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INNOVATION AND GROWTH IN RESOURCE RICH COUNTRIES

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Resumen

Numerosas economías ricas en recursos han sido mucho más dinámicas que sus similares en América Latina y hay poca evidencia de largo plazo de que países con abundantes recursos naturales tengan un desempeño económico inferior al promedio en general. Sin embargo, hay dos factores que históricamente han distinguido a países latinoamericanos de experiencias más exitosas como las de países escandinavos o Australia. En primer lugar, la deficiente capacidad "innovadora" o "de aprendizaje" originada por la reducida inversión en capital humano e infraestructura científica que conllevó a una débil capacidad para innovar o incluso para aprovechar avances tecnológicos del exterior. Y en segundo lugar, el periodo de industrialización hacia adentro, que creó un sector cuyo crecimiento dependía de rentas monopolísticas artificiales más que de cuasi rentas provenientes de la adopción tecnológica, y al mismo tiempo, debilitó a los sectores intensivos en recursos que tenían potencial para un crecimiento dinámico.

Abstract

Numerous resource rich economies have been far more dynamic than those in Latin America and there is little long term evidence that natural resource abundant countries generally under perform. But two factors historically distinguish Latin America from the more successful experiences of Scandinavia or Australia. First, deficient national "learning" or "innovative" capacity arising from low investment in human capital and scientific infrastructure led to weak ability to innovate or even take advantage of technological advances abroad. Second, the period of inward looking industrialization created a sector whose growth depended on artificial monopoly rents rather than the quasi-rents arising from technological adoption, and at the same time undermined resource intensive sectors that had the potential for dynamic growth.

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I. Introduction

Raul Prebisch's concern that resource abundance would lead to disappointing growth performance in Latin America has found new life in recent years. Most notably Sachs and Warner, using a data set spanning 1973-1995, find resource intensive exporters grow more slowly. This article argues that the emphasis of these investigations should probably be on why Latin America was not able to realize the potential of its natural resource riches that international evidence suggests exists. A couple observations to begin:

First, natural resources have played an integral role in the success of many successfully industrialized countries and provide important counterexamples to those arguing that there is a "resource curse." The literature is clear that, many of the richest countries in the world- Australia, Sweden, Finland, Canada, the United States based their development strategies on natural resources and as figures 1 and 2 suggest, continue to be net resource exporters today as measured by Leamer's more appropriate measure of patterns of trade, net exports per worker.[1] Latin America also offers its success stories. Mexico's dynamic industrial city, Monterrey, emerged from the mining boom of the 19th century as a processor of iron ore and steel. Colombia's Antioquia, with its epicenter Medallin, was also originally based on mining, and then coffee, before becoming an important industrial center. As is frequently noted, São Paolo, if taken alone, would have the GDP of Belgium, and it too was built on mining and coffee.

Second, growth processes take place across the very long run and probably cannot be convincingly summarized by cross section regressions of one highly turbulent 20 year period at the end of the 20th century. Maddison's well known growth data over two centuries suggest that at the beginning of the century, Latin America and other natural resource rich countries were growing faster than either Asia or the more established technological powers of Europe (Table 1). As a convenient summary of the data, table 2 runs Maddison's growth estimates on Leamer's measure.[2] The greater temporal scope comes at a high cost in terms of available control variables and the regressions must be treated as suggestive only. But across the whole period 1820-1989 there is no obvious

[1] Irwin(2000) argues that the U.S. industrial success must be considered that of the most natural-resource-rich nation that made a gradual transition to resource-rich manufacturing industries. Innis (1933) and Watkins (1963) had Canada in mind when they developed their "staples theory" where primary good exports-through either demand or supply linkages—as driving subsequent industries that drove Canadian development. Although wool would be Australia's most famous staple, extraordinary and continuing success in mining and the derivative industries of both made Australia one of the richest economies in the world in the early 20th century, and discoveries of new deposits might put it near the top of the list again (Wright 2001, Czelusta 2001). Blomstrom and Kokko (2001) show the importance of, especially the forestry industry in much of Swedish development, and natural resources drove most of Scandinavian progress (Blomstrom and Meller 1987).

[2] Leamer, for instance, long ago argued that the relevant measure should be NET exports not simple exports to account for the fact that very open economies may not only export such products in quantity, but also import them. This destinction turns out to be important. Where the extreme NR intensive countries in the S and W are Cote D'Ivoire, Ghana, Kenya, Tanzania and South Africa, using the Leamer measure, these are replaced by Norway, Mexico, Canada, Australia and Finland, all countries with substantially higher long run growth rates.

prejudicial effect of natural resource abundance and, if anything for the 130 years leading up to 1950, natural resource abundance increased growth. Only the post war period arguably suggests a negative relationship, but this becomes insignificant when a Latin America dummy is included, a dummy that was not significant in the pre-war period. These simple correlations suggest that the question should not be why natural resource abundant countries did worse… they didn't, but why Latin America in particular under performed.

Third, the growth literature increasingly emphasizes total factor productivity as the key determinant of cross country differences in per capita income and in growth rates, a position that Prebisch would have been comfortable with.[3] Yet the evidence by no means confirms his concern, or more recent skeptics[4] that natural resource based industries have lower possibilities for TFP growth. Even in that era, future Nobel Prize winner Douglass North argued that "the contention that regions must industrialize in order to continue to grow.. (is) based on some fundamental misconceptions" and the pioneer trade economist Jacob Viner stated that "There are no inherent advantages of manufacturing over agriculture, or, for that matter, of agriculture over manufacturing. (Viner 72, cited in North). Viner's view is supported by Martin and Mitra's (2001) estimates of TFP growth in agriculture and manufacturing from 1967-1992 (see figure 3) that suggest that for both LDCs and industrialized countries, TFP growth in agriculture was, on average twice that in manufacturing, a result found elsewhere.[5] Blomstrom and Kokko (1991) make a very strong case that forestry will remain a dynamic and important sector in Sweden and Finland where rapid productivity growth ensures competitiveness relative to emerging producers in Brazil and Chile. Wright (2001) and Czelusta (2001) argue that the stock of minerals is, to an important degree, endogenous and as with manufacturing, major increases in productivity both in discovery and exploitation could be reaped by the application of knowledge. Mining growth kick-started the U.S. growth success, restarted the Australian economy in the 1960s, and has boosted the Chilean, Brazilian, and Peruvian economies.

The relevant question is not so much what Latin America specializes in, but why it is that these sectors have proven more dynamic motors of growth in comparable

[3] Most recently, Parente and Prescott (2000) have argued that it is not resources, nor education that is responsible for income differences among countries, but rather differentials in total factor productivity, the part of growth that can't be explained simply by the accumulation of more factors of production Parente and Prescott's (2000) simulations suggest that a TFP level one third of the United States can explain GDP differences of 1:27, or roughly the difference between the incomes of the highest- and lowest-income countries in the world. Colombia, they simulate, has TFP levels of 64 percent of the United States, and 59 percent of Paraguay. Dollar and Wolff (1994) concur that the convergence of TFP, not of factor accumulation, was the central force behind the catch of the OECD countries to the US in the 1960s and 1970s. Rodriguez-Clare and Klenow (1997) find that TFP growth was responsible for over 50% of per capita income dispersion in 1985, and 90% of the variation in growth rates of output per worker across 98 countries over 1960-1985.

[4] Most recently Matusayama, Sachs and Warner, and Rodriguez and Rodrik have argued that agriculture has few prospects and as Wright notes, there is a bias toward seeing mineral sectors as pure extraction with few gains from possible gains from technology.

[5] Looking across the 1970s and 1980s, Bernard and Jones find TFP growth of 2.6% in agriculture as against 1.2% in industry and in only one of their 14 sample countries was TFP growth in industry. Lewis, Martin and Savage find productivity growth higher in agriculture in the Australian economy than for the rest, and Martin and Warr found similar evidence for Indonesia.

countries. Figure 3 shows that the countries on both the manufacturing and agricultural "TFP growth frontier" are precisely those already close to the knowledge frontier: France, Sweden, Denmark, Italy, Japan, Korea. Most LDCs, including Latin America who have the most potential to grow quickly "catching up" to those at the frontier perversely lag. More impressionistically, the 1944 Haig technical assistance mission to Chile revealed the "indisputable truth that an adequate management of our forests could become the basis for a ..great industry of forest products" yet nothing remotely similar to the Scandinavian experience appeared until the late 1970s. Wright categorizes Latin American countries as mineral "underachievers" and massive discoveries of deposits throughout the region in recent years support this view.[6]

Arguably, we should be looking more at barriers to technological adoption that have prevented the region from performing as well as others. Two areas merit focus:

First, during the initial phase of export growth, the dynamic networks of institutions that promote innovation and the development of new comparative advantages gradually and "organically" from their leading resource export sectors emerge far less strikingly than in Scandinavia, Canada, the US or Australia.

Second, the inward looking policies and focus on fomenting manufacturing in the mid 20th century dealt a double blow to possibilities for innovation and growth. Not only did they create a sector without potential for long run productivity gains, but to finance its inefficiencies, the potential sources of growth in the resource sector were undermined.

The methodology is more "historical" or heuristic, broadly comparing the experience of several Latin American countries with those of a group of "beta" countries who have had more success with resource based growth: Australia, Canada, and Sweden and Finland in particular. This approach does two things. First, it attempts to look beyond the data points in the overworked cross country regressions to see what students of these countries have identified as critical elements of success or failure. Second, it establishes that Latin America was not *sui generis* in the concerns about dependency or degree of suffering during the Great Depression, nor, in fact, in adopting the inward looking policies it did. But its response should be seen as lying at the extreme end of a continuum that extends through Canada and Australia to Sweden at the most successful end. Acknowledging the similarities is vital since it prevents us from isolating the region as some sort of rare and unredeemable case operating under separate economic laws. Indeed the persistent Australian interest in Argentina stems precisely from its perceived kinship and a desire to avoid its fate. By the same logic, there was probably nothing

[6] Baer (2001) notes how the recent application of satellite technology led to a vast expansion in estimates of mining potential in Brazil relative to the stock confidently seen as fixed in the 1960s. Previously, most mineral reserves were though to lie in the mountain ranges of Central Brazil, especially in the state of Minas Gerais. However, massive deposits of iron ore were discovered in 1967 in the Serra dos Carrajas in the Amazon, which was also found to contain large deposits of Bauxite. Tin reserves now appear to exceed those in Bolivia, copper was found in Bahia and offshore oil exploration vastly expanded available reserves of oil. In Peru, mining exports doubled between 1992 and 1999 making it the world's second larger silver, bismuth and tin producer, sixth in copper and eighth in gold, but Wright argues that this is far below potential.

preordained about the disappointments of the last half of the 20th century -different policies may have led to better outcomes.

