THE IMPACT OF THE ASIAN MIRACLE ON THE THEORY OF ECONOMIC GROWTH

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ABSTRACT

This paper, divided into seven sections, considers the development of economic growth theory in light of the spectacular advances of the economies of China, India, and Southeast Asia. Section 1 reviews the debate over the sources of technological change and the measurement of total factor productivity that emerged during the second half of the 1950s. Section 2, "Convergence and Divergence," deals with the closing of the economic gap between the U.S. and other OECD nations that existed after World War II and the increasing economic gap between OECD and Third World nations. Section 3, "The Asian Miracle," describes the new recognition among Western economists that the sustained, very rapid growth in China and Southeast Asia was changing the global economic balance. Section 4, "Endogenous Economic Growth," deals with the work of a group of mainly verbal theorists, including Simon Kuznets and T.W. Schultz, who sought to define social, political, demographic, religious, and ideological conditions that preceded the epoch of modern economic growth, which began in the late eighteenth or early nineteenth centuries. That line of thought was extended by more mathematical economists who studied the invention and modeled the diffusion of new technologies in agriculture (Zvi Griliches) and industry (Edwin Mansfield). Section 5, "Bridges between Two Cohorts of Theorists on Technological Change," compares the work of Griliches, Richard Nelson, and Dale W. Jorgenson, whose quantitative analysis of endogenous technological change spanned the period from the mid-1950s to the new cohort of growth theorists that emerged during the mid- to late-1980s. Section 6, "The Economic Historians," focuses on their investigations of the interrelationships of the evolution of social, economic, and political institutions and on findings about the impact of institutional changes on invention, innovation, the process of technological change, and economic growth. Section 7, "The Impact of the Asian Economic Miracle on Growth Theory," focuses on the theorizing about the likely impact of the rapidly expanding Asian economies on the shaping of the global economy over the next several decades.

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Before considering the impact of the "Asian Miracle" on growth theory, I need to consider when the term *Asian Miracle* became common among economists and what ideas preceded it. I also need to review the concept of growth theory, tracing its origins and its evolution. This is not an easy task because of the complex way that theory, measurement, and the needs of economic policy have interacted in the work of growth economists since World War II.

Nevertheless, I believe there is widespread agreement that two papers by Robert M. Solow, both published in the second half of the 1950s (Solow 1956 and 1957) are nodal points in the huge literature on the theory and measurement of long-term economic growth.[1] They became nodal points despite the fact that similar growth models by others had been published about the same time. Solow (2007) has recently singled out a paper by the Australian economist Trevor Swan (1956) that embodied all of the elements of his model, but that had little impact on subsequent research.

1. Aggregate Production Functions, Total Factor Productivity, and
Exogenous Technological Change

In his 2007 paper, Solow mused on this discrepancy. Why, he asked, did his paper become so influential? The way to do it, he said, was to:

(i) keep it simple; (ii) get it right; and (iii) make it plausible. (By getting it right, I mean finding a clear, intuitive formulation, not merely avoiding algebraic errors.) I suspect that all three of these maxims were working for the 1956 paper. It was certainly simple; it didn't get lost in the complications and blind alleys that beset Trevor Swan's attempt; and it was plausible in the

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[1] See also Solow (1958).

sense that it fitted the stylized facts, offered opportunities to test and calibrate, and didn't require you to believe in something unbelievable. *(p. 4)*

In his 1957 paper, Solow applied a Cobb-Douglas production function to the explanation of the growth of U.S. output, with the astounding result that increases in the inputs of labor and capital explained only about 13 percent of the increase in output between 1909 and 1949. Eighty-seven percent was unexplained. Solow attributed this unexplained portion to improvements in technology, which he treated as being outside of the model; hence the term: *exogenous* technological change.

From an empirical standpoint, perhaps the most important consequence of the Solow papers was to shift the attention of economists from labor productivity to total factor productivity as the principal measure of changes in economic efficiency or technological change. However, Solow's analysis did not emerge, like Athena, fully grown from the head of Zeus.

Economists had been struggling with the concept of total factor productivity for several decades. Some such measure was, as pointed out by Griliches in 1996, much discussed in the 1930s, especially in connection with the National Bureau of Economic Research programs on developing time series in national income. [2] This concern led the Bureau to launch projects that produced long-term time series on the measurement of capital formation in various sectors and in the economy as a whole. An interim report on the progress of this work was published by Goldsmith (1952). Bureau economists were constructing indexes of output divided by total input in the late 1930s, the 1940s, and the 1950s, and they identified such indexes as measures of the efficiency of the economy (see, for example, Copeland and Martin 1938, Stigler 1947, Fabricant 1954, Kendrick 1955).

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[2] In Europe, Jan Tinbergen, in a 1942 paper published in German, used a Cobb-Douglas function with an exponential time trend, which he interpreted as a measure of changes in efficiency for Germany, Great Britain, France, and the United States. But Tinbergen's paper did not become known in the U.S. until much later.

Perhaps the most important Bureau paper on total factor productivity prior to Solow's work was published by Moses Abramovitz in 1956 under the title "Resource and Output Trends in the United States since 1870." Making use of Simon Kuznets's data on real national income, he estimated that real net product per capita had increased at an annual rate of 1.9 percent, quadrupling over the 75 years between 1869–1878 and 1944–1953. He also computed an index of all resources, labor, and various forms of property, weighted by their shares in national income. To his surprise, this index of inputs explained only 14 percent of the increase in output over the 75 years. The remaining 86 percent was due to an unexplained increase in productivity.

The results were not only surprising to Abramovitz, but also defied adequate explanation. He called the unexplained rise in total factor productivity "the residual," and also a "measure of our ignorance." He attributed much of the residual to errors in the measurement of the inputs. With respect to labor, he singled out changes in the age structure of the labor force, which concentrated hours of work at the most productive ages. He also noted the neglect of increases in skills and of investments in health and education and in on-the-job training of labor.

On the side of capital, he emphasized the failure to measure the increased stock of knowledge, improvements in the organization and technique of production, and greater investments in research and development. He also pointed to, but did not attempt to measure, the contributions of increasing returns to scale, which Edward Denison later put at 10 percent of the increase in total factor productivity (Dension 1962).

2. Convergence and Divergence

In 1945, the idea of high-performing Asian economies was not in the mind of American or

European economists. In the United States, economists worried about the problems created by the

demobilization of over 20 million people (half from military ranks and half from war industries) and their

integration into the civilian labor force. There were widespread fears that America might slide into a

severe new depression. In Europe, the central issues turned around the Allied occupation of Germany

and Italy and the restoration of the war-devastated economies. In Asia, the central issues were the

demilitarization of Japan and the restoration of the nations that had been occupied by Japan. On the

horizon were problems related to the dismantling of the colonial empires of Britain, France, and other

European powers.

Several events between 1945 and 1950 set the stage for the political economy of the remainder

of the twentieth century. One was the outbreak of the Cold War and the strategy of containing the

expansionist ambitions of the Soviet Union. Another was the rapid recovery of Western Europe and the

transformation of West Germany into an ally in the anti-communist coalition. A third was the

communist victory in the Chinese civil war that followed the defeat of Japan. Still another important

event was the partition of India into independent Hindu and Muslim nations. There was also the

emergence of newly independent governments throughout South and Southeast Asia[3] that were each

struggling to find its road to rapid economic growth.

As Table 1 shows, the countries of South and Southeast Asia were at different economic levels in

1950, at the beginning of this quest. Japan, an occupied nation, had suffered severe reversals in fortune

and had slipped to a level of per capita income characteristic of a low middle-income economy. Even the

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[3] As used in this paper, the term *Southeast Asia* applies to the first group of eight nations in Table 2.

more prosperous Asian nations shown in Table 1 had per capita incomes that were less than a quarter of that of the United States. In contrast, the war-ravaged economies of Europe were by 1950 already on their way to a quarter century of unprecedented economic growth that would raise standards of living, health, and life expectancy for ordinary people to levels that few would have predicted (Crafts and Toniolo 1996). Thus, the stage was set for intense debates among economists and policymakers about the way to deal with global disparities. Among the points at issue were the virtues of centralized and decentralized planning and whether international trade was a handmaiden of domestic economic growth or an obstacle to it.

When Western economists began talking and writing about convergence in the 1950s and 1960s, the focus of their conversation was not convergence between the West and the East, but convergence between Western Europe and the United States. Immediately after World War II, the U.S. was by far the richest country in the world, not only by per capita income but also by total income. With just 7 percent of the world's population, the U.S. accounted for a quarter of global GDP (cf. Nelson 1991).

This does not mean that Western economists lost sight of the rest of the world. During the 1950s and 1960s, they developed an increasing interest in the progress of the ex-colonies of Asia, particularly India and China. The political leadership of both countries was heavily influenced by the Soviet model of centralized planning. Both countries developed successive five-year plans for the economic growth of their countries. These plans sought rapid economic growth by placing special emphasis on the rapid development of heavy industry. Both taxed rural areas to subsidize cities and urban industries.

