

# The Quest for Development

## What role does history play?

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“[A] country’s potential for rapid growth is strong not when it is backward without qualification, but rather when it is technologically backward but socially advanced.”

(Abramovitz, 1986)

An idea that has recently found its way back into writings on economic growth is that the capability for modern growth may vary among societies for historical and cultural reasons that may ultimately be linked to their long-run economic experience. That there may exist capabilities for economic growth that differ across countries, and that are reflected in the quality of organizational skills and institutions, was brought to the fore in the 1990s when the experience of former Communist countries convinced many economists that changing formal rules alone might not by itself bring dramatic improvements in economic performance (Murrell, 1995; Clague, 1997). The same insight appears to apply with equal force to developing economies quite generally. The idea that the economies of East Asia enjoyed certain cultural advantages over those of other countries, for instance, had obvious appeal in the decades of rapid growth that preceded that region’s late 1990s economic crisis. Yet there are good reasons for resistance to theories of differential economic success that depend on unexplained cultural variation, and equally good reasons to resist appeals to institutional quality in the absence of a better understanding of what it is and what explains it.

In this article, we discuss attempts to explore the role of social capabilities in explaining differences in growth performance. We examine

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definitions of social capability or capacity for growth and evidence about the impact of that capacity. We develop the idea that the capacity for growth is lodged not only in institutions, but in certain qualities of a population that are likely to escape measures of formal education, although they belong to what is usefully thought of as human capital in its broadest sense. We focus on the tacit dimension of capability, on knowledge that is learned by doing, and on institutional or societal know-how that is greater than the sum of its parts in that it requires interaction among individuals to accomplish tasks that no individual alone knows how to perform. We discuss ways in which such societal capabilities are likely to have been built up over very long periods of time, and why some societies were perhaps better positioned than were others to undergo the process of economic modernization in the second half of the twentieth century. We look at implications of these ideas for development policy, as well as for the interpretation of differential rates of growth in the past few decades.

The core idea explored is that forms of capability that are tacit, learned by doing, suffused within populations, and not adequately proxied by formal schooling, may play a large part in explaining the degrees to which different societies have been able to take advantage of the opportunities of a rapidly technologically evolving and increasingly open international economy. A poorer starting point in terms of level of per capita income may have conferred advantages with regard to the rate of catch-up, but inauspicious preconditions with respect to these broader forms of human capital may have burdened economies with disadvantages that were not easily overcome. The possibility that modernization of social capabilities may in important respects be a precondition for economic growth, suggests that building capability ought to be viewed as an intermediate goal worth pursuing even in the absence of measurable short-term economic returns.

In what follows we first review the evidence that groups of countries have been diverging rather than converging in their absolute levels of productivity and incomes in recent decades, and we revisit the problem of the unexplained portion of the variation in growth across countries. We then discuss the inadequacy of formal education differences as predictors of growth performance, and the evidence that the diffusion of ideas across societies has faced impediments in spite of the increasing openness of international borders and the advent of cheaper means of communication. Ideas of modernization and social capability, as discussed in an interesting

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paper by Temple and Johnson (1998), are the subject of the following section, which includes also a discussion of the related idea of “social capital”. After this, we discuss an evolutionary approach to the development of capacities for modern growth, and we lay out the evidence that developed capacities indeed contributed to differences in performance in the post–Second World War period. We conclude with some remarks on implications for development policy.

### Economic growth, the unexplained residual, and education

World economic history records dramatic changes in living standards over the past few centuries due to unprecedented and sustained technological and organizational change. It is a truism that the sustained increases in average incomes in industrialized countries have given the majority of households in those countries standards of living reserved in earlier centuries for only the wealthiest individuals. Equally striking, however, is the unevenness of the distribution of changes in income levels worldwide. Already, in 1776, Adam Smith could write that “in a civilized and thriving country ... the accommodation of [a] prince does not always so much exceed that of an industrious and frugal peasant, as the accommodation of the latter exceeds that of many an African king, the absolute master of the lives and liberties of ten thousand naked savages”.<sup>1</sup> As the industrial revolution that was only beginning in Smith’s time deepened and gradually spread, the gap between the world’s richest and poorest nations widened.

Pritchett (1997) gives an estimate of how differently countries have fared in the years since 1870. Starting with (a) current estimates of relative incomes across nations; (b) estimates of historical growth rates of the now-rich nations; and (c) the assumption that even the poorest country in the world in 1870 must have had a per capita income equal to the subsistence level, he estimates the ratio of the GDP per capita of the richest to the poorest country in 1870 at 8.7:1. For 1960, the corresponding estimate rises to 38.5:1, and by 1990 the estimate is even higher, at 45.2:1.

Following the influential work of Romer (1986), a large recent literature has attempted to explain the divergent economic fortunes of nations. Building on the touchstone theoretical approach of Solow (1956), they

<sup>1</sup> Adam Smith, *An Inquiry into the Nature and Causes of the Wealth of Nations* [1776], New York: Modern Library, 1985, pp. 13–14.

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have estimated equations for economic growth in which the growth rate of output per capita is expected to be increasing in the rate of growth of the capital stock and decreasing in initial per capita income. The limited explanatory success of the simplest of these models led to efforts to identify variables other than the capital/labor ratio that may be contributing to differences in per worker output.

