mechanisms. Known until recently as an exporter of cheap and low-tech products, China is no longer simply a producer of bad quality goods or assembler of electronics to European and U.S. corporations. Now, the country´s exports and imports comprehend a large and diversified range of goods, which comprise both cheap and high tech products. China has progressively become more competitive in sophisticated goods, having its share in the world exports of high-tech products increased from 6.5 per cent in 2000 to 36.5 per cent in 2013.[92] This upgrade is explained by the acquisition of sophisticated equipment, parts and components, as well as by outsourcing, local improvements associated to in-house investments in R&D, technological alliances, acquisition of companies abroad and by government determination in turning China a major knowledge-driven economy.

Today, China is the world´s largest exporter and second largest economy, the major destination for foreign direct investment (FDI) and Chinese companies are going global through growing outward direct investment, with special interest in natural resource investments and acquisition of foreign firms with advanced technologies or brand names. Income per capita has increased steadily while poverty declined. China's exports and imports have grown faster than its GDP and trade plays an important role in its economic performance. China is not only a major exporter, but also a huge importer of a broad basket of goods. As a great consumer of commodities, the country imports from agricultural products to fuels and minerals, providing markets to many countries. The Chinese dynamism has contributed both to the increase of the relative prices of commodities and the fall of prices of

[92] Kynge, J. (2014) - China leads EM surge in high tech exports. Financial Times blog. http://blogs.ft.com/beyond-brics/2014/03/18/china-leads-em-surge-in-high-tech-exports/

manufactured goods. The first effect benefits developing countries in the short and medium run, but also raises the price of energy and produces environment concerns in the case of non-renewable natural resources. The second effect (which is associated to the first) produces also two contradictory results. On the one hand, it expands the access to manufactured goods over the world, benefiting the poorer with cheap products and contributing to control inflationary pressures elsewhere. On the other hand, and at the same time, it displaces manufacturing activities even in low-wage countries, what makes deeper the process of deindustrialization initiated with the liberal reforms of the 1990s.

As Winters and Yusuf (2007) show, although most of the increase in China´s imports of natural raw-materials reflects a net increment in the world demand, part of the Chinese additional demand is offset by the equivalent reduction in the consumption in countries that China has displaced manufacturing. In the same way, the boost of the U.S. and European countries trade deficit with China is to some extent balanced by reductions in their deficits with other Asian countries, due to the ongoing transfer of assembly and production from other countries to China.

While a few years ago figures about foreign investment in China used to cause some fears about the scarcity of funds elsewhere, today many concerns are related to the growing investments of Chinese companies abroad, especially through acquisitions. Yet, the country is moving steadily to become an important innovator in many technological fields, including clean technologies and renewable energies.

The present economic dynamism of China can be regarded as a regaining of the economic prominence that it enjoyed for centuries and lost with the European colonialism (Mandelson, 2007). For a long time, the country produced and provided a wide range of commodities to almost all corners of the world, enjoying a trade surplus with most of their partners. According to Swamy (2005), in the late 18th century, China was considered a developed nation by the criteria of the time, accounting together with India for about 50 per cent of the world product. Joel Campbell (2012)[93] notes (supported by Joseph Needham researches) that centuries ago Chinese scientists and technicians provided mankind with some of the most important pre-modern inventions, such as gunpowder, ceramics, crossbows, pulp paper, magnet

[93] Campbell, Joel R. – *Becoming a Techno-Industrial Power: Chinese Science and Technology Policy*. Issues in Technology Innovation number 23. Center for Technology Innovation at Brookings.

compass, seed drills and iron plows, seismographs, and sternpost ship rudders. Many of these inventions would have become the foundation of the Western industrial progress from the 17th century onward (Campbell, 2012).

The country lagged behind in technology and economic development during the 18th and 19th centuries due to internal and external turbulences, at the time that the first and second industrial revolutions took place in the West. The economic decline of China started coincidently with the Imperialism of Britain and other Western powers, which subjugated nations and occupied vast territories in Asia, Africa and Oceania.

After being defeated by Britain in the Opium Wars (1842 and 1860), China was subdued by five different empires and began the 20th century as one of the poorest nations in the world. In 1949, already liberated from foreign occupation (from Western powers and Japan) and with an economy based on traditional agriculture, the country started to pursue a rapid industrialization to catch up with the West under the so-called proletarian dictatorship, commanded by Mao Zedong. Mao adopted an economic system inspired by the Soviet Union, which was based on central planning, agrarian collectivization, investments in heavy industries and state-owned companies. The forced economic modernization, so-called “the great leap forward”, carried out by the Communist regime implanted heavy industries with the support of the Soviet Union; however, this modernization produced inefficiencies, unemployment and scarcity.

The economy grew about 5-6 per cent a year between 1950 and 1980, a performance unable to change the country’s economic status and improve living conditions for the majority of its population. Actually, the modernization was responsible for perhaps the worst famine in world history, under which millions of people perished between 1958 and 1961. After unsuccessful intents to deal with the economic problems and losing political power, Mao started the Cultural Revolution to reaffirm socialist values, defeat enemies and regain influence. The priority given to the military industry and ideological issues – with persecutions and executions of internal “enemies”, dismantlement of universities and research institutes etc. - increased the poverty, caused a demographic explosion, and depleted natural resources and human capital.

By the end of the Cultural Revolution (1966-1976), the country was a poor, over-populated and centrally planned economy, with deficiencies in physical and human capital, infrastructure and natural resources. China's economic trajectory started to change in the late 1970s with the first chapter of economic reforms towards a more market-oriented economy under the leadership of Deng Xiao Ping, following the death of Mao Zedong. In the beginning of the 1980s, after a subsequent retreat due to internal resistances, the Communist Party elected economic modernization as a priority. Since then, China has experienced sustained growth without precedent in the modern economic history, with a remarkable reduction in poverty and improvements in living conditions, although inequality is increasing.[94] Two decades after the first round of reforms, the country had become the most dynamic and fastest-growing economy in the world, with a per capita income more than three times higher than in the late 1970s. A decade later China had overtaken Germany as the world's top exporting nation (2009) and Japan as the second largest economy in the world (2010).

The engines of growth of the Chinese economy have changed over the last decades. Initially it was driven by capital-intensive investments in manufacture and infrastructure (including housing). The large domestic market and the abundant supply of labor facilitated the expansion of large-scale industries, FDI, and labor-intensive sectors, such as consumer goods, electronics, automobiles, domestic appliances, pharmaceuticals and engineering. High investments in manufacture progressively transformed the country into the largest world production platform of cheap goods, and then, within a short period of time, into a major assembly platform for imported high-tech components.

Instead of getting stuck in low-end markets, however, the country has searched to upgrade technologically and to develop innovative capabilities through global alliances, acquisitions and growing investments in R&D. According to Jin, Lee

[94] Between 1981 and 2010, the poverty rate in China declined from 84 per cent of the population to about 10 per cent, with more than 680 million people removed from poverty, the equivalent of more than the entire population of Latina America. China accounts for around 75 per cent of the world's total reduction in extreme poverty over the past 30 years. (*The Economist.com*. June 1st 2013 - Not always with us. The world has an astonishing chance to take a billion people out of extreme poverty by 2030).

and Kim[95], if foreign investments and exports had a major impact on economic growth between the mid-1980s and the early 1990s, from the late 1990s knowledge or innovation elements became more influential on growth, indicating that China has moved toward knowledge-based growth. In fact, the Chinese government made a strategic decision to develop high-tech industries in the late 1980s when the China's national high and new technology industrial development plan, called the Torch Program, was put into force.