However, India sought to achieve its objectives under a political democracy, in which some industries would have government backing but the bulk of economic production and distribution would

be left to the private sector. It also embarked on a protectionist policy aimed at promoting infant

industries. New financial institutions were set up that placed the supply of capital largely under the

control of the government, which directed investment into sectors given prominence by the plan. The

first five-year plan, which ran from 1951–1956, was successful in meeting its goals, and private

enterprise expanded. As indicated by Table 2, the annual rate of growth in per capita income during the

plan was in the neighborhood of 2 percent. However, annual net investment was in the neighborhood of

just 6 or 7 percent (Pepelases, Mears, and Adelman 1961, Malenbaum 1959, 1982).

By the early 1960s, the Indian economy began to stumble. Not all of the problems were due to

errors by policymakers. Some problems arose from border clashes with Pakistan and China. Some of the

food shortages were due to droughts. But the main pressure on the food supply was due to explosive

growth of population as mortality rates fell sharply. As a result of the successful public health measures

undertaken during the 1950s and 1960s, such killer diseases as cholera, malaria, and smallpox were

brought under control, helping life expectancy at birth to rise from 32 to 51 years between 1950 and

1968 (Chandrasekhar 1968). Moreover, growth of per capita income also raised the demand for food,

putting upward pressure on food prices that pinched both the urban and rural poor. Government efforts

at land reform may actually have increased rural inequality (Mellor et al. 1968, Blyn 1971). Attempts at

government-controlled industrialization thwarted private investment and promoted uncompetitive

enterprises (Shenoy 1968, Sklaeiwitz 1966, Healy 1972, cf. Bhagwati and Chakravarty 1969). As a result,

Indian growth slipped badly during the first half of the 1960s (see Table 2).

Although India and China were the cases most frequently discussed by economists, attention

was also paid to other nations in Southeast Asia. During the 1960s, there was considerable pessimism

about Indonesia's future. Although there was a spurt of economic growth immediately after

independence, during which the nation recovered from the setbacks associated with the Japanese

occupation, the economy stagnated between 1955 and 1965, a period long enough to make economists wonder if Indonesia could overcome its problems (Mears 1961). Beginning with the mid-1960s, however, the country began vigorous growth that lasted for three decades (see Table 2). Malaysia and Singapore also stagnated during the decade of the 1950s, contributing to the sense among some Western economists that adverse institutional factors might thwart their development. But in these countries, fortunes changed decisively in the 1960s.

Table 2 shows that eight Southeast Asian nations all grew vigorously from 1965 on, and that several of them (Hong Kong, Taiwan and Thailand) had vigorous economic growth throughout the second half of the twentieth century. Indeed, their growth rates far exceeded the previous growth rates of the industrialized countries. Few American or European economists anticipated growth rates that would double, triple, or quadruple the long-term rates of the industrial leaders between 1820 and 1950.

The most startling change of fortune was in Japan. With the outbreak of the Korean War, United Nations forces placed large orders with Japan, greatly stimulating its industrial growth. Even after the end of fighting, Japan's economy benefited from large orders for the build-up of the U.S. military establishment in the Pacific region. The Japanese export boom powered the dramatic rise in the Japanese economy. In one industry after another, including scientific instruments, cameras, sewing machines, and shipbuilding, Japanese firms displayed their command of the latest technology. During the 1960s, Japan moved from producing under a half million cars to becoming the world's second-largest supplier, displacing Germany and France among others. The rise of auto production helped promote the expansion of steel and moved the country toward world preeminence in that basic product (Allen 1972). As Table 2 shows, from 1950 through 1970, the growth of Japanese per capita income exceeded that of all the other high-performing economies. In the space of two decades, Japanese per capita income increased more than fivefold, a feat that had required more than a century for the

nations that led the industrial revolution (Kuznets 1971a, Maddison 1995). Although the growth of

Japanese per capita income slowed after 1970, it still increased by about 40 percent between 1970 and

1980, making it the second largest economy in the world, bigger than France and the UK combined

(Maddison 1995).

During the late 1960s and early 1970s, many analysts became alarmed at what appeared to be

the unchecked growth of population in Asia. It was widely predicted that such growth would not only

swamp the capacity of South and Southeast Asia to feed itself, but would also smother the tenuous

economic growth of the region. In the 1950s, many demographers had predicted that population growth

would moderate because a decline in fertility would soon follow the decline in the death rate, which had

caused the Asian population explosion. That view was called the theory of the demographic transition.

But fertility rates remained high through the end of the 1960s, causing some demographers to declare

that the theory of the demographic transition was dead (Coale 1975). As it turned out, that gloomy

forecast was incorrect. As Table 3 shows, between 1970 and 1980, total fertility rates fell sharply in all

Southeast Asian nations. Today all of these nations, except for Malaysia and Indonesia, have total

fertility rates below replacement. Indeed, fertility rates in most of these nations are below the fertility

rates of three of the five rich nations shown in Table 3.

The forecast that Southeast Asia would be unable to feed itself because of the unbridled growth

of population also turned out be erroneous. Table 4 shows the food situation throughout South and

Southeast Asia in 1961. Per capita consumption of calories in China, even after the famine, was at or

below the level of consumption in England and France toward the end of the eighteenth century (cf.

Fogel, Floud, Harris, and Hong 2009). The same desperate situation prevailed in India, Thailand, and

Korea. By 2000, the food situation had changed dramatically. Despite the erroneous agricultural policies

that precipitated the famine of 1960–1961, and again slowed agriculture during the "Cultural

Revolution" of 1966–1967, China's progress in agriculture between 1962 and 2000 has been remarkable (Clark 1976, Lin 1998). China not only found a way to feed itself, but did so well enough to increase its average daily consumption of calories by 73 percent, despite the near doubling of its population. Although not as dramatic, there were also substantial gains in caloric consumption in the rest of South and Southeast Asia, ranging from 12 to 68 percent. Another point worth noting is the improvement in the quality of the diet, as indicated by the increase in the proportion of nutrients coming from animals. In China, the rise was from under 4 to over 19 percent of total caloric consumption. Only Indonesia and India still have levels of the consumption of animal products that hearken back to eighteenth-century conditions in England and France (cf. Fogel et al, forthcoming). Still another problem is the unequal distribution of food in many of the nations of South and Southeast Asia. In these countries, the proportion of low birth weights is still high, which implies the early onset of chronic disabilities at middle and late ages, a problem that will contribute to the high cost of medical care for the elderly in future years (Barker 1998, Doblhammer and Vaupel 2001, Fogel 2003, 2004b).

Let us now consider expectations of economic growth right after World War II, viewing them from the standpoint of the present. At the close of World War II, there were wide-ranging debates about the future of capitalist economies that pivoted on the Keynesian proposition that a macroeconomic equilibrium is possible at less than full employment and, in particular, the interpretation of that proposition by Alvin Hansen in his 1938 presidential address to the American Economic Association (Hansen 1939). Hansen argued that secular stagnation was likely because of: (1) the end of the frontier, (2) the end of rapid population increase, and (3) the end of capital-intensive technological change. The key issue, as the stagnationists defined it, was not whether the growth of the GDP would come to an end, but whether a high level of government spending was necessary to prevent a high level of permanent unemployment, even if GDP did grow.

That such a debate would erupt in anticipation of the peace is not surprising. The alarm about

massive unemployment was widespread in 1943 and 1944 because the country was demobilizing over

11 million soldiers from the armed forces and there were some 9 million or more workers in defense

industries that were simultaneously being let go. So there were about 21 million people thrown on a job

market of about 60 million, including the armed forces and the defense establishment (U.S. Bureau of

the Census 1955, Table 220). But as it turned out, the recession of 1945 only lasted eight months and

was followed by a robust expansion that lasted 37 months. Moreover, the recession of 1949–1950

lasted 11 months and was followed by another robust expansion that lasted 45 months (U.S. Bureau of

the Census 2003, Table 771). The peak came in 1953 after the economy had already absorbed 20 million

potentially unemployed workers, and unemployment was below 3 percent by 1953. Total civilian

employment was up by 15 percent over the wartime peak (cf. Bratt 1953).

Although unemployment remained over 5 percent during some of the years of the long 106-

month Kennedy-Johnson expansion, it dropped to 3.5 percent in 1969. So even a quarter of a century

after the war, there were still economists who believed that the U.S. could not have an economy with

both growth and low unemployment unless there was a very big government sector. By the late 1950s,

the U.S. and other OECD countries were well into the post-World War II expansion, now called "the

Golden Age," with growth rates twice the long-term average of the world leaders during 1840–1940.

