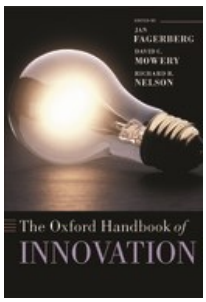


The Oxford Handbook of Innovation

Jan Fagerberg (ed.), David C. Mowery (ed.)

https://doi.org/10.1093/oxfordhb/9780199286805.001.0001

Published: 2006 **Online ISBN:** 9780191577314 **Print ISBN:** 9780199286805

CHAPTER

19 Innovation and Catching-Up

Jan Fagerberg, Manuel M. Godinho

https://doi.org/10.1093/oxfordhb/9780199286805.003.0019 Pages 514–542

Published: 02 September 2009

Abstract

"Catch-up" relates to the ability of a single country to narrow the gap in productivity and income vis-à-vis a leader country, while "convergence" refers to a trend towards a reduction of the overall differences in productivity and income in the world as a whole. Successful catch-up has historically been associated not merely with the adoption of existing techniques in established industries, but also with innovation, particularly of the organizational kind, and with inroads into nascent industries. This article discusses some of the perspectives that have emerged in the catching up literature. It extends the perspective to the most recent decades, compares cases of successful catch-up to less successful ones, and considers the lessons that may be drawn. Finally, it raises the question of what present day developing countries can learn, particularly with respect to policy, from the literature on innovation and catching up.

Keywords: productivity, convergence, innovation, catching up, policy

Subject: Organizational Theory and Behaviour, Innovation, Business and Management

Series: Oxford Handbooks

19.1 Introduction

THE history of capitalism from the Industrial Revolution onwards is one of increasing differences in productivity and living conditions across different parts of the globe. According to one source, 250 years ago the difference in income or productivity per head between the richest and poorest country in the world was approximately 5:1, while today this difference has increased to 400:1 (Landes 1998). However, in spite of this long-run trend towards divergence in productivity and income, there aremany examples of (initially) backward countries that—at different times—have managed to narrow the gap in productivity and income between themselves and the frontier countries, in other words, to "catch up." How did they do it?What was the role of innovation and diffusion in the process? These are among the questions that we are going to discuss in this chapter.[1]

The "catch-up" question should be seen as distinct from the discussion of "convergence," although the two issues partially overlap. "Catch-up" relates to the ability of a single country to narrow the gap in productivity and income vis-à-vis a leader country, while "convergence" refers to a trend towards a
p. 515 reduction of the overall differences in productivity and income in the world as a whole. The issue of ↳ convergence has been central to the economists' research agenda, in part because some prominent theoreticians formulated models of long-run growth implying such convergence (Solow 1956).[2] Of course, if all countries below the frontier catch up, convergence will necessarily follow. But if only some countries catch up (and perhaps forge ahead), while others fall behind, the outcome with respect to convergence is far from clear (Abramovitz 1986). What the empirics show is that, at best, such convergence is confined to groups of countries—or "convergence clubs" (Baumol et al. 1989)—in specific time periods. Arguably, to explain such differences in the conditions for catch-up through time, it is not enough to rely on general mechanisms. Some historical perspective is required.

During most of the nineteenth century, the economic and technological leader of the capitalist world was the United Kingdom, with a GDP per capita that was 50 per cent above the average of other leading capitalist countries. However, during the second half of the century, the United States and Germany both started to catch up and substantially reduced the UK lead. They did not achieve this growth by merely imitating the more advanced technologies already in use in the leading country, but rather did so by developing new ways of organizing production and distribution, e.g. by innovating (Freeman and Soete 1997; Freeman and Louçã 2001). In the case of the US, this led to the development of a historically new and dynamic system, based on mass production and the distribution and exploitation of economies of scale. Germany introduced new ways of organizing production, particularly with respect to R&D in the chemical and engineering industries, that in the long run would come to have a very important impact. More recently, the very rapid catch-up of Japan to Western productivity levels during the first half of the twentieth century was associated with a number of very important organizational innovations (such as the "just-in-time system," see Box 19.1) that, among other things, totally transformed the global car industry. These innovations did not only benefit Japan, but diffused (with a lag) to the established leader (the USA) and contributed to increased productivity there.

As these brief examples show, successful catch-up has historically been associated not merely with the adoption of existing techniques in established industries, but also with innovation, particularly of the organizational kind, and with inroads into nascent industries. However, as is equally clear, this has been done in different ways and with different consequences. If we extend the perspective to the most recent decades, as we will do in this chapter, this diversity in strategies and performance becomes even more striking. In the next section, we discuss some of the perspectives that have emerged in the catching up literature. Section 19.3 extends the perspective to the most recent decades, compares cases of successful catch-up to less successful ones, and considers the lessons that may be drawn. Finally, Section 19.4 raises, by way of conclusion, the question of what present day developing countries can learn, particularly with respect to policy, from the literature on innovation and catching up.

p. 516

19.2 Lessons from the Literature

The potentially relevant literature on why growth differs (and why some countries catch up while others do not) is arguably very large. Providing an overview of all the literature would be beyond the scope of a short essay. However, the work in this area focusing specifically on catch-up—as distinguished from economic growth more generally—and, in particular, on concepts and theories that may be helpful for understanding catch up (or lack of such), is appreciably smaller. We will in the following limit the discussion to three central cases within the latter. First, there are the contributions of Thorstein Veblen, Alexander Gerschenkron, and others on European catch-up prior to World War I.[3] The main point of interest here is the interpretation of the German catch-up with the UK, and the role of policy and institutions in this context. Second, there is a large literature on the Asian catch-up, particularly Japan, but increasingly also South Korea, Taiwan, and other countries that, to varying degrees, have attempted to follow the Japanese route. The argument that an activist, "developmental state" is an efficient mean to successful catch-up has been a central focal point in much of this literature. Third, there is a strand of macrohistorical and macroeconomic analysis focusing on interpretations of longrun data on economic growth, and on the role of technology and innovation in this context. A central contributor here has been Moses Abramovitz. In what follows next, these three perspectives will be briefly reviewed.

19.2.1 Lessons from European Catch-Up

The discussion of continental Europe catch-up illustrates nicely some of the central issues in the catch-up literature. Veblen (1915), who initiated the discussion, put forward the argument that recent technological changes altered the conditions for industrialization in latecomer economies. In earlier times, he argued, the diffusion of technology had been hampered by the fact that technology was mostly embodied in persons, so that migration of skilled workers was a necessary prerequisite for its spread across different locations. However, with the advent of "machine technology," this logic changed (ibid. 191). In contrast to the conditions that had prevailed previously, Veblen argued, this new type of knowledge "can be held and transmitted in definite and unequivocal shape, and the acquisition of it by such transfer is no laborious or uncertain matter" (ibid.). Although Veblen did not use the terminology that is now commonly applied to the process he described, it is pretty clear what he had in mind. Effectively, what he was arguing is that, while technology was previously "tacit" and embodied in persons, it later became more "codified" and easily
p. 517 transmittable. Hence, catch-up should be expected to be relatively easy, and was, ↳ under "otherwise suitable circumstances,"[4] largely "a question of the pecuniary inducement and ... opportunities offered by this new industry" (ibid. 192). Since the latecomers could takeover the new technology "ready-made," without having to share the costs of its development, this might be expected to be a very profitable affair (ibid. 249). This being the case, Veblen predicted that other European countries, e.g. France, Italy, and Russia, would soon follow suit (he also mentioned the case of Japan).

While in Veblen's interpretation, the German catch-up was a relatively easy affair, the economic historian Alexander Gerschenkron (1962) took a different view, emphasizing the difficulty of the matter. While, he argued, technology at the time Britain industrialized was small-scale, and hence institutionally not very demanding, these conditions were radically altered in the nineteenth century when Germany started to catch up. What Gerschenkron particularly had in mind was the seemingly inbuilt tendency of modern technology to require ever larger and more complex plants (static and dynamic economies of scale), with similarly changing requirements with respect to the physical, financial, and institutional infrastructure. He argued that, because of the high potential rewards from successful entry, and the heavy transformation (modernization) pressure on the rest of the economy it helped to generate, it was of paramount importance for the latecomer to target such progressive, dynamic industries, and to compete globally through investing in the most modern equipment/plants.[5] However, to succeed, catching-up countries had, in Gerschenkron's

view, to build up new "institutional instruments for which there was little or no counterpart in the established industrial country" (1962: 7). The purpose of these institutional instruments would be to mobilize resources to undertake the necessary changes at the new and radically enlarged scale that modern technology required. His favorite example[6] was the German investment banks (and similar examples elsewhere in Europe), but he also admitted that, depending on the circumstances, other types of institutional instruments, such as, for instance, the government (in the Russian case),[7] might conceivably perform the same function.

Gerschenkron's work is often identified with his focus on the role of banks in industrialization, although as pointed out by Shin (1996), it is possible to see it as an attempt to arrive at a more general theory about catch-up, focusing on certain requirements that must be met for successful catch-up to take place, as well as different, though "functionally equivalent," institutional responses (or catch-up strategies). An important chain in Gerschenkron's argument is the emphasis on the advantages of targeting rapidly growing, technologically advanced industries. It should be pointed out, however, that for him this was a generalization based on historical evidence. Thus it is not obvious that his recommendations would be equally relevant for later time periods/technologies. Neither did he rule out that there might be other paths to successful industrialization than the one he recommended, although he held that to be rather exceptional. For instance, he pointed to Denmark as an example of a country that managed to catch up
p. 518 without targeting the ↳ progressive industries of the time, and explained this with its close links to the rapidly growing British market for agricultural products.