II. Determinants of Capacity for Technological Adoption

The outstanding question appears to be why certain nations are able to tap into the existing external stock of know-how and why others cannot (Baumol Nelson and Wolff 1994) or, more specifically as Amsden and Hikino (1994) frame it, why some countries, the Nordic countries, caught up while countries like Argentina or the Phillipines stumbled back. Argentine economist Guido Di Tella (1985) phrased the issues as more one of a historical dynamic, noting a continuum of countries' abilities to move beyond a state of exploiting the pure rents of a frontier or extraction of mineral riches and beyond "collusive rents" offered by state sanctioned or otherwise imposed monopoly. Referring to the closing of the Argentine frontier, he argues:

> This kind of area of new settlement was bound to see its rates of growth falter after initial colonization. Argentina behaved, to some extent, in this fairly predictable fashion. But the same was not true for the other countries. It must be acknowledged that the ability of the United States, Canada and Australia to continue a process of vigorous growth even at the end of the expansion of the frontier has been a most extraordinary feat, and one that could not be take for granted… At that point the successful cases were able to move to a quasi-rent based stage-early for the most successful of all, the United States, less so for Canada and Australia, and rather later for Argentina; further development for the United States and Canada was more clearly based on innovation and less so in Australia. For Argentina it arose exclusively from collusive quasi-rents. To the extent that development was based on innovation, these countries were switching to an alternative and unlimited source of growth. To the extent that it was based on collusion, it opened up a limited, alternative path." (Di Tella 1985 p 51).

The distinction between entrepreneurs being driven to appropriate the quasi rents arising from arbitraging innovations abroad, vs. exploiting artificially created rents is critical and taps into a long literature searching for the barriers to innovation and the adoption of technology.[7] Most recently, Parente and Prescott (2001) argue that the reason cross-national TFP differences persist, in spite of an immense stock of global knowledge that offers ready quasi-rents to any less-developed country (LDC) entrepreneur, is the existence of monopolistic structures that prevent new entry and ratify labor's intransigence in the face of job-threatening new technologies. Their simulations suggest that the impact of such barriers far exceeds the few percentage point differences in GDP accounted for by counting the Harberger triangles of traditional static models or, for that

[7] We use " innovation" not only to refer to the process of generating new knowledge, but to making the necessary adaptations to externally developed techniques.

matter, differences in education.[8] Their analysis echoes Albert Hirschman's (1958) broader point that in an uncompetitive situation such as the one posed by the guild system, "an innovation in producing a given commodity could only be introduced by someone who was already engaged in its production by the old process….[T]his fact would, in itself, militate against many innovations that might render painfully acquired skills useless and valuable equipment obsolete…"[9] Similar effects can appear due to concentrated credit markets that only lend to insiders, foreign exchange shortages that simply inhibit access to technology, and explicit trade barriers.

The Importance of National "Learning" Capacity.

But contemporary theory and economic history also suggest the importance of factors that actually encourage and facilitate the adoption of new technologies by developing national "innovative" or "learning" capacity". Stern, Porter, and Furman (2000), Romer (1990), Nelson (1993), Wright (1999) are among the increasing number who seek to explain the factors determining the flow of innovation in terms of the interrelationships of a variety of social institutions and actors.

"Mining" Wright would argue about the US mining success, "was fundamentally a collective learning phenomenon" (1999 308) incarnated in intellectual networks linking mining universities, and both government and private research. From the initial investments in exploration techniques, to training mining engineers and geologists, in fomenting a metallurgical revolution. For instance, the development of electrolytic processes in the 1890s was essential to the later development of copper and aluminum. Before WWI, the US would have the world's highest level of human capital and boasted the worlds best mining institutions, with the University of California at Berkeley and the Colombia Mining School as preeminent. The case of Australia, suggests that a similar process of collective learning could be replicated later in a small peripheral economy. Most notably Australia's "transparent earth" initiative, a collection of numerous technologies that permit looking through the first kilometer of the earth's crust, have put them at the forefront on modern mining discovery and processing technologies, and Australian significant exports of mining expertise (environmentally friendly extraction, mine closure techniques) point to the development of industries less tightly linked to minerals themselves. Wright identifies the lack of the human capital and knowledge infrastructure as precisely the roots of the problems of mineral underachievers.

Blomstrom and Kokko argue that knowledge networks or clusters of universities and private and public think tanks are the key to further productivity growth and development of new products and are "perhaps the main strategic and competitive asset of the Swedish forest industry." Even in the mature pulp and paper industry, most firms devote considerable resources, roughly 4% of value added, to research in the industry's institutes and there is ongoing upgrading of human capital through in-house education. This has maintained competitiveness, generated new uses for forest resources, and the development and leadership of environmentally correct forestry practices. But such

[8] Hall and Jones (1999), after controlling for differing levels of education, still find differing levels of log TFP highly correlated with log of output per worker with a correlation coefficient of .89.
[9] Hirshman p. 57 (1958)

clusters, by virtue of preparing firms to identify and exploit unforeseeable technological opportunities can have far greater impacts on national development. It was precisely the human capital and knowledge clusters that linked Nokia's former excellence in forestry (Nokia was the site of Finland's earliest pulp mill) to its present leadership role in telecommunications. Focusing on these types of linkages, rather than the more mechanistic conceptions of clusters (see Ramos, for example) based on product similarity probably makes more sense as a development strategy.

These examples suggest that a concentration in natural resource intensive sectors per se is probably not at the root of Latin America's growth disappointments, but rather the inability to take advantage of the productivity gains that are possible in all sectors.

III. Deficient National Learning Capacity?

Harvard historian David Landes in his encyclopedic *Wealth and Poverty of Nations* sees the divergence of the two paths of Latin America and Scandinavia dating from the differing reactions of northern and southern Europe to the phenomenon of British industrialization. The literature is uniform that Scandinavia was poor at the beginning of the 19th century, but had laid the groundwork for rapid growth. They enjoyed high levels of literacy, excellent higher education and Landes argues that they were "equal partners in Europe's intellectual and scientific community…They also operated in an atmosphere of political stability and public order. .. Property rights were secure; the peasantry was largely free; and life was a long stretch of somber hard work broken intermittently by huge bouts of drinking and seasonal sunshine. …"(248-252)

To this Landes offers the dramatic counter example of Mediterranean Europe, in particular of Italy, Spain and Portugal, hurt by political instability and a religious and intellectual intolerance with roots in the *reconquista* and counter-reformation. Further, Spain in the 18th century was a resource-rich nation that used its fantastic returns from silver and gold mines in the new world to purchase all that was needed, developing a *rentier* mentality rather than that of a nation of hands on tinkerers, such as appeared in Britain, the U.S. and Scandinavia. Landes argues that this cultural Dutch disease was exported wholesale to the New World.

There is no shortage of Latin observers disposed to self-flagellation far more severe than Landes' critique. As an example, Pinto (1959) in his *Chile, a Case of Frustrated Development* is only the best read of a line of critics of aristocratic dandyism and indolence as the root of Chile's stagnation and dependence on foreigners.[10] Nor, in the

[10] Monteon summarizes the underlying critique that "The economic ideal of the nineteenth century remained that of a rentier-someone who makes his fortune in one quick speculation and thereafter lives on land rents or some other long term yield. Domingo Sarmiento in 1842 referred to the effect of this ideal on native entrepreneurs: southern hacendados and northern mine –owners left their affaires in the hands of supervisors and moved to Santiago where they 'tried to imitate or rather parody the European Aristocracy." (Monteon 14.) This critique finds an even earlier expression in Juan Jose Santa Cruz who in his "Reflections on the Economic State of Chile in 1791" saw the potential with a small outlay of displacing the British fishing and whaling activity off the Chilean coast. But he lamented the introduction into the

light of extraordinary expenditures on luxury goods, is there much willingness to accept financial considerations as binding constraint on growth. [11]

But there must be some tempering of the condemnation of the entrepreneurial mettle of the Chilean elite, and that of the region more generally. Pinto is also clear that the elimination of Spanish restrictions on trade caused Chilean exports to boom immediately after and this was the case throughout the continent. Chilean entrepreneurs were the second largest presence in Peruvian nitrate fields, ahead of the British, and pioneered copper mining in their home country. When the price of copper rose in the mid-19th century, production by Chileans increase four fold from 1844-1860. In response to increased demand rising from the Gold rushes in California and the US, Chilean wheat exports rose ten-fold in value from 1848-1850.[12] Southern Hacendados borrowed heavily to clear lands to expand acreage three-fold from 1850 and 1870 (Conning 2001. More generally, Cariola and Sunkel (1985) offer a vision of global dynamism of the early nitrate economy, not, in fact as an enclave in the Norte Grande, but one eliciting a strong response of Chilean entrepreneurs throughout the economy. In general, local talent proved very responsive in certain well-trodden sectors and would earn global acclaim across history in non-technical sectors including two Nobel prizes in literature, a major surrealist painter, and first-class musicians.

Arguably, the disappointing growth of Latin America had more to do with a lack of supporting infrastructure for learning and innovation that would enable local

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Colony of "luxury, ostentation and expensive tastes" and saw no permanent improvement in the economic conditions of Chile as possible as long as the population remained improvident and susceptible to sumptuous living (Will p 57). The theme again recurs in Marcial Gonzalez 1874 speech "Luxury our Enemy" where he argued that the cloths, jewels, coaches and statues exceed those found anywhere else in America. Pinto cites the historian Francisco Encina, "'If half of what we have wasted in the last 40 years or invested in luxury we had applied to buying Nitrate mining machinery or to setting up the copper industry, to irrigating our fields.. the position of Chile in America would today be different.' The propensity to save and invest was not, then, the most striking virtue of our community"75

[11] Though Pinto acknowledges some, although almost certainly not enough, of a role for corruption, "what was decisive was the absence of local individuals and groups interested in developing, on their own, the nitrate riches."57 In fact, although Chilean capital finance was very important, the British had dominated the Nitrates industry in Peru and Bolivia and had substantial marketing networks. This made them the natural agents to continue mining once these lands were taken by Chile. Monteon also argues that the global condemnation of Chile's imperialism may have induced a strategy of dividing the world community by offering Britain a sweet deal. In any case, it appears that the British were aware of a government plan to allocate ownership on the basis of who owned the Peruvian titles. This inside information allowed them to purchase shares at a discount and emerge as owners. A question does emerge as to why Chilean capital was so willing to sell and to why it did not protest more after the fact. One of the earlier Chilean nitrate pioneers, Jose Santos Ossa petitioned that given this dearth of local entrepreneurship, the government take over the job, but the minister of the interior replied that the state would be corrupted by such an undertaking and that it was better to leave it to private interests, implying, foreign capital. This may have been due as much to an embrace of classical liberal economic values during the period as much as any Catholic hangover, but Pinto seems less convinced. "The decision of the managing groups of the country to 'live from the rents" of the industry"56 and not play the Schumpeterian entrepreneurial mid-wife would cost the country, not only in income foregone, but also in expertise and dynamism that Pinto argues let foreigners dominate in every field of domestic endeavor.