A number of studies have suggested that a key missing variable is human capital. Proponents of this view suggest that much of the unexplained residual in the growth process in the industrialized nations over the past century or more can be attributed to the failure to distinguish between “raw” labor and skilled labor. In an influential paper, Mankiw, Romer and Weil (MRW, 1992) tested the hypothesis of a Solow type convergence of growth rates with data from as many as ninety-eight countries for the period 1960–1985. In their initial estimates, they treated labor as a homogeneous input and found only weak evidence of convergence. After augmenting the Solow model with human capital as a separate input, represented by the secondary school enrollment rate, they found stronger evidence of convergence in growth rates of output per worker. While this result suggests that differences in education might go a long way in explaining variations in economic growth and incomes, other studies, using more sophisticated measures of human capital, have raised new doubts about that conclusion. For instance, Hall and Jones (1999) suggest that differences in productivity that remain unexplained after accounting for human capital are still enormous, and that differences in human capital are not sufficiently important to explain cross country variation in growth rates. Output per worker in the five countries in which it was highest in 1988 was 31.7 times output per worker in the five countries where it was lowest in their sample of 127 countries. Of this huge gap, differences in per worker physical capital and human capital contributed difference factors of only 1.8 and 2.2, respectively, leaving the most productive countries 8.3 times more productive than the least productive ones *after* accounting for input variation, including that of formal human capital.<sup>2</sup> Furthermore, a number of empirical works such as those of Pritchett (2001) and Bils and Klenow (2000) find little support for the argument that

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<sup>2</sup> That is,  $1.8 \times 2.2 \times 8.3 = 32$ .

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increases in the stock of human capital (measured by education) are a major cause of differences in per capita output growth.

### Policy, institutions, and social factors

If formal human capital is only of limited help, to what might the unexplained portion of the differences in growth rates be attributed? Kormendi and Meguire (1985) and Barro (1991) are early influential papers that study growth variation as a function of economic policy differences. The variables looked at include investment ratios, government expenditure, measures of market distortions, domestic credit growth, export share growth, growth in money supply, and the standard deviation of the inflation rate.<sup>3</sup> The studies do find correlations between some of these variables and rates of economic growth. However, Barro finds that a good deal of the variation remains unexplained. Particularly striking is the fact that his analysis fails to capture differences in growth rates between countries in Latin America, in sub-Saharan Africa, and in other regions. The persistent statistical significance of dummy variables for the first two regions in his regression equations suggested to Barro an incomplete understanding of the critical determinants of growth.

Unexplained growth variation and significant regional effects have led researchers to turn to variables which can be referred to as “institutional” or “social” in nature.<sup>4</sup> These include measures of political stability, indices of human rights, freedom of the press, security of property rights, and bureaucratic efficiency. Each of these variables has displayed significant correlations with growth performance in multivariate regression analyses. Among the studies worth noting for their connection to our later themes is Easterly and Levine’s (1997), which suggests that the poor post-War growth records of sub-Saharan African countries in the 1960s, ’70s, and ’80s might to a substantial degree be attributed to ethno-linguistic heterogeneity, which is quite high in many of the region’s nations. Another noteworthy study is that of Hall and Jones, referred to earlier. Those authors postulate that differences in capital accumulation, productivity and output per capita are driven by differences in “social infrastructure”, which they define as “institutions and government policies that determine the

<sup>3</sup> For a critique of the use of these measures see Levine and Renelt (1992).

<sup>4</sup> An up-to-date review is provided by Aron (2000).

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economic environment within which economic individuals accumulate skills, [and] firms accumulate capital and produce output” and which they proxy by the sum of (a) an index of country risk to international investors, and (b) an index of openness to international trade.

To account for the likely two-way relationship between income levels and social infrastructure, Hall and Jones attempt to identify exogenous instruments for that variable. They find that distance from the equator and the extent to which French, German, Spanish, and especially English are spoken as first languages, are effective predictors (with the help of one other variable) of social infrastructure. Using these variables as statistical “instruments” and correcting for possible measurement error, they find that variations in social infrastructure can account for a 25.2-fold difference (out of an overall 35.2-fold difference) in output per worker across economies. Hall and Jones’ finding about the roles of language and European settlement hint at impediments to the flow of ideas that may lie behind what Romer (1993) has called “idea gaps”.<sup>5</sup> And as we shall comment again later, both the Easterly–Levine and the Hall–Jones studies suggest that social variables reflecting centuries of world history may play a large role in explaining the growth and income differences of recent times.

In an attempt to sort out the profusion of results in the growing literature, Sala-i-Martin (1997) tested the relative importance of fifty-nine different economic and non-economic variables for their association with economic growth. Of these, twenty-two turned out to be robustly associated with growth, and more than half of the latter (fifteen) can be labelled as non-economic. These fifteen are (in order of importance): fraction of population coming from a Confucian culture, strength of the rule of law, fraction Muslim, political rights, Latin America continental effect, sub-Saharan Africa continental effect, civil liberties, revolutions and coups, degree of capitalism, wars, absolute latitude, fraction Protestant, fraction Buddhist, fraction Catholic, and former Spanish colony. While there might be some overlap between these variables (e.g. former Spanish colonies and the Latin American continental effect), clearly there is strong evidence that non-economic factors cannot be ignored.

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<sup>5</sup> A similar idea is seen in Goodfriend and McDermott’s (1998) idea of “familiarity” as a facilitator of catching up to the world technological frontier.

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Another “social” variable that has received much recent attention in economics as well as in sociology and political science, is what is dubbed “social capital”. First proposed by sociologists, the term was introduced into economics by Loury (1977), who used it to describe the “authority regulations, relations of trust and consensual allocation of rights which establish norms”.<sup>6</sup> This usage overlaps with but differs slightly from that of sociologists, for instance Narayan (1997), who uses social capital to refer to “the quantity and quality of associational life and related norms” (p. 1), and to “the rules, norms, obligations, reciprocity, and trust embedded in social relations, social structures, and society’s institutional arrangements which enable its members to achieve their individual and community objectives” (p. 50). In recent discussions of social capital in economics, the concept is related to the extent of trust, associational memberships, and general social and political participation (Temple, 1998).