We may use Veblen's and Gerschenkron's accounts of the German catch-up to make a preliminary classification of catch-up strategies. The type described by Veblen assumes that technology is easily available/transferable, not very demanding in terms of skills or infrastructure, and that market forces are able to take care of the necessary coordination without the large-scale involvement of external "change agents." In contrast, there is the Gerschenkronian case in which technology transfer is so demanding in terms of skills/infrastructure that market forces, if left alone, are considered unlikely to lead to success, and so some degree of active intervention in markets by outsiders, whether private organizations or parts of government, is deemed necessary.

19.2.2 The Asian Experience

Similar perspectives to those of Veblen and Gerschenkron have also played a role in the discussions of the Asian catch-up in the post-World War II period. The primary examples are, in addition to Japan, the cases of South Korea, Singapore, and Taiwan. Although some observers have attempted to classify these as Veblen-type catch-up stories (World Bank 1993), there is by now an abundant literature showing that the catch-up strategies applied are much closer to the Gerschenkronian scheme (Johnson 1982; Amsden 1989; Wade 1990; Shin 1996).

There are many accounts of the Japanese catch-up. The so-called Meiji restoration in 1868 provides a natural starting point. What happened in 1868 was that a fraction of the ruling elite established a new regime, with the explicit purpose of strengthening the economy and the military strength of the state, which at the time was strongly challenged by Western imperialism (Beasley 1990). "A rich society and a strong army" was the slogan of the day. Since Japan lacked other "modernization" agents, the government (bureaucracy) took on the challenge. It modernized the legal system, the physical infrastructure, and the educational system, initiated new businesses (that later on were privatized) in industries that were deemed strategically important, etc.[8] Universities, colleges, and research centers were also founded, often with a bent towards engineering and applied science. While, particularly in the initial phase, the public sector played a vital role, private initiatives and cooperation between public and private actors became gradually more important. Much of the initiative came to rest with a number of emerging family-owned business

groups, the Zaibatsus, in interaction with the bureaucracy and the military. Initially, the dominant industries were food processing and textiles, but, during World War I and the period that followed, the Japanese economy underwent a rapid transformation, with machinery and other "heavy industries" taking
p. 519 over as ↳ leading sectors. R&D activity also flourished, partly for military needs, and was, according to one source (Odagiri and Goto 1996), well above 1 per cent of GDP in the early 1940s.

The defeat of Japan in World War II changed the power structure in Japanese society by eliminating two of the three contending power centers, the military and the (owners of the) Zaibatsus, hence giving a boost to the bureaucracy that once more took on the challenge of gearing the economy and the society at large towards economic catch-up with the West. The sequence of events from the late nineteenth century somehow repeated itself, with a very important role for the state (and—in particular—the Ministry for Trade and Industry, MITI) in the early phase, and a growing role for private initiatives (and business groups) as the economy grew stronger (with no role left for the military). The new business groups that emerged, the Keiretsus, were in some cases based on the pre-war groupings (which had been dissolved by the American occupation forces), while in other cases they were totally new constructions. This reorientation differed from the pre-war groupings in respect of a stronger role for banks, and a smaller role for private investors/family ownership. In the early phases, the banks were very dependent on credit from the state, reinforcing the power of the bureaucracy in getting business to cooperate with the government in its preferred catch-up path. After a few decades of rapid growth, the banks (and business more generally) grew more independent, and the role of the state diminished and took on more "normal," Western proportions.

The exact role of the government versus private actors in the various phases of Japanese economic growth is a matter of considerable controversy, and we shall not attempt to resolve it here. Suffice it to say that government/bureaucracy intervention, through activist economic, industrial, and trade policy (protectionism), was very important, especially in the early phases. Although not everything it touched turned into "gold," and sometimes its interventions were strongly resisted by private business (and for perfectly good reasons), there is no doubt that it contributed significantly to focusing the attention of private business to catch-up with the West. An important element in this catch-up process (and the policies that were pursued) was a very rapid but orderly process of structural change, through which industries "of the past" were gradually phased out in favor of technologically more progressive industries, emphasizing in particular the combination of economies of scale, product differentiation, and rapidly growing demand, on the one hand, and continuous improvements of products and processes through learning, on the other. In this way, Japanese industry soon rose to the productivity frontier in its chosen fields, first in the steel industry and in ship-building, and later in cars and (consumer) electronics.[9] Although Japanese innovation in the catch-up phase also included a large number of product innovations, especially of the minor type (adaptations to demand), the main emphasis was on process innovations, particularly of the organizational type, that allowed for simultaneous exploitation of scale economices and flexibility, leading to high
p. 520 through-put, efficient inventory management, high ↳ quality/reliability, and a proven ability to adjust to the needs of the end-user (see Box 19.1).

Not surprisingly, the Japanese experience generated a lot of interest in other developing countries, particularly in Asia, that considered the policies and practices pursued as a possible model for their own catch-up towards Western levels. The prime examples are, as noted, South Korea, Singapore, and Taiwan, although the Japanese influence is also recognizable in other countries. Focusing in particular on the
p. 521 former, what these countries have in common is that they have caught up very ↳ rapidly, undergone extensive structural change, and—finally—established themselves as among the major producers (and exporters) internationally in the most technologically progressive industry of the day, electronics (broadly defined). The government appears to have played a very important role in these processes.[10] Everywhere, emphasis has been placed on the expansion of education, particularly that of engineers (Lall 2000). In the

early phases, governments in South Korea and Taiwan intervened heavily with tariff protection, quantitative restrictions, financial support, etc. to benefit the growth of indigenous industries in targeted sectors. Singapore is a special case, since its government has relied heavily on inward Foreign Direct Investment (FDI) in its industrialization efforts, and thus targeting has had to be achieved through selective FDI policies (Lall 2000). In all countries, targeting production for exports and rewarding successful export performance was very important. More recently, all countries have placed emphasis on policies supporting R&D and innovation. However, when it comes to the industrial structure, there is a considerable element of diversity. In South Korea, large, diversified business groups (chaebols), similar to the family-owned groups in pre-war Japan, have been and continue to be very important, while in Singapore, foreign multinationals dominate the scene. Taiwan, by contrast, is characterized by an industrial structure dominated by small and medium-sized private firms.

Box 19.1 Organizational innovation in Japan

Henry Ford allegedly once said that a customer could get a car in any color he wanted as long as it was black. This was the quintessential logic of the American system of manufacturing, based on standardized products, produced in long series for mass consumption, by low-skilled (often immigrant) labor, controlled by a hierarchy of foremen, engineers, and managers.

The attempt to adapt this system to Japanese conditions after World War II led to important modifications. First, the Japanese market was much smaller, so critical mass could only be reached through exploiting demand diversity. Second, the Japanese labor force was well educated, trained, and culturally homogeneous, and the differences in status and pay between blue and white collar workers small. As a result of these differences, the production system that evolved in Japan came to look very different from that of the USA (Freeman 1987).

The kanban or "just-in-time" system, developed by the Japanese auto industry, combines the advantages of mass production with flexibility in adjusting to changes in the composition and level of demand (Aoki 1988). What is going to be produced (and when) is decided by the part of the firm close to the end users (market). Orders are placed on a daily basis at the firm's production units, which have to deliver the requested products "just-in-time." This also holds for suppliers of parts, and the system is referred to as the "zero inventory" method. However, "zero inventory" implies that defect parts cannot be tolerated (because otherwise production would be halted). To increase quality and eliminate defects, organizational practices such as "total quality control," originally borrowed from US industry, and "quality circles" were introduced. Eventually, a new organization of work emerged, with workers rotating through different tasks and a much greater role for the individual worker (and work-team) in surveying production and quality, than what was common in the US auto industry. This new organization of work also meant more competent, committed, and motivated workers.

Important efficiency improvements stemmed from these organizational innovations. By the late 1980s, Japanese manufacturing, particularly in the car industry, was unrivalled in its efficiency (Womack et al. 1990). The time needed to produce a car in Japan in 1989 was 16.8 hours, while the equivalent figures for the US and Europe were, respectively, 25.1 and 36.2 hours (*The Economist*, 17 October 1992).

With respect to the Gerschenkronian scheme, the experiences of these Asian economies fit well with the emphasis on targeting the technologically most progressive industries. On a general level, in all four countries, the state (bureaucracy) has played a very important role in the early stages. However, as noted

above, this has been achieved in different ways in different countries. For instance, in both Japan and South Korea, credit rationing by the state (so-called "directed credit") was extensively used to persuade private business to go along with the government's objectives, while this mechanism played virtually no role in Taiwan (which underwent a financial liberalization early on). In the Taiwanese case, the government had to rely on other instruments such as state-owned firms (which came to play an important role) and, in particular, heavily supported "intermediate institutions" (R&D infrastructure etc.) with mixed public/private sector participation. Moreover, while industrialization in Japan, and in the USA and Germany before it, was mainly geared towards the home market, exports played a similar role in the catch-up strategies of the three "tigers." This may, arguably, have to do with the fact that the domestic markets in the latter were in many cases too small to support large-scale industrialization efforts, but the gradual reduction in barriers to trade during the post-World War II period also played an important role (Abramovitz 1994).

