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MISSED OPPORTUNITIES: INNOVATION AND RESOURCE-BASED GROWTH

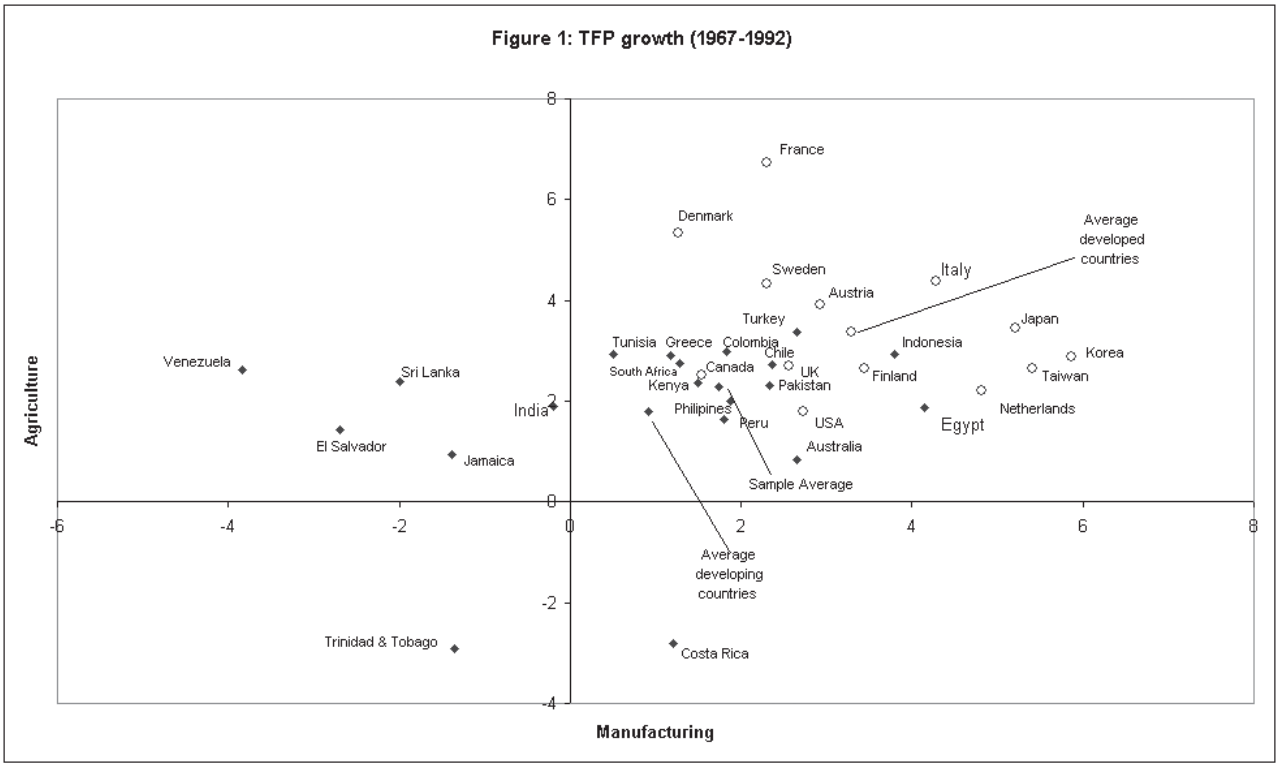
William F. Maloney

The 20th century offered opportunities for rapid natural resource-based growth that Latin America systematically missed. Even if it were the case that resource abundant countries have experienced relatively slow growth, the more interesting question is why some -Australia, and Sweden for example -successfully and rapidly developed while others did not. Latin America's underperformance, and its particularly virulent strain of dependency, are in substantial measure due to impediments to technological adoption and innovation arising from weak national "learning" capacity, and the perverse incentives of the protectionist era.

A recent LAC publication *From Natural Resources to the Knowledge Economy(2002)* argues that the belief that resource-based sectors intrinsically lack dynamism is probably mistaken . The findings of a "resource curse" in recent studies are not robust to time period, measure of resource abundance or econometric technique and, in fact, Lederman and Maloney (2003) find a positive growth effect of natural resource abundance. Further, Total Factor Productivity (TFP) growth, the dominant explanation of differences in the growth of GDP/capita was roughly twice as high in agriculture as in manufacturing globally from 1967 to 1992 (see figure 1 and Martin and Mitra 2001). Blömstrom and Kokko (2001) argue that forestry will remain a dynamic sector in Sweden and Finland, where rapid productivity growth ensures competitiveness relative to emerging low-wage producers. Wright (2001), drawing on the early US and Australian cases, argues that the stock of minerals is, to an important degree, endogenous and major increases in productivity can be realized in discovery and exploitation. More generally, the literature is clear that these development successes based their growth on natural resources and, by appropriate measures of resource abundance, several still do.

