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Openness, R&D, and Growth: Differences in Latin American and East Asian Policy and Political Economy

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This paper reviews recent theoretical and empirical literature relating openness, research and development (R&D) policies, and growth in developing countries. Although there are indications that openness is associated with improvements in productivity due to technological spillovers, active R&D policies and complementary institutions (intellectual property rights) play an important role in bringing about such gains. The article compares East Asia and Latin America, with special attention to the latter. The puzzle is that both regions opened their economies and carried out a set of similar industrial and technological strategies, yet their experiences in growth and R&D performance are divergent. After considering differences in each region's pace of integration into the world economy, the analysis moves to a closer look at the political economy of policy formation in Latin America and East Asia. The paper is divided into four sections. The first section introduces the debate; the second encompasses a comprehensive theoretical and empirical literature review; the third discusses the policy and political economy experiences of the regions. Finally, the conclusion offers policy recommendations for Latin America, based on the success of the East Asian experience.[1]

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Introduction

The question of whether integration into the world economy has positive implications for economic development is one of the most recurrent issues in the political economy field, dating back to the work of Adam Smith and David Ricardo. Economic theory suggests that openness[2] is conducive to growth due to potential efficiency gains derived from division of labor and comparative advantages. There is an ongoing discussion in the empirical literature, especially with respect to the policy orientation of developing countries, questioning if outward-oriented countries grow faster (Baldwin 2003). This debate has continued into the present, with ever more relevance after World War II. Multilateral and regional trade negotiations and institutions have been established to promote free trade, representing a mechanism to encourage economic development.

More recently, trade talks have sought to address the liberalization of the institutional framework in which the economies of signatory countries operate. Agreed norms include not only measures to facilitate the free flow of goods, but also issues such as rules of investment and intellectual property rights (IPR) protection. IPR protection and its proper enforcement is a necessary condition to create incentives that will lead to innovation. Yet, it may not be a sufficient condition: there is still a great debate on the optimal level of governmental intervention in research and development (R&D) that is necessary to guarantee innovation, given a particular IPR regime.[3]

Much of the debate surrounding trade negotiations evolves around international trade regimes and the extent to which they may limit the ability of developing countries to carry on domestic R&D and industrial policies.[4] The recent experiences of developing countries in two regions –Latin America and East Asia—indicate considerable differences in terms of economic development performance. The proper mix of integration into the world economy and sound policies, along with the presence of crucial domestic institutions, may explain the results. In addition, the domestic political economy and even bureaucratic characteristics may explain different outcomes.

This paper discusses integration into the world economy and R&D policies, focusing on IPR and its consequences for economic growth. Concurrently, the paper assesses domestic political economy differences as important explanatory variables for economic growth. The following section presents a comprehensive review of theoretical and empirical literature with respect to economic growth. The third section contrasts the political economy characteristics of R&D policy formation in East Asia and Latin

America, with specific focus on the latter. Throughout this section, active industrial and technological policies and data, mainly associated with Import Substitution Industrialization (ISI) will be reviewed. The following discussion suggests that differences in the political economy of policy formation and the higher degree of institutionalization of R&D policies may explain the better performance of East Asian countries. The article concludes by drawing some policy recommendations aimed at Latin American policy makers based on the successful East Asian experience.

Theoretical and Empirical Review

Openness and Growth

Modern neoclassical economic theory stresses the importance of openness as an explanatory variable for economic growth. Openness increases foreign direct investment (FDI) and improves human and physical capital productivity. Neoclassical economics is based on the notion of utility-maximizing rational actors and the market equilibrating forces of supply and demand. Thus, with free trade, rational actors within countries optimize scarce factors by specializing in the production of goods with favorable factor endowments to sell to the international market, spurring growth in the long-run. The principal neoclassical growth model (Solow) also posits that economic development is a consequence of capital accumulation due to high rates of investment and savings. Hence, FDI may contribute to growth by offering an external source of savings to a country. Finally, neoclassical growth models take production technology as exogenous. As the rest of this section will discuss, this feature is one of the main differences between neoclassical and new growth theories.

However, the openness-growth relationship may be somewhat unclear because of endogeneity and reverse causality.[5] Historically, trade growth happens in countries already experiencing modern economic growth; and developed countries trade more with each other than with developing countries (Kravis 1970; Easterlin 1998, 41-42). Technological change is the crucial cause of economic growth, which must be combined with institutional arrangements, such as property rights (e.g., intellectual property rights) and law enforcement of contracts to create incentives to foster markets. Rational actors will then look for mechanisms of comparative advantage (North 1993).

There is growing evidence in the empirical literature that the simple removal of tariffs is insufficient to promote economic growth. Rodriguez and Rodrik (1999) categorically dismiss the negative causal relation between trade barriers (tariff or non-tariff) and economic growth. Rebutting a se-

ries of empirical works, they state that other factors contribute to growth, including differences in macroeconomic policies and domestic institutions, and suggest that the study of variations in trade policy may prove to be a better avenue of analysis. Frankel and Romer (1999), however, defend the idea that the link between trade and growth is somewhat tenuous, but exists. They argue that the impact of trade on income growth depends on a country's size and geographical characteristics. Controlling for these factors, they affirm that trade has a positive impact on income growth. Their results apply both to developed and developing countries. They also minimize the impact of tariff removal and acknowledge that policies and institutions are important channels influencing growth.