3.2.1 The transitional institutions in China

The originality of the Chinese catching up refers to the creation of original institutional arrangements and enterprise strategies (Zonenschain, 2006). The state has played a crucial role regarding both elements, providing the macroeconomic conditions and all kinds of incentives for investment and innovation, as well as promoting the necessary institutional adjustments as the catching up proceeds (Zonenschain, 2006).

China has made its transition towards a market economy without following the policies prescribed by mainstream economics for planned economies or adopting many of the best practice prescribed by multilateral organizations. According to Qian (2003)[96], for most of the 1980s and 1990s, China's economic reforms worked effectively "without complete liberalization, without privatization, and without democratization".

One of the key elements of the Chinese transition to a market economy was the building of transitional institutions according to its peculiarities, needs and goals. In Qian's view, the Chinese transitional institutions of market, firms and government worked very well because they matched China's initial conditions and were consistent with the interest of the ruling groups (Qian, 2003). Indeed, those institutions were a way of the country to address the existing economic distortions

[95] Furong Jin, Keun Lee and Yee-Kyoung Kim, 2008, Changing Engines of Growth in China: From Exports, FDI and Marketization to Innovation and Exports, China and World Economy, Vol. 16 (2): 31-49.

[96] Qian, Yingyi (2003) - How Reform Worked in China. In Dani Rodrik, editor, *In Search of Prosperity: Analytic Narratives on Economic Growth*, Princeton University Press, pp. 297-333.

without affecting the income and status quo of several social segments. Therefore, according to Qian, transitional institutions reached two objectives at the same time: improving economic efficiency, making the reforms a win-win game; and pacifying political concerns on how the interests of those in power would be served.

Qian (2003) discusses the general principle and specific mechanisms of China's fundamental transitional institutions by analyzing four successful reforms and one that he considered a failure when he wrote his paper. The first example refers to the market liberalization through the so-called "dual-track" approach, or dual-price system, adopted initially in agriculture, through which commodities were sold at both planned and market prices. Under the system, economic agents had the obligation of selling fixed quantities of goods at fixed planned prices, according to the plan track. Once they fulfilled their obligations (quotas), they could participate in the market track, selling their products at free market prices. The introduction of the market track provided an opportunity of extra gains for farmers and state companies, while the continuation of the plan track compensated potential losers with the market liberalization by preserving their status quo rents, since they also had the right to fixed quantities at fixed prices. Thus the dual-track mechanism simultaneously protected existing rents and improved efficiency, illustrating how market-oriented reform can use successfully existing institutions, designed for central planning.

The second example was the creation of an innovative ownership type of firms – the local government ownership, especially the rural Township-Village Enterprises (TVEs). In the first fifteen years of economic reform, between 1979 and 1993, private firms were under-developed in China because, among other reasons, the lack of legal protection for private property rights. Contrary to what happened in the transitional economies of Eastern Europe and other developing countries, most of the new Chinese firms were neither private firms nor national government firms, but rather local government firms in rural areas. Despite their non-standard ownership, the TVEs were one important engine of the Chinese growth until the mid of the 1990s, when 1.5 million of them contributed with 42 percent of the national industrial output and employed 52 million workers. Only in late 1990s, with the privatization of TVEs, private companies also started to drive China's growth. Qian (2003) states that TVEs improved efficiency in an environment without guaranteed protection of private property rights and, at the same time, served interests of both local and national

governments by providing them with a higher share of revenue, when compared to the standard private companies. The ownership of TVEs is also an example of how existing institutions can be used and adapted to reach development goals and can be regarded as functional substitutes of private companies, in the Gerschenkron perspective.[97]

The third example was the fiscal reform that granted more autonomy and revenues to local governments, stimulating them to pursue economic prosperity. The fiscal decentralization started as an experiment in 1977. In 1980, the central government sanctioned a revenue-sharing agreement dividing revenues and expenditures with each level of government, through which the revenues were classified in central fixed, local fixed and shared. The criteria of sharing changed over time, but the local government autonomy and revenues were preserved. Before the decentralization, the fiscal system in China was highly centralized and sub-national government did not have a separate budget. The central government collected all revenues and set a consolidated budget for governments at all levels (Lin, 2001)[98]

The fourth example refers to the grant of incentives to private activities, in the absence of rules of law, through the creation of anonymous banking accounts. This mechanism limited the charge of discretionary taxes on individuals and allowed the government to collect revenues that in other circumstances would be kept out of the banking system. With the anonymous banking accounts, the state was not able to target particular individuals, but could levy a flat tax on the growing savings deposits. These accounts also facilitated the control of interest rates and capital flows.

The four arrangements mentioned by Qian contributed to increase economic efficiency without creating big resistance to change. With the dual-track market liberalization, market prices played a role in resource allocation whereas the plan track protected the existing rents. When compared to private enterprise, TVEs provided more revenues to both national and local governments. The fiscal decentralization stimulated the latter to develop local non-state enterprises and the reform of state-owned enterprises. In the absence of rules of law, anonymous

[97] For details about the concept of functional substitutes in the Gerschenkron perspective, please see the first chapter.

[98] Justin Yifu Lin (2001) – *Fiscal Decentralization in China*. Initiative for Dialogue, Working Papers Series.

financial transactions restrained the state's discretionary behavior, but, at the same time, enabled the government to extract quasi-fiscal revenues from the banking system.

As the growth proceeded, the transitional institutions were progressively substituted by other institutional arrangements. In the mid of 1990s, the dual track started to be eliminated and the TVEs privatized. Today, many private Chinese companies had originally been TVEs. In 2000, the identification of all baking accounts became mandatory, but only for new deposits. In the Qian's view, conversely to the common understanding of the relationship between state power and reform, state enforcement power is necessary not to carry out an unpopular reform, but, instead, to execute one that creates only winners, not losers. O course, this has not always been the case and there certainly have been losers. In Qian's words:

> *"China's experience has shown that there will be a time period in which impressive growth does not require perfect institutions, and imperfect but sensible institutions can perform. On the other hand, China's success in unconventional institutions does not constitute an argument against fostering best practice institutions such as rule of law, private ownership of firms, and transparent government. It is an argument against simplistic and naive views on institutional reform.* (*Qian, 2003, p. 330*)

The example mentioned by Qian as a failure was the reform of state-owned enterprises SOEs, which has taken longer than expected to reduce their number and weight in the Chinese economy. The reform of SOEs and the role of these companies are examined in the next section.

3.2.2 State owned enterprises - SOEs

Until 2013, four rounds of SOE reforms took place in China. The first round (1978-1992) basically aimed to increase the operational autonomy of managers and introduce a commercial orientation for these companies, with the incorporation of governance mechanisms and decentralization of decision making (Ho and Young, 2013). The second round of SOE reforms (1993-1997) opened the way to the

transformation of selected enterprises from wholly state-owned entities into shareholding companies in which the state remained the main shareholder (Ho and Young, 2013). There were some strategic sectors excluded from this arrangement, such as: security-related industries, natural monopolies and natural resources (power, oil and petrochemicals, and telecommunication), sectors supplying infrastructure and important public goods and services, and high-tech industries. According to Ho and Young (2013), these modernization reforms did not intend to reduce the state's control over SOEs, but essentially to shift the way how SOEs were financed and to introduce a modern management structure.

The third round of SOE reforms (1997-2003), known by the motto "grasping the big and letting go the small", included a large-scale privatization program for the less strategically important (poorly performing) businesses and a plan to strengthen large SEOs through mergers, restructuring and public offering of equities (IPO). The Government decided to keep the ownership of the majority of large SOEs in order not to lose its overall control over the economy. At the same time, however, the government encouraged the rapid expansion of the non-state sector, with the aim of preserving the job of millions of workers employed in the privatized small and medium SOEs.