The freeing of international capital flows, and the deregulation of financial markets towards the end of that period, placed the "tigers" and other late-latecomers in a somewhat different situation from that of Japan 50–100 years earlier, with a greater potential role for external finance, whether in the form of FDI or
p. 522 lending. ↳ For instance, while Japanese catch-up was largely self-financed, the South Korean catch-up came to depend heavily on foreign lending. However, such increased debt exposure, while providing opportunities for catch-up, may also make countries vulnerable, as shown by the financial crisis in Korea (and to some extent in other Asian countries) towards the end of the 1990s (see Box 19.2). Although controversial (Shin and Chang 2003), the crisis may also be seen as an illustration of the important point that policies and institutions that worked well during the catch-up phase may not be equally well suited when this phase is completed and the former catch-up country has to compete with other developed countries on an equal footing. Another example of this, also from the financial sector, comes from Japan. The Japanese financial system was designed to generate large savings among the general public and to funnel these to the large industrial conglomerates, which were the vanguards of the catch-up process, on preferential terms, and as such it was very effective. However, when the catch-up was completed, this financial machine continued to generate large savings, even though the profit opportunities created by the potential for catch-up were largely gone. This led to excesses, crises, and depression. Hence, from being a very valuable asset, the country's financial system actually turned into a considerable burden for the Japanese economy.

Box 19.2 The financial crisis in Korea

South Korea went through a deep financial crisis in 1997–8. A factor contributing to this was the, by international standards, very high debt-exposure of Korean chaebols, which had to do with the way catch-up in Korea traditionally had been financed (as in Japan, through loans, often by state-controlled banks on concessionary terms, rather than equity). As long as international capital flows were subject to strict government control, as occurred in most of the post-World War II period, the system may have been said to fulfill its purpose (rapid catch-up). But when these restrictions eased, several Korean chaebols and financial institutions exploited their new freedom to increase their financial exposure and, as a result, substantially increase the country's national debt. This paved the way for the crisis. To resolve it, the Korean government went into a settlement with the IMF, involving, among other things, expectations of extensive "structural reforms," intending to bring the Korean system closer to the Anglo-American model (see Shin and Chang (2003) for an extended discussion). The crisis was relatively short-lived, as the Korean economy underwent a rapid recovery in 1999. It had some repercussions elsewhere in Asia, although Taiwan and Singapore were much less exposed, simply because debt financing and foreign lending did not play the same prominent role as in Korea.

p. 523

19.2.3 A Macro-View

The third strand of catch-up research mentioned above operates on the macro-level and asks questions of the extent to which the catch-up or convergence actually occurred, for whom and how this may be explained. As mentioned in the introduction, an important finding in this literature is that the long-run trend since the British Industrial Revolution points to divergence, not convergence, among capitalist economies. It has also been shown that these trends differ considerably between time periods. For example, one such period in which the conditions for catch-up appear to have been especially favorable (and during which many countries managed to narrow the gap in productivity and income vis-à-vis the leader) is comprised of the decades following the end of World War II, what Abramovitz (1986, 1994) has called "the post-war catch-up and convergence boom." He suggested that such differences in performance over time and across countries might, to some extent, be explained with the help of two concepts, technological congruence and social capability. The first concept refers to the degree to which leader and follower country characteristics are congruent in areas such as market size, factor supply, etc. For instance, the technological system that emerged in the USA around the turn of the century was highly dependent on access to a large, homogeneous market, something that hardly existed in Europe at the time, which may help explain its slow diffusion there. The second concept points to the various efforts and capabilities that developing countries have to develop in order to catch-up, such as improving education, infrastructure and, more generally, technological capabilities (R&D facilities etc.). Abramovitz explained the successful catch up of Western Europe in relation to the US in the first half of the post-war period as the result of both increasing technological congruence and improved social capabilities. As an example of the former, he mentioned the manner in which European economic integration led to the creation of larger and more homogeneous markets in Europe, facilitating the transfer of scale-intensive technologies initially developed for US conditions. Regarding the latter, he pointed to, among other things, such factors as the general increases in educational levels, the rise in the share of resources devoted to public and private sector R&D, and the ability of the financial system in mobilizing resources for change.

There have also been attempts to develop testable models of cross-country differences in growth performance (or productivity) that includes the potential for catch-up as one of the explanatory factors. Classical papers on the subject are Nelson (1968) and Gomulka (1971). In a highly innovative contribution,

Cornwall (1977) analyzed economic growth in the first half of the post-World War II period as driven by catching-up processes, the ability to mobilize resources for change (investment), demand, and endogenous technological change (through the working of the so-called "Verdoorn's law"). Baumol et al. (1989)
p. 524 presented and tested a model of ↳ cross-country growth, including the potential for catch-up and social capability (proxied by education), for a large number of countries and different time-spans, and since then there has been a plethora of such exercises confirming (or questioning) the importance of such factors (see Fagerberg 1994 and Temple 1999 for overviews). However, most of these studies have ignored Abramovitz's emphasis on the importance of technological congruence as well as the role of innovation. More to the latter, Fagerberg (1987, 1988) has suggested an empirical model based on Schumpeterian logic that includes innovation, imitation, and other efforts related to the commercial exploitation of technology as driving forces of growth. Following this approach, catch-up or convergence is by no means guaranteed, as it depends on the balance of innovation and imitation, howchallenging these activities are, and the extent to which countries are equipped with the necessary capabilities. According to Verspagen (1991), who implemented similar ideas into a non-linear setting that allows for both catch-up and a "low-growth trap," poor countries with a low "social capability" are the ones at risk of being "trapped."

Abramovitz's work has been criticized by Shin (1996) for not being sufficiently historically specific. In particular, he argues that the "social capability" concept is very difficult to operationalize, a fact admitted by Abramovitz himself. However, Abramovitz's emphasis on technological congruence clearly points to an awareness of the importance of changes in technological dynamics over time, although it is clear that he himself did little to substantiate it. In this he clearly sided with Gerschenkron, who also focused almost exclusively on catch-up in scale-based technologies. There is, however, no scarcity of contributions that argue that the dynamics of the scale-based system is waning (Nelson and Wright 1992; Fagerberg et al. 1999). If so, this may have strong implications for the conditions for catch-up. We return to this issue in the final section of this chapter.

19.3 Catching up: A Review of Recent Evidence

We will now take a closer look at the global catching-up process (or lack of such) during the four last decades. While other studies have provided highly aggregated analyses of differences in growth across large samples of countries (for overviews, see Fagerberg 1994 and Temple 1999), we will in this section limit the analysis to a selection of countries that we find particularly relevant for the study of such processes, and for which good data on relevant factors, such as R&D and innovation, are available. This includes the countries
p. 525 discussed so far, such as the previous—and ↳ present—world leaders (US and UK) and Gerschenkron's favorite object of study, Germany (we also include data for two other countries he studied, France and Italy, for comparison). Moreover, we include a group of Asian countries, which, in addition to those mentioned so far, also contains China, Hong Kong, India, Malaysia, and the Philippines. Finally, we introduce two other country groupings, with which the experience of the catch-up countries of Asia may be compared, a group of European catch-up countries (Finland, Greece, Ireland, Portugal, and Spain) and a group of potential catch-up countries from Latin America (Argentina, Brazil, Chile, and Mexico).

Table 19.1 ranks the countries in our sample by initial GDP per capita level (1960). The countries that industrialized a century or more ago are, not surprisingly, at the top, headed by the USA, while the seven countries at the bottom of the list are all Asian. In the middle, we find the remaining European and Latin American countries, joined by two Asian economies, Hong Kong and Japan. Figure 19.1 illustrates the way in which these changes in the distribution during the last four decades came along. Evidently, there is a group of Asian countries that have caught up very rapidly. In fact, the top seven performers in terms of per capita growth are all from Asia. Annual per capita growth for these countries ranges from6.5 per cent (South Korea) to 4.2 per cent (Japan). The European catch-up countries follow, headed by Ireland (4.1 per cent) and

Portugal (3.9 per cent). The more established countries, which were in the lead in the early 1960s, cluster towards the lower half of the distribution, with growth-rates in the 2–3 per cent area. At the very bottom, we find three potential "catch-up" countries that have experienced very dismal performance, the Philippines, Argentina, and Mexico, each of which evidently has "fallen behind," to use the terminology suggested by Abramovitz. The remaining potential "catching-up" countries of Latin America, plus India, although performing slightly better, also failed to reduce the gap vis-à-vis the leader, the USA. The result of this dynamic is that, while the seven Asian countries at the top of the list all improved their relative positions during this period, by moving to a higher quartile of the distribution, all the Latin American countries moved down one or more quartiles (Table 19.1).

We will now explore the manner in which these differences in performance relate to differences in relevant "social capabilities." Although, potentially, there may be many variables of interest, we have in the present context chosen to limit the discussion to three that we believe are of particular relevance, these being skills (education), R&D, and innovation (as reflected in patents). Traditionally, many analyses of differences in cross-country growth, based on large cross-country samples, have focused on differences in the extent of primary and secondary education as a possible factor behind the observed differences in performance (see e.g. Baumol et al. 1989). However, while relevant for understanding the failures of some developing countries, in Sub-Saharan Africa for instance, to enter the catch-up phase, these variables discriminate less well between the countries in our sample, which, with very few exceptions, all have relatively extensive
p. 526 primary and secondary ↳ education systems.[11] We have, therefore, chosen to focus on third-level education (universities, colleges, etc.).