Measured by per capita income, the long-term average growth rate of the leaders prior to 1940 was

about 1.9 percent per annum and the growth rate during the Golden Age was, for Western Europe,

about 3.8 percent (Kuznets 1971a, Maddison 1995, Crafts and Toniolo 1996). Over the whole period

from 1950 to 1999, expansion multiples for GDP averaged about fivefold in Western Europe and the

United States (see Table 5). The wide-ranging debates over the causes for the accelerated growth rates

of the Golden Age suggested some points of consensus. These included the reduction of barriers to

international trade, successful macroeconomic policies, and opportunities for catch-up growth following the end of World War II, especially in France, Germany, and Italy. The destruction of much of the pre-war capital stock, the reconstruction aid that rebuilt industry with a more advanced technology, the successes of macroeconomic policy, the elasticity of the labor supply, high levels of education, and the weakness of vested interests have all been advanced as explanatory factors (Abramovitz 1990, Mills and Crafts 2000, Crafts and Toniolo 1996, Denison 1967, Maddison 1987, 1991, 1995, Olson 1982). [4]

The eventual fading away of the stagnation thesis, of the notion that there was something in the operation of capitalistic economies that made them inherently unstable, brought to the fore several new concerns. These included the growing gap in income between developed and less developed nations, and a new emphasis on cultural and ideological barriers to economic growth in poor countries. In contrast to some of the early theories associated with the Harrod-Domar model, which suggested that poor countries would grow rapidly if there were large injections of capital from rich countries, by the 1960s, the emphasis was that the export of capital would fail to promote growth unless the deep cultural barriers that made these countries unreceptive to the conditions needed for economic growth were somehow overcome. Some commentators, most notably Gunnar Myrdal, in his three-volume work on the Asian economies, said that India would have difficulty in sustaining high growth because it promoted asceticism and thus undermined the acquisitive culture that spurred Western Europe (Myrdal 1968, c.f. Lau 1969).

There was also a shift from worries about over-saving, which I must say, never caught on at certain universities. It didn't catch on at Chicago or at Columbia. Nor did it catch on at the National Bureau of Economic Research. Analysts such as Simon Kuznets, Arthur Burns, and others thought that savings were not a threat to economic growth, but were a necessary condition for economic growth

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[4] When the value of increased longevity and improved health are added to GDP, growth rates increase significantly (cf. Fogel 1989b, 2000, 2004a, Murphy and Topel 2005).

because you needed the savings to build both infrastructure in developing countries and also to get a thriving public sector growing (Kuznets 1961, Colm 1962, Samuelson 1992).

There was, about this time, a new emphasis on export-led growth. The practice of poor countries selling their exports to rich countries got a bad name during the interwar period and was widely viewed as exploitation of these countries by imperial powers. The later view, looking at the Canadian and American experiences, was quite the contrary (North 1966, Kravis 1970). Selling raw materials and other labor-intensive products to the rest of the world is a way to get capital and entrepreneurship from the developed countries to provide those same talents and qualities to the less-developed countries. One of the great discoveries of economic historians during the 1960s and confirmed in the 1980s and 1990s was that the Hobson-Hilferding-Lenin thesis that English coupon-clippers got rich from investments in poor countries such as India, and then withdrew large sums of annual earnings, was wrong. After the computer revolution, it was possible to put the whole late nineteenth-century portfolio of British overseas investments into machine-readable form (Simon 1970, Davis and Huttenback 1986, Stone 1999). Lo and behold, it turned out that there was a strong correlation between a country's per capita income and the share of the British overseas portfolio invested in it. The United States received the largest share, followed by Canada and Argentina (which at the turn of the twentieth century had one of the highest per capita incomes in the world). Of course, that did not stop diehard critics of Western imperialism, who then denounced Britain for *failing* to have invested in underdeveloped nations (cf. Davis and Huttenback 1986).

3.   The Asian Miracle

As remarkable as what was widely forecast in the post-World War II debates were the things not

foreseen in the 1940s, 1950s, or even the early 1960s. One of these was the extraordinary economic

growth in Southeast and East Asia, beginning first with Japan, which in four decades went from a poor,

defeated country to the second largest economy in the world, increasing per capita income tenfold. This

was a feat that took leaders of the industrial revolution about 150 years to accomplish (Kuznets 1971a).

The economic miracle of the high-performing Asian economies other than Japan was also unforeseen,

and that state of mind persisted into the 1970s. It wasn't that economists didn't know that per capita

income was rising, but there was a widespread opinion that it couldn't last, that somehow it was a fluke.

That view was based on the uneven economic performances of several of the Southeast Asian nations.

Indonesia, for example, had some catch-up growth during the first half of the 1950s but faltered in the

1960s. Of the "Four Asian Dragons," only Taiwan did better than Italy or Germany between 1950 and

1970 (see Table 2). The idea that all of the Southeast Asian nations, including China, were in the midst of

an unprecedented expansion that might affect the global economic balance did not emerge until the

early 1990s.

So, except for Japan, there was little excitement about the growth rates elsewhere in East Asia

until the late 1970s and early 1980s, when some analysts began taking note of the Korean economic

miracle (GNP per capita tripled in less than two decades) (Krishnan 1982) and comparable accelerations

in the growth rates of Hong Kong, Singapore, and Taiwan. These four economies began to be called "The

Four Asian Dragons" or "The Four Asian Tigers" (Hicks 1989).

The phrase "Southeast/East Asian Economic Miracle" and the acronym *HPAE* (for "high-

performing Asian economies") were added to the economic lexicon by the World Bank when it

published a book, *The East Asian Miracle: Economic Growth and Public Policy*, in 1993. The term was almost immediately embraced by economists, some of whom felt it neatly summarized a new phase of global economic development, and by a few, such as Paul Krugman, who wrote about "The Myth of the Asian Miracle" (1994), arguing that the marginal productivity of capital would soon decline because the miracle depended mainly on investment in capital and not on efficiency growth. In later work, Krugman modified his predictions (1998, Krugman and Wells 2005), allowing for a longer period of growth, but still maintained his earlier skepticism.

However, Chinese economic growth did not slow down for reasons delineated by Abramovitz in his 1955 paper. The new investments embodied new technologies that greatly improved the efficiency of the productive process. Moreover, China invested heavily in raising the educational level of the population, concentrating first on primary education. As early as 1980, the gross enrollment ratio[5] of primary schools reached 113 (see Table 6). The extension of secondary school has also been impressive, with the enrollment ratio rising from 46 in 1980 to 76 in 2006. The sharpest rate of increase has been at the tertiary level (colleges and universities), where the enrollment ratio tripled between 1980 and 1997, and tripled again between 1997 and 2004, reaching 19 in the latter year. This rapid increase in educational levels was promoted both by business and political leaders who recognized not only that they had to expand the supply of highly trained technicians, but that the demand for high-tech consumer products required well-educated consumers.

Hence, the marginal productivity of physical capital has risen, not only because of the advanced technology embodied in new physical investment, but also because of the greater investment in raising the quality of labor. The quality of labor has risen, not only because of formal education, but also because of on-the-job training, increased experience, improved health, and increased longevity. Rather

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[5] Persons in school x 100 ÷ persons of school age.

than declining, the rate of increase in Chinese per capita income rose to 9.2 percent per year between 1990 and 2005, which is more than a third higher than the growth rate during the previous 15 years. Indeed, there is no convincing evidence that long-term Chinese economic growth is faltering (cf. Fogel 2007).

4. Endogenous Economic Growth

To those who know the non-mathematical literature of the pre-1975 growth theorists, the belief that endogenous theories of economic growth are an invention of the late 1980s is surprising. While it is true that Solow and some other modelers treated technological change as exogenous in papers written in the 1950s and 1960s, verbal theorists such as Simon Kuznets, Moses Abramowitz, Theodore W. Schultz, and Douglass C. North paid a great deal of attention to endogenous technological change, emphasizing the synergies between improvements in the quality and quantity of labor and of physical capital.

Kuznets (1966, 1971a, 1971b), for example, stressed that economic growth both required and produced major changes in the structure of the economy (defined as the distribution of inputs or output among the major sectors of the economy). Not only were increases in agricultural productivity a condition for the rapid growth of manufacturing, but new manufacturing technologies, which produced more efficient agricultural equipment or new varieties of seeds and fertilizer, were major factors in the growth of agricultural productivity and stimulated changes in agricultural technology.

According to Kuznets, many current economic opportunities and problems were determined by economic conditions and relationships that evolved slowly, often taking many decades to work out. At a time when Keynes declared that "in the long run we are all dead," an aphorism reiterated by many

economists not only during the 1930s but during the 1940s and 1950s, Kuznets continued to call attention to the role of long-term factors that had to be taken into account by policymakers, factors which led him to conclude that the opportunities for returning to high employment levels and rapid economic growth were greater than generally believed in the decades immediately following World War II.

Current social problems, Kuznets emphasized, in the late 1960s and 1970s, were often the result of past growth—the consequence of past desirable attainments, which at a later time produce socially undesirable consequences that require remedial policy action. Of his numerous illustrations of this principle, one is particularly cogent: the explosion of population growth in the less developed nations of Asia, Africa, Oceania, and Latin America in the quarter century following World War II. This population explosion threatened to thwart efforts to raise per capita incomes from their dismally low levels because birth rates remained traditionally high, while public health policies and improved nutrition cut death rates in these regions by more than 50 percent in less than a generation. One obvious solution to the problem was to reduce fertility, yet there was a web of traditional patterns of behavior and belief that tended to keep fertility high. Nevertheless, Kuznets believed that properly designed public policies could hasten the social and ideological changes required to reduce fertility and to lead these societies to prefer a greater investment in a fewer number of children (cf. Becker 1960, 1981, Becker and Lewis 1973). Such a program required not only government and private campaigns to disseminate the technology of birth control but a restructuring of social and economic incentives that would provide rewards for families with fewer children.