Knack and Keefer (1997) try to measure the importance of social capital to economic growth. Based on the World Values Survey, they construct indicators of the level of “trust” and “civic norms” for twenty-nine market economies. In a passage that has received renewed attention due to the current wave of research, Kenneth Arrow (1972) had emphasized the role of trust in transactions, writing: “Virtually every commercial transaction has within itself an element of trust, certainly any transaction conducted over a period of time. It can be plausibly argued that much of the economic backwardness in the world can be explained by the lack of mutual confidence”. A higher level of trust in a society is said (a) to allow easier implementation of contracts; (b) to lead to lower expenditure on protecting oneself from the threat of economic expropriation and of losses due to unlawful violation of contracts; and (c) to encourage innovation by facilitating property rights enforcement. In addition to “trust”, “civic norms” are also linked to economic growth in much the same way. To the extent that civic norms effectively constrain opportunism, the cost of monitoring and enforcing contracts are likely to be lower, raising the payoffs to many investments and other transactions. Knack and Keefer find that both indicators are significant predictors of per capita income growth in the period 1980–1992. Furthermore, both measures are higher in countries that effectively protect property rights and contracts and in countries that are less

<sup>6</sup> Coleman (1988) is now the classic citation in sociology. For an excellent overview of the literature, see Woolcock (1998). A more extended discussion of economic accounts is provided by Dasgupta (1998).

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polarized along lines of ethnicity and class. Countries with higher amounts of both also have lower economic inequality (as measured by the Gini coefficient). Unfortunately, the sample of countries for which the required measures are available is small and consists mainly of developed and middle-income economies.

One quantitative study of the impact of social capital is available from a developing country which is indeed among the world's poorest. Narayan (1997) develops a quantifiable index of average "associational social capital" in eighty-four villages in Tanzania, and Narayan and Pritchett (1999) study the effect of this variable upon standards of living, proxied by consumption and expenditure. They find strong statistical evidence of a linkage between these variables, concluding that a one standard deviation increase in village social capital increases household expenditures per person by at least 20% to 30%, more than four times the impact found for a similar increase in levels of schooling. Echoing these findings, one of us was told by both farmers and NGO workers during field investigations of the difficulties of organizing village level farmer associations in Tanzania that such associations routinely fail because "peasants cannot trust one another with money".<sup>7</sup>

### **The role of social capability**

The discussion to this point suggests that there are good reasons to believe that the social and political environment of a country plays an important role in determining its rate of economic growth. However, including factors like the strength of the rule of law, level of political stability, trust, and ethnic homogeneity as separate and exogenous elements in a model of economic growth is in some respects unsatisfying. Many of these variables are strongly correlated with each other, impeding unbiased estimation. Excessive data requirements reduce sample sizes, and too many variables reduce degrees of freedom and make statistical inference problematic. More substantively, one suspects that some commonality of historical process lies behind the differences among societies, and that further light may be cast upon the problem of explaining differential growth performances by investigating the impacts of history in a more direct and

<sup>7</sup> See Putterman (1995a), p. 324, note 57.

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integrative fashion. We now begin to trace out a line of research that may hold the potential to do this.

Building on an earlier tradition in the study of economic growth and history, Abramovitz (1986) argues that technological backwardness is not merely an accident. Tenacious societal characteristics, he contends, account for a substantial portion of a country's failure to achieve high levels of productivity. These deficiencies can prevent a country from making a great leap forward or even cause it to make abortive leaps, harming itself in the process. Abramovitz coins the term *social capability* to denote the factor differing across societies. According to Abramovitz (1995), the notion of social capability can be understood as consisting of two groups of elements. The first group comprises people's basic attitudes and political institutions, including:

- An outlook on the world compatible with that of empirical science.
- Social attitudes and arrangements that form an effective incentive structure.
- An effective set of political institutions.

The second group consists of a set of characteristics that determine the population's ability to exploit modern technology. These characteristics include the spread of education, the experience of the people with administration and organization of large-scale establishments, and the functioning of capital markets. The importance of education has been much stressed in the literature,<sup>8</sup> although perhaps without sufficient attention to the less formal dimensions of human capital. Happily, these dimensions are noted immediately by Abramovitz, who points out that competence in organization and administration of firms of larger than traditional scale requires skills and knowledge that are acquired outside the classroom. It requires an ability to envision the proper organization of a firm of considerable size, in which there is an effective division of responsibilities, an adequate flow of information, and an effective system of incentives. Clearly, the development of all of this depends on experience—a constraint for poorer economies following more traditional methods of production.

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<sup>8</sup> See Easterlin (1981).

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Abramovitz also includes in his second group of elements making for “social capability” the well-known component of capital markets and intermediation. The traditional argument here is that the people who have the information and ability to undertake risky investment projects are not necessarily the ultimate savers in the economy, so there is a need for well functioning capital markets to channel resources from the former to the latter. To this, one can add the need for these markets to finance human capital investments. While Abramowitz refers to the markets themselves, when spelling out his concept of social capability, a focus on *the capacity to operate them*—paralleling the capacity to run large-scale organizations—is also consistent with his approach. Here again, then, the experiential background can be viewed as the critical input.

Is there evidence that different “social capabilities” account for different growth experiences? For the years 1950–1980, Abramovitz finds evidence of a tendency towards convergence in productivity within the sample of OECD countries, an absence of such convergence when the sample is enlarged by including middle income, partially industrialized countries and, finally, divergence of productivity when the sample is enlarged to include poor countries. Conditional convergence suggests that backward countries (in term of per capita output) should exhibit faster growth (or catch up technologically). However, a country may not have an unqualified chance of growing fast when it is relatively economically backward. To quote again from our opening: “[A] country’s potential for rapid growth is strong not when it is backward without qualification, but rather when it is technologically backward but socially advanced” (Abramovitz, 1986).