Table 19.1 Income groups, 1960–1999 (GDP per capita, 103 $US, 1990 constant PPPs)

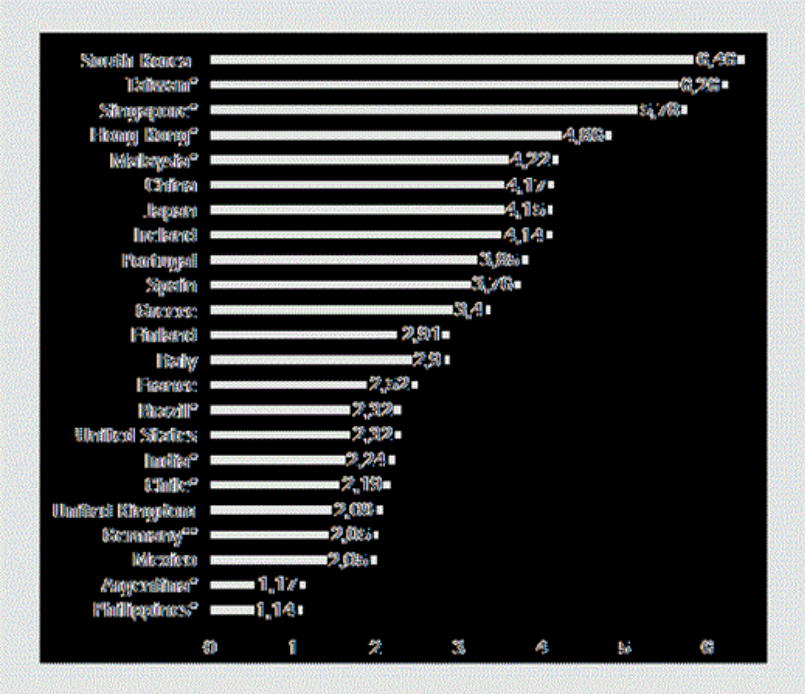
	1960	GDPpc	1999	GDPpc
1st Quartile	US	11.3	US	28.1
	(West) Germany	10.1	Japan	21.0
	UK	8.6	Singapore	20.7
	France	7.5	France	20.1
	Finland	6.2	Hong Kong	19.9
	Italy	5.9	Ireland	19.7
2nd Quartile	Argentina	5.6	UK	19.2
	Chile	4.3	Finland	19.1
	Ireland	4.2	(Unified) Germany	19.0
	Japan	3.9	Italy	18.2
	Spain	3.4	Taiwan	16.6
	Mexico	2.2	Spain	14.6
3rd Quartile	Greece	3.1	Portugal	13.5
	Hong Kong	3.1	South Korea	13.2
	Portugal	3.0	Greece	11.5
	Brazil	2.3	Chile	10.0
	Singapore	2.1	Argentina	8.7
	Malaysia	1.5	Malaysia	7.7
4th Quartile	Taiwan	1.5	Mexico	6.9
	Philippines	1.5	Brazil	5.4

	South Korea	1.1	China	3.3
	India	0.8	Philippines	2.3
	China	0.7	India	1.8

Source: Calculations based on Angus Maddison/Groningen Growth and Development Centre and The Conference Board, Total Economy Database, July 2003, http://www.ggdc.net.

Figure 19.2 confirms that the established industrialized leaders, with the USA in a comfortable lead, place strong emphasis on higher (third level) education.[12] But some catching-up economies also figure relatively
p. 527 high. Finland, for instance, is ↳ second, followed by South Korea. However, one should not overemphasize such differences, because today, in sharp contrast to the situation thirty to forty years ago, the great majority of countries under study share a strong emphasis on higher education. The increase in higher education is especially impressive in some of the catching-up economies in Asia and Europe, such as, for instance, Finland, South Korea, and Spain. The deviants from this strong emphasis on third level education consist of a group of (low-income) Latin American and Asian countries (Mexico, Brazil, Malaysia, India, and China) that continue to have very low levels of higher education.

Figure 19.1



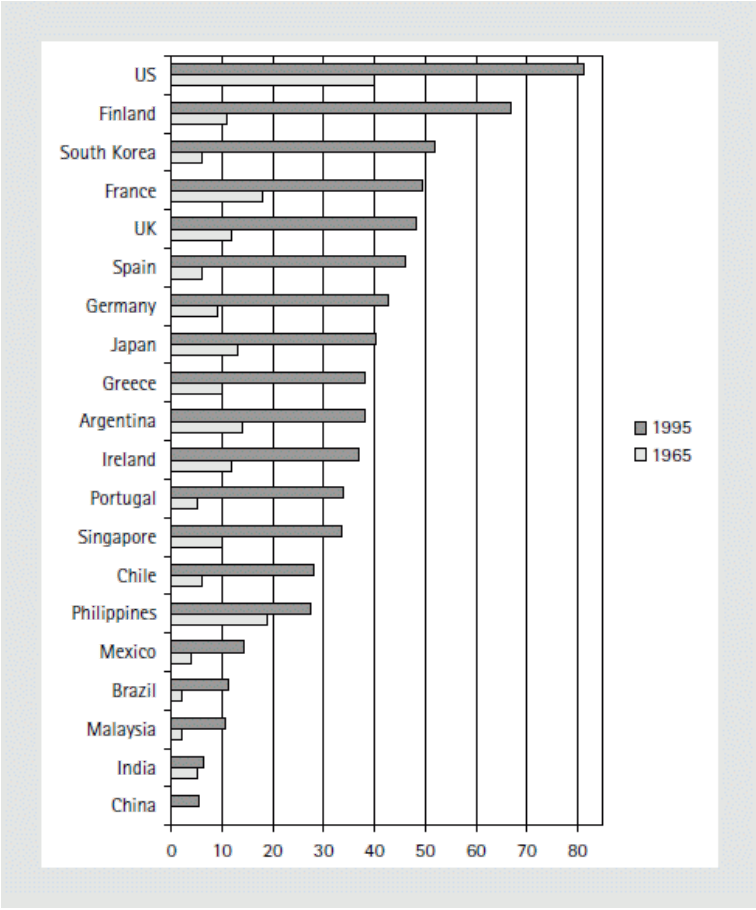
GDP per capita growth 1960–2001

Notes: All calculations based on 1990 constant prices. For countries with (*) the calculation period is 1960–1999. The German growth rate (**) refer to West Germany, 1960–1997.

Source: Calculations based on Angus Maddison/Groningen Growth and Development Centre and The Conference Board, Total Economy Database, July 2003, http://www.ggdc.net.

Higher education is, however, a mixed bag, and not every element is necessarily equally essential for
p. 528 innovation or catch-up in technology. In Figure 19.3, we focus ↳ more narrowly on the production of (undergraduate) university degrees in natural sciences and engineering (as a percentage of 24 year-olds in the population). In this case, we see a much clearer divide between the countries in the upper half of the distribution, in which between 6 and 9 per cent of the cohort take such education, and the countries in the lower half, in which—in all but one case—less than 3 per cent of the cohort get such degrees. As is evident from the figure, the countries that place most emphasis on education in natural sciences and engineering
p. 529 are the ↳ developed countries (the early industrializers) and the four Asian countries discussed in the previous section, joined by some of the catch-up economies in Europe (Finland, Ireland, and Spain, in particular). The lower half of the distribution, those with low investments in this area, includes all the Latin American countries, the less developed countries of Asia and—closer to the mean of the sample—some of the catch-up countries in Europe (Portugal and Greece). It is also noteworthy that, while in the USA, one out of six students graduate in natural sciences or engineering, in South Korea the equivalent number is one-third and in Singapore two-thirds. Hence, countries such as Korea, Taiwan, and Singapore not only place
p. 530 strong emphasis on higher education in general, but to a larger extent than most other ↳ countries direct their educational investment towards types of education of particular importance for technological catch-up (and innovation).

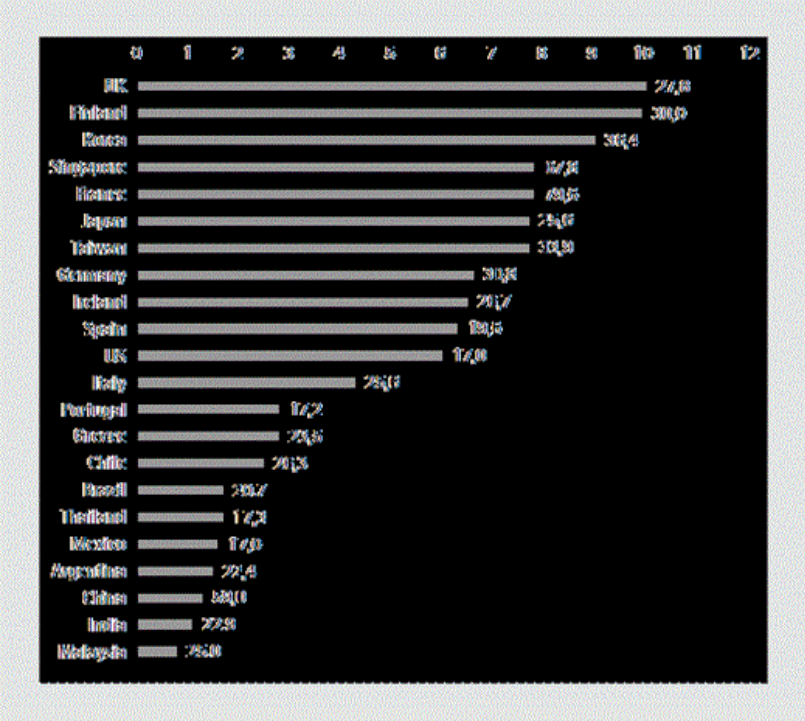
Figure 19.2



Third level enrollment in relation to age group, 20–24 years old (1965–1995)

Source: UNESCO, Education Statistics, various years.