Yet, as the experience of the U.S. and other developed nations has shown, the success of the program to curtail fertility is bound, much further down the line, to create a new set of issues, similar to those that have become the center of the modern women's movement: the restructuring of society in

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such a way as to promote equal opportunity for women in all occupational markets. The rapid economic

growth of 1945–1970 also produced new concerns about equity issues, particularly between whites,

blacks, and Hispanics, and gave momentum to the movement for equal rights for women. [6]

Economic growth creates social problems because it is profoundly disruptive to traditional

values and religious beliefs, to longstanding social and family patterns of organization, and to numerous

monopolies of privilege. Despite the fact that modern economic growth has brought with it tremendous

increases in longevity and good health, has brought to the lower classes standards of living as well as

social and economic opportunities previously available only to a tiny minority, and has greatly reduced

the inequality in the income distribution of developed nations, the social restructuring of society

required by modern economic growth has been fiercely resisted—sometimes because of an

unwillingness to give up traditional values and ways of life, sometimes by entrenched classes

determined to protect their ancient privileges. Because of the complex responses to change and

because the epoch of modern economic growth was still unfolding, many aspects of the social

restructuring that were underway were still obscure and difficult to predict (Kuznets 1966, p. 15). As late

as 1972, Kuznets felt compelled to point out that despite the multitude of tentative partial

generalizations, cross-sectional studies, and econometric exercises, there was as yet no "tested

generalization, significantly specific to permit the quantitative prediction of aggregate growth, or even

of changes in the structural parameters in the course of growth" (Kuznets 1972, p. 58).

Kuznets was particularly concerned with longitudinal issues, such as the length of the period of

observation that was needed to identify the underlying process at work in any specific aspect of

economic growth. How, he asked, can one determine whether such a process, once identified, is

sufficiently stable to provide a reliable basis for prediction? These problems are illustrated by an issue

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[6] Further down the line, the drop in fertility rates creates new problems as the population ages. See Fogel 2003
and 2004b, cf. Fogel et al. 2009.

on which Kuznets was the preeminent investigator of his age: the interrelationship between demographic processes and modern economic growth.

A particularly important aspect of the issue was the concentration of the decline of death rates at early ages, which contributed to the reduction in fertility rates. The reduced fertility rate released a large proportion of the female labor force to gainful occupations, accelerated the transition to modern families, mobile and responsive to economic incentives, and promoted new ideologies conducive to economic growth (1966, p. 56–62). In subsequent work, Kuznets noted the increase in the share of women in the U.S. labor force from 17 percent in 1890 to nearly half in the 1980s, which he attributed to the lower fertility rates, the shift in employment opportunities from manual to service sector positions, and urbanization, which made organized labor markets more accessible to women (Kuznets 1989, Fogel 1989a). He also called attention to the fact that the most rapidly growing occupations— those in the professional, technical, clerical, sales, and other services—were the ones in which women had made the greatest inroads. Nevertheless, in the late 1950s and early 1960s, when the new women's movement was still incipient, Kuznets did not anticipate fully the explosive entry of women into the labor force during the next quarter century, nor the new ideology that would facilitate that development (1966, p. 193–195).

Ideas of endogenous technological change were also deeply embedded in the work of economists who studied the diffusion of new technologies. Among the earliest of these studies was the dissertation of Zvi Griliches (1956) and papers based on it (particularly 1957 and 1960), which analyzed the factors affecting the rate of diffusion of hybrid corn. Griliches traced that process from the early scientific research of agricultural experimental stations to the sequential adoption of various strains of these seeds by commercial producers. He also analyzed the rate of spread of this type of seed by

farmers, looking at the difference in the characteristics of early and late adopters within and across

states. Indeed, it took more than half a century for hybrid corn to displace its rivals everywhere**.**

Consequently, at any point in time, the existing average technology was a weighted average of

technologies of different vintages, not merely of the prehybrid seeds per se. Seed manufacturers

produced new vintages of hybrid seeds as technology adapted to the climate and soil types of particular

regions and subregions. Griliches also related the educational level, institutional connections, and

income of individual farmers to the rate at which they changed over to the new strains of corn.

What Griliches did for the diffusion of new technologies in agriculture, Edwin Mansfield did for

diffusion of industrial technologies. Mansfield (1971) measured the lag between invention and

innovation for 46 inventions. The lag varied from one year for Freon refrigerants to 79 years for

florescent lamps. The lag for some other notable inventions was 24 years for the distillation of

hydrocarbons with heat and pressure, 22 years for television, 27 years for zippers, 13 years for radar,

and 14 years for jet engines.

He then turned to the factors that influence the decision to innovate. After emphasizing the

risks associated with innovation (only two out of 10 new products that emerge from research and

development become commercial successes), he set forth the costs and benefits of both leading and

waiting for others to lead. The investment needed to bring a new innovation to market is usually in the

range of 10 to 20 times the original research costs.

Mansfield then analyzed the rates of diffusion of 12 innovations in four industries (coal, iron and

steel, brewing, and railroads). He found that the diffusion of a new technique was generally a slow

process. Among the factors that affected the rate of diffusion were the size of the firm, the expected

rate of profit from investing in the innovation, the growth rate of the firm, the overall profit level of the firm, and the liquidity of the firm. [7]

It was not only characteristics of the firms but also characteristics of the managers that influenced rates of diffusion of new technologies. Presidents of early adopters of complex new technologies were younger and better educated than heads of firms that were late adopters.

In subsequent studies, Mansfield (1980) found that both firm and industry expenditures on research and development had a substantial impact on firm and industry rates of growth in productivity. Both basic and applied research, individually and in conjunction, increased productivity growth. With respect to interfirm, interindustry, and international transfers of technology, Mansfield (1975) delineated among material, design, and capacity transfers. Capacity transfers often involved the transfers of people, since there was often "no substitute for person to person training and assistance" (p. 373). That was especially the case when the transferred technology had to be adapted to take account of local conditions, including differences in relative costs, abilities, cultures, and climates (cf. Mansfield 1972).

The notion of endogenous technological change did not begin with the cohort of Griliches and Mansfield. Walt W. Rostow (1990, especially chapters 15–17 and 20) has summarized the known theories of technological change, endogenous and exogenous, going back several centuries. More relevant to the issues in this paper is the work of Joseph Schumpeter, who was the most important growth theorist between the deaths of Smith and Malthus and his own death in 1950. His earlier work focused on long cycles in economic output, which he attributed to fluctuations in the rate of inventions and innovations (Schumpeter 1934). His analysis led him to single out entrepreneurs as the dynamic agents of change, to point to the equity effects of economic growth (embodied in his concept of

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[7] See Perkins 2006a and Maddison 1998 for discussions of the lag of China and India in adapting modern technology.

"creative destruction"), and to make the creative clusters of innovations inherently inflationary. Later in his career, Schumpeter focused on the conflict between economic concentration and competitive markets, and between the capitalist system of economic organization and the political, social, and intellectual movements that were hostile to capitalism for ideological reasons. It was these conflicts, he argued, rather than the secular diminution of investment opportunities that threatened the continuation of economic growth under a system of political democracy (cf. Rostow 1990, especially p. 233–242).

Theodore W. Schultz was another major motivator of the theory of endogenous technological change. He received the most acclaim for his contributions to the theory of human capital (Schultz 1962, 1971). But that was only one aspect of his broader concern with economic growth and the elimination of poverty. These broader concerns led him to examine closely the impact of government fiscal policies and specific interventions into agriculture in both developed and developing countries, policies that distorted agricultural production and had perverse effects on the distribution of income. Like Schumpeter, Schultz was concerned about new sources of future income growth, and this concern led him to recognize that in the 20th century, human capital had become more important than physical capital in explaining both economic growth and the inequality of the income distribution. His theory of human capital led him to conclude that unregulated high fertility was a major factor in destabilizing an agricultural sector. Such considerations also caused him to emphasize the importance of the investment in improving nutrition and health as a key to economic growth in poor nations and to identify investment in "allocative skills" as a key to dealing with problems of disequilibria (cf. Bowman 1980).

Schultz was influenced in his thinking about human capital by his experiences with postwar reconstruction. Despite the devastation of Europe, all of the war-ravaged countries experienced rapid economic growth in the 1950s, quickly exceeding their prewar levels. This led Schultz to dwell on the

central role of human capital in modern economic growth, to consider the possibility that a significant

share of the so-called residual factor in economic growth was due to improvements in the quality of the

inputs, particularly in the quantity of capital embodied in human labor. Although his empirical work on

this question focused on education, Schultz recognized that improvements in health, in the capacity to

process information, in the development of allocative skills, and in on-the-job training might be more

important than the effects of formal education per se.