[12] Encina, Historia de Chile XIII, 486 cited in Will (1957)

entrepreneurs to innovate and hence stay abreast of competition than any rentier temperament inherited from Spain.

The foundation of technical absorptive capacity: Literacy

Recent thinking suggests that Latin America's persistent inequality may have had a role to play in slowing the region's ability to adopt foreign technologies.[13] Engerman and Haber (2000) argue that the period of sustained economic growth during the eighteenth and early nineteenth centuries that distinguished the US and Canada from the other New World Economies was fundamentally due to the patterns of settlement and crops that led to a relative unequal distribution of income in the slower growing areas. This concentration preserved the political influence of the advantaged elites and marginalized much of the population measured as lower access to the franchise, natural resources, financial institutions, and property rights as well as primary schooling,.

The marginalization in education may have been particularly important. The concerns with social control, extreme inequality of income, weak public finance, and perhaps an intellectual commitment to a small state, all led to dramatically smaller efforts in Latin America toward universal education than the successful natural resource exporters made. As Figure 4 suggests, more than 70 percent of the population age 10 or above in Australia, United States and Canada and Sweden, were literate, three times the percentage in Argentina, Chile, Costa Rica, and Cuba, and four times the percentage in Brazil and Mexico. By 1925, Argentina, Uruguay, Chile, and Costa Rica would attain literacy rates of over 66 percent, while Mexico, Brazil, Venezuela, Peru, Colombia, Bolivia, Guatemala, and Honduras would hover at 30 percent until much later (Mariscal and Sokoloff 2000).

As Engerman, Haber and Sokoloff (2000) note, this is particularly important given that early industrialization reflected the cumulative impact of incremental advances made by individuals throughout the economy, rather than being driven by progress in a single industry or the actions of a narrow elite. As one manifestation critical to the development of innovation, they note that the greater equality in human capital accounted partially for the high rates of invention in the United States overall, but also that the more general concern with the opportunities for extracting the returns from invention contributed to a patent system which was probably, at the time, the most favorable in the world to common people. This stands in stark contrast to Mexico and Brazil, where patents were restricted by costs and procedures to the wealthy or influential, and where the rights to

[13] The Scandanavian countries did not start with an egalatarian Tabula rasa. In the 18th century, Danish land with in the hand of a few thousand families on large estates tilled by serfs and only 23 percent of rural households owned land in Finland. But as Blomstrom and Meller argue, "what laid the foundation for the Scandinavian transformation to modern wealthy societies were the agrarian reforms" 6 that ranged in timing from Denmark's precocious beginnings in 1788 to Norway and Sweden's in the 1850s and Finland's of the 1920s that created small and medium sized privately owned farms. As with the relatively equal distribution of land in Canada (Watkins 86 Armstrong) and the US, Blomstrom and Kokko argues that the "it is hardly possible to over-emphasize the importance of the improvement in agricultural productivity for Swedish industrialization which facilitated transfer of labor and made possible exports that generated capital for investment in forestry and manufacturing in addition to providing a local market."

organize corporations and financial institutions were granted sparingly, largely to protect the value of rights already held by powerful interests" (p. 17).

Blomstrom and Kokko argue that in Sweden, the introduction of a mandatory school system in 1842 and emphasis on literacy and numeracy was essential for the ability of individuals and firms to learn and adopt new technologies: much elementary learning and technology transfer was based on written instructions like blue-prints and handbooks. This also suggests that the extensive literature comparing Argentina and Australia may be missing a critical point. Despite a strong feeling of "there but for the grace of God go we" on the part of Australian authors, it is very clear that, in the mid 19th century, Australia was far closer to the industrialized countries in levels of literacy. This, in a country that until the 1840s was a penal colony of the UK.[14] The story of the global conglomerate Broken Hill Proprietary (BHP), started by a boundary rider on a sheep station, suggests the importance of a broad base of literate everymen to run with ideas and enjoy supporting institutions.

Technical Education: The Critical Lag

A central theme of Blomstom and Kokko's account of the Swedish growth experience is the early abundance of high level human capital--the "impoverished sophisticate" Sandberg (1979) called it. The Universities in Uppsala and Lund date from the 15th and 17th centuries and technical schools were established in the early 1820s. Other institutions, such as the Swedish Academy of Science date to 1739 and the Swedish Ironmaster's Association to 1747 which published a mining science journal in 1817 and financed foreign study trips by Swedish engineers and scientists. New engineering workshops established for construction of iron bridges and lock-gates of the Göta canal served as training centers. Sweden possessed the fundamentals of a modern engineering industry by about 1850 (Ahlström 1992)) and was exporting engineers by 1900. Similarly, by that year, serious research in chemistry was undertaken at the University of Oslo that would lay the foundation for the dominant fertilizer, electrochemical, and electrometallurgical industries in Norway.[15] As in Britain and the US, Scandinavian mechanization was a slow process that implied ongoing accumulation of know-how, continuous interaction with the outside world, and extraordinary contributions at the technological frontier.[16] The exceptional long run performance of Swedish firms established during this period, Blomstom and Kokko note, "has been

[14] Free, secular and compulsory education was established beginning with the Victoria Education Act of 1872.

[15] Hveem (1991)

[16] Very early on, Scandinavia was exporting know-how in the form of its own émigrés toward tsarist Russia for example, where Alfred Nobel was one of the pioneers of the infant petroleum industry. To a significant extent the expansion of manufacturing during the first decades of the twentieth century was based on Swedish innovations-steam turbines, centrifugal separators, ball bearings, the adjustable spanner, the safety match, air compressors, automatic lighthouse technique, various types of precision instruments, techniques for precision measurements and so forth (1974 p 5.) Lindbeck . The great companies known today were built on innovations in these areas. Ericson (1876) telephone, Alfa Laval (1879) the separator; ASEA *1890) electrical equipment 1907 SKF (bearings) (Amsden).

based on the ability of Swedish industry to create, adapt and disseminate new technologies."

By contrast, the Colonial period in Latin America enforced a negative intellectual bias in many ways that exactly discouraged the adaptation of foreign innovations. Most countries had a local franchise of the Inquisition and, largely for reasons of political control, the icon of intellectual discourse, the printing press, was banned in Brazil until 1809 (Baer 2001). The Spanish crown kept out non-Spanish and non-Catholic businessmen, traders and craftsmen and thus deprived new world of important skills and knowledge.

Further, the nature of education in Latin America was less technical than that found in Scandinavia or the English ex-colonies. Spanish higher education was largely religiously based and focused on law, philosophy, and theology, and somewhat less respectably, medicine and this pattern was replicated in the colonies. The Spanish enlightenment after 1750 saw the establishment of groups of autonomous *sociedaded economicas* that sought to diffuse technology from abroad and establish libraries throughout the country, and some Royal Societies emphasizing applied science. But Spain began training engineers seriously only in the 1850s, and by 1867 had only one *Escuela de Ingenieros Industriales*, located in Barcelona.[17]

Latin America necessarily lagged behind Spain and Portugal in developing a technical class. In both Chile and Colombia specific royal initiatives gave the initial impetus to scientific inquiry in the last decades of colonization.[18] However, as Will (1957) documents for Chile "With the exception of the inadequate facilities provided by a few religious organizations, there did not exist…before the middle of the eighteenth century an institution capable of furnishing the youth of the colony with the barest essentials of a secular education (17)." Similar stories are found throughout the region: [19] recurring political instability silenced prominent scientists and undermined fledgling universities, fiscal weakness prevent consistent financing of the sciences, and the unreliable demand for local engineers prevented the career from being lucrative, let alone socially respectable.

A corps of locally trained engineers emerged by the end of the 19th century in many countries, but arguably, this was little and late. As table 3 suggests, Australia had at least 5 times the numbers of Chile or Colombia in 1920 and Meredith argues that by 1926, Australia had 27 times more graduates of technical schools per capita than Argentina, perhaps the most educated country in the region. And to repeat, in this period, Scandinavia was exporting engineers innovating at the frontier. The persistence of this deficit, measured as the percentage of architects and engineers per worker continued into the 1960s: Sweden (5.03), Finland (2.52) Denmark (1.03) compared to Argentina (.55), Chile (.7), Educator (.18), Uruguay (.42).[20] Further, it is not clear how good the quality of the Latin product was. At the end of the 19th century in both Colombia and Chile,

[17] Riera I Tuebols (1993)
[18] See Will (1957); Safford (1976)
[19] See Safford for Colombia, Villalobos (1990) and Greve(1938) for Chile, Baer (1969) for Brazil
[20] OECD (1969) Occupational and Educational Structure of the Labour Force in 53 countries

local engineers complained that the government and private firms preferred to import engineers from France or the US even for fairly straightforward tasks.

Does This Really Matter?

The US, Scandinavian and Australian literature strongly supports the idea that such technical capacity, and more generally the ability to learn from abroad was critical to accessing technological progress abroad, and, in the long run, the establishment of knowledge clusters. And there are some provocative examples from Latin America.

Perhaps the first bit of evidence is the extraordinary dependence on immigrants as innovators and entrepreneurs in new sectors. Industrialization in Mexico in the late 19th century would be almost entirely undertaken by the resident foreigners (drove the growth boom of the *Porfiriato* (Hansen 1971). Using machinery from the homeland, the French started the textile industries in Veracruz and Puebla (Buffington and French 1999) and foreigners also started Mexico's first iron and steel plant, the *Fundidora de Fierro y Acero de Monterrey*, in 1903, that would build on the region's ore deposits and anchor its industrial development. Hansen argues that there were entrepreneurial spillover effects that drew many Mexicans into the capitalist ranks, but the initial impulse came from foreigners.