The fourth round of reforms (present round) has focused on the regulation and management of state assets, as well as on a higher supervision of SOEs. These reforms assigned local government with the responsibility for supervising small- and medium-sized SOEs and left to the central government the supervision of large SOEs. Additionally, this round of reforms has searched to enhance horizontal and vertical integration, increase economies of scale and scope, and foster competition in accordance with the enactment of China´s anti-monopoly law in 2008. Moreover, SOEs were allowed to raise venture capital outside the Mainland China, by listing on

the Hong Kong and New York stock exchange[99] (Ho and Young, 2013).

The State-owned Assets Supervision and Administration Commission (SASAC), an agency established in 2003 by the State Council to oversee China's biggest SOEs, has taken measures to strengthen the supervision of the SOEs and pushed for corporate governance reforms and diversification of SOEs ownership structure. Apparently, however, the agency has given more attention to its mandate of growing and supervising state assets than to reforming and restructuring SOEs (Zhang and Freestone, 2013)[100]. The large SOEs under the *SASAC* supervision are known as the national champions and its portfolio includes telecommunication, automotive, shipbuilding, steel, petroleum and aviation, among others industries. Most of these companies have subsidiaries that hold assets of other companies, although the control remains with the state, which is the owner of all the shares, which are not tradable (Zonenschain, 2006).

In the last two decades, a large number of small and medium SOEs were sold and non-profitable large ones (often listed on the stock market) were restructured, but in 2014 they account for more than 150,000 companies (most of them controlled by local governments), of which 117 (2014) large ones and under *SASAC* supervision. Zonenschain (2006) notes that the gradual privatization of the SOEs meets the strategic objectives of the government, although the process

[99] Chinese companies started to issue equity shares to the public in early 1980s. The growing number of shareholding companies and equity shares created over-the-counter trading of shares in cities such as Shanghai and Shenzhen, where shareholding companies were concentrated. The Chinese government established the Shanghai Stock Exchange in December 1990 and the Shenzhen Stock Exchange in July 1991, in order to prevent the development of a black-market trading, and recapitalize and restructure large state-owned enterprises (SOEs). Policy interventions and regulations regarding the listing and approval process made the equity market in Mainland China heavily inclined toward large SOEs, instead of the more competitive private companies. Shanghai Stock Exchange (SSE) is the world's 5th largest stock market by market capitalization (USD 3,658 trillion in 2011) and the PetroChina is the largest company in the stock market. Distinctly from the Hong Kong Stock Exchange (the world's 6th largest stock market), the stock exchange in Shanghai and Shenzhen are not completely open to foreign investors because the strict governmental capital account controls in Mainland China. Chinese authorities has announced that soon (maybe still in 2014) foreign investors will be allowed to trade shares directly in China's mainland stock market, whose poor performance in the last four years has withdrawn domestic investors, but made prices very attractive to foreigners (http://www.world-stock-exchanges.net/top10.html; http://online.wsj.com/articles/as-china-opens-stock-market-to-foreign-investors-bargains-await-risk-takers-1410471001**).**

[100] Dong Zhang and Owen Freestone – China's Unfinished State-Owned Enterprise Reforms. In Economic Roundup Issue 2, 2013, Australian Government, the Treasure. http://www.treasury.gov.au/PublicationsAndMedia/Publications/2013/Economic-Roundup-Issue-2/Economic-Roundup/Chinas-unfinished-SOE-reforms.

apparently carries a high degree of economic inefficiency.[101] According to the author, the permanent and gradual character of the SOE reforms has produced better results when compared to other international experiences of privatization, with privatized companies absorbing an expressive part of workers and thereby mitigated the social costs. Concerning social and political costs of privatization might explain why central and local governments still keep thousands of state companies, many of them not performing well, in non-strategic sectors, running from hotels to shopping centers.

Zonenschain (2006) also calls attention to the diversity of firms in terms of ownership structure and decision-making, which is one of peculiarities of the Chinese economy. There are different degrees of participation of the State, national private capital and foreign capital. Although giving power to government in strategic decisions, state participation also benefits private capital for granting privileged access to special conditions, such as cheaper financing from state-owned banks and other kinds of favoritism.

Although SOEs are still used as an instrument of the governmental technology policy, and of the industrial and commercial integration of the country, the private sector has increasingly driven the innovative activities, with the State´s support.

3.2.3 From cheap to high-tech goods, from imitation to innovation

The economic openness allowed China to take advantage of the IT revolution and the increasing modularization of production in many industrial sectors. With the economic reforms, multinational companies started to set production units in the country to reduce costs and take advantage of the huge Chinese market. Since the very beginning of economic reforms, the Chinese government has taken measures to discipline foreign investments according to the country's interests. In effect, the attraction of foreign capital has been embedded in a strategy to leverage local firms

[101] According to estimates by GaveKal Dragonomics, since the financial crisis, the productivity gap between SOEs and private companies has enlarged, with average return on assets for state entities at around 4.6 per cent, compared with 9.1 per cent for private firms (*apud* Wildau, Gabriel (2014) - *China announces plan for reform of state-owned enterprises*. Financial Times, http://www.ft.com/intl/cms/s/0/07928638-0c24-11e4-a096-00144feabdc0.html#axzz3EpCOeVKP.

and develop internal technological capabilities. In this sense, many policies have been used to ensure technology transfer and local capability building, including requirement local content and alliances with domestic companies. Foreign investors had to accept the demands of joint-ventures with Chinese companies, to transfer technology to local partners, and to purchase inputs from local firms (Zonenschain, 2006).

The associations with foreign companies gave to the local companies the opportunity to access new technologies and foreign markets. According to Campbell (2013), the nature of technology transfer has changed from equipment contracts to technology licenses, technological consultation fees and joint production of design. In the beginning, most of the Chinese counterparts in the joint-ventures were SOEs. The immense domestic market provided leverage for Chinese companies to compete with multinational corporations. To narrow their technological gap with these companies, Chinese firms adopted a market-oriented innovation strategy, focusing initially in the domestic rural market and low-end market (low technology markets), and then moving to larger cities. Chinese firms opted for incremental innovation to reduce cost and to combine imported technologies with Chinese designs, developed in-house according to the needs and preferences of the local markets. The market-oriented innovation strategy provided competitive advantages for Chinese firms and their lower costs of production also allowed them to surpass their competitors in industries such as consumer electronics.

Many Chinese firms in the telecommunications industries and also automobiles took advantage of component modularization to develop their products with the support of several component suppliers, combining them with their own development efforts and commercializing the final products with their own brand logo. In the case of cell phones, for instance, local producers initially concentrated their efforts in peripheral R&D to meet local-specific demands, introducing functions and designs based on their knowledge of the local markets. However, as Jin, Lee and Kim (2008) note, the strategy of relying on lower modularity in the long does not allow producers to keep up with the frequent technological changes or to meet the demand of more technologically sophisticated consumers.

For many years, Chinese mobile phone producers remained trapped in the production of peripheral technologies due to their limited in-house technological capabilities. As a result, by 2000, the mobile phone markets showed a dual structure, with foreign MNC dominating the high-end markets and local producers, the lower-end markets. Soon, the MNC also started to produce lower-end mobile phones, while keeping their advantage in the more sophisticated markets. Many local brands, however, remained at least until the late 2000s in the middle- and lower-end markets. The local companies that succeeded in accessing more sophisticated markets were those that gave a step further to upgrade their innovative capabilities. These strategies allowed local brands to access big markets and became known in short period of time.