Temple and Johnson (1998) take up Abramovitz’s idea of social capability and attempt to test it more formally. To proxy for social capability, they use an index which Irma Adelman and Cynthia Morris (1967) constructed in an effort to study the economic and non-economic forces at work during the process of development. In the view of the latter authors, certain economic relationships observed in richer countries may take quite different forms in poorer countries for reasons that are largely political, social and institutional. To gain quantitative insight into the relationship of these factors with the level and pace of economic development, they defined 41 indicators of socio-political and economic organization and development. Of these 41, twenty-four were not purely economic. With these

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twenty-four variables they performed a factor analysis, a statistical procedure for simplifying a large set of data and discovering its underlying regularities. They constructed four factors—of which the first one explained as much as 53% of the variation in per capita GNP in 1961. In this factor the set of variables which had the highest loadings<sup>9</sup> (i.e. the most explanatory power) were twelve “... which could be interpreted to represent the processes of changes in attitudes and institutions associated with the breakdown of traditional social organizations (p. 153)”:

- (a) size of the traditional agricultural sector;<sup>10</sup>
- (b) extent of dualism;<sup>11</sup>
- (c) extent of urbanization;<sup>12</sup>
- (d) character of basic social organization;<sup>13</sup>
- (e) importance of indigenous middle class;<sup>14</sup>
- (f) extent of social mobility;<sup>15</sup>
- (g) extent of literacy;<sup>16</sup>
- (h) extent of mass communications;<sup>17</sup>
- (i) degree of cultural and ethnic homogeneity;<sup>18</sup>
- (j) crude fertility rate;<sup>19</sup>
- (k) degree of national integration and sense of national unity;<sup>20</sup> and
- (l) degree of modernization of outlook.

<sup>9</sup> All 24 variables were used to construct each factor. However the weight or *loading* of each variable differs across the factors.

<sup>10</sup> Defined as the fraction of the population engaged in self-sufficient subsistence agriculture.

<sup>11</sup> Countries were ranked on a scale with one pole being the largely agrarian society having an extremely small exchange sector and the other pole being “the incipient stage of economic maturity in which continuous interaction between modern and non modern sectors is a pervasive phenomenon” (p. 23).

<sup>12</sup> Based on a definition and data from the Urban Land Institute.

<sup>13</sup> This is a purely qualitative indicator with countries divided into three groups based on whether the principal form of social organization as of about 1960 was the immediate family group, the extended family (or clan), or the tribe.

<sup>14</sup> Based on (a) statistical estimates of the importance of selected middle-class occupations, together with (b) qualitative information concerning the comparative weight of indigenous and expatriate elements in the middle class.

<sup>15</sup> Social mobility is assumed to be signified by broad access to educational attainment, importance of the indigenous middle class, and absence of prohibitive cultural and ethnic barriers.

<sup>16</sup> Taken from Russett *et al.*, *World Handbook of Political and Social Indicators*.

<sup>17</sup> A composite index based on daily newspaper circulation and number of radio receivers, taken from the *World Handbook of Political and Social Indicators*.

<sup>18</sup> A composite index based on data on religious, linguistic and racial homogeneity from the *World Handbook of Political and Social Indicators*.

<sup>19</sup> Source: *United Nations Demographic Yearbooks*.

<sup>20</sup> For lack of space we cannot go into the details of (k) and (l). The interested reader is referred to Adelman and Morris (1967), p. 49 and p. 54.

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Using the individual scores for their first factor, Adelman and Morris divided countries into three groups. Relating their findings to modernization theory,<sup>21</sup> they noted that the group of countries with the lowest factor scores was that which had societies which were primarily tribal and economies characterized by a preponderant non-market sector. They found the intermediate group to be made up of countries in which the typical kinship structure was the extended family and in which the exchange sector of the economy was generally much larger than it is in the lowest group. Finally, the group of countries with the highest factor scores included only countries which, although still underdeveloped in the late 1950s, were already relatively advanced with respect to both social and economic development.

Adelman and Morris had stressed that the results of their analysis could not demonstrate either that economic growth is caused by sociopolitical transformation or that variations in development determine patterns of social and political change. Since their sociopolitical and economic development indicators were contemporaneous ones, it would have been impossible to demonstrate causality. With the benefit of the three decades that had elapsed since the Adelman–Morris study, however, Temple and Johnson could treat social capability (or “social development”) as proxied by the Adelman–Morris (A–M) measures as an initial condition potentially influencing subsequent economic growth. If Abramovitz’s insight is correct, then of a group of countries having approximately the same income per capita at around the time the variables used in deriving the factor scores were measured (*c.*1960), those with higher factor scores should be expected to have exhibited faster subsequent economic growth. Temple and Johnson (1998) found this to be the case. After controlling for initial income per capita, the average economic growth rates for the period 1960–85 for sixty countries for which the required data are available are higher for countries with higher A–M factor scores. Differences in A–M factor scores continue to be a significant predictor of economic growth after controlling also for human capital and investment rates. This suggests that social capability works through channels not captured by the investment rates, formal schooling measures or the initial level of development. Relatedly, Temple (1998) shows that for the subset of

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<sup>21</sup> See, e.g., Inkeles and Smith (1974).

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sub-Saharan African countries, low values of the A–M social development index mean a higher likelihood of bad policy outcomes and low investment. For any two countries with the same level of income per capita, the one with a higher index tended to have more schooling, a more extensive financial system, better fiscal policy, and a wider telephone network. In Temple-Johnson (1998), however, the statistical significance of the index's effect is not robust to introduction of the continental effect referred to earlier.

### Historical experience and “broad human capital”

In an argument which in some respects parallels that of Abramovitz, Putterman (1995b) suggested that important differences in the pace of modern growth might be attributable to differences in the levels of broadly defined stock of human capital, capabilities, and predispositions. He argued that parts of this stock are acquired by doing, sometimes interactively with others. The relevant know-how may be tacit in nature: it is at the disposal of the individual or group, but is not easily articulated by them, and it may not even be consciously understood. Beliefs and attitudes as well as knowledge form part of the relevant stock. The conception of this stock as it shifts during the transition to an industrial society is similar to the notion of modernization, but the focus is more restrictedly on the capacities of human agents (rather than structural conditions in the society and economy). More importantly, Putterman explicitly linked his notion of “broad human capital” to a longer-term developmental scheme that includes modernization in its conventional sense, but only as one end of a more extended evolutionary process.