Collier and Sater also note the influence of immigrants in introducing new industry and technologies in Chile. Immigrants set up many of the industrial enterprises of the 1860s and 1870s: 36 of the 46 dressmakers counted in 1854 were French; Americans installed the flourmills; Americans and British built railroads. Loveman (1979) notes the list of officers and member of the executive committee of SOFOFA, the principal organization of industrialists showed the disproportionate influence of immigrants "Only three Spanish surnames accompanied those of the other members of the directorate: Edwards, Subercasseaux, Hillman, Tupper, Tiffou, Mitchell, Gabler, Lanz, Klein, Muzard, Lyon, Bernstein, Crichton, Osthous, Stuven." (193).

Fogarty tells a similar story for the development of Argentina's "super staple", beef where a small group of hacendados, recently arrived from Europe, formed the *Sociedad Rural Argentina* in 1866. This group spearheaded the transformation of the Pampa, improving the quality of livestock, pastures, and methods of animal husbandry necessary to take over the US position as principal exporter of cattle to Europe by the WWI with dramatic forward and backward linkages throughout the economy. He also notes that while in the US, Canada and Australia railroads were sponsored, financed and constructed largely by nationals, in Argentina, Europeans were the prime movers.

In each of these major sectors in three countries, it was not locals who saw the possibilities for technological arbitrage, as was the case in Scandinavia, but those embodying the knowledge from abroad.

As important is the importance observers present and contemporary put on the impact of engineering schools, such as the Antioquia *Escuela de Minas* as critical providers of talent for emerging industry (see, among others, Safford). In Brazil, Baer (1967) argues that despite a tradition of iron smelting dating from the mid-16th century,

the techniques used at the end of the 19th century were primitive: of the 30 ironworks in the headwater region of the Rio Doce in 1879, only seven used Italian forge methods and the rest used the old African *cadinho* technique. The critical event for the development of the native steel industry Baer sees as the foundation in the same year of the School of Mines at Ouro Preto, Minas Gerais that led to the establishment of the first new blast furnace since the failures of the beginning of the century. Graduates of the *Escola de Engenharia do Exercito*, established in 1930, would lead the steel industry as it developed through the 1960s.

Australian observers also put great emphasis on the role of non-university innovation infrastructure in explaining the disparate evolution of the wheat industry in Australia, Canada and Argentina. In all three countries, wheat had an early and firm toe-hold, but it became the super staple in Canada, largely due to government assistance to prairie agriculture in the form of experiment stations, seed testing services, and technical assistance. Again, these efforts also came on top of massive efforts in Canada and Australia to achieve widespread literacy in the prairies that have no analogue in Latin America. There was also provision of other important less knowledge related public goods: public granaries and a wheat grading system provided quality control which gave Canada an edge over Argentina's wheat which had the reputation for inferior quality and lack of uniformity.[21] But the provision of an extensive institutional and scientific infrastructure was recognized as key to their success by contemporary Argentines and contrasted with the lackluster efforts of the Argentine government.

Mining in Chile and Australia

The interaction of deficient local technical capacity and reliance on foreigners led to Chile's loss of leadership in copper over the course of the last two centuries and goes some way towards explaining why Australia's BHP, hailing from an antipodal dependency of similarly small size would discover *la Escondida* and be the major force in expanding Chilean production in the 1980s and 1990s. Chile, saw its world share fall from one third to under 4% by 1911 and even by 1884 the *Sociedad de Mineria* openly wondered whether Chile's copper mines would survive at all. (p. 139) Collier and Sater (1996) attribute this largely to a failure to update technology in the face of declining ore quality and excessive reliance on the wasteful *piriquJn,* system. Chilean historians date this technological slippage to the beginning of the 19th century when they note that there was little diffusion of European technologies and that "the work of mining was not very systematic." With the disappearance of the Academy of San Luis, there was no technical teaching of mining in the country and the "receipt of industrial innovations was slow and without visible influence." (Villalobos 96) Charles Lambert, representative of a British mining company in La Serena and trained in the Politechnique in Paris noted the poor

[21] As an illustrative pseudo experiment, Fograrty cites that fact that the same year that Spanish Merino sheep were introduced into New South Wales, Australia, a flock was introduced to the River Plate region. European capital was available for sheep breeding in both areas, and both suffered the ups and downs of the world wool market. However, in 1885, the two countries had the same number of sheep, but the average "clip" was getting almost twice as much on the world market in Australia as in Argentina due, not only to differences in wool types and quality, but inferior yields per sheep. The differences he attributes to the innovation and visions of individual figures, rather than any structural features of the economy.

mining practice, scarce knowledge of minerals, and inefficient smelting, all of which represented poor technique relative to that employed in Europe. The Polish mining engineer, Ignaci Domeyko, in 1841 helped establish a small school and in 1847, the University of Chile would begin to teach engineering. But Chile was, at this point, 80 years behind the first mining school in Europe, and even 50 years behind Mexico.

Chilean historians note the dominance of foreigners in applying new technologies[22] and Pinto spectacularly underlines how Chile tragically passed up the power that gradual accumulation of know-how offered to maintain competitiveness and dynamism.

> ….the technological demands of the period, in contrast to what is occurring today in some areas of mining or industries, were relatively modest and thus not too costly. What could and had to be done in the national mining companies and in agriculture, except in certain exceptions… was perfectly compatible with the resources accumulated in the long periods of bonanza. If the process had been initiated and maintained adequately, without doubt, it would have created the means to confront more challenging tasks, such as those posed by copper mining when it was necessary to exploit less rich veins. However, faced with the technological revolution, the local mining companies had behind them neither sufficient accumulated resources, nor the organizational or administrative capacity that were indispensable. In these circumstances, there was no other option but the introduction of foreign capital and expertise at a cost, without doubt of a considerable retribution. 71.

We can imagine a bad feedback loop where inability to innovate leads to lower profits and less experience and hence further inability to innovate that may have led Chile to a bad technological transfer equilibrium that would eventual push local entrepreneurs them out of the market. Perhaps this accumulated deficiency of technical facility was what led to a self-perception that Chileans were perhaps "unfit for the modern era." Tancredo Pinochet Le-Brun, granting that Chileans were inferior to Europeans, still wondered "don't we have minds in this country that can go to Europe to learn what professors, whom we have imported and continue importing, have studied? Are we truly incapable of steering our own ship?" Francisco Encina, in *Nuestra Inferioridad*, answered pessimistically in 1911, on the now clearly specious grounds that the high content of indigenous blood that made rapid catch up to Europe unlikely.[23] One can imagine a sense a frustration among concerned Chileans that, in fact, the big and visible advances were in the Guggenheim mines at el Teniente and Chuquicamata, a French steel mill "El Tofo" in Coquimbo, and experiments in fishing by foreign capitalists (Monteon 75).

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[22] " It is worth noting that the empresarial spirit united with the motivation to apply new techniques was almost always the result of initiatives of foreigner who came to chile and saw opportunities to develop or solutions to problems with practical experience. They brought and had a greater tradition of information, spirit of action, attention to detail and urgency to capitalize the on the results or resources generated, which was not common trait of the average inhabitant of the country whose nature of work was little developed beyond the artesanal level. (Villalobos et. al. 1990 p 99)."

[23] In La conquista de Chile en el siglo XX (1909) cited in Monteon (p 62).

Chile would continue to slip in its technical capacity in Copper. Meller argues that "in the 1950s one could have learned more about Chilean copper in foreign libraries than in Chilean ones…Neither was there training of Chilean engineers and technicians specializing in copper." The fact that, in 1952 the Controller General admitted that he had no idea of what went on in the companies(Moran) suggests that part of the feeling of vulnerability and dependency must be attributed to the lack of technical capacity to monitor and confidently critique the actions of the *Gran Mineria*.[24] It was not until 1955 that the Copper Department was created to oversee U.S. firms' copper operations and a bureaucracy of Chilean professionals, engineers, economist and the basis for a local Chilean expertise. "In short, it took about forty years, from 1925-1965, to develop a domestic capacity to analyze the role of copper and to educate Chilean professionals and technicians in the management of the [large copper firms]." (Meller 1991). This is a striking statement in a country that began exporting copper long before the U.S. or Australian firms that would dominate the Chilean industry. Even today, there is relatively little interaction between the copper companies and universities or other think tanks. As Such a knowledge cluster, Lagos (1997) argues may be necessary to transform the North into a regional service center after the inevitable decline in mining production over the next decades.

Australia's trajectory was very different. While most mining was begun by Cornishmen who had a high degree of applied skill, in 1886 Australia recruited highly paid engineers and metallurgists from the US, and this firmly linked the country to the innovations generated in the US (Wright 1999). Diaz Alejandro would note that Australia's mining exports provided a general interest in scientific and technical research absent in Argentina. Duncan and Fogarty argue that "geological knowledge and mining expertise became part of the Australian heritage enriched by schools of mines of world class and the industry has been in the forefront in the development and application of mining and treatment technology." (Duncan and Fogerty 129). Although far ahead of Chile, Australia lagged the US until after 1920 in engineers per 100 thousand population, 47 vs. 128, but would reach 163 by 1955. Several important universities could offer local beach heads for foreign research. The Sydney Mechanics Institute was established in 1843 and the Sydney Technical College in 1878, both with the goal of the diffusion of scientific knowledge. The University of New South Wales was founded in 1949 on the campus of the Technical College with MIT and the Berlin University of Technology as models and a core focus on research and teaching in science and technology. The UNSW School of Mining Engineering now ranks as one of the largest educators of mining engineers in the world.[25]

In this context emerged one of Australia's most influential mining companies and industrial conglomerates Broken Hill Proprietary Company LTD (BHP) in 1883. Called

[24] An interesting parallel can be found here in the Balkans which Landes argues were- "societies that did not generate enterprise from within. Trade and money were for Greeks, Jews, Armenians, Germans." 252 Here also, arose, independently, a school of dependency affiliated with Manoelescu that shares many characteristics with that articulated by Prebisch. (See Love 199?)

[25] http:// www.mines.unsw.edu.au/school.htm; http://unsw.edu.au/about/about_history..html

by those of the region "the cradle of Australian industrialization"[26] Broken Hill saw the expansion of mines and smelters would expand and in 1893 the establishment of Australasian Institute of Mining and Metallurgy. When the easy to access oxide zone was exhausted, Broken Hill metallurgists and engineers among others developed the flotation process, which, as a residual, allowed the expansion of zinc production by new firms. During WWII, Australia, as the principal ally in the pacific, benefited for demand for iron based goods and transfer of technology. Industrial production rose by 45% in the war period and technological acquisition jumped, a gain which subsequent Australian governments would seek to continue. BHP and similar conglomerates became modern corporations with vertical control from mining to blast furnaces to wire rope factories to shipping lines with links to foreign capital through joint ventures. BHP gained global reach, acquiring mines in Utah and Canada and Chile.