Figure 19.3



Ratio of first university degrees in natural sciences and engineering to 24-year-olds in the population, 1999 (all values in %)
Notes: All figures for 1999 or most recent year. The numbers to the right of the horizontal bars refer to the percentage share of "1st University Degrees in Natural Sciences and Engineering" in "Total 1st University Degrees" (French and Greek numbers refer only to "long" degree courses, and are therefore not directly comparable to the numbers for other countries).

Source: NSF, Science and Engineering Indicators 2002, http://www.nsf.gov/sbe/srs/seind02/start.htm

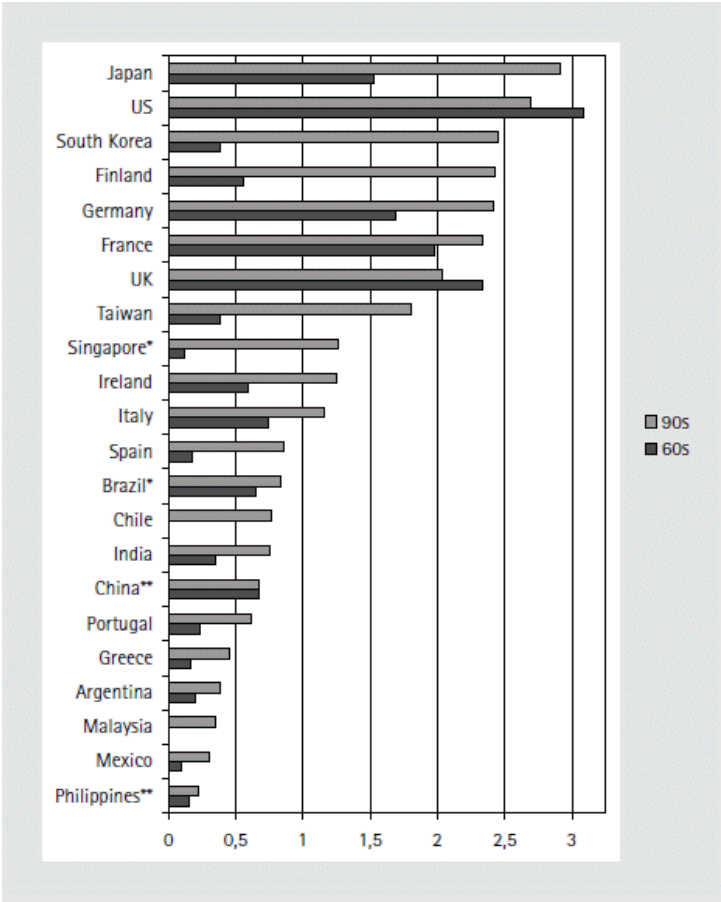
It should be noted, however, that there are some examples of countries that have fallen behind despite quite substantial investments in higher education, for example, in the present sample, Argentina and the Philippines. Arguably, important as education is, what matters for growth in the long run is how it is put into use, and the failure to expand the employment opportunities for highly educated labour may seriously impede the potential growth effects from investments in higher education. In fact, one of the reasons the Asian NICs managed to expand higher technical education so rapidly was the similar rapid increase in employment opportunities for engineers (and scientists). Thus, for these countries, industrial, technology, and education policies were complements, not substitutes, and the ability to carry out these policies in a sustained and coordinated fashion probably explains a good deal of their economic success. Similarly, attempts to target high-growth, strategic industries without investing sufficiently in complementary assets, such as higher education, or without providing sufficient incentives for technological upgrading (a "dynamic" competitive environment), are also bound to fail, as the evidence of some countries in, for instance, Latin America shows.

One important use of highly competent labour is, of course, in R&D. Figure 19.4, which focuses on R&D as a share of GDP, shows that, in the early 1960s, only a few of the countries in our sample, with the USA, the UK, and France in the lead, devoted a significant share of GDP to R&D activities.[13] Apart from these three countries, and Germany and Japan, all countries in our sample devoted less than 1 per cent of GDP to R&D. Today, the USA has been replaced by Japan as the country that employs the largest share of its income on R&D activities, and the club of high R&D performers has been enlarged by a number of new members, with South Korea, Finland, and Taiwan deserving of particular mention. However, Singapore, Ireland, and Italy have also increased expenditures on R&D beyond the 1 per cent of GDP level. The remaining countries, including those from Latin America, many Asian and most of the catching-up economies in Europe, remain

low R&D performers, although R&D investments have in several cases increased significantly compared to the situation a few decades ago. Data on patents reveal a very similar pattern (Figure 19.5).

Another indicator that is often invoked in analyses of catching-up and technology transfer is inward foreign direct investments (FDI), on the grounds that those who do such investments are assumed to control, and are willing to share, superior technology. The available evidence, however, indicates that the distribution of FDI is highly skewed, with a disproportionately high amount invested in two small economies, Hong Kong and Singapore, and, more recently, and to a lesser extent, in a number of other lower income countries, such as Ireland, Chile, Malaysia, and China. However, some of the most successful catching-up economies, such
p. 531 as Japan, Taiwan, and South Korea, have received very little inward FDI. This does not imply, ↳ of course, that these countries did not benefit from international technology flows. It is just that they found other—and perhaps equally or more efficient—ways of absorbing foreign technology (see Box 19.3).

Figure 19.4



R&D as percentage of GDP, 1960s and 1990s
Note: Countries with (*)–1970s; Countries with (**)–1980s.

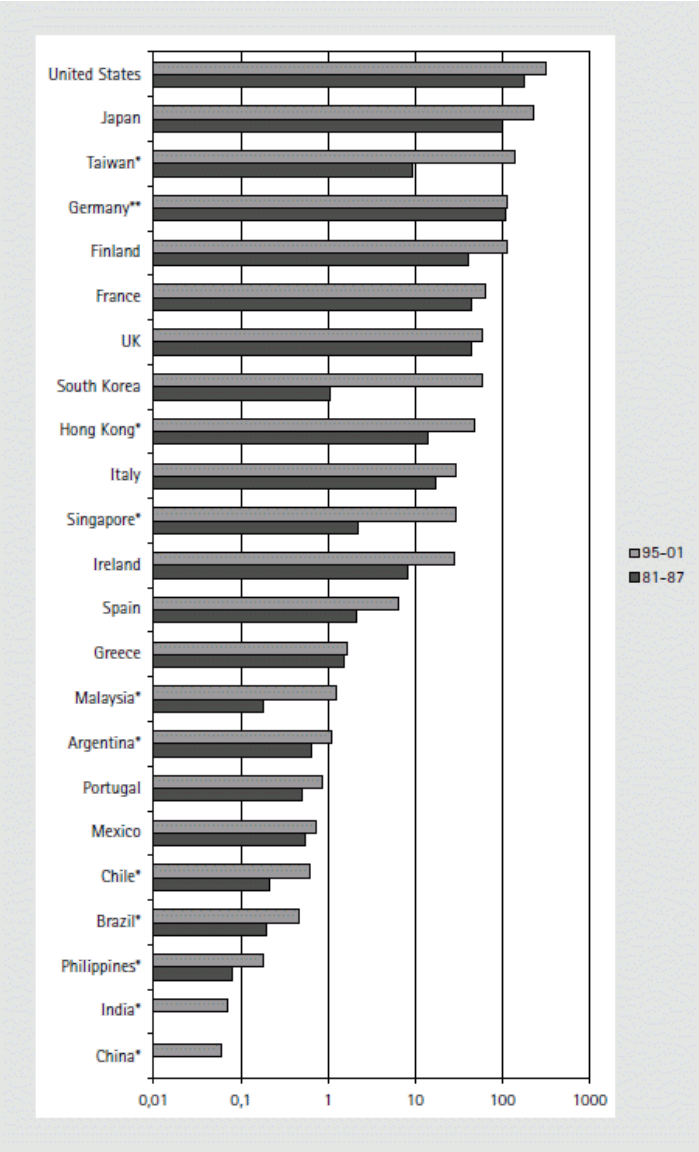
Source: Calculations based on OECD, UNESCO and national statistics.

The evidence presented here confirms the relevance of the Gerschenkronian scheme referred to earlier, in the sense that the countries that have been most successful in catching up, namely South Korea, Taiwan,
p. 532 and Singapore (and Japan before them), have all—after initially having acquired some capabilities through ↳

p. 533 ↳

more traditional activities—aggressively targeted the most technologically progressive industries of the day, in which they today play an important role. This transformation of the economy has been accompanied by extensive investments in higher education, particularly in engineering and natural sciences, and big increases in the resources devoted to R&D and innovation. As discussed in the previous section, proactive governments—and policies—have played an instrumental role in these processes, though in different ways, reflecting different historical backgrounds and conditions. However, not far behind these success stories, measured in terms of economic performance, we have a more diverse group of countries that also have managed to reduce substantially the gap vis-à-vis the frontier. Some of these, such as Finland, Ireland, and Malaysia, share the focus on targeting the technologically most progressive industries of the day (ICT), although with considerable differences between them with respect to the instruments pursued in achieving
p. 534 that goal. ↳ Others, such as Portugal, Spain, and Greece, have preferred to pursue catch-up without similarly ambitious goals for changing the industrial structure, and, arguably, with more modest results, both in terms of economic performance, accumulation of skills, and technological capabilities. Still others, such as the Latin American countries considered here, have failed to invest sufficiently in skills and technological capabilities, and have as a consequence fallen further behind.

Figure 19.5



US patenting per million inhabitants (log scale)
Notes: (*) For these countries the second period is 1995–1999; (**) Up to 1989 the data refers to the Federal Republic of Germany.