Abramovitz was another of the nonmathematical theorists who grappled with issues of

endogenous technological change throughout his career. In papers published in 1972 and 1993, he

called attention to the shifting bias of technological change, which was intensive in physical capital

between 1850 and 1950 (the era of the building of railroads and the electrical grid) but became human

capital-intensive thereafter. Since 1950, "technological change tended to raise the marginal productivity

of capital in the form of education and training of the labor force at all levels; in the form of practical

knowledge acquired by deliberate investment of resources in research and development; and in other

forms of intangible capital, such as the creation and support of corporate structures and cultures and

the development of product markets, which are the infrastructure of economies of scale and scope"

(Abramovitz 1993, p. 229).

Abramovitz also stressed the interdependence of technological progress and both tangible and

human capital accumulation. He noted both tangible and intangible capital formation influenced the

pattern of technological progress. But he cautioned Lucas, Romer, and other contributors to the "new

growth theory" from overemphasizing the impact of capital accumulation on the direction of

technological change. Although the bias of technological change was influenced by capital accumulation,

it was also influenced by the evolution of scientific and technological knowledge that was "quite

unrelated to the terms of factor supply," including the influence of relative factor costs, the evolution of

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science and technology, and the "impact of political and economic institutions and modes of organization on which the discovery and acquisition of new knowledge depend" (Abramovitz 1993, p. 237).

5. Bridges between Two Cohorts of Theorists on Technological Change

This section compares the work of Zvi Griliches, Richard Nelson, and Dale W. Jorgenson, whose research on technological change spanned the period from the mid-1950s to the present. All of these investigators focused on the difficulties of measuring technological change. All three were concerned with endogenous as well as exogenous sources of technological change. All three were deeply involved in problems of the identification and measurement of endogenous technological change. Although they dealt with national patterns of change, much of their research was focused at the level of industries and on the characteristics of the firms that comprised the industries. All three welcomed the new enthusiasm brought to the studies of technological change and economic growth by a younger cohort of investigators led by Romer, Lucas, Helpman, Barro, Acemoglu, Aghion, Howitt, Krugman, and Young, among others.[8]

Griliches's studies were notable for their display of statistical skills. He made important contributions to econometric modeling of specification biases, to models of distributed lags, and to models that dealt with "unobserved" or "omitted" variables, such as ability. He also developed the hedonic technique for separating changes in the prices of complex products into components due to improvement in qualities of such products (such as automobiles and pharmaceuticals) and to inflation. He was also one of the pioneers in the study of the impact of investments in research and development

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[8] Helpman (2004) provides an insightful tour of the new growth theory, pointing out its major issues and evaluating its foundations (cf. Helpman 2008).

on productivity at the firm, industry, and aggregate levels. He emphasized that much of the unmeasured residual in productivity gains was due to the "spillover" effects in one firm or industry on the inputs and outputs of other firms and industries (Heckman 2006, cf. Trajtenberg and Berndt 2001, David 2003). These are all key points in the explanation of the Asian Miracle (see section 7 below).

Richard Nelson has been a thoughtful analyst of the economics of invention and the processes by which inventions become incorporated in the process of production and marketing. In the late 1950s, he critically surveyed the economic literature on these topics and pointed to numerous unresolved issues. Among the points he stressed were the high risks in research and development, and the few initiatives launched by firms that ever got to the point of yielding commercially viable projects (1959). He also delved into the problem of explaining changes in total factor productivity and attributed much of the difference between Solow and Denison to such issues as the rate of improvement in the quality of labor and capital and the average age of the capital stock. But he also emphasized that interactions between these variables had not been sufficiently explored, and he also stressed the need to focus on the processes, which differed among firms, that affected incentives and their feedback (1964). In later papers (1981, 1988, Nelson and Wright 1992), Nelson stressed the need to focus on the processes that generate, screen, and spread new technology at the firm, interfirm, and interindustry levels. Along with Stanley Fischer (1993) and others, Nelson placed much emphasis on the role of macroeconomic policy in creating favorable contexts for rapid technological progress. Nelson collaborated with Harold Pack (1999) on an insightful discussion of the interrelationship of "The Asian Miracle and Modern Growth Theory" (see section 7 below).

Jorgenson has been at the forefront of the elaboration of the theory of production and in the measurement of the improvements in the quality of inputs, the improvements in the economic and social organization of production, and the identification of spillover effects that account for a significant

part of unmeasured inputs. Jorgenson's early work made important contributions to the theory of economic growth in dual economies: two-sector models with an advanced and a backward sector (1961a, 1961b). Indeed, much of his work has focused on the movement from a highly aggregated level of analysis to disaggregated levels.

Thus, he has placed a great deal of emphasis on moving to the industry and firm levels for purposes of both analysis and measurement, demonstrating that in so doing, one could explain much of Solow and Denison's unmeasured residual. In this connection, he pointed to the need to recognize that much of the change in total factor productivity was explained by measuring the substitution of higher qualities of labor for lower ones as well as the substitution of improved vintages of capital for earlier ones. He also sought to measure unmeasured spillover effects from one industry or one firm to another (1967 [with Griliches], 1969 [with Christenson], 1980 and 1986 [with Fraumeni], and 1980 [with Gollup]). Jorgenson also called attention to the need to take account of changes in the quality of intermediate goods at the sectoral level, estimating that these changes explained more of the change in sectoral output than improvements in the quality of labor and capital (1990).

Jorgenson has led the way in explaining the sharp increase in U.S. productivity growth that began in the 1990s. In his presidential address to the American Economic Association (2001) and in papers with Stiroh (1999 and 2000), he attributed the rapid diffusion of information technology (IT) between 1990 and 2000 to the decline in IT prices, which he said was triggered by an earlier and even sharper decline in the prices of semiconductors. Moreover, all of the increase in U.S. total factor productivity during 1990–1995 and two-thirds of the increase during 1995–2000 was due to improvements in IT.

In several of his recent papers (e.g. 2001, 2005, 2005 [with Nomura]), he found that in the U.S., IT-using industries were leading economic growth, and through wage effects, were promoting

improvements in labor quality, and that IT was having a similar effect on other G7 countries (cf. Crafts 2004). Improvements in the quality of inputs, best measured at the industry level, were major factors in output growth (e.g. 1992 [with Gallop], 1999 and 2000 [with Stiroh], 2005 [with Nomura], 2005)**.**

In a paper with Dougherty (1996), Jorgenson characterized the recent work on endogenous economic growth as an effort to account for spillover effects. He linked unexplained productivity to spillover effects that increase output in unrelated firms and industries but were normally unmeasured. Jorgenson provided a direct accounting of the benefits of such spillovers. In his most recent paper with Vu, Jorgenson finds that the accelerated pace of globalization and IT penetration between 1989 and 2006 may be important factors in explaining the jump in output productivity. He estimates that developing Asia accounted for 40 percent of global economic growth during this period (Jorgenson and Vu, forthcoming).

6. The Economic Historians

No students of economic growth have been more absorbed in issues of endogenous technological change than economic historians. Their interest in these issues is as old as the concept of the Industrial Revolution of the second half of the eighteenth and the first half of the nineteenth centuries. They traced out the succession of inventions in textiles and iron that transformed these industries, as well as successive improvements in steam engines going back to the early seventeenth century, that made it possible to substitute mechanical power for human power in mining and manufacturing and for animal power in transportation.

This progress turned partly on accidents, but mainly on the creation of an economic, social, and political environment that encouraged and supported new technologies by ethical and religious dictums

and by pro-growth ideologies. As David Landes put it, Britain's large lead in technology over France

(citing Joel Mokyr [1985] and Walt Rostow [1979]), was no accident. With one innovation after another,

repeatedly, England was the leader, and France and others were followers.

British inventors, Landes said, were responding to the high cost of labor (in the case of textile

inventions) and the vicissitudes of deep coal mines (in the case of steam engines). Moreover, the British

pool of skills in such areas as millwork and machine building was apparently larger than in Continental

countries. It was not that Britain had a large monopoly of skills, but "the size of the pool, its free, non-

corporate character, and direction (provenance) of its efforts and experience. These seem to have made

a difference" (Landes 1994, p. 650, c.f. Crafts 1997 and 1995, see also Harley 1992 and Temin 1997).

Landes (1994) continued:

The key invention falls within the Smithian paradigm: the adoption of rural putting-out. This

goes back to the middle ages and represents a crucial departure from the town-based,

corporate (guild) mode of production. The key is the division of labour and the recruitment

into the production process of women and children. Say no more: the effect is to reduce costs

and prices, increase demand, widen the market, promote further division of labour, lay the

basis in specialization for small but cumulative improvements in technique…. The effect of

this fall in prices and increase in markets at home and abroad was to turn Britain into the

workshop of the world. (*p. 651*)

Among economic historians writing about changes in patterns of U.S. economic growth, no one

has done more to emphasize the critical role of institutions in affecting economic growth than Douglass

C. North. In an article published in 1968, North estimated the substantial increases in the total factor

productivity, on the order of 300 percent, in ocean shipping between 1600 and 1850. The principal

technological change was the increase in payload capacity brought about by the changes in the design of

the ships, which became larger and swifter. The more efficient ships (called flutes) had been in use in

the Baltic trade since the early seventeenth century. Why did it take so long for ships of this design to

become dominant in the Atlantic trade? The answer, said North, was the threat of piracy located in the

Caribbean. As long as the pirate threat existed, freighters had to be armed, and arming required smaller,

sturdier ships that could withstand the recoil of the canons. It was not until the elimination of pirates

from their shelters in the Caribbean that the faster, longer, lower-cost ships became dominant in the

trans-Atlantic trade.