IV. ISI as a Double Disincentive to Innovation: A Continuum of Experiences

The barriers to trade and investment that comprised the inward looking policies implemented after the Great Depression stand as the second impediment to the transition to a innovation based economy and offer a rationale for the negative post-1950 Latin American dummy in the growth regressions. Di Tella's distinction between entrepreneurs being driven to appropriate the quasi rents arising from innovations abroad, vs. exploitation of artificially contrived rents is not new, but highlights why the natural resources/manufacturing debate probably misses the point. It is not that you have created a manufacturing sector, but whether you have created a source of innovation, or a brake on the dynamism of the traditional sectors who are forced to subsidize it. Blomstrom and Meller capture much of the ISI critique when they argue that

> When Latin America decided to force industrialization by import substitution, it was not an industrialization based on the countries' endowments that was supported. While the Scandinavian countries slowly and gradually filled in the empty slots in their input-output tables, the Latin American countries filled in all the numbers at the same time; and even worse, they tried to fill in the U.S. numbers! Suddenly there were several small Latin American economies with production structures similar to that of the United States.(p 9)

[26] New South Wales Department of Mineral Resources (2001) http:// www.minerals.nsw.gov.au/silver.htm. This section also draws on http://www.bhpbilliton.com/. And mining, in turn, enriched the educational network. A product of the gold rushes, the University of Melbourne was founded in 1852 as a specifically secular university to assert the city's equality with Sydney University founded in 1852. It opened in 1855 with faculties in Mathematics, Natural Sciences and in the early 1860s added Engineering along with the Latin favorites, Law and Medicine.

Not only were these sectors out of line with comparative advantage and walled off from competition and the source of innovation, but they would need to be subsidized, or at least would divert attention from sectors that had the potential for innovation.

However, Latin America's turn inward and suspicion of resource dependency is at one end of a continuum that passes through Australia and Canada and then to Sweden. As a crude proxy, figures 5-7 suggest that virtually all of the sample countries saw an increase in average effective tariffs after the Great Depression. Latin America's average jumps from .22 to .34 while those of our beta countries move from .1 to .16. Within the latter, however, Australia is as dramatic as Brazil, Mexico or even Argentina and arguably Canada could pass for Latin across much of the period.

The usual battery of protectionist measures appeared and from observers in these countries we hear exactly the critiques of inward strategies so familiar in Latin America. Dehem's (1962) cite of the Hirschman quote above about barriers to innovation was employed, not to explain LDCs, but Canada's "stunted growth" of the 1950s, a theme picked up by Stykolt and Eastman (1960) seeking to explain the 30-35% differential in US and Canadian incomes and low labor productivity. One of the Deans of Canadian economic history Melville Watkins (1963) ended one of his better known article noting the "the emphasis increasingly placed by economists on the link between the inefficiency of Canadian secondary manufacturing industry and the Canadian tariff."

Prolonged Australian protection also remains the general culprit in most analyses of that country's lackluster industrial growth in this century (Anderson 1987 Maddock and McLean 1987). Fogarty argues that Australia's tariffs probably were responsible for the stagnation of the industrial sector in the late 1920s, precisely when Argentine manufacturing was growing well. Although it did have an indigenous automobile industry of some promise, and BHP type conglomerates with solid roots, Australia and New Zealand would also would nurture import substituting industries that were neither of efficient scale or appropriate given comparative advantage. McLean (1989) and Anderson (1987) conclude that ongoing protection of the manufacturing sector (into the 1970s "led to a stifling, rather than promotion of desired structural change to no reduction in the dependence on natural resource-intensive exports, and to lower growth and living standards." 22.

That the policy of other natural resource abundant countries would parallel that of Latin America is not so surprising. Many of the factors cited in the canonical recounting of the reasons for the region's turn inward are found elsewhere.

The Great Depression, the watershed for inward looking policies appears to have affected the beta countries as hard as Latin America. Figures 8-10 and 11-13 show that the beta countries were far more open than Latin America, most were exporters of raw materials and most showed falls in export earnings as large as those seen in Latin America. Latin America appeared to recover more slowly, especially Colombia and Brazil who suffered most by the fall in coffee prices, but some, such as Argentina, are not distinguishable from the other sample.

Table 4 suggests somewhat conflicting measures of actual impact. On the one hand, the reported falls in per capita output follow the continuum: Latin America hit hardest, then Canada and Australia, and least affected, the Scandinavian countries. Yet the resulting unemployment rates, although notoriously incomparable, suggest that even the impact on Scandinavian countries was very high, roughly doubling during the Depression to levels between 20% and 30%. Meanwhile Argentina remained relatively unscathed at under 5.6%. Supporting evidence suggests that the general picture is broadly correct. Aldaheff (1985) cites *the Review of the River Plate* as arguing that Argentina was one of the least-if not the least-hard hit to be found anywhere in the world, an impression confirmed by Alejandro Bunge, a prominent industrialist, in 1932 to London's Argentine Club. [27] Further, that both the lower need for "safety net" expenditures and the fact that the British carried the railway debt implied that Argentina would have far fewer fiscal problems than either Australia or Canada as well.[28]

At a deeper level, the region's concern with asymmetrical power relations in the world economy can be heard elsewhere. As Love (1996) argued, the Rumanian Mihail Manoilescu independently developed a dependency theory that strikingly parallels that of Prebisch to explain the evolution of east-central Europe. Foreign control over the economy emerges as a theme in even the most successful economies. In 1909, 80% of Norway's mining, 85% of its chemical 44% of its paper and textile, and 33% of its metal industries were foreign owned and foreign control of almost 75% of all waterfalls essential to power generation generated widespread protests. Finland's extraordinary dependence on Russia as a Grand Duchy and extraordinary debt service repayments from 1945-48, 5-6% of GDP (139) is high by even 1980s Latin standards. At Australia's centennial in 1880 a sizable fraction of the population, many the descendents of imported convict labor, resented the dependence on the UK. The Republican newspaper *Bulletin* argued that the convict "chains of iron are merely exchanged for chains of gold" and citing the exploitive nature of British capital investment, argued that it was better to be poor and independent, referring to Chile and Mexico as enviable examples. (Hughes 1987 509)[29] Canada surely can share Mexico's traditional lament about being so close to the U.S. and so far from God. The percentage of the value of production that was produced by U.S. controlled and affiliated companies in 1932 ranged from 39% in iron and

[27] Sodersten testifies to the traumatic levels in Sweden as well.

[28] This also implied that fiscal problems during the Great Depression would be minor in Argentina compared with Canada or Australia. Both the lower demands of supporting the unemployed, and the fact that the railways, which ran major losses in all three countries, were largely in private hands in Argentina where in both Canada and Australia they had far larger public participation, lessened the impact on some Latin states. Aldaheff suggests that half of Canada's budget deficit in 1932/33 and 34/5 were dedicated to financing. Real expenditures between 1928/9 and 1933/4 rose 66% in Canada, 46% in Australia and only 10% in Argentina. Further, in terms of managing external debt, debt service was calculated at 17%, 22% and 23% for Argentina, Australia and Canada respectively and per capita indebtedness was 167 pesos vs. 863 and 224. Argentina's repayment record was excellent across the period and it was Australia, who had over-borrowed in the 1920s, had the most trouble servicing the debt. In sum, all three countries shared conservative, and reasonable fiscal management in the face of shocks, but the Latin American entrant was relatively better off.

[29] These same themes would continue through history and would surface over American ownership of Australian mines, which had risen to 41% by 1967, and agriculture in the 1960's and 70s and would peak in virulent objection to the war in Vietnam, and a reaction against Yankee Imperialism that featured prominantly in the 1972 labor campaign.

products to 63% in non-ferrous metals including electrical apparatus. (Marshall, Southard and Taylor 1936 cited in Wylie 1990). Some observers cited the "satellitic" nature of tariff jumping US industries as responsible for their low rate of innovation.

There are clearly important differences that are being elided here. But the fact is that in many ways these economies were similar and they would react to perceived dependency in the same way Latin America did. Wynia (1990) sees far more similarities than differences in "Opening Late-Industrializing Economies: Lessons from Argentina and Australia" Analyzing the difficulties of shifting away from a "rent-seeking" approach he sees both economies as attempting more merciful and less costly industrial revolutions, by relying heavily on government regulations and controls, and contrived economic rents. He is careful to note

> None of this is confined to Latin America. Rent-seeking economics is not derived from that region's patrimonial political traditions or Hispanic affection for corporatist ways of doing politics. .. Rather it was a strategy chosen by authorities in nations that were, at the time that economic modernization was accelerated, already too activated socially and politically to permit less politically self-conscious approaches to economic renovation (187). …The Australians were not radically different from the Argentines in their approach to the protection of industry and labor. … They were guided by sentiments of nationalism and nativism, stressing the nation's defense against competition from cheaper labor and/or more powerful foreign economies. 188

The reaction was one of dependent countries seeking both to diversify away from the natural resources that maintained a dependent relationship and which appeared to have taken them down during the great depression. Locating the region along a continuum is important since it shows precisely that the Latin American countries are not rare species operating under special economic conditions or laws but are firmly members of the "late industrializing resource-rich countries" phylum. They share similar liabilities, but arguably similar possibilities for growth.

However, figures 5-10 also suggest some critical differences. First, the Scandinavian experiment with protection reached levels attained by the Latin Americans only at their most open. Second, most of the beta countries reduce rates pretty much across the board and most all below .1 by 1950. By contrast, the Latin series are far more volatile and show no consistent trend toward decrease through the end of the 1980's. Average openness series suggest a similar pattern- the beta countries also became more closed in the 1930s and 1940s, but by 1950 had retained their previous levels and even at their most closed were far more open than their Latin counterparts who, by 1989 still had not recovered their 1895 levels.