Source: USPTO, Patent counts by country/state and year—All patents, all types,
http://www.uspto.gov/web/offices/ac/ido/oeip/taf/reports.htm

Box 19.3 How to access foreign technology? The OEM system

Asian catch-up has benefited greatly from technology developed elsewhere. However, the mechanisms used to tap foreign technology sources differ. One central mechanism, used extensively by Singapore, is inward Foreign Direct Investment (FDI). By contrast, Taiwan and especially South Korea relied mostly on a form of subcontracting, "Original Equipment Manufacturing" (OEM). As suggested by Hobday (2000), OEM might be seen as an organizational innovation, facilitating learning and technological upgrading in latecomer firms.

Under an OEM contract, a product is produced according to a customer's specifications, normally a transnational corporation (TNC), that markets and sells the product under its own brand-name (such as, for instance, "NIKE" or "IBM"). From the 1970s onwards, many US and Japanese firms, particularly in the ICT sector, used this mechanism to contract out their production to Korean and Taiwanese firms. This allowed the latter to acquire basic producing capabilities in electronics, since the TNCs normally "helped with the selection of equipment; the training of managers, engineers and technicians; and advice on production, financing and management.... Local learning was encouraged because the TNC depended on quality, delivery, and price of the final output" (Hobday 2000: 134).

As successful OEM arrangements evolved into closer long-term relationships, the Korean and Taiwanese firms gradually acquired more advanced capabilities, first in process engineering and later in product design. This led OEM to evolve into a more advanced stage, ODM (Own Design and Manufacturing), with a greater emphasis on R&D. A next step, OBM (Own Brand Manufacturing), occurs if a firm uses the acquired capabilities to produce and to market products under its own brand-name. This requires new capabilities in marketing, and very substantial investments in distribution. Hence, it is a difficult step, but potentially very rewarding, since a lot of the value added is generated at this stage. Several Korean and Taiwanese firms have tried, with mixed success, although a few (e.g. Samsung) have managed quite well.

19.4 Catching-up and Policy

The literature on catch-up processes in Europe, particularly in Germany, led to a strong focus on the relationship between catch-up, "institutional instruments," and policy. Similarly, the more recent idea of a "developmental" state, modeled on the experiences of Japan, has brought increased attention to the important role played by policy in catch-up processes. This led, among other things, the World Bank to publish a study on East Asian catch-up in which it sought to emphasize the advantages of its so-called "market friendly" approach, and to downplay the role that interventionist politics had played in the catch-up of these countries (World Bank 1993, for rebuttals see Rodrik 1994 and Cappelen and Fagerberg 1995). However, the discussion of catch-up and policy arguably has older roots (Chang 2002). Two hundred years ago, when the Americans began to consider how to reduce the gap vis-à-vis the UK, this issue was lively debated. Some, basing themselves on the great authority of Adam Smith, argued that the best thing would be to practice free trade, refrain from governmental intervention in economic affairs, and stick to America's acquired advantage in agriculture. Others, such as the first Secretary of the US Treasury, Alexander Hamilton, doubted the wisdom in this approach, and advocated an industrialization policy based on so-called "infant industry protection." The German economist Friedrich List, who came to be known as the chief protagonist of this approach, pointed out that Britain—the main advocate of free trade at the time—had itself used infant industry protection intensively during its rise to economic and technological leadership (List 1841). Its more recent advocacy of free trade, List argued, was simply an attempt to "kick away the ladder" the country itself had used to industrialize.

Since that time, the issue of catch-up and policy has been highly contentious. Recently Chang (2002) has taken a fresh look at the evidence on this issue. Based on an extensive overview of policies carried out in the industrialization phase of various (developed) countries, he demonstrated that the interventionist policies applied by Japan and other Asian countries during their catch-up were not historically unique. On the
p. 535 contrary, most (though not all) present-day developed countries applied ↳ such policies when in the same situation. Many different policy instruments were used to support the growth of new industries, trade protection (tariffs, etc.) being only one, and not always the most important. However, during the last few decades, Chang points out, there has been a concerted effort, led by the USA, with international organizations such as the World Bank, the IMF, and the WTO as central players, to reduce the room of maneuver for such interventionist politics by catching-up countries.[14] He argued, as List before him, that these efforts may be seen as an attempt by the present economic and technological leaders to "kick away the ladder" their own countries used to arrive at their present levels of development.

Do the changes in international rules and regulations during the last few decades, making certain types of policies (or practices) previously applied by catching-up countries more difficult (or even impossible) to pursue, imply that catch-up is becoming progressively more difficult? This is an important question that deserves a place on the research agenda in this area. But it needs to be emphasized that what is a suitable policy nowadays depends not only on the characteristics of the policies that seemed to work well in the past, but also on the economic, technological, institutional, and social context today (which may be quite different from those of previous times). However, a cautionary look at the empirical evidence from the last few decades suggests that many developing countries have found it increasingly difficult to exploit the potential for catch-up. This reading of the evidence is also confirmed by a recent empirical study by Fagerberg and Verspagen (2002), which found that the conditions for catch-up have become more stringent over time, with ever-greater demands on the technological capabilities and innovative efforts of countries striving to narrow the gap vis-à-vis the frontier. While in the 1960s and 1970s, the main factors supporting catch-up were found to be capital accumulation and a sufficient manufacturing base, in the 1980s and 1990s, the accumulation of technological capabilities and specialization in services were shown to be more relevant. These findings indicate that what has happened cannot be explained solely by changes in

institutions and policies, but also has to do with a shift in the underlying technological conditions, an area clearly in need of further research. Fagerberg and Verspagen suggested that the observed shift in the conditions for catch-up "may be a reflection of the radical technological change in the last decades, with ICT-based solutions substituting earlier mechanical and electromechanical ones, and the derived change in the demand for skills and infrastructure" (2002: 1303). This is, of course, the kind of change that Abramovitz hinted at with his concept of "technological congruence." Following this, one might hypothesize that, compared to the situation three or four decades ago, the progressive technologies have become less "congruent" with the economic conditions (particularly skill-base and R&D infrastructure) that prevail in many developing countries. In fact, as shown in the previous section, today only countries that have invested massively in the formation of skills and R&D infrastructure seem to be able to catch up (while those that have not fall further behind).

p. 536 A weakness of much of the existing discussion on catch-up and policy has been an excessive focus on the policy level (government) at the expense of the recipients of these policy initiatives, e.g. the firms of the potential catching-up country. As pointed out by Teece (2000: 124): "If firms are indeed the instruments of development, the study of economic development cannot take place separate from the study of the theory of the growth of the firm." We suggest this as an important area for further research, theoretical as well as applied. Although an extensive treatment of the role of firms in catching-up processes is beyond the scope of this chapter, we will nevertheless try to emphasize a few points that we believe may be useful for further work.[15] Research on the role of firms in innovation and long-run economic change commonly stress that, in most cases, firms only have imperfect knowledge of the relevant options in front of them, and that they tend to be myopic, searching in the neighborhood of their existing competence for relevant information, suggestions, and solutions (Nelson and Winter 1982; Dosi 1988; Fagerberg Ch. 1 and Lam Ch. 5, both in this volume). These characteristics are, of course, common for developed and developing country firms, but, being far from both the technology frontier and the potential market, greatly accentuate these problems. Moreover, the developing country firm may be, to a much larger extent than developed country firms, constrained by its environment: it may have awish (and perhaps even the capability) to introduce a new product or process, but the possibility to do so may depend on capabilities in other firms or skills that are simply not there (or require substantial investments to occur). Arguably, to avoid being stuck along an inferior path and never catch up, "institutional instruments" may be needed to compensate for some of these "latecomer disadvantages," to use a Gerschenkronian term. In particular, what the developing country firm may need are "institutional instruments" that improve:

- links with the technology frontier,
- links with markets (and sophisticated users),
- supply of needed skills, services and other inputs,
- the local innovation system/network.

Arguably, much of what firms and governments in catching-up countries have done can be understood from this perspective. For instance, the diversified businessgroups that developed in Japan and South Korea might be seen as "institutional instruments" fulfilling some of those needs (Shin 1996). The OEM system (original equipment manufacture, see Box 19.3) that has developed in the electronics industries of East Asia may also be seen as an "institutional instrument"—or "organizational innovation" (Hobday 2000)—geared towards simultaneously improving links with the technology frontier and the market. Similarly, attracting inward FDI may be seen as a "functional equivalent" to OEM, which, however, judged by the empirical evidence, seems to be less favourable for indigenous innovation. Other, more demanding, but
p. 537 perhaps also more rewarding ways—since it allows the ↳ latecomer firm to reap a larger share of the profit generated—include technology licensing, investments in own brands (OBM), etc. Improving the supply of

needed skills has, of course, been a central preoccupation of many latecomer governments, as illustrated in Section 19.3 above. Moreover, we have witnessed sustained efforts by several latecomer governments in accommodating the needs of firms for a high quality R&D infrastructure (innovation system).