Overall, there have been a variety of empirical methodologies employed in the literature, which may contribute to divergent results obtained in terms of the trade-growth relationship. In light of this diversity, Greenaway et al. (2001) criticize different methodologies and employ lagged dependent variables to account for the income growth effects of trade liberalization on developing countries. They find that the impact of trade liberalization on income is illustrated with a J-shaped curve, with positive but modest impacts on GDP per capita. Of note, this literature discusses the impact of openness on income growth rather than on income levels; therefore, distributional consequences of trade liberalization, which can be severe, are seldom considered.

New Growth Theory

New growth theory—known as endogenous growth theory—also posits a causal relationship between openness and growth; however, it acknowledges that the causes of growth are complex, depending on the accumulation of human capital. New growth theory focuses on understanding the economic motivations triggering technological investments. Thus, in contrast to neoclassical economics models, it considers technology as an endogenous variable. R&D activities, carried out both by private and public actors, are believed to increase the stock of ideas available in the economy, some of which may promote innovation and technical progress, as well as increased profits. Hence, R&D stimulates economic growth because it affects total factor productivity (TFP)—new technologies promote more efficient methods of production with a given amount of capital and labor.[6]

New growth theory emphasizes the importance of human capital for R&D activities and innovation. The accumulation of human capital stock facilitates not only the creation of new ideas—i.e., domestic R&D—but also the absorption of knowledge developed elsewhere. Thus, in theory,

long-run economic development is connected to the growth of the number of people dedicated to research, which positively affects the growth of ideas. The cost of innovation falls as human knowledge improves, due to increasing returns to scale[7] (Romer 1990). Summing up, improvements in human capital, leading to technical innovation, are responsible for economic growth in the long-run.

Such theoretical findings have policy implications and justify the importance of formal education and labor force training. However, definitive conclusions are still unresolved in the literature. Jones (2003), for instance, stresses that market forces out of the control of policy makers (e.g., the population growth rate) determine technological and long-run economic growth.

However, new growth theory posits that countries can improve the level of R&D investment and innovation when increasing their degree of integration in the world economy. This occurs because of international knowledge spillovers resulting from trade in goods and foreign direct investment. Coe et al. (1997) observed that the stock of R&D capital of industrial countries was positively related with the growth of TFP in developing countries. Thus, the absorption of technology increases as a country imports more sophisticated products—for instance, machinery and equipment used in domestic production processes—or as FDI increases and local firms enhance their productivity by copying methods of production from foreign companies.

Nonetheless, this latter mechanism has limitations since foreign firms may limit the transfer of technology in order to preserve a competitive edge. The absence of a qualified work force in the receiving country may be another obstacle. In addition, companies may transfer only a certain level of technology due to license restrictions. A minimal level of IPR protection must be required, and the lack of it may hinder the transfer process (Narula 2003, 191-192). Therefore, one of the logical linkages between IPR protection and economic growth is that, by constructing an environment conducive to technical innovations and to the accumulation of human knowledge, IPR will contribute to increased economic growth (Gould and Gruben, 1996).

Another point of dispute regarding IPR results from the presence of both static and dynamic effects. Generally speaking, in a static environment, IPR are not welfare maximizing because, after an innovation, the economic entrepreneur has a legal monopoly. Once the innovation is made, however, spillover effects might spread over other sectors of the economy. A temporary monopoly is justified because research activity requires large

sunk costs, such as building high-level human capital. The incentives for continuing innovation will be greater if the results of new discoveries are protected by an extensive system of IPR. In a dynamic setting, the patent is justifiable because society will be better off when economic actors undergo risky activities, causing knowledge to advance and spread into other sectors (Narula 2003; Maskus 2000).

IPR protection also has asymmetric distributive effects on a global level: the efficient degree of protection might not maximize every country's welfare. Net importers of knowledge products may be required to pay more royalties. Thus, the creation of domestic IPR systems, by itself, may not guarantee any economic growth. Under the assumptions of new growth theory, however, lower access to external R&D due to inadequate institutional settings is usually associated with lower TFP growth rates (Schiff and Wang 2004). Since externalities and knowledge spillovers are international on a first basis, the global economic integration of a developing country may contribute to its economic growth.

Diao et al. (1999) verify that trade openness impacts the absorption of foreign R&D stock: the effect is greater if countries are able to process this body of foreign knowledge effectively. This last point relates to the issue of domestic R&D capability. Lederman and Maloney (2003) examine patterns of R&D investment and development, verifying that although rates of return for R&D investments are higher for developing countries, other institutional variables count in R&D investment decisions. This may suggest that countries with national innovation institutions may be better equipped to integrate into the world economy.

Summing up, based on new growth assumptions, policy-oriented literature suggests that trade and FDI are important channels to allow spillover and growth in productivity (Schiff et. al. 2002). The theoretical literature also holds the technological spillovers hypothesis: Diao et al. (1999) and Coe et al. (1997) verify that more open countries experience an increase in both foreign and domestic stock of R&D. The next subsections address some of the empirical findings regarding Latin America and the specific causality between IPR, economic growth, and FDI.

The Examples of Mexico and Brazil

Considering TFP improvement, the benefits of integration into the world economy can work both via trade and FDI channels. The Inter-American Development Bank (IDB) (2002) compared several manufacturing sectors in Mexico and Brazil: the results are consistent with the hypothesis that trade integration spurs productivity. Lopez-Córdova and Mesquita

Moreira (2004) also examine the effects of trade liberalization and regional integration on productivity gains in the recent experiences of Brazil and Mexico.