Putterman's argument drew upon Nelson and Winter's (1982, chs. 4 and 5) and in turn upon Michael Polanyi's (1962) concept of “tacit knowledge” to argue that the capabilities that individuals bring to an economic organization such as a business firm are to a significant degree inarticulable and are not only learned, but also *known* by virtue of *doing*. The commonplace that skills such as the ability to swim, to ride a bicycle, or to drive an automobile are mainly learned in the doing, not through verbal instruction, was here argued to apply to a wide range of abilities useful to the functioning of economic organizations. Abilities learned-by-doing may not only be difficult to explain verbally; they may also be “remembered-by-doing”.

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Thus, it is often impossible for inexperienced personnel to replicate a successful production activity in a new location by reading a manual or a “book of blue-prints” describing the relevant procedures and techniques. The book may be impossible to write, or if written, impossible for the reader to decipher. Teece (1982) provided a similar discussion of tacit knowledge and technology transfer, and Landes (1998) provided numerous examples of how industrial techniques could not be transferred from one European country to another, in the nineteenth century, without the active participation of individuals who had acquired the skills in earlier industrialized locales.<sup>22</sup>

The ideas that Nelson and Winter lay out with reference to business firms may be readily applied to the economic capabilities of societies as larger economic systems. Although unmeasured differences in the quality of formal schooling may go some way to explaining those differences in productivity not explained by measures of the number of years of schooling, an even more important factor may be differences in informally-learned capabilities, as well as in attitudes towards work, innovation, risk-bearing, and cooperation. Nelson and Winter argued that organizational capabilities are more than the sum of the capabilities of individual members: the organization’s personnel possess collective know-how that depends upon on-going multi-person interactions that any individual participant may only partially comprehend. This idea too can be extended to the societal level, where an implication is that the contribution to social product resulting from the skills of any one individual depends heavily upon the presence of other individuals having complementary capabilities, as well as a complementary cognitive style and ability to interact fruitfully with the other bearers of the relevant human capital.

Putterman suggested that different repertoires of capabilities have different degrees of adaptability and usefulness for different problems and stages of economic development. Just as many specialized modern skills would have proven to be of little use in the technological and economic environment of an ancient or prehistoric society, skills critical to survival in pre-modern environments may be of little use in industrial settings. Putterman’s conjecture was that the speed with which modern skills and outlooks are acquired may vary depending on the nature of the pre-modern system.

<sup>23</sup> See also Nelson and Sampat (2001) for a discussion of institutions as “social technologies”.

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Whereas development economists usually content themselves with the dichotomy between the “traditional” and the “modern”, human history has seen several technological and organizational transitions of equal profundity. Differences in rates of adoption of modern institutions and technologies across the diverse set of societies commonly viewed as “underdeveloped” around 1950 may in part be traced to differences in the extent of transition towards modernity that would have been evident centuries earlier. In particular, for reasons that are not yet fully understood but that most likely are mainly determined by geography, climate, and natural resources, people in different parts of the inhabited world abandoned the hunting-and-gathering economy of mankind’s common ancestors at significantly different paces over the past ten thousand years.<sup>23</sup> The repertoire of human capability achieved in past centuries by the inhabitants of China, Japan, or Korea, which had densely-populated agrarian systems marked by state-level organization, taxation, writing, and considerable specialization and commerce, may have been more like those used by modern modes of organization and technology than were the corresponding repertoires of tribal peoples in parts of sub-Saharan Africa, the Americas, or New Guinea.<sup>24</sup> Differences in the nature of contact with more “modern” societies and in the subsequent manner of incorporation into the modern world would also have had telling effects.<sup>25</sup>

Some reasons why dense populations in contiguous contact make possible higher levels of productivity and growth are familiar to economists. Greater population density tends to lower the cost of local trade, thus spurring the division of labor and raising productivity, following the famous formulation of Adam Smith (1985 [1776]). A more refined division

<sup>23</sup> Social evolution from the hunter-gatherer stage to modern industrial society is discussed by Service (1971), Johnson and Earle (1987), Boserup (1965, 1981), and Diamond (1998), among many others. For supportive tests of Diamond’s hypotheses regarding the geographic and biogeographic determinants of agriculture’s origins, as well as tests of the hypothesis that early agricultural development is correlated with the level of economic development today, see Hibbs and Olsson (2003).

<sup>24</sup> There were also large differences among societies in these macro-regions, as discussed for instance by Sanders and Marino (1970) for the Americas. Early states in Africa are discussed by Shifferd (1987).

<sup>25</sup> Indeed, many indigenous societies which still practiced hunting-and-gathering or a mixture of this with extensive agriculture, and which accordingly were marked by low levels of population density at the time of contact by advanced agrarian societies, were in effect “replaced” by populations from the latter societies, transferring human capital, e.g., from Europe to large parts of North America and Australia, in the process. This process was not dissimilar to that which had occurred earlier when Bantu peoples displaced non-Bantu Africans in much of central and eastern Africa and when Han Chinese expanded into what is now southern China more than a thousand years ago. In the course of Europe’s outward expansion, the most densely populated places, such as China, avoided colonization and massive foreign settlement, while places of intermediate densities and climatic hospitability to Europeans underwent colonization with varying degrees of non-indigenous settlement.

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of labor not only increases the productivity of existing technologies, wrote Smith; it also spurs the invention of new ones, as illustrated by inter-European competition in the early industrial revolution (Landes, 1998). More recently, Kremer (1993) and others have argued that large populations, whether dense and local or spread out over a larger area but with a geography or technology facilitating easy communication, can be expected to generate higher levels of technological progress. The argument is that if the proportion of unusually creative persons is constant across populations, then on average larger populations yield a larger number of innovators whose ideas disperse to more individuals. As future innovators build upon the inventions of past innovators within populations in contiguous contact, technological change accelerates there relative to epochs and areas of low contact and/or small population.<sup>26</sup>

As an aside, it is worth noting that the high rates of innovation occasioned by higher population densities and larger areas of contact may not immediately have led to higher standards of living. While thousands of years of development of agricultural and urban societies prior to the industrial revolution were marked by increasing specialization, social stratification, and standards of living for elite classes, it is not clear that denser populations resulted in higher living standards for most of the people affected. With industrialization, however, increasing population density at least temporarily shed its Malthusian character.<sup>27</sup> Greater densities were now associated not only with greater social complexity and output, but also with greater output per capita and levels of consumption.