Indeed, the greatest departure from the ISI trajectory is arguably Sweden who maintained low tariffs and an aggressive outward orientation throughout the post war period. Sweden's labor dynamics are highly suggestive of the importance of resolving distributional issues early and bringing labor on board to a countries position along the policy continuum. Hjaalmarsson, in his *The Scandinavian Model of Industrial Policy*, finds the anchor of this policy in the attitude of Swedish Trade Unions who, "as early as

the 1920's strongly promoted a productivity enhancing industrial policy, emphasizing the rationalization of firms" that placed a premium on continual renewal of technology, plant organization and machinery. The 1951 policy document of the Confederation of Trade Unions stressed competition to increase productivity and forcing less-efficient firms out of the market combined with active labor market policies to reallocate displaced workers. In the 1950s, the confederation was resolutely free trade, strongly criticized government protectionist measures and "argued that tariffs would decrease productivity growth since it would protect stagnating and less competitive industries." The importance of this case is precisely that it shows that that there were alternatives to managing resource abundant economies the way that Latin America did.

Industrial Drag on Natural Resource Development

The same continuum of effects is found surrounding the second innovation impeding effect of ISI: industrialization policies, to greater or lesser extent, were implemented on the backs of the traditional exporting sectors. Possible productivity gains and growth more generally were stymied by price incentives that and a general inattention to the primary sectors that undercut their dynamism.

Again, the Scandinavian and US cases testify to the possibilities of sustained development building on resource endowments. Australian observers again see their country as an intermediate case, where the lesser degree of their turning away from traditional exports constitutes the critical difference from the Argentine case. As Australia encouraged investment in petroleum and refining and electrical equipment in the post war period, it initially neglected the rural sector, which grew at only half the rate of population growth. This led to debates about the logic of stimulating secondary industry to the detriment of its comparative advantage whose lagging performance, it was argued, had led to the country's periodic BOP crisis. Agricultural policy was reversed in 1952 with granting of investment subsidies, extension of credit, price stabilization programs, and extension of research and extension programs that led to a doubling of production over the next decade.

Argentina, across the same inward looking period of the 1940s-50s, inflicted permanent damage on its traditional leading sector, driving output growth to .2% per year and leaving the country perilously close to ceasing to export food stuffs. This combination of inefficient industrialization with the demise of its traditional export sectors left it exceptionally vulnerable and prey to the cycles of boom and bust characterizing the region. Australia would continue to suffer from a mild cycles of boom and balance of payments crisis (and required IMF assistance in 1952). But a rebirth of interest in traditional mining sectors in the 1960s led to increased dynamism in the resources sector that may lead Australia to 4th in per capita income in the near future[30]

[30] Nonetheless, there are concerns. Dowrick and Nguyen, argue that, once allowances made for initial conditions, post-war Australian growth not worse than oecd more generally 28 Mclean, however, most growth due to factor accumulation and not TFP. The recent debate between X and Krugman on a similar finding in Singapor suggests that this is not necessarily critical, but the US switched at turn of century and Scandanavia would become more "knowledge led" after WWII. 1980s- debt accumulation put

despite inattention to the continuing inefficiencies of the ISI strategy that wouldn't be addressed until the 1980s.

Chile Redux: Fruit Redevivus

Lest the magnitude of neglect or taxation of the traditional sectors be under appreciated, it is worth going into some detail again, on the case of Chile that aggressively undertook the public good and pro-innovation policies found in the successful natural resource exporters, but would find them undermined by policies toward the industrial sector. The promethean efforts of Chilean Development Corporation (CORFO) founded in 1939 and growing to control 30% of total investment laid the foundations for the dynamic export industries of the next-half century. Much as Wright documented was the case in the US, it financed and promoted prospecting for Gold, silver, manganese and iron. To develop the fishing industry CORFO contracted technical assistance missions, established a marine biology station near Valparaiso in 1945, granted sizable tax exemptions in 1952, and joined the army and the University of Chile in surveying the coastal waters in 1954. It took the first inventories of forest stocks, and contracted the 1944 Haig technical assistance mission to examine the forestry sector. In 1953 it financed processing plants for cellulose and newsprint. In the fruit industry as well, CORFO financed technical assistance missions, extended credit for cultivation and experimental plots, and invested in supporting infrastructure and in 1941, it financed efforts to promote exports of wood products and wine. Throughout the 1950s and early 1960s CORFO had established an experimental fishing stating in Arauco, financed construction of modern boats and dock facilities in Tarapaca and Valivia, and founded fish canneries and fishmeal mills. The World Bank-financed Paper and Carton Manufacturing Company in Bio Bio stimulated paper and cellulose-related forestry activities after 1957.

CORFO may have been correct, in boasting on its 20th birthday , of Chilean history being divided in two eras, that before the construction of the Huachipato iron works near Concepcion in 1947 and that after transformed the region an important center of manufacturing. But early on, local observers wondered at the costs. A compilation of seminars given in the business community in 1954 entitled *Negative Aspects of Economic Intervention: Failures of an Experiment* praised CORFO's irreplaceable role in creating the electricity and fishing industries, but derided the gross inefficiency of Hachipato and the National Petroleum company and saw the capriciousness of exchange controls as the overriding disincentive to needed foreign investment. The halving of export volume over the previous decade, the stagnation of agriculture, and the frustration of Chile's tremendous potential in vegetable and fruit exports were laid at the feet of irrational intervention in the price mechanisms and the persistently overvalued exchange rate (Correa Prieto 1954).

In the 1960s, recurrent balance of payments crises would lead the Christian Democratic Government of Eduardo Frei in Chile to seek to promote non-traditional and

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large claim on export revenues, negative tot evolution, and long standing structural problems become critical.

traditional exports. Yet, Chile's areas of natural comparative advantage were stymied by the gross protection and inefficiencies that were the logical culmination of a system of protection and incentives that had mutated into literally incomprehensible degrees of distortion. Jeanneret (1972) a researcher at CEPLAN at the Catholic University noted that in 1965, "the multiplicity of instruments used, and the frequency with which they were modified, had arrived at such extremes that it was humanly impossible to have a clear vision of their final impact by sector or for the economy as a whole." She found effective rates of protection extreme by global standards, ranging from –100 to 650 compared to -50 to 500 for Brazil, -25 to 200 for Malaysia, and –17 to 106 for Norway. These heavy negative rates of protection implied that ten of twenty one manufacturing industries studied could export only at a loss and that "some of these sectors, principally wood, paper, paper products, fish and other minerals , would have become, perhaps, significant exporters. (Jeanneret 1972) A contemporary observer, Marko Mamalakis also wondered at the inability of the agro-export industry to grow, given that export demand for raw or processed Chilean fruit, seafood, oils, wine and so forth [was] almost unlimited." (Mamalakis 1976).

That these disincentives to invest and innovate were critical is borne out by subsequent history. As well known, the history since 1975 was one of relentless pursuit of integration with the world economy and a correction of the distortions accumulated in the previous decades. In the next 20 years, non-copper exports increased by a factor of 10 essentially eliminating the traditional foreign exchange bottleneck to industry. The most dramatic story occurs in the fruit sector where exports would grow at a rate of 20% annually in the first 20 years since the reforms of 1974. Areas planted to commercial orchard almost tripled and fruit production quadrupled as did the number of fruit entrepreneurs.

Jarvis (1992) attributes this success to the rapidity with which Chileans were able to transfer, adapt and extend fruit technologies initially developed for California and other fruit growing regions to Chile. CORFO, again, had played an important role in the early 1960s in laying the foundations for this boom as did the [31] ten year program for cooperation with the University of California, and University of Chile established in 1965 to permit technical cooperation and improve graduate training. This helped the University of Chile to develop first-rate faculty in fruit-related sciences and to begin modern fruit research. But Jarvis is also clear that most of the initiative in these areas post liberalization were privately funded and driven by changes in price relationships and

[31]CORFO's interventions included analysis of potential demand to establishing a in surveying existing fruit orchards, analysis of potential demand in foreign markets, elaboration of production goals, introduction and screening of new varieties, establishment of nurseries to propagate disease-free plants, construction of cold storage facilities at strategic locations to promote post harvest care, phytosanitary inspection of exported fruit, establishment of favorable credit lines and working capital and "drawback" payments for fruit exports. In 1964 Chile establish the National Institute of Agricultural Research which paid relatively higher salaries and attracted more skilled researchers and INIA initiated a fruit research program. By these means, Chile developed the scientific personnel and knowledge to achieve technological transfer; identified and began to plant new varieties suitable for foreign markets; improved orchard and post-harvest management; upgraded fruit research and teaching; developed the infrastructure necessary to export fruit to foreign markets. Several export companies emerged that gained experience with foreign markets.

industry structure that increased returns to private R & D. Further down the innovation chain the number of university theses on fruit submitted in Agricultural Engineering from 1976-80 to 1986-1990 increased by a factor of 2.5. Though Jarvis expresses concerned that private provision of a non-excludable good might not be a likely as profits to the industry are eroded, there can be no question that story of the renaissance of Chilean fruit is one of innovation made profitable by eliminating a bias against the sector.

In Conclusion

The logical question is why Latin America occupies the extreme of the continuum sketched here. Though beyond the scope of this paper, much of the explanation lies in political-economy dynamics- timing of the mobilization of urban classes and modernization of the rural areas, the form of integrating new actors in traditional power structures etc.- and these receive attention, particularly among Australian observers. Further, if the data in table 5 are to be trusted, Latin America may have suffered a greater fall in income.

However, in keeping with the general focus on national learning capacity and adoption of knowledge from abroad, three angles are suggestive.

First, the necessary degree of protection to preserve or jump start industries is likely to be a function of their ability to innovate as fast their foreign competitors. The Swedish forestry industry does not seek protection from Brazilian and Chilean exporters. But it is perhaps not surprising that 19th century Brazilian iron smelters using archaic *cadinho* technologies complained of competition from more modern producers abroad, despite the high shipping costs. A lower "national learning capacity" would dictate higher necessary levels of protection to have a comparable stimulative effect.

Second, the same deficiency in national learning capacity may have implied reliance on technological on foreign actors that implied a greater sense of dependency and additional suspicion of natural resources. It is likely that had Chile had the capacity to monitor the *Gran Mineria* in the 1950s, it would have enjoyed a stronger bargaining position and a greater confidence in copper as continuing growth industry.

Finally, innovation in economic knowledge may depend on the same factors. Between low levels of general literacy and the same weakness in tapping into foreign advances, Latin America may have been less familiar with the laws of economics and sound management than the beta countries. Duncan and Fogerty argue that Australia emerged from its traumatic period of Depression unemployment with a renewed commitment to economic management and state intervention. But, it retained the professionals from business and the universities who had successfully managed war production and directed them toward maintaining post war prosperity. There was a fundamental belief in the need for a technically sound basis for economic management and a commitment to remaining engaged in the world economy. In Sweden, Jonung (1992) notes how unusually involved professors of economics were and remain in public life. Globally renowned figures such Cassel, Heckscher, Ohlin, and Wicksell were frequent government advisors, promoters of public debate, and even parliamentarians.