What can the extraordinary success that some catching-up countries have had, and the failure of others, teach present-day developing countries? One important lesson is that there is no one unique way to successful catch-up that every country has to emulate. Every country has to find its own way based on an understanding of (*a*) the contemporary global technological, institutional, and economic dynamics, (*b*) the behavior (and needs) of the relevant agents (of which the firm arguably is the most important), and (*c*) the specific context in which the catch-up takes place and the broader factors that influence it, being economic, technological, institutional, political, or cultural (Freeman and Louçã 2001). There are, one may suggest, big potential rewards in following the Gerschenkronian strategy of targeting technologically progressive sectors, as part of a broader attempt to transform the economy, stimulate learning, and enhance the creation of new skills (or assets). However, not every country is equipped with the necessary capabilities to pursue such a strategy. For instance, when, in the mid-nineteenth century, Japan initiated its efforts to catch up with the West, the technology gap vis-à-vis the more advanced countries was much smaller (compared to what developing countries face today), and its population already had a level of education that compared favourably with most other countries at the time (Odagiro and Goto 1996). Given that educational standards have been rising ever since, investing in education may be a good place to start for countries that have not succeeded in catering to those needs already. For those that have, there is a wider set of options, and for them some of the experiences outlined in this chapter may be highly relevant (see Box 19.4).

Box 19.4 A tale of two countries

Ireland and Portugal are two small countries on the western periphery of Europe. Both failed, for various reasons, to exploit fully the possibilities for catch-up and industrialization during the first half of the twentieth century, and were, therefore, at the beginning of our period of study, among the poorest in Europe, their economies characterized by an industrial structure dominated by traditional, low-skill activities.

However, during the second half of the century, both countries took steps to integrate their economies with the more dynamic economies of Western Europe, first through membership of EFTA (1961), and later by joining the EU (1981 and 1986, respectively). As members of the EU, Ireland and Portugal received substantial economic support through the so-called "Structural Funds," designed to induce technological and economic catch-up, and to facilitate the necessary structural changes, in poorer areas in the Union (Cappelen et al. 2003). During the 1980s and 1990s, both countries grew rapidly, and the gaps in GDP per capita between them and the more advanced Western economies decreased substantially. In tandem with this, both economies underwent extensive structural changes, with traditional ("low-tech") activities contracting and more advanced activities expanding. In Portugal, as a result of inward FDI, a rapid expansion of the automobile sector occurred. In addition, one of the traditional activities, footwear, underwent substantial technological upgrading, and managed to expand in spite of raising relative labor costs (Godinho 2000). Ireland, by contrast, leapfrogged into one of today's most progressive technologies, ICT, almost exclusively due to inward FDI (O'Sullivan 2002). As a consequence, Ireland has become one of the most "high-tech" economies in the world today, comparable to the Asian "tigers," with an export structure strongly geared towards ICT and so-called "hightech" manufacturing.

Why did the two countries develop differently? A common language, and traditional strong ties, may have helped to focus the attention of US multinationals on Ireland. Another commonality is education. Although Irish educational efforts were not particularly high by developed country standards, Portugal lagged much further behind. This was the legacy of the authoritarian regime of Salazar, which did not wish to equip its people with more skills than strictly necessary. As a consequence, twothirds of the Portuguese today have primary school as their highest level of education, and only one out of ten has higher education of some sort. Among the OECD countries, only Turkey is at a similarly low level.

Both countries face challenges today, but these differ, and so will, arguably, the adequate policy response. In the Irish case, worries have emerged about the weak links between the foreign-owned ICT firms and the economy at large (in spite of, it might be argued, a blooming software sector), and the allegedly negligent attitudes of many of these firms when it comes to developing technological capabilities and undertaking R&D in Ireland (O'Sullivan 2002). The Portuguese, naturally, are concerned about the increased competition for its products stemming from the enlargement of the European Union to many Eastern European countries, many with a better educated labor force.

p. 538

Notes

1. We thank Fulvio Castellacci, Sandro Mendonca and the authors and editors of this volume for helpful comments and suggestions, retaining sole responsibility for remaining errors and omissions.

2. More recently, economists have formulated theories (so called "new growth theory") that do not necessarily predict convergence. See Fagerberg (1994, 2000) and Verspagen, Ch. 18 in this volume, for an extended account.

3. For instance, although there is a sizeable literature on US economic growth, most of it is not written from a catch-up perspective, e.g. focusing on what the US experience may tell us about what other countries should do (or not do) to succeed in catching up. See, technological and economic catch-up, and to facilitate the necessary structural changes, in poorer areas in the Union (Cappelen et al. 2003). During the 1980s and 1990s, both countries grew rapidly, and the gaps in GDP per capita between them and the more advanced Western economies decreased substantially. In tandem with this, both economies underwent extensive structural changes, with traditional ("low-tech") activities contracting and more advanced activities expanding. In Portugal, as a result of inward FDI, a rapid expansion of the automobile sector occurred. In addition, one of the traditional activities, footwear, underwent substantial technological upgrading, and managed to expand in spite of raising relative labor costs (Godinho 2000). Ireland, by contrast, leapfrogged into one of today's most progressive technologies, ICT, almost exclusively due to inward FDI (O'Sullivan 2002). As a consequence, Ireland has become one of the most "high-tech" economies in the world today, comparable to the Asian "tigers," with an export structure strongly geared towards ICT and so-called "hightech" manufacturing. Why did the two countries develop differently? A common language, and traditional strong ties, may have helped to focus the attention of US multinationals on Ireland. Another commonality is education. Although Irish educational efforts were not particularly high by developed country standards, Portugal lagged much further behind. This was the legacy of the authoritarian regime of Salazar, which did not wish to equip its people with more skills than strictly necessary. As a consequence, two-thirds of the Portuguese today have primary school as their highest level of education, and only one out of ten has higher education of some sort. Among the OECD countries, only Turkey is at a similarly low level. Both countries face challenges today, but these differ, and so will, arguably, the adequate policy response. In the Irish case, worries have emerged about the weak links between the foreign-owned ICT firms and the economy at large (in spite of, it might be argued, a blooming software sector), and the allegedly negligent attitudes of many of these firms when it comes to developing technological capabilities and undertaking R&D in Ireland (O'Sullivan 2002). The Portuguese, naturally, are concerned about the increased competition for its products stemming from the enlargement of the European Union to many Eastern European countries, many with a better educated labor force. ↳ however, the recent book by Chang (2002) and the discussion in Section 19.4 of this chapter.

p. 539

4. Veblen mentions factors such as the "funds available for investment" (Veblen 1915: 186), a sufficient supply of "educated men" (ibid. 194), as well as a "sufficiently well-instructed force of operative workmen" (192). The latter, he noted, did not have to be particularly well educated or trained (188).

5. "To the extent that industrialization took place, it was largely by the application of the most modern and efficient techniques that backward countries could hope to achieve success, particularly if their industrialization proceeded in the face of competition from the advanced country" (Gerschenkron 1962: 9).

6. Surprisingly, perhaps, he did not (nor did Veblen) put much emphasis on the achievements made by Germany in other areas, such as the educational sector, and in pioneering the development of an R&D infrastructure.

7. See Gerschenkron (1962: 16–20).

8. For instance, as a result of these efforts, illiteracy—which was relatively low by international standards even before the Meiji-restoration—was almost eliminated among Japanese youth by the turn of the century, and by 1920, more than half of the children graduating from elementary school proceeded to secondary schools (Odagiri and Goto 1996).

9. Productivity (and productivity growth) remained low, however, in sheltered industries (agriculture and services), and this imposed growing burdens on the economy during the 1990s and the early twenty-first century.

10. See Johnson (1982) on Japan, Amsden (1989) on Korea and Wade (1990) on Taiwan.

11. Most countries in our sample have between 80 per cent and 100 per cent of their youth attending secondary schooling. However, some (but not all, Malaysia, for instance, has 93 per cent) of the poorer economies have less. For instance, Argentina and Chile were reported to be in the 70–75 per cent range, and China and Mexico lower still, between 50 per cent and 60 per cent. Brazil is reportedly very low, only 15 per cent. Note, however, that the data for Argentina and Brazil quoted here were from the 1985–7 period, while for the other countries it was 1998 (source UNDP, Human Development Report 2002).

12. UNESCO defines the "gross enrolment ratio in tertiary education," which is the indicator used in Figure 19.2, as "total enrolment in tertiary education, regardless of age, expressed as a percentage of the population of the five year age group following on from the secondary-school leaving age." If many tertiary students are older than this, as may be the case in

several advanced countries (with a high emphasis on “long” degree courses), this indicator may give a too optimistic view on the actual share of an age group enrolled in tertiary education. Comparisons with other available indicators of tertiary education, based on educational attainment, indicates that such a bias may be present, and more so for the USA than other countries. Hence, the figure probably exaggerates the difference between the USA and other countries in the emphasis on tertiary education.

13. Note that the data reported here refer to total R&D, including the public part. If we had focused on only the part undertaken (and/or financed) by the business sector, the ranking of the countries would have been approximately the same, but the differences between the top and the bottom would have increased (in general, the more a country invests in R&D, the higher the share financed by business).

p. 540 14. A recent example, mentioned by Chang, is the so-called TRIPS agreement, forcing developing countries, which used to have a very lax attitude to protection of intellectual property rights, to accept developed countries' standards and institutions in this area. See Granstrand (Ch. 10 in this volume) for an extended discussion.

15. See Granstrand (1999: ch. 6), and references therein, for an attempt to link discussion of catch-up and firm strategies.