The Smithian and innovation explanations for a link between population density and economic growth may be only part of the reason why greater pre-modern development could spur faster modern growth. Societies that reached agrarian state status at earlier points in time, thus attaining higher population densities before the modern era, may have achieved more rapid industrialization in recent decades due to characteristics of their human capital stock that are correlated with but not necessarily caused by high population densities. Possible growth-enhancing characteristics of agrarian state societies include (a) a pre-modern mechanical skill base closer to that needed in industrial economies; (b) greater

<sup>26</sup> This idea is also emphasized by Diamond (*op. cit.*).

<sup>27</sup> The idea that the industrial revolution marked a turning point from a Malthusian to a post-Malthusian demographic regime is modeled by Galor and Weil (2000).

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economic independence of households and a higher degrees of commercialization and trade;<sup>28</sup> (c) a head start in modern state capacity conferred by pre-modern experience with large-scale polities; (d) related advantages conferred by greater social (including linguistic and ethnic) homogeneity, which was established across larger groups where state-level organization was achieved earlier; and (e) work styles or norms more consistent with those required by modern societies. High population density, intensive agriculture, early state-level political organization, and similar phenomena may therefore serve as markers for the repertoires of human capabilities which are societies' legacies from their pre-modern experiences.<sup>29</sup>

### Evidence on the impact of historical experience

Empirical evidence on the idea that more "advanced" pre-modern development has been conducive to recent catching-up, among developing countries, has been provided by several studies. Lenski and Nolan (1984) classified the world's post-War developing countries into two simple categories: "horticultural" societies, whose pre-modern agriculture depended upon the hoe or digging stick, and "agrarian" societies, whose pre-modern agriculture used animal-drawn plows.<sup>30</sup> Using this binary classification, they identified as "industrializing horticultural" thirty-five countries, all except Papua New Guinea being located in sub-Saharan Africa. Forty-five countries, located in Latin America, Asia, and the North Africa, were classified as "industrializing agricultural". Lenski and Nolan predicted and found that both the level and the growth rate of GNP per capita were lower in the former "horticultural" countries.

Unlike the dichotomous classification by Lenski and Nolan, a continuum of pre-industrial development levels was used in Burkett, Humblet and Putterman's (1999) tests of early development's effects on recent economic growth. Drawing on the long-period developmental schema of

<sup>28</sup> Some economists have speculated that norms of sharing within communities, clans, or extended families, may have slowed modern economic growth in societies where they are especially strong because they act like a tax on the returns to the efforts of individuals and small family units. See, for example, Platteau (1996). The relationship between commerce and culture is also discussed by Grief (1994).

<sup>29</sup> The argument that the higher population densities associated with early development facilitates modernization in the industrial era is also laid out by Lenski and Nolan (1999) and by Crenshaw, Oakey and Christenson (1999).

<sup>30</sup> Lenski had proposed the connection between pre-modern development and modern growth at least as early as the 1970 edition of his book *Human Societies*.

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Boserup (1965), they used population density, farmers per hectare of farmland, and the proportion of farmland that is irrigated, as proxies for a country's level of pre-industrial development.<sup>31</sup> They added observations on each of these variables as measured in 1960, and the first principal component of the three variables, to the list of independent variables in a set of cross-country growth regressions following Barro (1991) and Levine and Renelt (1992), in which the dependent variable is the rate of growth of GDP per capita from 1960 to 1990.<sup>32</sup> They found that any one of the three indicators of pre-industrial development (PID) or their first principal component contributes as much to the explanation of recent economic growth as do the more standard variables in these equations. Also, the PID variables explain approximately the same fraction of the growth residual otherwise picked up by region dummies, although both region dummies and PID indicators remained significant in their equations when both were included.

The tests by Burkett *et al.* showed that countries with higher population densities, more farmers per hectare, or more irrigated farmland—each an indicator of more advanced pre-modern development—grew faster both before and after controlling for other factors. The results were robust to the inclusion of other explanatory variables, including life expectancy (arguably an alternative measure of human capital), ethnic heterogeneity, and a set of variables including access to ports and natural resource exports as a share of GDP.<sup>33</sup>

Crenshaw *et al.* (1999) performed a similar test in a cross-country growth model influenced by sociological and demographic considerations. Their measure of pre-industrial development, which they call “demographic inheritance”, is the product of agricultural labor force and of the ratio of that labor force to cultivated area—hence labor force squared over area rather than labor force over area as used by Burkett *et al.*<sup>34</sup> For a sample of 79 developing and developed countries, they estimated a series of nested

<sup>31</sup> An important consequence of using continuous variables rather than a dichotomous “horticultural”/“agrarian” distinction is that the continuous approach reflects differences between the many Asian societies which have had densely populated agrarian states for centuries, and Latin American societies which are a less densely populated amalgam of pre-Columbian “horticulturalists” and of immigrants of mainly “agrarian” origin.

<sup>32</sup> The other independent variables are initial GDP per capita, the investment rate (I/GDP), initial formal education (represented by the secondary school enrollment ratio), the rate of population growth, and the black market premium.

<sup>33</sup> The last variable set is due to Sachs and Warner (1997).

<sup>34</sup> Their rationale is that both total labor force size and density, measured by the man-land ratio, matter to modernization prospects.