Two years later, together with Robert Paul Thomas, North published an "Economic Theory of

the Growth of the Western World" (1970). In that essay, they argued that changes in product and factor

prices, promoted by population growth and the increased size of markets, led to a set of institutional

changes that channeled incentives toward "productivity-raising types of economic activity…. These

institutional innovations and accompanying changes in property rights built productivity into the system,

enabling Western man to finally escape the Malthusian cycle" (p. 1). North and Thomas collaborated

again on articles explaining the rise and fall of the manorial system (1971) and on the substitution of

settled agriculture for hunting and gathering (1977).

In a highly influential paper with Barry R. Weingast, a political scientist, North (1989)

investigated the impact of the English Glorious Revolution of 1688, which "fundamentally redesigned"

fiscal and governmental institutions to limit the confiscatory power of the crown. The elevation of the

role of Parliament and introduction of an independent judiciary "produced a marked increase in the

security of private rights" (p. 804). As a result, private capital markets flourished and the government

was able, within a decade, to increase borrowing by an order of magnitude. The institution also created

more favorable conditions for economic growth, including the growth and development of banks, the creation of new instruments of private credit, and the promotion of a wide array of businesses (cf. North 2005).

Several other economic historians have had a substantial influence on the recent wave of growth theory. Papers by Stanley Engerman and Kenneth Sokoloff called attention to the importance of distant history in establishing institutions and pathways that influence patterns of current economic growth (Engerman and Sokoloff 1997, Sokoloff and Engerman 2000). This theme has resonated with growth theorists such as Acemoglu, Johnson, and Robertson (2001, 2002) and Ray (2008). Paul David's emphasis on the impact of path dependency, which links particular inventions and the large investments by their users to explain the difficulty of getting users to switch to more efficient substitutes for the original innovation, has also been influential (David 1985).

In another important paper, David (1990) explained the long lag between the invention of new technologies and their impact on economic growth using the electrical dynamo as a case in point. Even when engineers correctly foresaw the potential usefulness of electricity, a wide range of businesses were still based on mechanical power, and numerous details had to be addressed to make the new type of power advantageous for many different products and in various locales. Moreover, architects, engineers, and managers had to be trained to design, install, and operate the new systems. The risks perceived by capitalists were large enough to cause many to hesitate to invest. These problems were worked on slowly. It took about four decades to go from the construction of the first generating stations to the 50-percent point in the diffusion of electricity to users.

Economic historians have also made major contributions to the study of industrial organization and its synergy with economic growth. Carefully tracing the growth of big business in the United States, Alfred Chandler Jr., the doyen of managerial history, laid out the circumstances that led to the rise of

large-scale enterprises led by professional managerial hierarchies. He also compared the U.S. corporate structure with large enterprises in England and Germany (Chandler 1977, 1990). Chandler had a strong influence on the theory of industrial organization as it was developing during the last third of the twentieth century (Teece 1993, c.f. Caves 1990). Efforts to reassess Chandler's legacy began to appear in the late 1990s and have continued, aimed at taking account of new industrial structures brought on by changes in technology, markets, business strategy, and communications (Galambos 1997, Ghemawat 2002).

It remained for Lamoreaux, Raff, and Temin (2003) to provide a new synthesis of the evolution of industrial organization as it stood at the beginning of the new millennium. Their aim was not only to take account of the changed circumstances that led the classical Chandlerian firm—vertically integrated and diversified—to be outperformed by more specialized and vertically disintegrated firms, but to also provide a theory of the new tendencies in firms and markets. They developed a dual perspective that brought to the fore the economic logic behind business choices. Changes in industrial structures and markets reflected the vast increases in per capita income, the huge declines in the cost of processing information, and the large decrease in transportation costs that altered spatial maps and permitted products to be designed again for individual needs.

7. The Impact of the Asian Miracle on Growth Theory

The Asian Miracle began to have a profound impact on growth theory well before the full scope of that miracle was apparent. The early papers in the new wave of theoretical work, those which appeared between 1986 and 1990, were responding mainly to European and U.S. developments in the period between 1950 and 1980. When theorists shifted some of their focus to Asia during the first half

of the 1990s, they concentrated mainly on the Four Little Dragons, sometimes adding such new

contenders for the title of "miracle" as Indonesia, Malaysia, and Thailand. China and India did not move

to center stage until the second half of the 1990s.

The extraordinarily high growth rates of China since 1980 and of India since the middle of the

1990s have profoundly challenged the discussion of theorists and policymakers. These extraordinary

growth rates, if they persist for two or three decades, will radically alter the global economic playing

field, transforming China and India from merely "newly industrializing countries" to titans of the global

economy.

Tables 7 and 8 compare the global economy in 2000 with a possible, perhaps probable,

restructuring less than a generation from now. In the year 2000, the global economy was dominated by

six groupings of countries: the United States, the European Union (which then consisted of 15 countries

[EU15]), India, China, Japan, and a group of six Southeast Asian countries (Singapore, Malaysia,

Indonesia, Thailand, South Korea, and Taiwan [SE6]). As measured by gross domestic product (GDP),

these six groupings accounted for 73 percent of the world's economic output and 57 percent of the

global population (see Table 7). The balance of the world (including Latin America, Africa, and Eastern

Europe) accounted for about 28 percent of GDP and 42 percent of the global population.

Table 8 presents a not improbable set of forecasts for 2040. The population forecasts are those

of the United Nations. The economic forecasts are mine but were influenced by the forecasts of the

C.I.A. and *The Economist*. To my mind, the most unsettling of the forecasts in Table 8 is the relative

decline of the European Union implied by its stagnation in population and its modest growth in GDP.

Although the EU population in 2000 exceeded that of the U.S. by about a third, by 2040 the EU

population will be somewhat smaller than that of the U.S. The projected stagnation of the EU15

population is based primarily on the persistence of extremely low fertility rates. The *total fertility rate*

(roughly the average number of children a woman is expected to have during the course of her childbearing years) has fallen far below the level required for the reproduction of the population (2.1 children) in most EU15 countries, and has been below reproduction for several decades.

One implication of the low fertility rate is that the population of the EU15 is aging rapidly. In the year 2000, the median age in Italy and Germany, for example, was about 40, which is a decade higher than in China and half a decade higher than in the U.S. By 2040, the median age in Italy and Germany is predicted to be about 50. This rapid aging of many EU15 countries means that their *dependency ratios* (the ratio of economically inactive to economically active persons) will soar. These demographic factors will, by themselves, significantly curtail the capacity for economic growth. However, political and cultural factors appear to be reinforcing the impediments to economic growth. These include limitations on the length of the work week and increasingly heavy taxes on businesses to support large social welfare programs (that are nevertheless facing bankruptcy) and are threatening to make EU15 firms uncompetitive in the global market. [9]

I do not mean to imply that labor productivity and per capita income in the EU15 will not grow. They will grow at a rate that, by past standards, was not bad (about 1.8 percent per annum), but they will not be able to match the surge in growth that will prevail in South and East Asia. The European market will be about 60 percent larger in 2040 than it was in 2000. But the U.S. market will be over 300 percent larger, India's will be over 1,400 percent larger, and China's will be 2,400 percent larger. Indeed, the Chinese market in 2040 by itself will probably be larger than the combined markets of the U.S., the EU15, India beyond and Japan. It may well be the case that English will survive as the principal

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[9] The expansion of the EU15 to EU27 will help to invigorate the EU15 through increased cross-country migration. However, it is unlikely that the migration rate will be large enough to offset the low fertility rates in Italy, France, and other EU15 countries. Moreover, resistance to immigration is likely to increase in low-fertility country as fears of loss of national identity increase.

commercial language beyond 2040, but I suspect that there will be an explosion of business managers in the West who also speak Mandarin.

The possibility of such a massive restructuring of the global economy has substantially changed the conversation of growth theorists of the late 1980s. The debates of those years were aimed at altering the canon of growth models to allow for slighted variables (such as knowledge and experience), changed parameters (such as large capital shares and different elasticities), to rethink the implications of returns to scale and externalities in different contexts suggested by new analyses of available empirical information, and to introduce such new terminology as "absolute" and "conditional" convergences[10]. The old set of issues has not been abandoned, but the locus has shifted, and a number of new issues have emerged.

One of the central issues among growth theorists is whether increases in factor inputs or in total factor productivity has been the main source of economic growth in the surging Asian economies (cf. Perkins and Rawski 2008). A companion issue is the role of governments and of macroeconomic policy in encouraging, permitting, and sustaining economic growth (Young 1995, Krugman 1994, Krugman 1998, Stiglitz 1996, Stiglitz 2001, Kim and Lau 1994, Park 2002). Growth theorists are also grappling with the implications of uneven economic growth across the provinces and socioeconomic groupings of both China and India, for the long run economic and political stability of both countries (Chaudhuri and Ravallion 2006, Zakaria 2005, Zakaria 2006, Pei 2006, Pei 2007, Lopez 2004).