Results, albeit somewhat counterintuitive in the Mexican case, support the idea that openness spurs productivity gains due to import competition and export orientation. Although these works do not disaggregate in terms of R&D intensive sectors, the results show that Latin American firms may be adopting more up-to-date production methods, thus narrowing the technological gap. The IDB found a significant increase in the number of domestic firms participating in world markets: from 39 percent in 1996 to 44 percent in 1999 in Brazil, and from 28 percent to 43 percent in Mexico. During the same period, the internationally-oriented firms experienced higher productivity gains. Consequently, at least in some outward-oriented sectors, these countries may be catching up and experiencing productivity improvements due to export discipline. Furthermore, FDI has encouraged these gains, suggesting that there are positive effects caused by competition, knowledge, and linkages.

The IDB study shows that the North American Free Trade Agreement (NAFTA) shaped the export drive in the case of Mexico, whereas in Brazil, the destination of exports was more diversified, going both to Mercosur and other regions of the world. In brief, even considering that other economic factors and policy reforms may have contributed to the outcome, Mexico's and Brazil's unilateral trade liberalization and regional integration through NAFTA and Mercosur, respectively, contributed to TPF gains during the 1990s (IDB 2002, 254-265). López-Córdova and Mesquita Moreira (2004) indicate similar results.

The Link Between IPR, Growth, and FDI

The literature has recently started to explore the complex relationship between openness, R&D activities, IPR protection, and economic growth. Gould and Gruben (1996) performed cross-country sample tests in which the dependent variable—average annual growth in real per capita GDP between 1960 and 1980—was regressed on a series of explanatory variables. These included: real per capita GDP in 1960, physical capital savings, secondary education enrollment, literacy rates (the latter two as proxies for human capital savings), and a measure for intellectual property rights protection, proxied as an index of patent protection.

Overall, the authors verified that IPR protection has a positive effect on per capita GDP growth, and coefficients are statistically significant. When they added other explanatory variables to the model (government

consumption, proxies for degree of political instability, and dummy variables for Sub-Saharan Africa and Latin America), the positive causal relation still held, while significance level fell only slightly. Their main objective, consistent with the ideas in this article and with the literature on new growth theory, is to show that the positive causal relationship between IPR protection and economic growth increases with openness. Therefore, in more open markets, the linkage between IPR and firms' technological development through R&D may be affected by the degree of foreign competition.

Additionally, Gould and Gruben added variables to measure openness (black market exchange rate premiums, real exchange rate distortion, and a dummy variable for a comprehensive trade index) in order to depict the effects of IPR protection on economic growth in different trade regimes. The results showed that IPR protection continued to be significant and positively related to economic growth in open trade systems, but less important in closed regimes. These results may indicate that protected domestic firms have fewer incentives to innovate, even in the presence of reasonably strict rules of IPR.

Smarzynska (2002) clarified the relationship between IPR regimes and foreign direct investment within the context of trade opening and policy reform in Eastern European countries. The author maintains that the relationship between IPR protection and FDI is not important in all economic sectors. In some segments, such as automobiles, in which firms cannot use competitors' technology without expensive and complex inputs (e.g., huge outlays), IPR are less important. Meanwhile, the relationship between IPR and FDI tends to be more apparent and important in sectors whose production technologies are easily absorbed, such as drugs, cosmetics, health care products, chemicals, machinery, and electrical equipment. Therefore, the author developed two hypotheses: (1) FDI in sensitive sectors will rely on IPR protection; (2) in countries with weak IPR protection, firms will be limited to distribution activities instead of local manufacturing.

Smarzynska designed a probit model describing investors' decisions to enter a particular host country. The second part of the model depicted the choice of foreign firms to set up production plants or to carry out activities that focus only on distribution. Next, she added other control variables related to IPR regimes. The overall results confirmed the hypothesis that IPR protection affects investment in sensitive technology sectors. After testing the second hypothesis, the results showed that foreign investors are indeed more likely to establish local production in countries with ef-

ficient IPR regimes.

In these tests, the degree of openness only seems to have significant coefficients in IPR-sensitive sectors. Hence, this study shows that countries with IPR efficient regimes tend to attract FDI to R&D activities. The next section outlines some policy and political economy explanations for the cases of Latin America and East Asia.

Policy Variations Due To Institutionalization Of R&D: A Key Difference Between Latin America And East Asia

There is some agreement within policy circles that East Asia's superior growth performance could be credited to export-oriented trade policies and more effective macro and fiscal policies (Birdsall and Jaspersen 1997). Yet during the 1990s, Latin America also implemented structural reforms and unilateral trade liberalization and joined regional integration arrangements (RIAs).

Adequate R&D policies and institutions are considered important instruments for productivity and innovation. However, several East Asian countries began the industrialization process with active "nationalist" domestic R&D policies, moving to greater IPR protection later on. Similarly, Latin America followed "autonomous" R&D in the early years of industrialization, while adopting market-oriented institutions in the 1990s. In light of similarities in R&D and industrial strategies in the two sets of countries, this paper seeks alternative explanations. To that end, it focuses on differences in the regions' domestic political economies.

This section reviews the drawbacks and merits of active industrial and technological policies mainly associated with the ISI period. Subsequently, particular attention is given to the differences in the political economy of policy formation and the higher degree of institutionalization of R&D in the domestic policy-making processes of East Asian countries.