But this was the same era when Peron dismissed *tecnicos* like Raul Prebisch and argued that "there can be nothing more elastic than the economy" and that economists' alarmist warnings should be ignored. The latter suggests that this is point should probably not be overstressed. Time and time again, in the region, the macro-basics are firmly understood by key actors, but the political conjuncture overrode their advice. Nonetheless, it is remarkable to hear many of the present cohort of Latin American leaders, in the face of vast international evidence, again recurring to policies that will guarantee only that over the long run, the region will remain far from the innovation frontier.

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Table 1 Rates of Growth of GDP per Capita, 1820–89 (Maddison 1994)

(annual average compound rate of growth)

	1820-70	1870-1913	1913-50	1950-73	1973-89
The European capitalist core and its offshoots					
Austria	0.6	1.5	0.2	4.9	2.3
Belgium	1.4	1	0.7	3.5	2.0
Denmark	0.9	1.6	1.5	3.1	1.7
Finland	0.8	1.4	1.9	4.3	2.8
France	0.8	1.3	1.1	4.0	1.9
Germany	0.7	1.6	0.7	5.0	1.9
Italy	0.4	1.3	0.8	5.0	2.6
Netherlands	0.9	1.0	1.1	3.4	1.3
Norway	0.7	1.3	2.1	3.2	3.1
Sweden	0.7	1.5	2.1	3.1	1.7
United Kingdom	1.2	1.0	0.8	2.5	1.9
Australia	1.9	0.9	0.7	2.4	1.7
Canada		2.3	1.5	2.9	2.4
United States	1.2	1.8	1.6	2.2	1.6
Average	**0.9**	**1.4**	**1.2**	**3.5**	**2.1**
European periphery					
Czechoslovakia	0.6	1.4	1.4	3.1	1.3
Greece			0.5	6.2	1.7
Hungary		1.2	1.2	3.5	1.2
Ireland			0.7	3.1	2.9
Portugal		0.3	1.4	5.6	1.7
Spain	0.6	1.4	0.2	5.1	1.8
Soviet Union		0.8	2.3	3.6	1.0
Average	**0.6**	**1.0**	**1.1**	**4.3**	**1.7**
Latin America					
Argentina		1.9	0.7	2.1	-1.2
Brazil	0.2	0.3	2.0	3.8	1.7
Chile			1.7	1.2	1.5
Colombia			1.5	2.1	1.8
México	0.4	1.1	1.0	3.1	1.0
Peru			1.4	2.5	-1.2
Average	**0.3**	**1.1**	**1.4**	**2.5**	**0.6**
Asia					
Bangladesh			-0.3	-0.7	2.2
China	0.0	0.3	-0.5	3.7	5.7
India	0.0	0.3	-0.3	1.6	2.7
Indonesia	0.2	0.5	-0.2	2.1	3.4
Japan	0.1	1.4	0.9	8.0	3.0
Korea			-0.2	5.2	6.4
Pakistan			-0.3	1.8	2.8
Taiwan			0.4	6.2	6.1
Thailand		0.4	0.0	3.2	5.2
Average	**0.1**	**0.6**	**-0.1**	**3.5**	**4.2**

Table 2: Summary Growth Regressions, 1820-1989

	Period					
	1820-1989		1820-1950		1950-1989	
	a	b	a	b	a	b
Net Primary Exports per Worker	-0.0727	-0.043	0.11927*	0.1095*	-0.344*	-0.2745
	-(0.73)	-(0.43)	(1.87)	(1.67)	-(1.72)	-(1.35)
Latin America		-0.38		0.13		-0.833*
		-(1.31)		(0.64)		-(1.68)
1870-1913	0.505885	0.5121	0.4972**	0.495**		
	(1.31)	(1.33)	(2.61)	(0.25)		
1913-1950	0.2646	0.29269	0.2569	1.37		
	(0.73)	(0.81)	(1.44)			
1950-1973	2.43	2.45**			1.44**	1.44**
	(6.90)	(6.96)			(3.84)	(3.88)
1973-1989	0.997	1.01**				
	(2.82)	(2.88)				
Constant	0.655**	0.6926**	0.633**	0.62**	1.69**	1.81**
	(2.27)	(2.39)	(4.45)	(4.30)	(6.34)	(6.60)
Obs.	**152**	**152**	**76**	**76**	**76**	**76**
R-squared	**0.35**	**0.35**	**0.13**	**0.15**	**0.20**	**0.13**

(t-student values)

Note: * Significant at 10% level; ** Significant at 5% level

Source: Author's construction using Maddison (1995) and WDI

Table 3: Density of Engineers		
	Year	#/100K
Australia	1920	47
Chile	1930	6
Colombia	1887	8
United States	1920	128

Colombia: Safford(1976), Chile: Villalobos (1990), Australia,US: Meredith (1995)

Table 4: Structure of Major Commodity Exports before Great Depression, 1928

	Agriculture	Tropical Agriculture	Meat, Wool and Fish	Wood and Paper	Minerals	Others
Argentina	53%		47%			
Brazil		100%				
Chile					100%	
Colombia		68%			18%	14%
México		15%			85%	
Australia	16%	2%	82%			
Canada	49%			34%	11%	6%
Finland	12%			84%		5%
Norway			18%	45%	20%	17%
Swedish	20%		10%	35%	20%	15%

Source: Argentina, Brazil, Chile, Mexico, Australia and Canada: Mitchell (1998); Colombia, Norway and Sweden: Blömstrom and Meller (1991); Finland: Hjerppe (1989)

Table 5: Impact of Great Depression

Country	**Changes in terms of trade of commodities exports 1928-1932**	**Max. Unemployment**	**Max.negative change in GDP compared with 1929**
Argentina	-45.0%	5.6 / 7%	-14.0%
Brazil	-61.1%		-6.0%
Chile	-45.6%	7.0%	-27.0%
Colombia	-56.5%		-2.0%
Mexico	-51.5%	6.0%	-17.6%
Australia	-51.5%	20.0%	-9.7%
Canada	-58.3%	19.0%	-25.1%
Denmark	-	32.0%	positive
Finland	-46.3%		-4.0%
Norway	-38.0%	33.0%	-2.6%
Sweden	-55%	24.0%	-4.0%
Sources: See Data Appendix			

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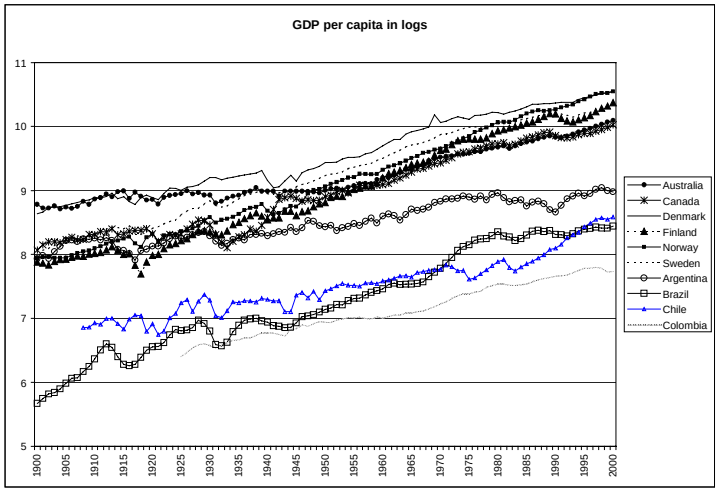
Figure 1



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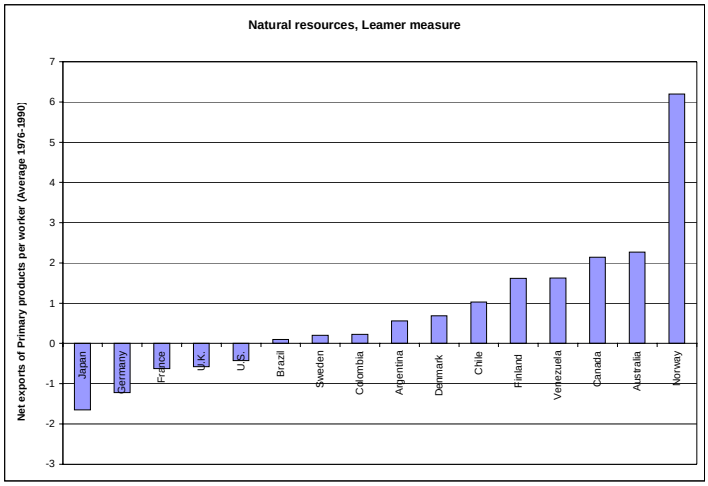

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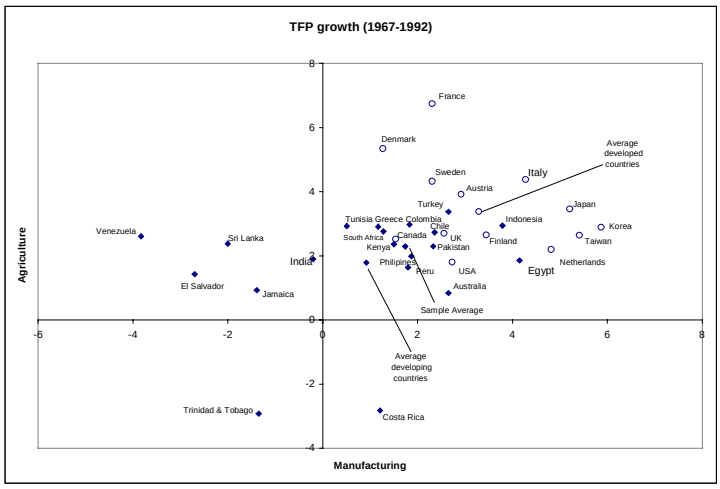

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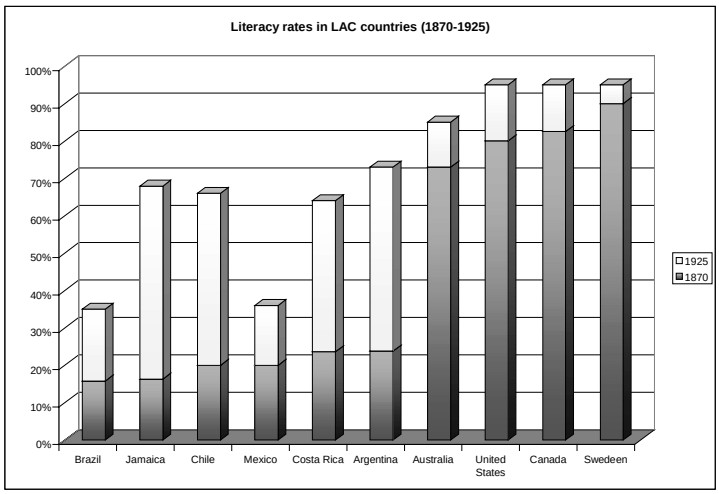