Huwaei, Lenovo, TCL and ZTE are examples of successful Chinese firms that became giant players in the IT industry, in both domestic and international markets. This first generation of innovative Chinese firms are building up global brands and increasing their operations abroad, taking advantage of mergers and acquisitions and the set of overseas R&D to access foreign knowledge. As they initially were not able to spend as big companies in Europe and the USA in R&D, the Chinese companies pursued open innovation strategies. As defined by Henry Chesbrough, the creator of the concept, open innovation is:

> "*the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively. [This paradigm] assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology.*" (Chesbrough, 2006, p.1)[102]

These companies, among other successful ones, also targeted the unexploited rural markets first, but moved progressively to large cities, always taking into account the market needs. Due to their limited capabilities in in-house technology development, they recurred to international outsourcing and alliances with foreign companies to follow through their market-oriented innovation strategy. According to Xielin Liu (2005), this option was the way that Chinese firms caught up, which is quite different from that of Japan, Korea and other latecomers.

[102] Chesbrough, H. (2006) – Open Innovation: A New paradigm for Understanding Industrial Innovation. In *Open Innovation, Researching a New Paradigm.* Oxford University Press.

The technology outsourcing strategy allowed some Chinese firms to follow the leaders and reduce the risk of falling into a no promising or a unique technology. As they gained muscle, the Chinese companies directed part of their investment to cross-border mergers and acquisitions, which became another important mechanism for technological catching up. Chinese firms also adopted the strategy that in the early 1990s Wu Xiaobo named 'secondary innovation', which is a process through which developing countries combine technologies acquired from developed countries with existing technologies and local developments.

Wu, Ma and Xu (2006)[103] state that secondary innovation is an incremental accumulative evolutionary process, which goes beyond learning and assimilation. It is far from being a linear process from imitation to assimilation and innovation. The concept emphasizes the linkage between imported technologies and local specificities, involving both qualitative development and qualitative change. Wu, Ma Xu (20006) state that the process may follow two patterns: the standard secondary innovation and post-secondary innovation. In the first pattern, the secondary innovations rely on the acquisition of mature technologies. The post-secondary innovations are based on emergent technologies or technologies that are still in their first stages. The second pattern demands higher capabilities in R&D and production than that based on mature technologies, but still relies on acquired technologies.

3.2.4 The Chinese strategy to become a knowledge-driven economy

In order to promote Chinese technological development, the state has acted in many dimensions (macroeconomic, regional, sectoral and social), and through horizontal and vertical interventions. The objectives are to provide favorable macroeconomic conditions, adequate physical infrastructure and other incentives to attract investments; to enhance competitive advantages of certain sectors and regions; and to provide technological change and innovative capabilities. The Chinese Government knows that it is crucial to enhance the capability building in science and technology, and has heavily invested in higher education. Most of the

[103] Wu, Xiaobo, Ma, Rufei and Xu, Guannan (2006) – Secondary Innovation: The Experience of Chinese Enterprises in *Learning, Innovation and Capability Building.*

basic research is carried out by the Chinese Academy of Sciences, Research Institutes attached to the Ministries (each Ministry has its own research institute), large universities and SOEs (Zonenschain, 2006). The CAS was created in 1949 in line with the Soviet research model and restructured in the 1990s. Now it comprises more than 100 research institutes, a university and a graduate school, with unites across China.

China has strengthened its S&T as the economic reforms proceed, allocating more funds both to basic and applied researches, connecting research units with local companies and attracting foreign partners (both companies and experts). Since 2000, government has heavily invested in building science and technological capabilities, creating a huge infrastructure to enhance R&D, providing incentives to high-tech firms and developing a legal framework (such as IPR rules and industrial standards) (Campbell, 2013).

According to Campbell (2012), the Chinese strategy to develop science and technology has four distinct phases. In the first period, 1949-1960, technological efforts were associated to the development of heavy industries, according to 156 large industrial projects designed by the Soviet Union (USSR). Huge volumes of equipment were imported from the Soviet bloc, which sent 3,000 technicians to China, mostly for training Chinese workers. About 20,000 Chinese were trained in the USSR and their satellites, many of which later led the Chinese scientific and technological initiatives. Mao Zedong supported technological development for military and industrial purposes to catch up with advanced economies, but the country experienced only punctual outcomes in heavy and military industries.

The second period, between 1960 and 1978, marked by the Sino-Soviet Split and the Cultural Revolution's political turbulences and economic stagnation. China concentrated its efforts in defense and still on heavy industries. The country became a nuclear power (testing an atomic bomb in 1964), developed intercontinental ballistic missiles and launched a satellite in 1970.

With the country's economic reforms launched by Deng Xiaping in late 1970s and carried forward by Jiang Zemin up to 2001, the third phase of the Chinese science and technological development took place. Deng Xiaoping endorsed the so-called four modernizations (set forth by Zhou Enlai in the early 1960s and then

abandoned) to reinvigorate China's economy. Science and technology was appointed as one of the most important goals for the country, along with agriculture, industry and national defense. Universities and research institutions were rehabilitated and called upon to develop and transfer technology to SOEs. Actually, the Chinese government made a strategic decision to develop high-tech industries in the late 1980s when the China's national high and new technology industrial development plan, called the Torch Program, was put into force.

Since the Torch Plan the government has reinforced the priority conferred to science & technology and to the construction of a high-performing national innovation system.[104] According to the 2006 *Medium to Long-Term Strategic Plan for Development of Science and Technology*, the objective is to make China an "innovation-oriented" economy by the year 2020 and overtime one of the world´s leading "innovation economy". China determination and steady efforts to develop inner capabilities to innovate indicate that the Chinese authorities are conscious of the challenges put by the country´s remarkable socioeconomic performance. As the *OECD Reviews of Innovation Policy: China (2008)* points out, without high investments in innovation, the high rates of economic growth, industrialization and urbanization may jeopardize the sustainability of economic growth and social development due to environmental degradation and ecological challenges, uneven distribution of the economic development across regions and high demand for energy and raw materials.

These constraints make imperative to China, the OECD report adds, to move from sustained to sustainable and comprehensive growth, which requires turning

[104] To enhance corporate R&D, a chain of science and technology industrial parks (STIPS) has been constructed since the Torch Plan in the late 1980s. The most important parks are in municipalities controlled by the central government – Beijing, Shanghai, Tianjin and Chongqing. Firms within the parks receive a variety of incentives, such as business support, physical infrastructure, tax benefits and exemptions from import license to materials and parts used in exports. To be admitted in a STIP, a firm need to meet the four qualification criteria: a) to develop or use technology in high-tech products or services listed in the Catalog for High and New Technology Products published by the Ministry of Science and Technology, such as electronics and information technology, aerospace technology, and biotechnology; b) to spend at least 3 percent of its annual gross revenue on R&D; c) to have least 30 percent of its employees with a college degree, and at least 10 percent involved in R&D; d) to be certified on annual basis by a provincial science and technology office (Haiyang Zhang and Tetsushi Sonobe, 2010 - An Inquiry into the Development of Science and Technology Parks in China Discussion Paper No. 2010-26. November 4, 2010. http://www.economics-ejournal.org/economics/discussionpapers/2010-26).

innovation its engine of growth through continued efforts to develop scientific and technological capabilities. China has, indeed, succeeded at mobilizing resources for S&T rapidly on an unparalleled scale, becoming a big global player in science and technology. The outcomes are impressive in terms of publications, patent applications, high tech content of exports and economic performance, but “it has not yet translated into a proportionate increase in innovation performance”: the output of its investment is still below that of the OECD countries with equivalent levels of R&D and China continues relying on imported technologies (OECD, 2008). The OECD report attributes this shortcoming to inefficiency of the NIS, such as the weak integration between actors and subsystems (e.g. regional and national; public and private sector), the limited innovation capability and low propensity of the private sector to innovate, slower development of human resources *vis-à-vis* the development of related infrastructure in R&D, particularly in the private sector, even with the growing contribution from foreign companies. The insufficient supply of specialized human resources may affect the Chinese future performance, even if with the growth of human resources for S&T (OECD, 2008).