Differences in the Application of ISI

Industrial policies in Latin America were dubbed "import substitution" because they were implemented in order to decrease the degree of dependence on imports, including final manufactured and capital goods (machinery and equipment) used to produce other commodities. The process of industrialization, thus, required an important partnership with the R&D sectors in order to acquire native capacity for the production of more sophisticated and capital-intensive products. Policy makers believed that technological self-sufficiency was the vehicle to overcome development

lags and establish autonomy in crucial sectors.

In both Latin America and East Asia, the process of industrialization was implemented in the context of restrictive IPR protection and active national R&D measures. Overall, in terms of industrial and R&D policies, both groups of countries had similar approaches (Katz 2000; Rodrik 1996). Several industries were regulated, state monopolies played an important role in R&D, and subsidies and tax breaks were granted. Realizing the importance of innovation, governments also tried to bolster domestic capability by sponsoring research projects and protecting R&D intensive sectors. In both regions, the state supported a national system of innovation in an effort to institutionalize the linkages between the research, academic, and productive sectors (Wade 1990, chapter 9; Chang 2002, 219-222).

Concerning IPR protection, the regions also showed similarities. In Latin America, international patents were not easily accepted unless they were attached to foreign technology transfers. Likewise, FDI in technologically intensive sectors was welcomed, provided it was connected with performance mechanisms and technology transfers. Complex legislation abounded in this area (Adler 1987, 116-117; 150-198). Similarly, East Asian countries such as South Korea had a restrictive approach on internationally granted patents. Nevertheless, international IPR protection increased in East Asia along with domestic technological capability. These countries shifted from imitation to innovation (Lee 2000, 284). The result of a similar set of policies was radically different in Latin America. As Table 1 shows, Latin America patent performance is extremely meager compared to that in East Asia.

Table 1: Number Of Patents By Country Of Origin (Selected Countries)

Rank	Country	Number Of Patents Per One Million Inhabitants
1	United States	308.7
2	Japan	246.6
3	Taiwan	210.3
12	Korea	70.1
19	Singapore	54.3
24	Hong Kong SAR	26.3
32	Costa Rica	1.8
34	Argentina	1.5
36	Venezuela	1.1

38	Chile	1
39	Mexico	0.8
42	Panama	0.7
43	Brazil	0.6
48	Uruguay	0.2
58	China	0.1

Source: Competitive Global Report 2001-2002 in Sachs and Vial (2002).

Data from the American National Science Foundation (NSF) measuring technological competitiveness of emerging countries depicts considerable differences between East Asia and Latin America. For instance, in 1996, R&D as a ratio of GDP in South Korea and Taiwan was 2.8 and 2 percent, while in Brazil, Argentina, and Mexico, it was 0.8, 0.4, and 0.37 percent, respectively (NSF 2003). It is difficult to find data on R&D/GDP ratios from the early ISI decades. Yet, in order to establish a baseline for comparison, it is worth noticing another difference between East Asia and Latin America: the former features higher levels of private sector participation in entrepreneurial efforts.

Private participation in R&D has been a feature of the East Asian model since the early years of industrialization. The private sector increasingly assumed more responsibility in R&D, while the state played a coordination role between governmental research institutions and their private counterparts (Chang 2002). As a result, the private sector currently holds the principal responsibility for sponsoring R&D activities in East Asian countries.

East Asia's higher number of patents vis-à-vis its share of scientific publications also reveals the technical and industrial orientation of its innovation systems (Archibugi and Pietrobelli 2002). Viotti (2002), for instance, shows that in the early 1990s, the Brazilian government accounted for approximately 82 percent of R&D expenditures, while the private sector contributed 17 percent. In Korea the figures were inverted: 17 percent government and 81 percent private sector. NSF statistics show that in 1996, the governments of Argentina, Brazil, and Mexico were responsible for 46, 57, and 66 percent of R&D financing, while industries (private or public) accounted for 28, 40, and 17 percent, respectively. Universities, nonprofits, and foreign sources accounted for the rest of the share. The data also reflect a trend for more private participation in R&D in Latin America between 1990 and 1996, particularly of US companies.

During the ISI years in Latin America, the state assumed most of the responsibility for R&D, both as a producer and a financer of technologi-

cal activities. This characteristic has not changed despite efforts to engage the private sector. The following section discusses the policy and political economy characteristics that explained the different paths and much of the difference in growth performance between the two regions.

Policy and Political Economy: The Missing Link

The political economy explanation for trade and industrial policies is not particularly original in the field of international political economy. Haggard (1990) compared internal social and political cleavages as determinants of industrial policy outcomes in East Asia and Latin America, given a constant international environment. The assumptions in this paper are original to the extent that they explain superior growth performance in East Asia as the result of a greater degree of institutionalization of R&D policies and bureaucracies in domestic policy-making.

Policy Implications

The recent literature emphasizes that East Asian countries were more successful in creating a national system of innovation at the core of their domestic policy-making. Those countries were able to bring together the domestic R&D sector, the government, academia, and the business community under a coherent development strategy (Vartiainen 1999; Lall 2000; Lee 2000). The national system of innovation in East Asia played a role in the improvement of productive capacity and competitiveness.