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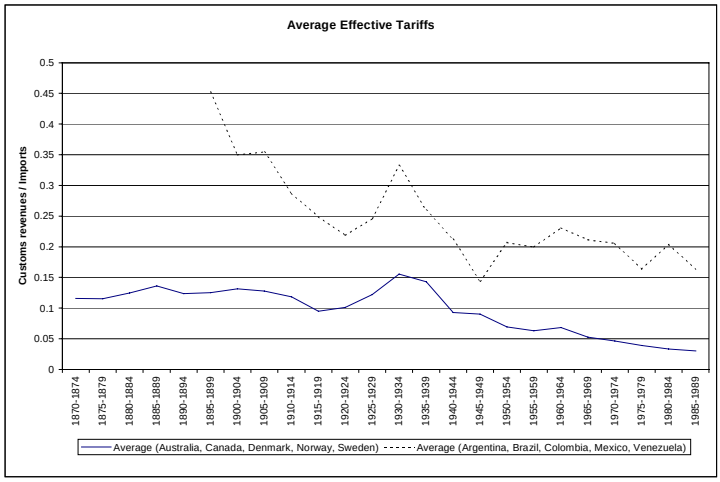

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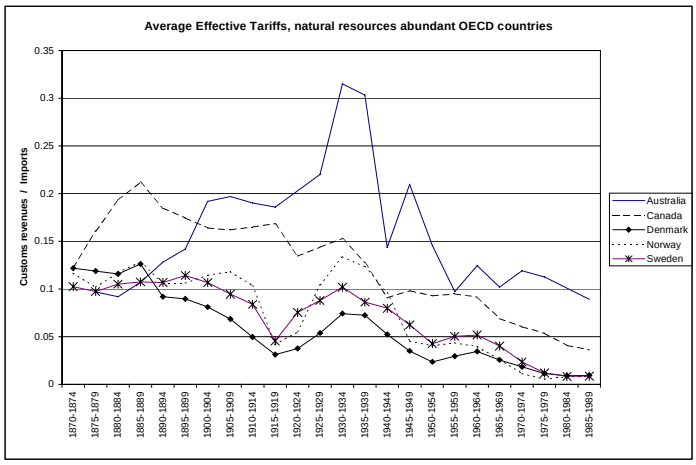

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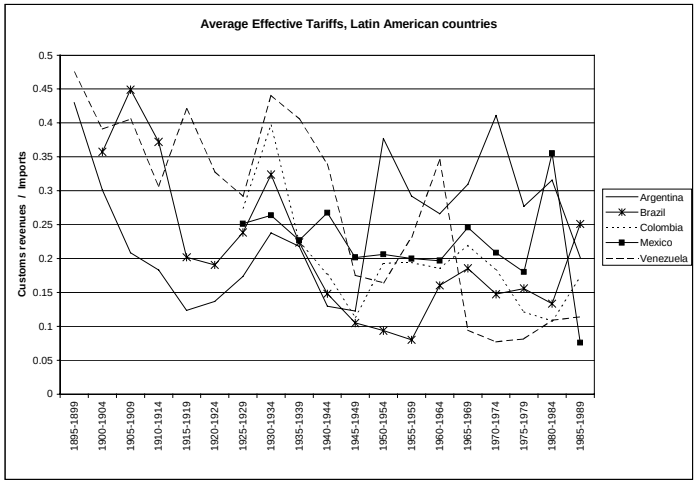

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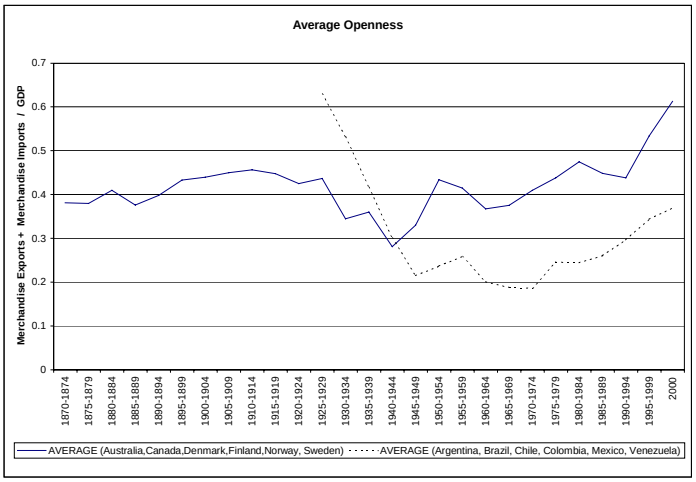

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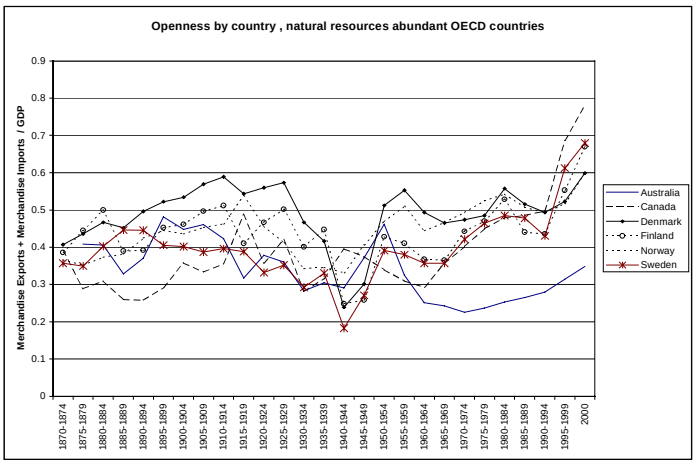

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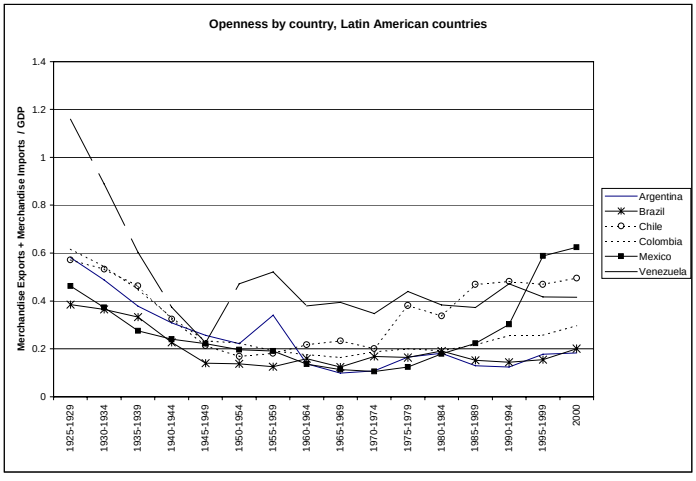

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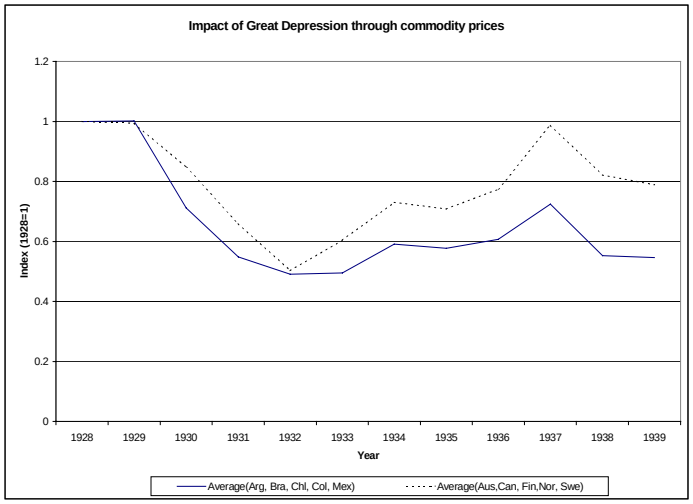

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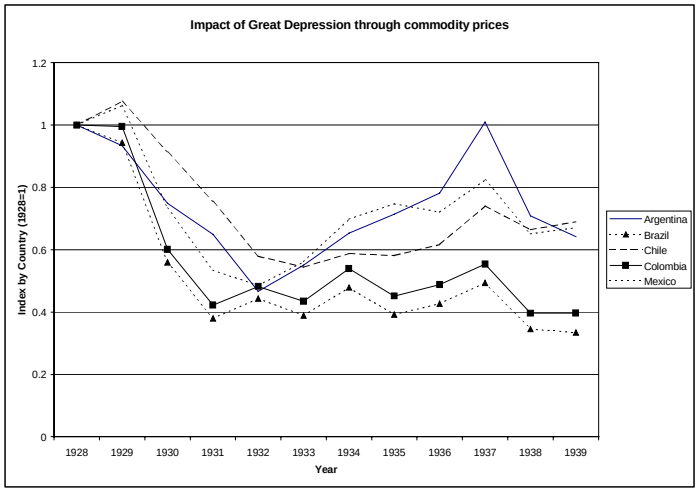
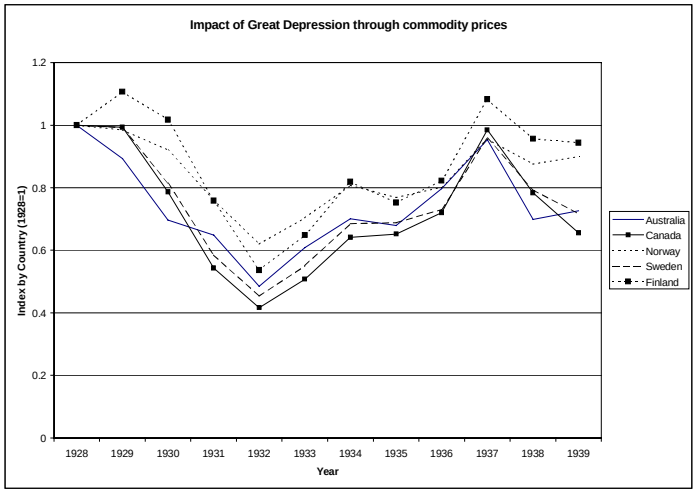


Figure 13



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