The improvement of some framework conditions, particularly of those concerning to corporate governance, financing of R&D and enforcement IPR rules, may provide the appropriate conditions to the development of “an open system of innovation in which indigenous innovation capabilities and R&D-intensive foreign investment could be mutually reinforcing” (OECD, 2008).

Although China had jointed the WTO in the December 2001, the poor enforcement of IPR rules is still a contentious issue with foreign companies. Actually, since China reopened its economy to foreign trade in the late 1970s, lax IPR protection has been the object of tough disputes between China and the United States.. Even today, it continues to be one of the main litigious matters in the US–China relationship, along with the implementation of other WTO obligations, the policies to maintain currency undervalued, the privileges granted to local companies in terms of financial support, trade and investment barriers and pressures for technology transfer (Morrison, 2014[105], Yu, 2010[106]).

[105] Morrison, Wayne M (2014) - China-U.S. Trade Issues. Congressional Research Service 7-5700 www.crs.gov. RL33536. July 10, 2014. http://fas.org/sgp/crs/row/RL33536.pdf.

[106] Yu, Peter K. (2010) – The U.S.-China Dispute over Trips.

When China was not engaged in building innovative capabilities, the posture of Chinese government regarding IPR protection aimed to facilitate for local firms to acquire foreign technologies and innovations through copy and reverse engineering without paying for it. Now that the country has conferred a strategic role to S&T, the lack of an effective IPR protection may become detrimental to Chinese interests. The infringement of rights not only affect the willingness of foreign companies to transfer technology to China, but also may affect the propensity of Chinese actors to invest in R&D and/or commercialize the outcome of their efforts in the country and the reputation of Chinese firms internally and abroad (OECD, 2008).

Probably China's attitudes concerning the enforcement of IPR rules will change in the same pace in which the local companies increase their technological capabilities and proprietary innovations. Indeed, some Chinese enterprises are already following this path. The emergence of China as a major international player in the S&T and innovation will change the dynamics of the global system of knowledge creation, diffusion and use. However, this process also carries the risk of additional tensions with other nations for the competitive pressures that it may generate (OECD, 2008).

3.2.5 China's investment in clean energies and green industries

China is the world's largest energy producer (since 2007) and consumer (since 2010), which makes the country a very influential player in the world energy markets. The country's fast growth has enormously increased its energy demand, especially for oil: China is already the world´s second largest oil consumer, below the US. Until the early 1990s, China was a net oil exporter, but became the second largest net importer in 2009, and the U.S. Energy Information Administration (EIA) estimates that it will surpass the U.S. in 2014.[107] China is the world's largest producer, consumer and importer of coal, and heavily contributes to the CO_2 emissions. In 2011, the country also became the world´s largest power generator.

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http://www.law.drake.edu/clinicsCenters/ip/docs/ipResearch-op5.pdf

[107] US Energy Information Administration (EIA) (2014) – *China Report*. Last updated February 4, 2014. http://www.eia.gov/countries/analysisbriefs/China/china.pdf.

Due to its growing pollution problems, since 2001, China has increased its investments in projects associated to energy technologies, especially projects related to renewable energies. In 2006, the *Medium to Long-Term Science and Technology National Plan* included energy and environment among its research priorities, while the *Twelfth Five-Year Technology Plan* (2012-2016) committed to invest USD 300 billion in renewable energies, and the Ministry of Science and technology (MOST) and the National Development and Reform Commission started an international cooperation for new or renewable energies with many countries and organizations, signing more than 100 cooperation agreements with 97 countries. (Campbell, 2013).

According to the Global Status Report, released by the Renewable Energy Policy Network for the 21st, China led the global investments in renewable energies in 2013, spending a total of USD 56.3 billion on wind, solar and other renewable projects, well above the U.S. total (of USD 36.7 billion) and Europe investments, and 61 percent of the total investment in renewable energies by developing countries. China has increased its investment in renewable energies for more than a decade and it now accounts for about 24 percent of the world's renewable power capacity. Its renewable energy investments are included in the 12th Five-Year Plan for Economic and Social Development, which established expenditures of USD 473.1 billion on clean energy investments from 2011 to 2015. China's objective is to have 20 percent of its total energy consumption from renewable energy by 2020.

The new Government since March 2013, headed since last year by Xi Jinping (President) and Li Keqiang (Prime-Minister), has reaffirmed the country's commitment to sustainable growth. Besides announcing policies and economic reforms to promote more balanced economic growth and changing emphasis from exports and investments to domestic consumption, the government outlined the policies to the energy sector. These policies include the adoption of a more market-based pricing system, energy efficiency measures, actions to enhance competition among firms, more investments in renewable energy projects and studies on how to attract more private investments in energy by speeding the project approval processes, enhancing the energy transmission infrastructure and loosening some price controls (U.S. EIA, 2014).

China has made steady efforts to diversify and clean up its energetic matrix that strongly relies on coal (69 per cent in 2011) and makes the country the biggest CO_2 emitter. The government intends to reduce the relative weight of coal consumption to below 65 per cent by 2017, and the EIA calculates that this share may fall to 55 per cent in 2040, but even in this case the EIA predicts that coal consumption will increase over 50 per cent during this time. For this reason, China has also invested to develop economical technologies that allow burning coal without releasing greenhouse gas into the atmosphere. Another initiative is the creation of low carbon centers, which similarly to the special economic zones, provide infrastructure and incentives to low carbon manufacturing and exports. Meanwhile, China has pressed the U.S. and other developed countries to accept stricter limits to their CO_2 emissions and to continue to support the adoption by poor countries of clean energy technologies.

The huge China´s market and economies of scale are reducing the cost of renewable energies (such as solar and wind) and other environmentally friendly technologies (such as electric car batteries), which help to turn green investments economical – nowadays many green investments still need subsidies to pay themselves. Chinese companies are becoming an important player in international markets, with cheaper equipment than their competitors in Europe, Japan and the United States.

China investments in the development of green technologies might contribute to mitigate global problems associated to the overuse of natural resources and environmental depletion, which the country has, with its impressive performance, contributed to aggravate. China initiatives towards a low carbon economy probably will contribute to reshape the usage and the sources of energy worldwide, dropping prices and encouraging more investment in R&D and innovations in green industries. The country may define a new frontier to economical clean technologies and open new windows of opportunity for developing countries to catch up, at least for those making efforts to build science and technological capabilities, to master emerging technologies and to innovate.

3.3. Concluding remarks

The environment for catching up has changed drastically in the last few decades and in this chapter the changing conditions associated with the emergence of the WTO and the resurgence of China as a major international player are analyzed. On one hand, the current international trade rules reduce the degrees of freedom to developing countries pursuing economic catching up through the same policies adopted by countries that successfully caught up in the past. However, it is also true that the requirements for catching up have changed immensely in a world increasingly driven by innovation, which demands specific policies to build up inner capabilities to innovate. Yet the new rules on intellectual property rights may restrain or make more expensive the access to new knowledge and its results, but probably now knowledge is more accessible than ever. The fact is that increasingly catching-up relies on the ability of countries behind the technological frontiers to adopt and adapt imported technologies, and develop inner capabilities to become an innovator.

On the other hand, China has challenged many established ideas and policy recommendations about growth, development and catching up, indicating new possibilities to other developing countries to move ahead. The country´s weight is growing in so many domains and what happens in China today matters more than ever to the world. The Chinese growth is disruptive and generates adjustment pressures elsewhere in the world, which demands accommodations and new strategies. It has changed and will continue to change patterns of comparative advantages and competitiveness, and therefore investment opportunities and the environment for catching up. China has put up great world challenges, but has also opened windows of opportunities for those that are at the technological frontier as well as those that aim to catch up.