On the other hand, the link between the government, academic, and productive sectors in Latin America was much weaker. Bastos and Cooper (1995) hypothesized that the technological effort in Latin America was supply driven, with weak linkages between the state and social actors demanding technological policies. Economies of scale or strategic and security considerations were often used to justify insulation or strong state intervention in some sectors. This was the case with the aerospace industry in Brazil, which began with the state-owned company EMBRAER. As Andrea Goldstein describes, the military aerospace industry is a successful example of a policy that started as part of a web of academic and bureaucratic interactions, later transitioning to productive and civil activities (2002).

Yet, overall, the policies were mismatched. Naun (1995) describes the nuclear program in Argentina as a project having little connection to the country's needs, despite the high level of expertise in this field. The R&D policies in Latin America—like many of its economic policies—were formulated in an environment of "embedded autonomy," in which state actors and institutions were somehow disconnected from social forces.[8]

This observation, however, does not place the blame exclusively on the shoulders of state actors, since the productive sector itself showed little concern with issues of technology and competitiveness. Rather, the sector took advantage of the high tariff walls that attempted to spur domestic technological capability in order to maintain market shares and profits (Naun 1995, 42-47; Bastos 1995, 76-80; Nadal Egea 1995, 130-135). Therefore, the technological effort was an initiative of the state.

Adler (1987) also formulated the concept of "technological guerillas": combative governmental officials and academic researchers that sought to promote technological projects in order to strengthen national autonomy and advance development. The computer hardware industry in Brazil, for instance, presents another example of the state implementing policies in order to build domestic capability. This case is widely studied as an illustration of embedded autonomy (Erber 1995, Evans 1995).

The effects of this autonomous and insulated approach were obviously not optimal from the point of view of productive linkages. Despite the great emphasis placed on development plans and considerable governmental investment in R&D during the 1960s and 1970s, at the end of the ISI period private companies had not initiated a culture of investment in R&D. During the 1980s and 1990s, the process of structural reform—trade liberalization, deregulation and privatization—was not able to reverse this trend, and the private sector did not embrace R&D responsibilities (Bastos and Cooper 1995, 23). Neither did it receive the proper incentives to do so.

Regarding the role of the private sector after the liberalization period, Ocampo (2003) remarks that the more open and internationally-oriented sectors of Latin America—those exposed to competitive pressures from privatization and trade liberalization—experienced higher TFP growth. His conclusions support the idea that Latin American economies possess a dual characteristic: a modern export-oriented sector and a backward inward sector. He considers the inability to spread gains of productivity from outward- to inward-oriented sectors one of the main drawbacks of Latin American economies. Such transfer of gains would benefit the whole national economy. The creation of linkages between outward and inward sectors was far more consistent in the East Asian countries.

Kim and Nelson (2000) observe that the most advanced and dynamic sectors of the East Asian economies, those connected to the world economy, were somehow linked to the traditional inward sectors. Those linkages triggered general externalities in terms of learning-by-doing, technological spillovers, and improvements in human capital. Katz (2000) argues

that many of the microlearning dynamics (spillovers) present in Korean and Taiwanese firms existed in Argentina, Brazil, and Mexico as well. He remarks, however, that with the exception of some areas (such as the already mentioned aerospace sector in Brazil), academic and productive linkages were negligible in the region.

Rough statistical estimates disaggregated at the country level confirm the policy characteristics described in the preceding paragraphs. Discussing the Brazilian case, Schwartzman et al. (1993) mention that between 1981 and 1989, science and technology expenses were approximately U.S. $2 to $3 billion per year, representing 0.6 to 0.8 percent of GDP. Only 0.6 percent of these contributions came from the private sector, while the state-owned companies accounted for 10 percent of expenses in the same period.

Nadal Egea (1995, 112-114) highlighted the low level of private investment and the high fluctuations of governmental R&D expenditures in Mexico between 1970 and 1990. Katz (1999) concluded that Latin American private conglomerates did little to contribute to the exploration of the region's rich natural resources. They preferred not to invest in technological improvements even in sectors that enjoyed considerable comparative advantage, such as the case of minerals.

On the other hand, Raunch (1999) mentions that East Asian conglomerates played a crucial role in the national economies, contributing to a more institutionalized process of innovation and learning among companies within the same network. This was the case, for instance, with the *chaebol* in Korea and the *keiretsu* in Japan. These types of businesses are typically family-owned industrial or service companies that rely on close relationships with the government. Arranged in clusters around a bank that provides them with credit and may own their equities, chaelbols and keiretsus exercised monopolistic or oligopolistic power in product lines and economic sectors. Wade (1990, 309) posits that the rationale behind them was to concentrate resources on entrepreneurs with proven track records, and to encourage technological and organizational economies of scale. However, Raunch notes, the same type of industrial organization was not the rule in Taiwan. Therefore, conglomeration by itself cannot be considered an explanation for better productivity performance. In short, in East Asia, innovation and learning at the firm level were more common and efficient due to proper public policies that managed to connect the academic and productive R&D spheres.

Education policy is unquestionably another major area of difference between the regions. There is a striking disparity in the level of formal education, with Latin America lagging far behind East Asia. The level of

human capital is the most important determinant in foreign R&D assimilation and in native R&D creation. Table 2, based on United Nations Development Program (UNDP) data, shows educational and technological statistics in selected Latin American and East Asian countries. Despite small differences in primary enrollment, and some gaps in the data, East Asia performed better in terms of secondary enrollment and number of researchers in R&D.

