

### Catch-up and Convergence: Leaders and Followers (20694475)

The convergence hypothesis at its most fundamental level posits that countries with lower productivity will tend to grow at faster rates than their more productive neighbors. This theory follows directly from the law of diminishing returns, which explains that the marginal output of a production factor progressively decreases as the factor is increased. Following this logic, a less productive country can exploit the same techniques utilized in more productive countries to achieve a greater output for any given level of input. While theoretically sound, the convergence hypothesis relies upon one key assumption that is not brought to bear in the real world – either no other determinants of productivity growth exist, or countries with varying productivities are equal in all other aspects. Empirical evidence runs contrary to both possibilities. For example, in the period from 1870 to 1913, America continued to increase its already well-established lead in productivity, while the average productivity level of laggard countries in Europe fell. Following the Second World War, however, Europe's rapid growth and convergence with the United States seems to validate the hypothesis. These discrepancies imply the existence of other important determinants of growth. This paper seeks to examine the mechanisms by which convergence occurs to uncover the characteristics that explain why some laggard countries experience accelerated growth rates, why others with high productivity remain leaders, and why still others fail to ever catch up.

In the literature, convergence and catch-up are often used interchangeably to refer to either the tendency for the productivities of countries within similar strata to converge with one another or to the tendency for countries with lower productivities to catch up with countries that are leaders in productivity. As class discussion focused primarily upon the latter definition, this paper will proceed by examining the international evolution of productivity as it relates to this distinction.

To begin its discussion, this study proposes the addition of a couple determinants of productivity growth to the fundamental convergence theory that will help explain its historical imprecision. These new factors can be divided into two categories – those that govern a nation’s *potential* to increase productivity and those that affect the country’s *ability* to reach its potential level. Given the small scope of this paper, the discussion restricts itself to conditions of the first type. Furthermore, while my research has revealed two primary determinants of a nation’s potential to increase productivity, I elect to focus on only one – technological congruence.<sup>1</sup>

Technological congruence calls upon related factors like natural resource endowments, market scales, and consumer demands that affect and are affected by the development and application of new technology. The idea is that without a matching landscape of factors that bred the invention of efficient techniques in a foreign country, a laggard nation cannot benefit to an equal degree from the adoption of said innovation. This restrictive condition accounts for Europe’s prewar inability to reach greater productivity growth rates compared to America, while its progressively declining importance after World War II explains Europe’s subsequent catch-up and convergence.

The existence and development of natural resources is one important aspect of technological congruence. Early in its development, America benefitted from an abundant and cheap supply of natural resources that helped it establish dominance during the wave of resource-intensive technologies introduced during industrialization. Factories and other manufacturers used resources like coal, iron ore, and copper en masse, and this market motivated the discovery of

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<sup>1</sup> Again, unfortunately, this decision is made for the sake of scope. The second determinant consists of a country’s *social capacity* for growth, a term coined by Kazushi Ohkawa and Henry Rosovsky in 1972, which refers to those non-technical factors like educational, political, and financial institutions that influence productivity growth.

new techniques to increase production, which were complemented by American educational initiatives like Columbia's School of Mines. American government also played a role in providing incentives to mine mineral resources by not claiming ownership of America's mineral deposits and offering unfettered access of such deposits to prospectors without fees or royalties. By contrast, Europe, despite having reserves of key minerals like iron ore as large as those identified in America, had not invested in exploiting those natural resources, and so was unable to benefit from industrial advances to the same degree as America.

Post-World War II, a reduction in the importance of natural resources paved the way for Europe to finally exploit America's advancements in resource-intensive production methods. Previously undiscovered mineral resources were located and developed in many areas of the world, which in conjunction with rapidly decreasing transportation costs, greatly diminished America's comparative advantage. Additionally, technical progress reduced factor input requirements per unit labor in the manufacturing industries, making continued development less resource-dependent. These factors allowed Europe, which had near-exhausted, high cost coal deposits, and Japan, which lacked an ample supply of natural resources, to rely upon Middle Eastern petroleum for cheap energy. This in turn raised Europe's potential to pursue the resource-intensive techniques developed in America, which can account for the quick convergence of several European countries to American levels of production in the postwar period.

A second important aspect of technological congruence is capital-using and scale-dependent technology. Basically, industrialization required heavier use of machinery per worker, which also obliged manufacturers to operate on a larger scale to be economical. America again proved itself as a leader of productivity for several reasons. First, America's sparse pattern of settlement and continuous westward expansion made wages high and local labor supplies inelastic, which

encouraged the development of capital-intensive, wage-saving mechanical technology. Additionally, the American domestic market was large and well-connected by an extensive steam-powered transportation network, which, combined with relatively unified preferences for unpretentious and functional consumer goods, provided demand for mass-produced outputs which made ample use of scale-dependent, capital-using technology. By contrast, European preferences were largely segmented, which did not facilitate the development of such technology – the rich cherished customized craftsmanship while the poor could not afford to demand durable goods. Additionally, America's advantage in scale, supported by higher wages, can be seen in capital to labor ratios. For example, in 1913, British and German ratios reached only 60% of those in America, and they did not catch up until after World War II.

In time, America's advantage in this realm waned due to growing domestic and international markets that resulted from a decrease in transportation costs. This could provide the necessary demand for laggard countries to pursue scale-dependent technology. Another important change involved an evolution in the nature of technological progress itself. Capital-using techniques gave way to technology that promoted more easily achievable intangible assets like research and development and education. The postwar era witnessed a boom in research and in particular its application to industry.

This paper has shown that the relative positions of countries alone are not enough to predict patterns of catch-up and convergence. Other important determinants like technological congruence play an important role as well. America remained a leader prior to World War II because it invested in innovation and other countries could not properly exploit its advancements, but as the influences of these restrictive determinants waned, countries in Europe achieved the conditions necessary for catch up and convergence. Further study of the subject

would analyze other determinants of productivity growth that were touched upon in the introduction. There is a wealth of information and evidence to suggest the validity of a more complex convergence hypothesis, and the research must only be done to determine the relevant interactions.