Conclusion

Development was the main concern of classical economists, who investigated the critical factors to attain prosperity, but the subject lost popularity with the emergence of Marginalism and its emphasis on the allocation of resources in late 19th century. Neoclassical growth models arose at the beginning of the 20th century, proposing single equations to explain the growth performance of all countries and predicting that growth rates and income per capita would converge among countries over time.

After World War II, the centrality of development issues and the recognition of broad differences among lagging countries gave room to the advent of development economics as a separate field of research. At that time, there was a lack of confidence in the efficiency of markets to allocate the investments needed, due to the traumatic experience of the Great Depression.. Hence, the state was believed to play a crucial role both in modernized and modernizing economies, through planning, coordination and direct participation in economic activities. Generally speaking, at least until the late 1960s, state activism and development policies (based on Keynesianism, Welfarism and interpretations of backwardness) were considered not only desirable but essential, according to a myriad of theories that emerged in the core and the periphery of capitalism.

Classical development economics started to lose prestige in the academic arena and on the political front by the end of “golden age” of capitalism (early 1970s) when a new generation of development or growth economists, emerged, postulating new methodologies, interpretations and policies that were rooted in neoclassical economics. Rather than broad theories and visionary models, they preferred to investigate the microeconomic aspects of growth processes and target specific policies. According to their view, strengthened by the reinvigoration of neoliberalism and the advent of the Washington Consensus, growth would be a natural consequence of getting macroeconomic fundamentals right through privatization, deregulation and trade liberalization.

Development economics began to re-gain its lost status in the mid-1990s, with the appearance of a new development economics, or post-Washington Consensus

development economics. The renewed interest in development issues was largely motivated by the poor economic performance of many countries that had followed the Washington Consensus guidelines. In the new context, the tradition of thinking of development as a catching up matter, inaugurated in the 1960s, was also reinforced. This tradition, which approaches development as a catching-up issue associated with technological change and innovation, provided the theoretical foundation to this dissertation, the objective of which is to examine the critical elements for developing economies to narrow their gap with the more advanced economies. The study focused on the role of technological change and innovation, and pursued its objective by addressing the following three questions:

1) How can we revisit the catching-up approach in light of the knowledge economy and the experiences of countries that have succeeded in narrowing their gap with the more advanced economies in the last decades?

2) What seem to be the critical factors for catching-up today and what is the role of knowledge and technological catching-up in attaining a higher level of development?

3) What can countries behind the economic and technological frontier still learn from the experience of economies that succeeded in forging ahead (especially Asian economies) or are on their way to do so (case of China), through the lens of the catching up approach?

In order to answer the first question we examined contributions associated to the catching up tradition, focusing on the elements that seem to matter most to catch up in the knowledge economy and by analyzing the catching up experience of Japan and other Asian economies. In the first chapter, one of the main points made is that today developing countries need to develop inner capabilities to innovate (both technologically and institutionally) in order to narrow their technological and economic gap with the more advanced economies (catching up), which may, occasionally, allow such countries to forge ahead and define new technological frontiers. The examination of theoretical and empirical studies of concrete experience in catching up shows that innovation has played a growing role in economic progress and that today an innovation-driven catch-up seems to be a pre-condition to attain development and escape from poverty.

Although technological change and innovation are more important to a country's economic performance than ever before, empirical studies have shown that mastering knowledge, skills and new technologies has been crucial to a country's ability to catch up since the late 19th century, when science-based industries emerged (such as the chemical industries), and the United States and Continental European countries caught up with England. Technological change has proven to be a critical factor in most successful catching up experiences, involving technological innovations and dissemination of existing technologies through learning by copying and learning by doing.

The need for countries that are behind the technological and economic frontier to build up capabilities to absorb imported technologies and eventually become innovators has increased, especially in the last few decades, due to the new science-based technologies (such as biotechnologies), the dissemination of the all-pervasive IT technologies and the adoption of stricter international IPR rules. Developing scientific, technological, managerial and other social capabilities has turned into one of the most strategic issues for countries to improve their economic performance and compete in the global economy. In other words, technological change and innovative capability have become not only a prerequisite of catching up, but the very essence of catching up today. Catching up increasingly relies on the ability of countries behind the technological frontiers to adopt and adapt imported technologies, as well as develop new technologies, which depends on the building of technological capabilities, technological infrastructure and efficient innovation systems, at the national, regional and sectoral levels.

For this reason, such elements for development have received the attention by many new-Schumpeterian researchers, and they were the object of this study. The option of focusing on technological change as a critical factor to catch up neither implies adherence to any kind of technological determinism nor any disregard for other elements also considered essential, such as state activism, financing, and institutions, which were critical elements that have also been taken into account in this study. In the present paper, knowledge has been recognized as a critical element to catch up today, but knowledge *per se* cannot enhance development if not supported by other elements such as a well-functioning financial system, good governance and proper infrastructure. In this regard, it has been demonstrated that

the state still matters and has key roles to play in supporting emergent technological fields, investing in infrastructure and mobilizing financial resources for key investments.

Although this dissertation has emphasized the critical role of technology for development in an endeavor to answer the second question formulated in the introduction, it has become clear that innovation goes far beyond the production of high-tech and sophisticated industrial goods. Indeed, innovation should be understood in a broader sense and encompass organizational, managerial and business model aspects not only in manufacturing but also in agribusiness and in services. It is important to point out this aspect because countries have different possibilities in terms of economic development and can become innovators in manufacturing sectors. Social, technological and scientific capabilities, history, geography, geopolitical issues and other aspects in the international scenario matter to development. Specialization in the production of a few sophisticated goods or the provision of certain services can be the best development alternative for some economies, especially small ones. It has been the path followed by economies like Costa Rica, for instance, which has acquired competitive advantages in IT and services segments. Countries with big markets and more complex economic infrastructure have more options, but they also may fall behind without a clear vision about the future they want to build. They may also lack the steady efforts and lasting institutional arrangements to carry on a consistent development strategy to make their vision come true.

Moving to the third question, it has become apparent from the experiences of the Asian countries that succeeded in sustaining fast growth and narrowing (or closing) their economic, technological and income *per capita* gap with rich Western countries, how important is to invest in capability building and create new institutions (in accordance with their background and needs), adapting imported technologies and innovating in a broader sense.

Japan was the first Asian economy to catch up economically and technologically with the US and the advanced European economies after World War II. One of the peculiarities of the Japanese catch-up was the very rapid and orderly process of structural change through the introduction of new technologies and

industries, as well as the continuous improvements associated with learning. Japan set the goal of establishing a broad-ranging industrial structure and developing a diversified manufacturing system; it updated technologically, and knew how to take advantage of the favorable economic and geo-political circumstances after World War II, as well as of the technological trends of the time. Japanese firms started by copying Western models through reverse engineering, but very soon went beyond imitation, improving and developing technologies and products created abroad.

Some East Asian economies followed the Japanese example, but pursued their own strategies to catch up. In this study, the experiences of Korea and Taiwan have been highlighted and compared with other development experiences, such as that of Latin America and South Asian countries. After initially targeting mature industries (heavy and chemical industries in case of Korea), both Taiwan and Korea directed their efforts towards the emerging electronics industries, beginning with the final assembly of consumer goods and then embarking on higher stages of production, heavily investing in a narrow range of products or processes. The East Asian countries accumulated physical and human capital at high rates, but such accumulation only partially explains their performances. What effectively made a huge difference in the success of East Asian countries was the fact that investments in physical capital embodied modern technologies and, thanks to the investment in human capital, those countries were able to learn, master and adapt the new technologies, as well as innovate in a broader sense.