Jere Berhman, an old hand in the study of economic growth among developing nations, surveyed the literature (2001) on growth in Asia and elsewhere, pointing out changing viewpoints since the end of World War II. In the 1950s, he wrote, the key issues raised by growth economists were (1) the

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[10] See Barro and Sala-i-Martin (2004) for an excellent review of growth theory and its empirical findings. For the foundational basis of the new work, see Romer (1986), Lucas (1988), and Barro (1991), c.f. Barro and Sali-i-Martin 1997. See also Jones (1997). For a critique of the empirical underpinning of this work, see Srinivasan and Bhagwati (2001).

need to raise capital-to-labor ratios; (2) the problem of overcoming the inefficiency of markets; (3) the key role of industrialization in overcoming low growth rates; (4) the belief that international trade was harmful to developing countries because the benefits of trade were siphoned off by monopolistic producers in rich countries; and (5) the belief that governments were unbiased, had good information, and pursued policies appropriate to promoting growth. By the beginning of the 21st century, most of these ideas had been jettisoned. Among the ideas that replaced them were the proposition that merely throwing capital at the problems was not enough; that markets are better than bureaucrats (many of whom were rent-seekers) in allotting resources; and that international trade stimulated rather than retarded growth.

Dwight H. Perkins, who has been studying economic, social and political developments in China and other Southeast Asian nations for more than half a century, recently put the accelerated growth in Chinese per capita income since 1978 in perspective (2006a). The available evidence suggests that China's decline from relative prosperity in the thirteenth century to relative poverty at the end of World War II was due partly to its lag in applying science to the development of modern technology, partly to destructive invasions, and partly to civil wars that prevented the emergence of a strong central government needed to provide the institutional foundation for modern economic growth. While some of these problems were solved after the accession of Mao Zedong, mistakes in economic policy, combined with Mao's desire to launch a cultural revolution that would transform Chinese values, led to nearly two decades of sluggish growth and to various economic and social calamities.

Perkins attributes the high rate of growth in Chinese per capita income during the past three decades to reforms that began in 1978. As a result of these reforms, the government was able to generate a high internal rate of investment, promote foreign trade, open China to foreign investment (with its accompanying advanced technology and know-how), and transform China into a market

economy. However, these processes of transformation are not complete, and the future rate of growth will depend on success in completing the necessary reforms. The main future challenge, he argues, will be "to maintain a stable environment" for economic growth while the Chinese "political system evolves to one more suitable for an educated, increasingly high income country" (Perkins 2006b, p. 263).

Perkins's historical perspective helps to inform recent efforts to resolve the conflicting views of growth theorists (cf. Maddison 1998). In a 1999 paper, Nelson and Pack stressed that it was not merely the introduction of advanced technology into East and South Asia that accounted for their rapid growth. More crucial was the restructuring of the economy to effectively absorb the new technologies. Such absorption required a policy regime that encouraged the development not only of an educational system that helped entrepreneurs and technicians to begin the process of mastering and deploying the new technologies, but also of an industrial structure that permitted this new cadre to gain the experience needed to effectively exploit the new technologies. "To learn to use new technologies," they wrote, "and to function effectively in new sectors required the development of new sets of skills, new ways of organizing activities, and becoming familiar and competent in new markets" (p. 418). They also stressed that "only a small portion of what one needs to know…is codified in machine manuals, textbooks, and blueprints; much of it is tacit and learning is as much by doing and using as by reading and studying" (p. 418, cf. Nelson and Winter 1982, Rosenberg 1994). The usual growth accounting procedures, they argued, "would attribute the major share of growth simply to the growth of capital," when assimilation and industrial restructuring were the main forces driving growth (p. 426).

Beyond these technical issues about how to interpret the available information, there is a lively debate about how long China can continue growth at rates greater than ever before achieved for long periods of time. China has emerged as a major global factor in an array of product markets. Now second only to the U.S. in oil consumption, and accounting for 40 percent of all the growth in global oil

consumption in recent years, China has also become the world's largest consumer of steel, cement, and copper (OECD 2005, Kato 2004, Morrison 2006).

Most of China's growth in terms of per capita income (69 percent between 1978 and 2002) is due to increases in labor productivity. Within industry, the increase in labor productivity was 6.2 percent per annum and 5.7 percent per annum in agriculture. About 30 percent of China's growth rate is likely to continue to come from modest increases in the labor force participation rate and inter-industry shifts. Much of China's labor force is still in agriculture, so there is substantial potential for growth through a shift to industry and services as it moves toward the current technological frontier.

Investment in capital—especially human capital—is capable of rapid development in the next several decades. The increases in enrollment ratios outlined in Table 6, combined with the knowledge that a college-educated worker is 3.1 times as productive, and a high-school graduate is 1.8 times as productive, as a worker with less than a ninth-grade education, underlie the potential for growth (Fogel 2005).

As a result of its rapid growth in per capita income, China has also emerged as a major player in the production and sale of manufacturing products. As indicated by Table 9, Chinese production of autos in 2007 exceeded all of the major national producers except the U.S. and Japan. Moreover, given the current rates of increase in the auto production of all the nations, it is likely that China will be the global leader in auto production by 2010 or 2011.[11]

Ownership of other major consumer durable products has also been increasing at spectacular rates. Between 1990 and 2007, Chinese households have increased ownership of air conditioners

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[11] Despite the slowdown in the production of China's automobile industry in 2008, it has been estimated by the China Association of Automobile Manufacturers (CAAM) that annual production will increase by 5 percent in 2009 (Li 2009). In February 2009, new car sales increased by 25 percent in China, partially due to reduced sales taxes on small passenger cars (Ying 2009).

annually by 15 percent, computers by 32 percent, and cell phones by 48 percent (National Bureau of Statistics of China 2008).

The rapidly expanding economies of China and India have led many analysts to speculate on the reemergence of these two economic giants as global political players. The most recent assessment of the U.S. National Intelligence Council (2008) conjectures that, by 2025, U.S. political dominance will be replaced by what it calls "multipolarity." This multipolarity it predicts is "unlikely to produce a single dominant nation-state with the overwhelming power and legitimacy to act as an agent of institutional overhaul" (p. 81).

However, we are already in a multipolar world, which the U.S. helped to create. Our ability to influence international affairs is already constrained by the desires of Europe, Russia, India, and China. Diplomacy under the Clinton and Bush administrations was shaped by such recognition.[12]

My own view of future U.S. global influence is more conditional. A lot depends on the future rate of growth in U.S. labor productivity. If that continues at the annual rate of 2 to 4 percent, then it is possible that the U.S. will remain well ahead of its competitors in economic and political influence down to 2025 and beyond. Much will depend on the willingness of the U.S. to invest heavily in scientific research and development, and to increase the share of the population educated in the sciences. I am optimistic on both of these counts. Unlike China, whose past growth has depended on its ability to adapt to the existing technology of the U.S. and other OECD nations to China's conditions, the U.S. is at the current production frontier. Hence, its continued growth depends on the rate at which it can develop new technologies, which requires a plentiful supply of engineers to design new systems of production and distribution, and new science on which these new systems will depend. Industry will respond to the

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[12] See Zakaria (2006) and Morrison (2006).

new technologies, as they have in the past, because they will increase labor productivity and raise

profits.

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Table 1

**A Comparison of the Per Capita Income of 15 Nations in 1950
(International Dollars of 1990)**

China	439*
Hong Kong	2218**
Indonesia	840**
Korea (South)	770**
Malaysia	1559**
Singapore	2219**
Taiwan	936**
Thailand	817**
India	619*
Japan	1926**
France	5270***
Germany	3881**
Italy	3502**
United Kingdom	6907***
United States	9561***

Source: Maddison 2001.

Rank by World Bank standards of 1990:

*   low-income
**   lower-middle income
*** upper-middle income

Table 2

Average Annual Percentage Rates of Growth in Per Capita Income 10 HPAEs
Compared with 5 Rich Nations by Quinquenna, 1950–2005

	1950--55	1955--60	1960--65	1965--70	1970--75	1975--80	1980--85	1985--90	1990--95	1995--2000	2000--05
China	5.5	3.2	1.0	2.1	2.2	5.1	9.1	6.2	11.1	7.6	8.9
Hong Kong	3.5	3.5	9.0	3.4	4.2	8.9	4.0	6.7	3.1	1.0	3.7
Indonesia	3.3	0.7	-0.6	3.8	4.7	5.9	3.9	5.1	5.8	-0.7	3.3
Korea (South)	6.5	1.0	3.2	8.6	10.1	5.4	6.5	7.8	6.4	3.5	4.0
Malaysia	-1.3	0.9	3.4	2.9	5.0	6.2	3.2	3.1	6.9	2.3	2.4
Singapore	1.2	-0.4	2.9	10.7	7.7	8.2	2.2	6.2	5.9	3.5	2.8
Taiwan*	6.0	3.7	6.6	7.7	6.0	8.3	6.7	3.9	5.6	6.8	
Thailand	3.0	2.7	3.9	5.3	2.9	5.6	3.7	8.4	7.6	-0.6	4.3
India	1.8	2.2	0.5	2.4	0.7	0.7	3.3	4.2	3.2	4.0	5.4
Japan	7.6	7.5	8.3	10.4	3.2	3.5	2.6	4.3	1.2	0.8	1.2
France	3.7	3.6	4.4	4.5	2.6	2.6	1.4	2.7	0.7	2.4	1.0
Germany	8.3	5.8	3.6	3.4	2.1	3.3	1.3	2.9	1.8	1.9	0.6
Italy	6.0	4.8	5.1	5.0	2.1	5.8	1.8	3.0	1.1	1.9	0.1
United Kingdom	2.5	2.0	2.4	2.0	1.9	2.1	1.8	3.1	1.3	2.9	2.0
United States	2.7	0.8	3.4	2.3	1.6	2.6	2.1	2.3	1.2	2.9	1.4

Sources:

1950--1975: Maddison 2001

1975--2005: World Bank, World Development Indicators Online. (http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/0,,contentMDK:21725423~pagePK:64133150~piPK:64133175~theSitePK:239419,00.html)

*1950: Maddison 2001

*1995--2002: Asian Development Bank 2003a and 2003b.