Latin America seemed unable to follow their lead. Natural resources appear to have had a *positive* growth impact from 1820-1950 in Latin America. But in the post-war period, the growth of total factor productivity in Latin America in agriculture *and* manufacturing perversely lags that of the countries at the technological frontier (Figure 1). For example, despite documented potential for a great industry of forest products in Chile, nothing remotely similar to the dynamic Scandinavian experience appeared until the late 1970s. Wright (2001) categorizes Latin American countries as traditional mineral "underachievers," and massive discoveries of deposits throughout the region in recent years confirm his view. But why was *La Escondida*, Chile's largest copper mine, only discovered a century after Chile's once dominant native industry had all but vanished, and by Australians who began mining significantly later?

The answer lies in missed opportunities to exploit global knowledge to increase productivity growth and create, or



perpetuate, dynamic industries as some Nordic and East Asian countries have done. Latin American observers have noted that the region proved unable to move beyond exploiting the pure rents of a frontier or extraction of mineral riches, or the collusive rents offered by state-sanctioned or otherwise imposed monopoly, to tap the potential "unlimited source of growth" from exploiting the quasi-rents of innovation.

The Importance of National "Learning" Capacity

This failure has two central (but not exhaustive) explanations. The first is deficient national "innovative" or "learning" capacity: the human capital and networks of institutions that facilitate the adoption and creation of new technologies. Wright (1999) argues that U.S. success in mining "was fundamentally a collective learning phenomenon" through intellectual networks linking world class mining universities, government and private research. Collective learning also underpins Australia's current success and is notably absent in underachievers. Blömstrom and Kokko (2001) argue that knowledge networks, or clusters of universities and private and public think tanks, are the key to further productivity throughout the economy, rather than being driven by progress in a single industry or the actions of a narrow elite. Other institutions critical to broad based innovation- access to patents, credit markets- were similarly exclusionary. By contrast in Sweden, the introduction of a mandatory school system in 1842 and emphasis on literacy and numeracy were essential to the ability of individuals and firms to learn and adopt new technologies: much elementary learning and technology transfer was based on written instructions like blueprints and handbooks. Despite a strong sense of "there but for the grace of God go we" on the part of Australian authors studying Argentina, Australia's high levels of literacy in the mid-nineteenth century put the children of imported convict labor far closer to the industrialized countries than Argentina.

Technical Education: The Critical Lag

Latin America also lagged behind comparable countries in technical capacity. Part of this came from being colonized by countries with little technical tradition (Spain's first permanent engineering school was established in 1867). By contrast, Sweden had technical educational institutions dating to the 18th century and a mature engineering capacity by 1850 and was exporting cutting edge engineers to the US. Austra-

Table 1: Density of Engineers at the Turn of the Twentieth Century

Country	Year	Engineers per 100,000 workers
Australia	1920	47
Chile	1930	6
Colombia	1887	8
Sweden	1890	84
United States	1920	128

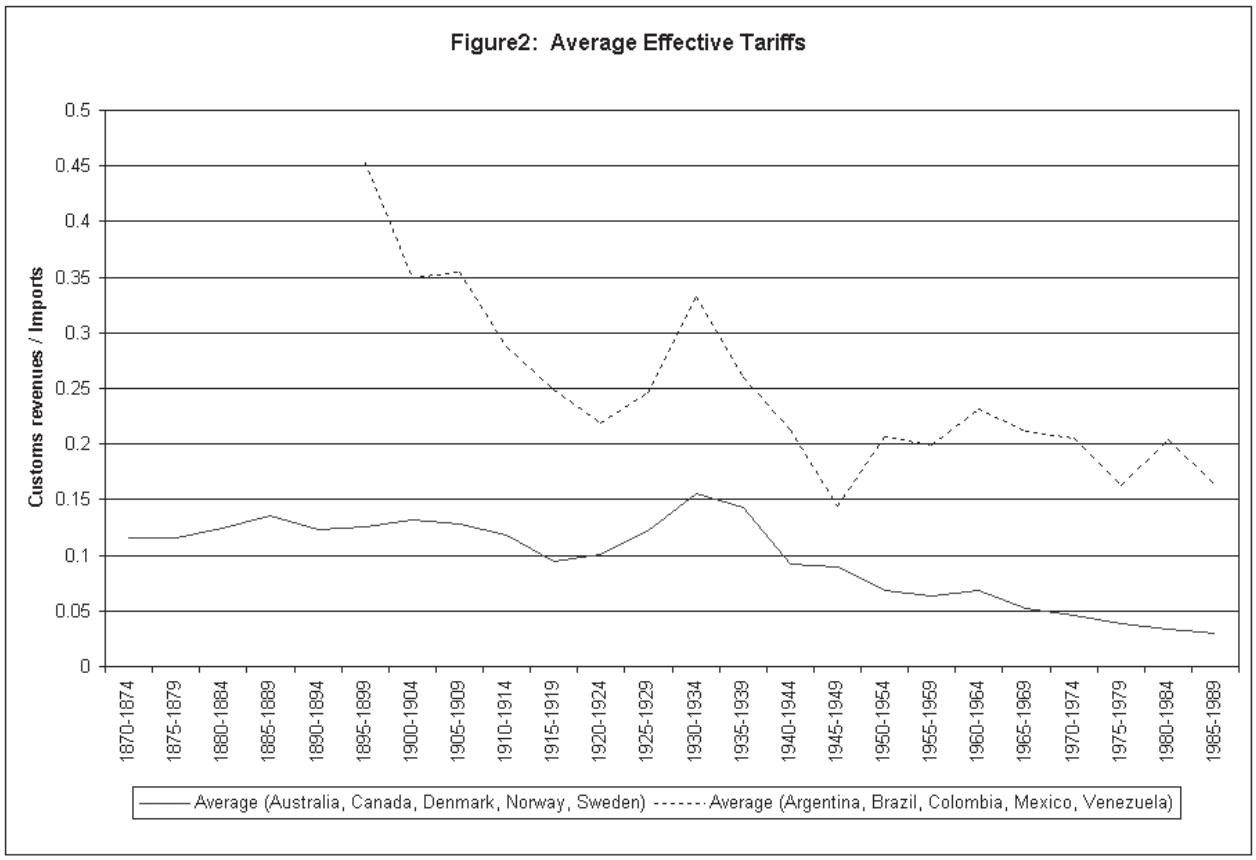
lia lagged the United States in engineers in the early 20th century but was far ahead of Latin America. Several important Australian universities offered local beachheads for foreign research and formed the kernel for the eventual knowledge cluster in mining. The Sydney Mechanics Institute was established 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 (UNSW) was founded in 1949 with MIT and the Berlin University of Technology as models and a core focus on science and technology research and teaching. UNSW's School of Mining Engineering is now one of the largest educators of mining engineers in the world. Sustained broad-based and intensive human capital formation has put Australia in the forefront of mining technology development and application.