The Asian industrialization/catching-up processes were comprised of a broad range of organizational and managerial innovations, as well as the construction of original institutional frameworks, according to the level of backwardness of each economy, their goals, and the international circumstances under which the modernization took place. One of the greatest merits of the East Asian economies was to perceive the windows of opportunity opened by the global production networks associated with the emergence of information technologies and globalization. As shown in Chapter 1, during the emergence of new techno-economic paradigms, windows of opportunity appear for latecomers because such paradigms diffuse new types of knowledge, skills and experiences, as well as create a favorable environment for easy entry. Throughout techno-economic paradigm shifts, newcomers with the new relevant knowledge and skills “are lighter and faster”

because they do not carry the onus of capital stocks and institutions of the previous paradigm. Such was the case of Korea and Taiwan at the beginning of information technology: when everybody was learning, investment costs were lower in absolute terms and international intellectual property right regulations were less strict.

The more successful Asian experiences of catching up seem to contradict orthodox *laissez-faire* interpretations, which essentially attribute the remarkable achievements of East Asia economies to their stability-oriented and market-friendly macroeconomic policies. In fact, contrary to what is believed by orthodoxy, Asian governments had adopted sound macroeconomic policies to get prices "wrong" according to strategic goals. Moreover, governments in East Asian countries, particularly in Korea and Taiwan, did more than pave the way for the private sector by providing a suitable macroeconomic environment. Actually, the state directly influenced firms' decisions through a complex system of incentives. Government agencies set up a closer relationship with private entrepreneurs, guiding and supporting them through planning and coordination of a number of financial, technical and managerial instruments. Thus, a critical element of Asia's trajectory to success was the combination of private entrepreneurship and state intervention, which guided, supported and disciplined the private sector through macro and sectoral policies. In the process, the role of new institutional arrangements and technological innovations were crucial, as has been proposed by the catching up approach. It is also worth mentioning the complementarity and synergy among Asian economies, which initially gravitated around the Japanese economy.

The Asian economies that succeeded in catching up occupied a subaltern position as subcontractors in global value chains at the beginning of their efforts to catch up but invested to develop inner capabilities and were able to change their status overtime. Some of them like Japan, Korea and Taiwan were able to assume a dominant position in some chains. Today China is doing the same.

China has been growing fast for more than three decades without following most of the conventional policies recommended for developing countries and transitional economies on their way to become market-oriented. From a large platform for the production of cheap goods, the country is moving steadily to become a major player in the knowledge economy, by heavily investing in higher education

and enhancing capability building in science and technology. China has also made efforts to move from sustained to sustainable growth through high investments in green technologies and is already an important player in this regard.

China is not only a major exporter, but also a huge importer of a broad basket of goods. As a great consumer of commodities, the country imports agricultural products as well as fuels and minerals, providing markets for many countries. The Chinese dynamism has contributed both to the increase the relative prices of commodities and the fall of prices of manufactured goods. The first effect (the increase of the prices of commodities) benefits developing countries in the short and medium run, but also raises the price of energy and produces environmental concerns in the case of non-renewable natural resources. The second effect (which is associated with the first) also produces also two contradictory results. On one hand, it expands the access to manufactured goods over the world, benefiting the poorer with cheap products and contributing to control inflationary pressures elsewhere. On the other hand, and at the same time, it displaces manufacturing activities even in low-wage countries, which makes deindustrialization processes initiated by radical liberal reforms in the 1990s even deeper.

In fact, although most of the increase in China's imports of raw-materials reflects a net increment in the world demand, part of the Chinese additional demand is offset by the equivalent reduction of consumption in countries where China has displaced manufactures. In the same way, the boost in the US and European countries trade deficit with China is to some extent balanced by reductions in their deficits with other Asian countries, due to the transfer of assembly and production from other countries to Chinese territory.

China has re-designed value chains in Asia and worldwide, creating challenges and also new opportunities for other developing countries willing to catch up.

On one hand, by providing cheap industrial goods to the whole world and by draining natural resources and food, China potentially inhibits the development of local industries in many developing countries, as well as maintains the exportation of primary goods more attractive for many countries than investing in the production of higher value-added goods and services. China's efforts to control sources of raw

materials, energy and food in poor countries in order to ensure that their needs may also be detrimental to their interests in the long run. In general, Chinese direct investments in the primary sector and infrastructure do not generate expressive dynamic effects in the recipient countries because the final beneficiaries are located in China – the country usually provides equipment and workers, paid in China with the funds lent to the recipient countries.

On the other hand, China makes catching up a feasible endeavour by showing that it is possible to catch up by following strategies that take into account local needs and interests, as well as by showing the importance of moving from imitation and extensive capital accumulation to innovation and knowledge accumulation. The country also provides markets for other emergent economies and supplies them with equipment and intermediate goods at more affordable prices.

Just as impact of China's impressive performance, the rules on trade and intellectual property rights also change the international environment for catching up, affecting the ability of developing countries to catch up and reinforcing the need to build up inner capabilities to absorb new technologies and innovate. Although restrictions for catching up go much beyond IPR rules, the challenges in this arena are huge because they potentially reduce the room for maneuvering public policies and increase the market power of incumbent players, rendering technological transfer more costly and ultimately restraining technological catching-up.

If it is true that current international trade and IPR rules either put constraints on the use or completely prohibit recipes that worked well in the past for many of today's advanced economies, it is equally true that some old policies are now a complete anachronism in light of the knowledge-intensive technologies, and the production and competition in the world economy. Some practices are still effective and can be used despite the restrictions placed by the new rules. Thus, industrial and trade policies are still possible, but they need to take into account that the requirements for catching up have changed immensely in a world that is increasingly driven by innovation, which demands specific policies to build up inner capabilities to innovate.

Since the US and continental European countries caught up with England in the 19th century, leading countries have been important references for backward

countries in terms of technology and institutions, and even finance. However, most or perhaps all the countries that succeeded in narrowing and surpassing their gap with the most advanced economies did so by finding an original way of doing what the leaders had already done to create their space and markets, and then they also developed something new. Moreover, backward countries that succeed in catching up knew how to take advantage of the international scenario instead of simply blaming leading nations or the circumstances for their underdeveloped conditions.

Historically, innovations have relied on elements such as a country's level of backwardness, its particularities (size, geography, natural resources, history, education and social capabilities), the techno-economic paradigm, the historical context and conditions in the international arena (finance, rules, and geopolitical elements). In some of the catching up experiences mentioned, the required innovations were associated with the creation of new financial mechanisms, such as the investment banks in Germany and other European countries, stock markets and public financial mechanisms. In others, the novelty was the design of planning and coordinating bodies or agencies to articulate public and market mechanisms. Yet, innovation has created new products, processes and also incremental or secondary innovations, which in some cases have implied the use of new raw materials and sources of energy. In sum, countries that succeeded in catching up have prioritized the knowledge aspects of development and those that want to keep going forward have to invest incessantly in creating knowledge capabilities.

Despite all kinds of innovations since the second industrial revolution in the 19th century, most countries have reproduced the production and consumption patterns of the leaders, based on the usage of fossil fuels (including oil, natural gas and coal) as a primary energy source and on the wastefulness of other natural resources. The continuity and the reproduction of non-friendly production and lifestyle patterns have depleted the environment, changed the planetary climate, polluted rivers and oceans, and increased the disparities within and among countries. The concern surrounding global warming has mobilized international civil society, states, international governmental and non-governmental organizations, as well as some firms and experts. This concern has produced local and global initiatives and actions that promote energy efficiency, clean energy sources, forest conservation, and eco-friendly consumption. However, the shifts are still relatively small considering the

global economy as a whole. As Celso Furtado commented almost four decades ago, the idea that the opulence and consumption patterns of developed countries could be universalized to the masses of peripheral countries is unfeasible.