Table 3

Secular Trends in Total Fertility Rates

	1950	1960	1970	1980	1990	2000	2005	2007
China	6.24	5.93	4.76	2.68	2.10	1.89	1.60	1.60
Hong Kong	4.43	4.97#	3.49	2.06	1.27	1.04	1.00	1.00
Indonesia	5.49	5.42	5.10	4.10	3.04	2.42	2.60	2.40
Korea (South)	5.18	5.60	5.24	4.02	1.77	1.47	1.20	1.10
Malaysia	6.83	6.72	5.15	3.91	3.77	2.96	3.30	2.90
Singapore	6.41	5.43##	3.10	1.74	1.87	1.44	1.30	1.30
Taiwan*		5.79	4.00	2.51	2.27	1.76	1.20	1.10
Thailand	6.62	6.42	5.01	3.52	2.10	1.86	1.70	1.70
India	5.97	5.81	5.43	4.75	3.80	3.07	3.00	2.90
Japan	3.30**	2.01	2.07	1.74	1.54	1.36	1.30	1.30
France	2.86**	2.80#	2.48	1.95	1.78	1.88	1.90	2.00
Germany (West)	2.10	2.41	2.01	1.46	1.45	1.38	1.30	1.30
Italy	2.40	2.42#	2.38	1.64	1.26	1.24	1.30	1.40
United Kingdom	2.18	2.82	2.45	1.89	1.83	1.64	1.70	1.80
United States	3.08	3.65	2.47	1.84	2.08	2.06	2.00	2.10

Sources: Keyfitz and Flieger 1990; Population Reference Bureau (see http://www.prb.org/datafind/ datafinder.htm; World Bank, World Development Indicators Online (see http://www.worldbank.org/data/wdi2004/index.htm); CIA World Factbook (see https://www.cia.gov/library/publications/the-world-factbook/)

* 1981	** 1951
# 1961	## 1962

Table 4

Trends in Caloric Consumption

	In calories per capita per day			Percentage increase		Percentage of calories from animals		
	1961	**2000**	**2003**	**1961--2000**	**1961--2003**	**1961**	**2000**	**2003**
China	1725*	2979	2940	72.7	70.4	3.8	19.4	21.9
Hong Kong								
Indonesia	1727	2913	2891	68.7	67.4	2.9	4.1	4.8
Korea (South)	2147	3093	3035	44.1	41.4	2.7	15.0	6.2
Malaysia	2401	2917	2867	21.5	19.4	10.5	17.8	17.9
Singapore								
Taiwan*								
Thailand	1938	2459	2424	26.8	25.1	8.8	11.7	12.5
India	2073	2489	2473	20.1	19.3	5.5	7.9	8.2
Japan	2468	2753	2768	11.5	12.2	9.6	20.5	20.6
France	3194	3597	3623	12.6	13.4	31.7	37.7	36.8
Germany (West)	2889	3505	3484	21.3	20.6	32.7	30.0	30.7
Italy	2914	3663	3675	25.7	26.1	15.5	25.5	25.7
United Kingdom	3240	3312	3450	2.2	6.5	38.8	30.1	30.6
United States	2883	3814	3754	32.3	30.2	35.1	27.4	27.8
World	2255	2805	2809	24.4	24.6	15.0	16.5	17.0

Source: FAOSTAT nutritional data, 2004 (http://apps.fao.org/default.jsp), using the "Food Balance Sheets" data collection.
            *1962

Table 5

**Expansion Multiples of GDP for 15 Economies 1950–1999
(ratio of GDP in 1999 to GDP in 1950, international dollars)**

United States	5.07
France	5.22
Germany	5.50
Italy	6.20
Spain	8.39
United Kingdom	3.19
5 European Nations	4.98
China	25.59
Hong Kong	28.01
Indonesia	9.48
South Korea	38.93
Malaysia	15.61
Singapore	36.72
Taiwan	46.84
Thailand	23.68
8 Southeast Asian Nations	24.06
India	8.11
Japan	16.09

Source: Maddison 2001; World Bank, World Development Indicators Online (see http://www.worldbank.org/data/wdi2004/index.htm).

Table 6

Gross Enrollment Ratios

	Primary School			Secondary School			Tertiary School[#]			Age for compulsory attendance
	1980	1997	2006	1980	1997	2006	1980	1997	2005	
China	113	123	111	46	70	76	2	6	19**	7–15
Hong Kong	107	94	98*	64	73	85	10	22	32	
Indonesia	107	113	114	20	56	64	4	11	17	7–15
Korea (South)	110	94	105	78	102	96	15	68	90	6–15
Malaysia	94	101	101*	48	64	69*	4	12		
Singapore										
Taiwan*										
Thailand	99	87	108	35	58	78	5	21	43	6–14
India	83	100	112	30	49	54*	5	7	12**	6–14
Japan	101	101	100	93	103	101	31	41	54**	6–15
France	111	105	110	85	111	114	25	51	56**	6–16
Germany (West)		104	103		104	101	27	47		6–18
Italy	103	101	103	72	95	100	27	47	63**	6–14
United Kingdom	104	116	105	83	129	98	19	52	60**	5–16
United States	99	102	98	91	97	94	56	81	82**	6–16

Sources: National Center for Education Statistics 2002 (1980, 1997), World Resources Institute EarthTrend ((http://earthtrends.wri.org/searchable_db/
index.php?step=countries&cID[]=63&cID[]=91&cID[]=189&cID[]=190&theme=4
&variable_ID=423&action=select_years))

Unesco.org (http://stats.uis.unesco.org/unesco/ReportFolders/ReportFolders.aspx)

* = 2005
** = 2004

[#] It has been argued that the high U.S. figures for tertiary education are misleading because of the wide range of educational content in U.S. institutions at the junior college and four-year undergraduate schools. While it is true that European *gymnasiums* provide educations equivalent to the first two years of many U.S. colleges, the elite American universities provide educations that surpass those of the *gymnasiums*. At the doctoral and postdoctoral level, elite American universities are superb—hence, the large number of foreign students who flock to U.S. programs.

Table 7

The Global Distribution of Gross Domestic Product (GDP) in 2000, by Grouping of Nations

Grouping	Population (in millions)	Percent of total	GDP in billions of $ (PPP)	Percent of total
United States	282	5	9,601	22
European Union (EU 15)	378	6	9,264	21
India	1,003	16	2,375	5
China	1,369	22	4,951	11
Japan	127	2	3,456	8
6 South East Asian Countries (SE6)	381	6	2,552	6
Subtotals	3,540	57	32,199	73
Rest of the world	2,546	42	12,307	28
World	6,086	99	44,506	101

Source: Fogel 2007.

Table 8

The Global Distribution of Gross Domestic Product (GDP) in 2040, by Grouping of Nations

Grouping	Population (in millions)	Percent of total	GDP in billions of $ (PPP)	Percent of total
United States	392	5	41,944	14
European Union (EU 15)	376	4	15,040	5
India	1,522	17	36,528	12
China	1,455	17	123,675	40
Japan	108	1	5,292	2
6 South East Asian Countries (SE6)	516	6	35,604	12
Subtotals	4,369	50	258,083	85
Rest of the world	4,332	50	49,774	16
World	8,701	100	307,857	101

Source: Fogel 2007.

Table 9

**Automobile Production in Southeast and South Asia Compared with
5 Western Nations and Japan**

	Production in 2007 (thousands)	Production Increase over 2006 (%)
China	8883	22
Hong Kong		
Indonesia	412	39
Korea (South)	4086	6
Malaysia	442	-12
Singapore		
Taiwan	283	-7
Thailand	1287	8
India	1708	14
Japan	11596	1
France	3016	-5
Germany	6214	7
Italy	1284	6
United Kingdom	1750	6
United States	10781	-5
World	73153	5.7

Source: Organisation International des Constructeurs d'Automobiles, survey for 2006–2007
(http://ww.oica.net).