Table 2: Educational and Technological Achievements (Selected Countries)

Country	Net Primary Enrollment Ratio (Percentages)		Net Secondary Enrollment Ratio (Percentages)		Tertiary Students In Science, Math, And Engineering (Percent Of All Tertiary Students)	Researchers In R&D (Per One Million People)
	1990-1991 a	2001-2002 a,b	1990-1991 a,c	2001-2002 a,b,c	1994-1997 d	1990-2001 d
Hong Kong, China (SAR)	..	98	..	72	..	93
Singapore	96	..	..	..	..	4,052
Korea, Rep. of	104	101 e	86	89 e	34	2,880
Argentina	94	108 e	..	81 e	30	684
Chile	88	89 f	55	75 f	43	419
Mexico	100	101 e	45	60 e	31	225
Brazil	86	97 e	15	72 e	23	323
China	97	93 f	..	..	53	584

Notes:

a. The net enrollment ratio is the ratio of enrolled children of official age to the total population of that age. Net enrollment ratios exceeding 100 percent reflect discrepancies between these two data sets.

b. Unless otherwise specified, data on net enrollment ratios refer to the 2001-2002 school year, and data on children reaching grade 5, to the 2000-2001 school year. Data for some countries may refer to national or UNESCO Institute for Statistics estimates. For details, see http://www.uis.unesco.org/. Because data are from different sources, comparisons across countries should be made with caution.

c. Enrollment ratios are based on the new International Standard Classification of Education, adopted in 1997 (UNESCO 1997), and so may not be strictly comparable with those for earlier years.

d. Data refer to the most recent year available during the period specified.

e. Preliminary UNESCO Institute for Statistics estimate. Subject to further revision.

f. Data refer to the 2000-2001 school year.

Source: United Nations Development Report (www.undp.org/statistics/data, accessed 3/31/2005).

Katz (1999; 2000) also sustained that macroeconomic imbalances bear some responsibility for the failure of ISI policies. However, sectoral policies were to blame for the dismal degree of competitiveness acquisition, which account for the poor rates of productivity growth in Latin America. Policy makers were simply unable to carry out adequate educational and R&D policies. Since some Latin American countries did create an innovation/R&D system, it is worth asking why policy performance was unsuccessful. This question leads to a political economy explanation.

Political Economy Implications

It is important to mention political economy approaches that apply Hecksher-Ohlin/Stoper-Samuelson endogenous trade policy models to developing countries (Cheng and Feng 2000; Grether et al. 2002). Latin America is not endowed with sufficient physical and human capital relative to land and labor. Thus, the owner of a scarce factor of production (human or knowledge capital) is likely to lobby against liberalization of R&D activities, holding back imports of knowledge intensive goods and blocking the granting of international IPR.

Although this article agrees with the conclusions of the literature, the following section seeks to incorporate the bureaucratic and social characteristics of the political economy of R&D in Latin America as key explanatory variables for the development outcomes of the region. In this respect, the concept of embedded autonomy is once again important. This discussion also relies on an analysis of the "developmental state," one that supports industrial development and shapes social forces within a country (Schneider 1999, 278). Therefore, the dynamic of R&D is part of a complex web of interactions between state agencies, economic, and social actors, including businessmen and industrialists, as well as the academic and research communities.

In the specific case of Brazil, the planning and finance bureaucracies in charge of economic policy introduced the technological policies of the 1960s and 1970s.[9] This occurred within a context of political authoritarianism and high rates of economic growth. The economic argument stressed the need to relieve the shortage of high-skilled labor, as well as to cut back payments for imported technology and capital goods in order to

reduce deficits in the current account.

Overall, the productive sector was not interested in technological considerations, but rather lobbied for protectionist measures as long as it perceived a possibility for rent-seeking (Bastos 1995). The computer industry in Brazil is the most illustrative example: in the mid-1970s, national policies attempted to create local technological capabilities (including innovation) to enable national enterprises to control the sector. Policies were designed to improve local contents, encourage transfers of foreign and develop domestic technology, and create procedures to avoid excessive market power. However, those same directives granted market reserves that benefited national and subsidiaries of foreign companies in the country. Therefore, despite the well-intentioned policies, noncompetitive interests were predominant as protectionist policies influenced the technological and industrial sectors (Erber 1995, 197-223).

An ideological component followed the economic argument. Several science and technology actors on both sides of the political spectrum based their behavior on an ideology that emphasized technological autonomy at the core of the nationalist agenda.[10] Thus, nationalist segments within the bureaucracy and the academic community established an alliance with the nationalist military. Strategic and security considerations also accentuated the nationalistic and autonomous approach on R&D policies, as in the aerospace sector in Brazil.

It is worth mentioning that the East Asian experience was characterized by political authoritarianism and high rates of growth in the initial years of ISI. According to Vartiainen (1999), the developmental state in Taiwan and South Korea had a corporativist approach, which managed to merge labor and business interests with the oversight of state actors, all within a common objective of industrialization and national competitiveness in international markets. Chang (2002) also underscores the cohesiveness of investment, trade, and industrial (including technological) policies backed by fairly institutionalized bureaucracies.

On the other hand, the absence of institutionalization that Bastos mentions (1995, 83-85) was an apparent shortcoming of the nascent R&D sector in Brazil. There was a low level of coordination among the various state agencies, and between the scientific and technological communities. In addition, some of the agencies were vulnerable to patronage and clientelism, as political appointments determined their management and recruitment policies.