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models with the growth rate of GDP per capita during 1965–90 as dependent variable, and the log of initial GDP per capita and the log of the “demographic inheritance” variable always among the explanatory variables. “Demographic inheritance” is positively correlated with growth, significant at the 1% level, when the two variables appear alone or in combination with measures of Confucian heritage, ethnic homogeneity, the change in the youth dependency ratio, and other demographic variables.<sup>35</sup>

Cross-national differences are not the only possible level at which to check for the effects of pre-modern development. Nations contain regions with different developmental histories, which might be expected to have responded differently to different opportunities for economic modernization. To test for such effects in one of the largest developing nations, Narayan and Putterman (1999) estimated models closely paralleling those used by Burkett *et al.*, to explain differences in growth rates across provinces in China. They found this to be the case for 1952–89 and especially for the market-oriented reform periods 1978–89 or 1978–92, but not for the period of central planning (1952–78), during which the PID measures show no significant impact on growth.<sup>36</sup> An interpretation is that the factors causing pre-modern development to affect modern growth may have been kept in abeyance by a command economy, then unleashed by market reforms.<sup>37</sup>

<sup>35</sup> A positive relationship between population density and recent economic growth has also been found in other studies, including Kelley and Schmidt (1995), who found a robust positive relationship with growth when controlling for other demographic variables and initial per capita income in both panel and cross-sectional estimates covering 89 countries in the 1960s, 1970s, and 1980s. Gallup, Sachs and Mellinger (1999) found a significant positive relationship between growth and population density in coastal areas, but the opposite relationship for non-coastal areas. Both papers attribute the positive effects to Smithian factors; factors which Gallup *et al.* suggested are properly activated only in regions with access to international trade. Chanda and Putterman (2002) revisit Gallup, Sachs and Mellinger’s results and find that while their result that coastal population density aids growth remains robust, their conclusion that high population density is harmful to development in non-coastal regions does *not* hold when only developing countries are included in the sample. This means that the Gallup-Sachs-Mellinger findings can be counted as consonant with the others discussed here *without* qualification.

<sup>36</sup> Narayan and Putterman used the index of multiple cropping (the ratio of annual crop sown area, which may count a given plot more than once, to cultivated area, which counts each plot of land once only) as their third PID indicator, rather than the irrigation ratio. 1989 is the last year for which province-level data using the old national income concept were available when they began their study, while a series for the recently substituted GDP concept was available for years up to 1992.

<sup>37</sup> It is well known that China massively redistributed investment funds from coastal to inland provinces prior to 1978 partly for defense purposes, and partly to counter trends of coastal primacy that the Mao leadership associated with colonialism and neocolonialism. Allowing a more “natural” process of coast-led development to take its course after 1978 was among the decisive breaks of the reformers with the Mao-era regime. Planned interventions to counter the differential development rates that are likely to have been found under a market economy, and that did indeed emerge in the more liberal environment following 1978, may have prevented not only the advantages conferred by location but also those conferred by more advanced human capabilities from having their otherwise anticipated impact in the pre-1978 period.

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Because of difficulties finding earlier data on a large cross-section of countries, Burkett *et al.* used values of their three PID indicators measured in 1960 to proxy for the pre-industrial legacy of a substantially earlier time. They were able to check the correlation between 1960 population densities and those of 1911, which is high, and they confirmed that substitution of the 1911 population density series for the 1960 series in their model produces even more significant, positive coefficients. After the Burkett *et al.* study had been completed, the present authors located population data for earlier years and constructed series for populations around 1850 and 1860.<sup>38</sup> From these, we constructed population density series for the territories comprising present-day developing countries. As anticipated, the series for earlier years were also highly correlated with those of 1960. For the population density of 1850 for which a relatively larger sample could be constructed, the correlations with population densities of 1911 and 1960 are 0.97 (52 countries) and 0.88 (87 countries) respectively.<sup>39</sup> Substituting the earlier for the later series in the growth equations used by Burkett *et al.* again confirms that high pre-modern densities appear to cause high post-1960 growth rates. Both the densities for 1860 and those for 1850 have positive effects on growth, although the predictive power of the regression is slightly diminished in part because of a significant reduction in the number of countries for which data are available.

The conceptualization of social capability as a function of a society's pre-modern experience offers an integrative framework potentially capable of encompassing a large number of the non-economic influences on growth discussed earlier. Thus, measures of "institutional quality" and "political stability" may be related to Abramovitz's capacity to operate large-scale organizations, which in turn may be influenced by pre-industrial experience. Ethnic heterogeneity, emphasized by Easterly and Levine among others, is to a substantial degree a function of the relationship between the size of the nation and the size of pre-modern socio-

<sup>38</sup> Data for 1850 were calculated on the basis of information provided in McEvedy and Jones (1978). For 1860 the data was from Mitchell (1982, 1993)

<sup>39</sup> For the correlation figures above, the sample excludes current members of the OECD and oil exporters (as classified by the World Bank). The correlations with 1860 are much poorer though still positive. For 1911: 0.25 (45 countries) and 1960: 0.11 (49 countries). This is possibly because we had to rely more on imputations when calculating the 1860 series.

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political units.<sup>40</sup> Use of European languages and distance from the equator, which Hall and Jones found to be key determinants of “social infrastructure” and thereby of technical efficiency, are associated with pre-modern development patterns in that transmission of technology is (for reasons related to our discussion of know-how) facilitated by common culture. Regions with low indigenous population densities and with climates inviting to Europeans (e.g., North America and Australia) received injections of European pre-industrial culture between the sixteenth and nineteenth centuries, positioning them favorably for modern growth.<sup>41</sup> Trust and civic norms, as studied by Knack and Keefer, are also higher in more ethnically and socio-economically homogeneous nations that exhibited relative cultural modernity at earlier points in time. Income inequality, which a large literature has found to be linked to economic growth, may also be connected to pre-modern development, although perhaps in more complex ways. For instance, inequality has long been high in parts of the Americas where cleavages between populations of indigenous or African origin and those of European or mixed origin have been pronounced. In this century, inequality has been low, by comparison, in densely populated Asian countries with high ethnic homogeneity (and high PID). Although they retain separate statistical significance in the regressions of Burkett *et al.*, some of the effects picked up by the Latin American and sub-Saharan African dummy variables in growth regressions may be due to aspects of pre-modern historical experience that are not fully captured by population density and cultivation intensity measures.<sup>42</sup>

As an alternative measure of early development, Bockstette, Chanda and Putterman (2002) considered the depth of experience with supra-tribal political organizations (i.e., states). They found that an index of the proportion of the past two millennia during which a present-day nation had a government is an excellent predictor of the rate of economic growth

<sup>40</sup> At the low-intensity end of the pre-modern development continuum, the largest sociopolitical units were tribes likely to have distinct ethnic identities and languages. For an exogenously given size of nation state (e.g., the nations created by the colonial powers in Africa), there would thus be more ethnic heterogeneity the lower is PID.