This happened to some degree in Latin America. Mining universities in Antioquia, Colombia and Minas Gerais and Sao Paulo in Brazil were the catalyst for the development of the industry that emerged in these areas. However more generally, the region may have slipped into a worse equilibrium by not maintaining its innovation-effective human capital. Chile offers a telling example. Once a dominant and dynamic global force in copper production, its world share fell from one-third to under 4 percent by 1911. Chilean historians note a failure to adopt new technologies and the deficiency of technical institutions as the underlying causes, far more than any other factor. As foreign capital and expertise revived and came to dominate the industry, Chile had no engineers who could even monitor the multinationals, let alone contribute to the industry's technological advance, and this exacerbated an already acute sense of dependency. Education, of course, is not the whole story. Another recent LAC publication *Closing the Gap in Education and Technology* (2003) details the other critical factors necessary for a functioning National Innovation System that would prepare developing countries to take advantage of the technological opportunities that the next millennium will offer.

Trade protection: a double disincentive to innovation

The second barrier to innovation in the region is found in the myriad barriers to technological adoption usually associated with artificially created monopoly power: guilds, labor unions, credit markets that only lend to insiders, and explicit trade barriers that impede knowledge spillovers from trade interactions or inhibit foreign investment. Simulations suggest that in a dynamic context, the costs of these barriers to new entry far exceed the few percentage point differences in GDP they appear to provide in static models.

The direct effect of reduced competition arising from high trade barriers (see Figure 2) was to ensure that the artificial and inappropriate manufacturing sectors would be largely innovationally sterile. Further, the extraordi-



nary range of effective rates of protection, from –100 to 650 in Chile, -50 to 500 for Brazil, compared to -25 to 200 for Malaysia, and –17 to 106 for Norway, ensured that far from innovating, the negatively protected primary sectors stagnated. In Chile these rates imply that 10 of 21 industries could export only at a loss. These included wood, paper, paper products, fish, and fruits; industries that become the driving force of the post liberalization boom and, in several cases, extremely innovative sectors.

Trade barriers have hampered the spread of innovation

Latin America was not alone in its concerns about dependency, its degree of suffering during the Great Depression, or, in fact, in adopting inward-looking policies. But the region's response lies at the extreme end of a continuum that extends through Canada and Australia to Sweden at the other extreme. All countries increased their protection levels after the Great Depression, and Australia is virtually indistinguishable from the Latin American countries in this respect. But the highest Scandinavian protection levels were the lowest levels reached in Latin America in the most open periods. Most comparator countries reduced effective tariffs below 10% by 1950, but 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 comparator countries also became more closed in the 1930s and 1940s, but by 1950 had retained their previous levels. Even at their most closed they were far more open than their Latin counterparts, which by 1989 still had not recovered their 1895 levels.

Clearly, there are important regional differences being surfaced here. However, acknowledging the similarities with more successful countries 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 a perceived kinship and desire to avoid its fate. By the same logic, there was probably nothing preordained about the disappointments of the last half of the twentieth century—different policies could have led to better outcomes.

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About the Author

William F. Maloney is a Lead Economist in the Chief Economist's Office of the World Bank's Latin America and the Caribbean Region

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