The weak institutionalization of the scientific and technological sectors in Latin America became more apparent with the economic challenges and

the re-democratization phase of the 1980s. In Brazil, even the creation of the Ministry of Science and Technology in 1985 did not strengthen the technological and scientific bureaucracies. In Latin America as a whole, ministries of trade, industry, and science and technology have historically played a minor role in national policy-making vis-à-vis the finance ministries.[11] Economic and political restraints, such as the increasing use of patronage in political appointments, the subordination of industrial and technology policies to the program of economic stabilization, the indiscriminate shrinking of state intervention, and financial crises ensued (Bastos 1995, 97).

The structural reforms of the 1990s were unable to reverse Latin American weakness in the areas of innovation and technical progress. For instance, the policies associated with the Washington Consensus did not address those issues. As the architect of that initiative admitted, R&D and innovation concerns—along with several other institutional enhancing measures—should be part of a second generation of reforms in order to spur Latin America's development (Williamson 2003, 12-13).

Therefore, a contemporary explanation emphasizes the lack of political influence of R&D sectors in Latin America. Compared with East Asia, the national innovation system was never successfully institutionalized in Latin America. The Ministry of International Trade and Industry (MITI) in Japan and the Ministry of Science and Technology in South Korea, for example, constituted powerful bureaucracies in the industrialization years, and continue to have policy relevance today (Lee 2000).

In summary, in spite of the appeal and elegance of new growth models, the political economy explanations should not be neglected. In Latin America, R&D bureaucracies had considerable less political clout in policy-making processes vis-à-vis finances ministries. Hence, Latin American countries did not manage to create an effective national innovation system. The opposite occurred in East Asian countries.

Policy Recommendations and Conclusions

Building on the preceding analysis of the recent literature and the historical records of East Asia, this section recommends two courses of action for Latin American policy makers: to continue integrating into the world economy, and to create and implement an effective national system of innovation.[12]

Integrating into the World Economy

Latin American governments should seek to benefit from the trends of

technological globalization. The example of East Asia and the recent upsurge of India's capabilities show that national R&D improvements are complements rather than substitutes for foreign R&D. Multinational companies have global investment strategies, seeking lower costs and better institutions in order to maximize R&D investment gains.[13] Thus, a modern institutional framework—for instance, the establishment of a system of venture capital or modern IPR legislation—may enhance investment opportunities and bring about innovation. Moreover, the adoption of a new trade agenda in multilateral and regional trade talks emphasizing institutional infrastructure may be an advisable step. Multinationals are not the only actors that stand to benefit from an efficient institutional climate: such a framework is also likely to encourage domestic innovators.

Governments should implement policies to promote dynamic exporting sectors, which may spur positive externalities and knowledge spillovers to domestic economic sectors—that is, the linkage effects. Exporting should not be considered a panacea; yet, the discipline required to penetrate more competitive markets is supposed to promote productivity gains and encourage innovation. Government intervention should help to provide positive information externalities (e.g., new market opportunities abroad) and coordination externalities (e.g., convene firms within the same production chain in dynamic activities). Governmental subsidies and tax breaks should still play a role, but they should be carefully designed toward "new" activities that offer exporting and innovation perspectives. They should be tied to performance and include mechanisms of accountability, transparency, and sunset clauses.[14]

Finally, national states should continue to provide incentives for basic research. Latin American countries should streamline the scarce resources, seeking a sort of comparative advantage in R&D. Instead of engaging in an autonomous "techno-nationalism" and electing "national champions," which may lead to a race to the bottom, countries should seek regional cooperation under the technical auspices of institutions such as the IDB and the Economic Commission for Latin America and the Caribbean (ECLAC).

For instance, Latin America is rich in natural resources. Thus, countries should try to master technologies in agricultural biodiversity or in renewable energy sources. Finding these promising areas should also be the mission of government agencies in cooperation with international institutions. Considerable regional variations—in terms of human and physical capital endowment, as well as domestic R&D capabilities—offer another justification for the coordination and oversight of international institutions.

Creating and Implementing an Effective National System of Innovation

Governments have a crucial role in coordinating the domestic public and private sectors. The election of several left-wing Latin American presidents in the last five years has spurred the quest for active technological and industrial policies. This process should start with a bureaucratic revamping of governmental R&D and industrial agencies. These bureaucracies should have more political clout vis-à-vis the finance ministries. This shift could be facilitated if prominent political figures in the executive branch assumed the oversight responsibility for R&D activities in the government.

The creation of a unified R&D and industrial agency would strengthen coordination among governmental branches. Such an agency should have a regulatory mandate to coordinate complementary policies of ministries of education, science and technology, industry and finance. It should also assume leadership for creating links between the academic and business and public and private sectors. The agency should rely on up-to-date legislation for R&D and industrial activities that seeks alliances and complementarities between the government, private sector, and civil society. In brief, the agency should be responsible for the creation of a national system of innovation where such a system is lacking. In cases where such a system already exists, the agency should be responsible for policy coordination among the various concerned actors.

A set of complementary policies such as those present in the East Asian model should also be adopted in Latin America. The most obvious ones are those that enhance human capital, improve basic formal education, and increase the number of midlevel technicians, engineers, and high-level scientists. Less apparent policies such as improving physical infrastructure should also be promoted.