China, whose impressive performance has contributed to aggravate the problem of consumption, may, however, contribute to change this situation in the years to come, if its strategy to move towards a greener economy is successful. China's movement may help to disseminate cleaner technologies more broadly, as well as create more economic, low-carbon supply chains in terms of waste management and consumption of energy, water and raw materials. It is an indispensable and challenging step in face of the costly environmental consequences of China's huge growth rates in the last few decades, which transformed the country into the world's largest producer of greenhouse gases, due to its heavy dependence on coal and oil.

The success of China towards a more sustainable development path will probably have a big influence on production and consumption at the global level, thereby encouraging more investment in R&D and innovations in green industries. In this case, the country would not only reach the technological frontier (catching up), but would possibly define a new technological frontier (forging ahead). It may open new windows of opportunity to developing countries to catch up, at least for those making efforts to build scientific and technological capabilities to master emerging technologies and innovate. In doing so, China is going beyond other Asian economies that took advantage of windows of opportunity to catch up. More than just demonstrating new ways of doing old things, it may be that China will show new ways of doing new things.

To conclude this dissertation, the following points should be made:

- Leaders are important references for backward countries in terms of technology and institutions, or even finance. However, each country must find its own way to succeed in catching catch up. Most or perhaps all countries that succeeded found an original way of doing the same thing that the more advanced countries were already doing in order to create its space and markets. They also knew how to take advantage of the international conditions instead of simply blaming the leaders or the end of the past

prosperity for their underdeveloped conditions. The additional challenge now it is to find original ways of doing different things.

- Technological catching up is necessary, and maybe the pre-requisite for catching up today. However, although much attention has been given to the key role of technological change for development today, it is clear that a socio-economic catching up also relies on other elements. Whereas capital accumulation and technological change may increase the GDP, they may not improve other development indicators. In fact, a country may move towards the technical frontier in some sector while remaining underdeveloped, with very poor socio-economic indicators.
- Since the 1990s, the conditions of international competition, the rules of the game on trade and intellectual property rights (IPR), the nature of new technologies, and the resurgence of China as major player not only impose constraints (as it is broadly claimed) but also offer opportunities for countries that are economically and technologically behind to catch up.
- For countries that are behind the economic frontier, the mediation role of the state continues to be crucial in order to take advantage of potential windows of opportunity opened by the new conditions in the international arena. The challenges put forth by globalization, international competition and the path of technological progress are so immense that even some advanced countries have also faced huge difficulties in adapting themselves and not falling behind.
- Even though some preconditions can be appointed as crucial to catching up, many elements, such as the appropriate institutional arrangements, are built in the course of the process itself. The requirements to keep going are context-dependent. They are determined by the specific characteristics of the backward country (such as degree of backwardness, geography, endowments of natural resources, initial level of social capabilities, technology gap, and the size of potential domestic market), international conditions (legal framework, international support, finance mechanisms etc.), technology trends, the country's target industries and technologies, the country's target markets and their competitive patterns.

- The new growth theories that emerged in the late 1980s have emphasized the increasing returns associated with education. Neo-Schumpeterians have showed the spill overs of high investments in education in East Korea, particularly in Korea. However, without productive investments, the newly educated people will not find employment, and the result of the education expenditures will be increased unemployment rates and brain drain. In the case of Korea's catching up, associated with high investments in education by many analysts, what was really impressive was the country's ability to invest in education and create opportunities to absorb the trained human resources at the same time. The capital accumulation and continuing absorption of new skilled human resources encouraged further investments in education and training, creating a virtuous circle. In fact, in East Asia economies that succeed in catching up, investments in human capital went far beyond the expansion of education. Similar to Japan, they enhance the human resources development through the creation of social opportunities, investing not only in massive basic education, but also in health care and other spheres that affect the living conditions, even before lifting millions out of poverty. Therefore, generally speaking, investments in human capital are a necessary but not a sufficient condition to succeed in catching up.

- Certain strategies and mechanisms applied in the past by countries that succeeded in catching up cannot be used any more. The reason is not only because the current developed countries are "kicking away the ladder" that they used to catch up (in List's and, more recently, Chang's terminology). In fact, changes in so many levels in the environment for catching up have made certain remedies that worked well in the past less effective, if not a complete anachronism. Although international regulations and practices play a very important role in the definition of policies to move ahead, the new requirements of technological progress are not less important. In any case, when new policy tools can no longer be used, whether for legal commitments or because they became dysfunctional, it is time to create new institutional arrangements to face the challenges of the time.

- Technological borrowing by followers is a necessary step in the path for catching up and, in fact, flows of applied knowledge from leaders to followers

are the essence of the catch-up hypothesis. However, imported technology may also be very detrimental to the lagging countries' interests. For these reasons, most countries that succeed in catching up adopted polices to take advantage of the methods and techniques already in use in the advanced countries in a way that enhanced the development of industrial activities and the improvement of the standard of living. In fact, the negative impact of leading countries can go beyond the importation of final products and technologies that may prevent, instead of enhance, the growth progress.

- Even more critical to development may be the borrowing of institutional arrangements that are totally alien to the local reality. Even though backward countries can take advantage of the successful institutional experiences of leader countries, institutions should be to some extent embedded in the country's socio-economic structure in order to function effectively. Institutional learning may reduce the time of institution building, but learning does not mean simply copy institutions created in more advanced nations. In other words, taking advantage of leaders' experience means to build institutions that perform similar functions in the backward country.
- The latecomers need to set priorities in terms of investments, but the catching up process itself can produce scarcities and bottlenecks, that often cannot be anticipated.
- Countries have uneven abilities to follow different technological paths, according to their capabilities, deficiencies, geography, endowments of factors and historical circumstances. There is no path that fits all. Some deficiencies can be surpassed over time, but not all of them.
- Knowledge is the critical factor to catch up today, but empirical evidence shows it needs to be supported by proper financial conditions, good governance and proper infrastructure.
- In the successful catching up experiences of Japan, Korea and Taiwan, the presence of strong business groups was crucial. Today's China is no different.
- Development policies are contingent upon the country's level of backwardness. As the social capabilities and degree of backwardness of the

diverse groups of developing countries differ a lot, the international programs to help them build the roads to progress and escape from poverty should be tailored to their particular conditions. Indeed, international policies toward the backward countries should take into account their peculiarities and external circumstances.

- The higher the social capability of followers, the higher is their ability to compete in new markets and displace the old established industries of the leader countries. Competitive pressures may be an incentive to research and innovate as well as an excuse for protection. Countries that succeed in their catching up processes quite often also challenge the older leaders in the technological frontier. In fact, as Abramovitz pointed out, as the technological gap falls, the direction of knowledge transfer may change in some domains, and the old lagging countries may become leaders in particular branches, thereby becoming sources of new knowledge for the countries that they had previously followed.
- Catching up more than ever relies on a country's´ ability to adapt and adopt new technologies as well as to innovate. It demands high effort to build social, scientific and technological capabilities; to develop physical infrastructure; and to create an environment that enhances the R&D activities by firms.

Finally, in the current international environment, some roads to catch up have been closed, but new ones have been opened. Countries that are now near to or on the socio-economic frontier have also faced challenges on their way to industrialization – perhaps challenges as big as those which many developing and least developed countries are facing now. The "old good times" were not so good and the "bad present times" are not so bad. There are no ideal conditions; often there are challenges and opportunities. And challenges can be turned into opportunities.

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