References

* ABRAMOVITZ, M. (1986), "Catching Up, Forging Ahead, and Falling Behind," *Journal of Economic History* 46: 386–406.
WorldCat

—— (1994), "The Origins of the Postwar Catch-Up and Convergence Boom," in J. Fagerberg, B. Verspagen, and N. von Tunzelmann (eds.), *The Dynamics of Technology, Trade and Growth*, Aldershot: Edward Elgar, 21–52.
Google Scholar Google Preview WorldCat COPAC

AOKI, M. (1988), *Information, Incentives and Bargaining in the Japanese Economy*, Cambridge: Cambridge University Press.
Google Scholar Google Preview WorldCat COPAC

AMSDEN, A. H. (1989), *Asia's Next Giant: South Korea and Late Industrialization*, New York: Oxford University Press.
Google Scholar Google Preview WorldCat COPAC

BAUMOL, W. J., BLACKMAN, S. A. B., and WOLFF, E. N. (1989), *Productivity and American Leadership*, Cambridge, Mass.: MIT Press.
Google Scholar Google Preview WorldCat COPAC

BEASLEY, W. G. (1990), *The Rise of Modern Japan*, New York: St. Martin's Press.
Google Scholar Google Preview WorldCat COPAC

CAPPELEN, A., CASTELLACCI, F., FAGERBERG, J., and VERSPAGEN, B. (2003), "The Impact of EU Regional Support on Growth and Convergence in the European Union," *Journal of Common Market Studies* 42: 621–44.
WorldCat

—— and FAGERBERG, J. (1995), "East Asian Growth: A Critical Assessment," *Forum for Development Studies* 2: 175–95 (repr. as ch. 3 in J. Fagerberg (2002), *Technology, Growth and Competitiveness: Selected Essays*, Cheltenham: Edward Elgar)
Google Scholar Google Preview WorldCat COPAC

* CHANG, HA-JOON (2002), *Kicking Away the Ladder: Development Strategy in Historical Perspective*, London: Anthem Press.
Google Scholar Google Preview WorldCat COPAC

CORNWALL, J. (1977), *Modern Capitalism: its Growth and Transformation*, London: St. Martin's Press.
Google Scholar Google Preview WorldCat COPAC

DOSI, G. (1988), "Sources, Procedures and Microeconomic Effects of Innovation," *Journal of Economic Literature* 26: 1120–71.
WorldCat

* FAGERBERG, J. (1987), "A Technology Gap Approach to Why Growth Rates Differ," *Research Policy* 16: 87–99 (repr. as ch. 1 in J. Fagerberg (2002), *Technology, Growth and Competitiveness: Selected Essays*, Cheltenham: Edward Elgar).
Google Scholar Google Preview WorldCat COPAC

—— (1988), "Why Growth Rates Differ," in G. Dosi, et al. (eds.), *Technical Change and Economic Theory*, London: Pinter, 432–57.
Google Scholar Google Preview WorldCat COPAC

*—— (1994), "Technology and International Differences in Growth Rates," *Journal of Economic Literature* 32: 1147–75.
WorldCat

—— (2000), "Vision and Fact: A Critical Essay on the Growth Literature," in J. Madrick (ed.), *Uncovential Wisdom: Alternative*
p. 541 *Perspectives on the New Economy*, New York: The Century ↳ Foundation Press, 299–330, 350–4 (repr. as ch. 6 in J. Fagerberg (2002), *Technology, Growth and Competitiveness: Selected Essays*, Cheltenham: Edward Elgar).
Google Scholar Google Preview WorldCat COPAC

—— GUERRIERI, P., and VERSPAGEN, B. (eds.) (1999), *The Economic Challenge for Europe: Adapting to Innovation Based Growth*, Cheltenham: Edward Elgar.
Google Scholar Google Preview WorldCat COPAC

—— and VERSPAGEN, B. (2002), "Technology-Gaps, Innovation-Diffusion and Transformation: An Evolutionary Interpretation," *Research Policy* 31: 1291–304. 10.1016/S0048-7333(02)00064-1
WorldCat Crossref

* FREEMAN, C. (1987), *Technology Policy and Economic Performance: Lessons from Japan*, London: Pinter.
Google Scholar Google Preview WorldCat COPAC

—— and LOUÇÃ, F. (2001), *As Times Goes By. From the Industrial Revolutions to the Information Revolution*, Oxford: Oxford University Press.
Google Scholar Google Preview WorldCat COPAC

—— and SOETE, L. (1997), *The Economics of Industrial Innovation*, 3rd edn., London: Pinter.
Google Scholar Google Preview WorldCat COPAC

* GERSCHENKRON, A. (1962), *Economic Backwardness in Historical Perspective*, Cambridge, Mass.: Belknap Press.
Google Scholar Google Preview WorldCat COPAC

GODINHO, M. (2000), "Desenvolvimento competitivo do sector de calçado em Portugal: Lições de um caso de *clustering*," in I. Salavisa Lança (ed.), *Trajectórias competitivas na indústria portuguesa*, Oeiras: Celta.
Google Scholar Google Preview WorldCat COPAC

GOMULKA, S. (1971), "*Inventive Activity, Diffusion and the Stages of Economic Growth,*" Report No. 24, Institute of Economics, Aarhus University, Aarhus.
Google Scholar Google Preview WorldCat COPAC

GRANSTRAND, O. (1999), *The Economics of Management and of Intellectual Property*, Cheltenham: Edward Elgar.
Google Scholar Google Preview WorldCat COPAC

HOBDAY, M. (2000), "East versus Southeast Asian Innovation Systems: Comparing OEM and TNC-led Growth in Electronics," in L. Kim and R. Nelson (eds.), *Technology, Learning & Innovation: Experiences of Newly Industrializing Economies*, Cambridge: Cambridge University Press, 129–69.
Google Scholar Google Preview WorldCat COPAC

JOHNSON, C. A. (1982), *MITI and the Japanese Miracle: The Growth of Industrial Policy, 1925–1975*, Stanford: Stanford University Press.
Google Scholar Google Preview WorldCat COPAC

* LALL, S. (2000), "Technological Change and Industrialization in the Asian Newly Industrializing Economies: Achievements and Challenges," in L. Kim and R. Nelson (eds.), *Technology, Learning & Innovation: Experiences of Newly Industrializing Economies*, Cambridge: Cambridge University Press, 13–68.
Google Scholar Google Preview WorldCat COPAC

LANDES, D. (1998), *The Wealth and Poverty of Nations*, London: Abacus.
Google Scholar Google Preview WorldCat COPAC

LIST, F. (1885), *The National System of Political Economy*, trans. from the original German edn. (1841), London: Longmans, Green and Company.
Google Scholar Google Preview WorldCat COPAC

NELSON, R. R. (1968), "A 'Diffusion' Model of International Productivity Differences in the Manufacturing Industry," *American*

Economic Review 58: 1219–48.
WorldCat

—— and WINTER, S. G. (1982), *An Evolutionary Theory of Economic Change*, Cambridge, Mass.: Harvard University Press.
Google Scholar Google Preview WorldCat COPAC

*—— and WRIGHT, G. (1992), "The Rise and Fall of American Technological Leadership: The Postwar Era in Historical Perspective," *Journal of Economic Literature* 30: 1931–64.
WorldCat

ODAGIRO, H., and GOTO, A. (1996), *Technology and Industrial Development in Japan*, Oxford: Clarendon Press.
Google Scholar Google Preview WorldCat COPAC

O'SULLIVAN, M. (2002), "Industrial Development: A New Beginning?" in John O'Hagan (ed.), *The Economy of Ireland: Policy and Performance of a European Region*, Gill and Macmillan, 260–85.
Google Scholar Google Preview WorldCat COPAC

RODRIK, D. (1994), "King Kong Meets Godzilla: The World Bank and the East Asian Miracle," in A. Fishlow et al. (ed.), *Miracle or Design? Lessons from the East Asian Experience*, Policy Essay No. 11, Washington, DC: Overseas Development Council, 13–53.
Google Scholar Google Preview WorldCat COPAC

p. 542 * SHIN, JANG-SUP (1996), *The Economics of the Latecomers: Catching-up, Technology Transfer and Institutions in Germany, Japan and South Korea*, London: Routledge.
Google Scholar Google Preview WorldCat COPAC

—— and HA-JOON CHANG (2003), *Restructuring Korea Inc.*, London: Routledge.
Google Scholar Google Preview WorldCat COPAC

SOLOW, R. M. (1956), "A Contribution to the Theory of Economic Growth," *Quarterly Journal of Economics* 70: 65–94. 10.2307/1884513
WorldCat Crossref

TEMPLE, J. (1999), "The New Growth Evidence," *Journal of Economic Literature* 37: 112–56.
WorldCat

TEECE, D. J. (2000), "Firm Capabilities and Economic Development: Implications for the Newly Industrializing Economies," in L. Kim and R. Nelson (eds.), *Technology, Learning& Innovation: Experiences of Newly Industrializing Economies*, Cambridge: Cambridge University Press, 105–28.
Google Scholar Google Preview WorldCat COPAC

VEBLEN, T. (1915), *Imperial Germany and the Industrial Revolution*, New York: Macmillan.
Google Scholar Google Preview WorldCat COPAC

VERSPAGEN, B. (1991), "A New Empirical Approach to Catching Up or Falling Behind," *Structural Change and Economic Dynamics* 2: 359–80. 10.1016/S0954-349X(05)80008-6
WorldCat Crossref

* WADE, R. (1990), *Governing the Market: Economic Theory and the Role of Government in East Asian Industrialization*, Princeton: Princeton University Press.
Google Scholar Google Preview WorldCat COPAC

WOMACK, J., JONES, D. T., and ROOS, D. (1991), *The Machine that Changed the World*, Cambridge, Mass.: MIT Press.
Google Scholar Google Preview WorldCat COPAC

World Bank (1993), *The East Asian Miracle: Economic Growth and Public Policy*, New York: Oxford University Press.
Google Scholar Google Preview WorldCat COPAC