The East Asian experience had some drawbacks. Due to the characteristics of the political economy, some policies increased the degree of market power of certain firms in domestic markets. As a result, the outward orientation and export subsidies were carried out at the expense of domestic consumers. Thus, the Latin American R&D and industrial initiatives should be complemented with competition policies aimed at avoiding excessive market power by particular firms.

In conclusion, the literature and the historic record seem to indicate a degree of correlation between openness, good policies and institutions, and economic development. The 1990s showed an increase in R&D expenditures and exports of dynamic R&D sectors in Latin America (NSF

2003). Although the figures remain meager, such a promising trend gives ground for cautious optimism.

NOTES

[1] The author wishes to thank Jeffrey Nugent for comments on an early version of this paper. Several editors (Abigail Ruane and Giancarlo Marchesi) and anonymous referees have greatly contributed to improving the manuscript. All remaining errors are mine.

[2] One can interpret openness in terms of the share of exports plus imports in a country's GNP (X+M/GNP). Here, I consider openness not only trade of goods or the level of domestic tariffs, but also the overall outward policy orientation of a country, for instance the degree of willingness to receive foreign direct investment. Thus, I use the term integration into the world economy interchangeably with openness.

[3] The benefits of innovation derived from R&D activities might be considered public goods, justifying the intervention of government to correct market failures and guarantee positive externalities to the entire society.

[4] On the one hand, developed countries advocate that IPR should be granted indiscriminately so that market forces would suffice to spur technological innovations. On the other hand, developing countries argue that indiscriminately granting IPR may hinder domestic R&D, and they are doubtful that private multinational companies will transfer up-to-date technologies and support domestic learning.

[5] Causality refers to the effect the explanatory variables may have on the dependent variable; whereas, endogeneity, in the sense of reverse causality, means that the values the explanatory variable takes are a consequence of the dependent variable (King et. al. 1997).

[6] The functional form of these assumptions is given by the Cobb-Douglas expression, which adds human capital to the textbook Solow growth model:

$$(1)\quad Y(t) = K(t)^{\alpha} H^{\beta}(A(t)L(t))^{1-\alpha-\beta}$$

where K is the stock of capital, L is labor, and A is the technology; and H is the human capital, which arises with the interaction between labor and the stock of ideas in the society (Mankiw et. al. 1992).

[7] The property of increasing returns to scale in the production function refers to the fact that the use of ideas by one economic actor does not preclude their use by others (non-rivalry). However, some may charge others for the use of their ideas (partial excludability). In the previously mentioned Cobb-Douglas functional form, based on the textbook of Romer (2002, 100), the property of increasing returns to scale is given by:

$$(2)\quad \dot{A}(t) = B[a_K K(t)]^{\beta} [a_L L(t)^{\gamma}] A(t)^{\theta}, \qquad B > 0,\ \beta \geq 0,\ \gamma \geq 1$$

where B is a shift parameter, Å is the variation of knowledge across time, K is the stock of capital, L is the stock of labor, a_K and a_L are coefficients associated with capital and labor, and A is the current stock of knowledge. This functional form may have constant, decreasing, or increasing returns to scale. The interaction among researchers, fixed set-up costs, and so on may be important enough in R&D that doubling capital and labor more than doubles output. Therefore, there are increasing returns to scale, and the parameter θ is positive.

[8] Evans (1995) describes "developmental states" as possessing "embedded autonomy," that is, the autonomy of state agencies and bureaucracies to carry on policies disconnected from social forces, thus acquiring a capacity to drive social change. Social "embeddeness," conversely, strengthens the link between the state and the business and industrial classes, allowing state elites to incorporate these groups into the national project.

[9] Bastos (1995) describes how the technological bureaucracies in Brazil were offshoots of economic policy and planning agencies in the ISI decades of the 1960s, 1970s, and 1980s. For instance, in 1972, the Ministry of Planning created the National System for the Development of Science and Technology (PNDCT). The Agency for the Financing of Research Projects (FINEP) was a branch of the National Bank for Social and Economic Development (BNDES). On the other hand, the scientific agencies had been established in earlier decades—most often under the aegis of the Ministry of Education—to carry out basic research and academic activities. They were not linked to the production sectors.

[10] Adler (1985) describes the Brazilian and Argentine "quest for technological autonomy" in the computer sector. He indicates that political economy pressures and even ideological motivations played a role in these countries' efforts to acquire a domestic hardware industry.

[11] In Brazil, a former Minister of Finance was appointed Minister of Science and Technology during the second mandate of President Fernando Henrique Cardoso (himself a former Minister of Finance). The new Minister complained that the Treasury Secretary's budget allocations for science and technology were insufficient. He also expressed concern about the lack of transparency in the allocation of resources within the governmental R&D sector (Bresser Pereira 1999).

[12] Some of these suggestions are based on Rodrik (2004).

[13] Narula (2003, 119-129) mentions the importance of global alliances between foreign and domestic firms as a vehicle for R&D diffusion.

[14] A sunset clause is "a provision of a law passed by a legislature which causes that law to repeal itself automatically as of a given date in the future, unless it is extended by another act of legislature. They are commonly included in controversial laws as an attempt to diminish the concerns of opponents, al-

though they are not solely found in that type of lawmaking, since they can also pertain governmental regulations, as in the example of subsidies or tax breaks for R&D activities." (Wikipedia, http://www.answers.com/sunset%20clause, accessed 4/23/2005)

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