<sup>41</sup> The interaction between the colonial experience and pre-colonial development is discussed at greater length in Putterman (2000). The effect of the colonial experience features prominently in studies by Acemoglu, Johnson and Robinson (2001, 2002).

<sup>42</sup> Two respects in which these measures are imperfect or incomplete are: (1) the population densities of the places where people actually live, and the degree to which those places have been able to interact, may be more important than the ratio of population to total land, which can include vast stretches of uninhabited land; (2) the measures do not directly account for the relative importance of pastoralists, nomads, and foragers in the recent pre-modern society.

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during 1960–95, and one that is robust to the inclusion of numerous control variables, including a set of region dummies.<sup>43</sup> 1960 population density and the state antiquity index are each highly significant when included in the same regression, implying that each captures a somewhat different dimension of the countries’ “initial conditions” for modern growth. In subsequent work, Chanda and Putterman (forthcoming) find that a similar index that considers state experience up to the year 1500 C.E. only is an equally strong predictor of 1960–95 growth rates, both in full world samples and in samples including present-day developing countries only.

How might the Adelman-Morris “social development” index studied by Temple and Johnson and the Boserup-type intensity measures studied by Burkett *et al.* (and Crenshaw *et al.*’s “demographic inheritance”) be related to one another? In principle, “social capability” as indicated by judgments about a society’s “degree of modernization of attitudes,” “economic dualism”, and so on, may well be the flip side of the coin of its long-term economic, social and demographic development in the sense of Boserup *et al.* The Boserup-type measures have the advantage of being based on physical data and being more easily quantified, but a drawback is that they are open to alternative interpretations—i.e., population density, for instance, could be contributing to growth not because it is correlated with historically built-up human capabilities, but for more direct reasons of specialization and scale. Correlation of the density measures with social indicators would be reassuring.<sup>44</sup> But both physical measures based on Boserup’s framework and judgments about social capability such as those of Adelman and Morris may be imprecise proxies for the underlying physical and social aspects (respectively) of development that they attempt to measure. It is of interest to investigate their relationship empirically and to see whether one type of measure adds explanatory power beyond that provided by the other.

The simple correlation between the A–M social development index and population density in 1960 for the 60 developing countries for which both

<sup>43</sup> The state antiquity index gives more weight to indigenous governments and to governments ruling more of the present-day territory of a country, and it weighs more heavily more recent experience by discounting the past (the main version explored applies a 5% discount rate per 50 year period). Details on and a revised version of the state antiquity index can be found at <http://econ.pstc.brown.edu/faculty/putterman/index.html>.

<sup>44</sup> Note again the complicating factor that we do not expect to find close correlation in places like Australia or Canada to which Western European human capital (culture) has been transplanted without Western European population densities.

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measures are available to us is .300, which suggests that there is indeed some overlap between them. However, the correlation between the social development index and the farmer/land ratio is negligible (.001) while that between the index and the irrigation share lies between these cases (0.155).<sup>45</sup> Addition of the Adelman-Morris (Temple-Johnson) social development index to the growth regressions of Burkett *et al.* does not affect the signs or significance levels of the PID measures. In these regressions, the social development index itself is positive but statistically insignificant.

However, further investigation shows that the relative explanatory powers of the two types of variables may be reversed by a change in the definition of growth and initial income. Temple and Johnson use the MRW specification, in which the dependent variable is the growth rate of GDP per worker, rather than of GDP per capita. Likewise, initial GDP per worker rather than per capita is the explanatory variable used to test conditional convergence. Burkett *et al.* use GDP per capita.<sup>46</sup> When both “social development” and production intensity measures (population density, etc.) are included in an MRW-style regression rather than in the regression of Burkett *et al.* (who follow Barro, 1991), “social development” is as significantly positive as it is reported to be by Temple and Johnson, whereas the production intensity variables are occasionally insignificant.

The interrelations between “social development” and the Boserup-type intensity concept warrant further investigation. Differences in the predictive powers of the two variables in different specifications suggest that pre-modern development may also have influenced the pattern of demographic change in the post-War period, with countries on the agrarian state end of the pre-modern development continuum reaching more advanced stages of their demographic transitions during recent decades. Regardless of this, both the Burkett *et al.* study and the Temple and Johnson study can be interpreted as pointing in the same direction: that the economic and social development legacies of some developing countries may be a key factor retarding their development in the post-War period.

<sup>45</sup> The correlation of the statehist index used by Bockstette *et al.* (2002) with the social development index is a high 0.447 when Latin American countries are excluded, but the two variables are essentially uncorrelated when those countries are included.

<sup>46</sup> A further difference is that the initial GDP and investment ratio variables are included in log form in MRW but in level form in Burkett *et al.*, which follows Barro (1991) and others. However, our tests show that it is the definition of the GDP variable, not this functional form, that drives the difference in results with respect to the PID and social development variables.

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## What difference does it make if the capacity for growth depends on history?

A considerable portion of cross-country differences in economic growth performance appears to be attributable to differences in institutional and social variables. This paper has centered on the suggestion that these variables may themselves be summarized under the heading of social capability or of a societal capacity for growth, and on the idea that this capacity may in its own turn to an important degree be a function of pre-industrial history. But what difference would it make if this were the case? Are bygones not bygones? Can such conclusions lead to anything other than a new form of cultural and geographic determinism (and for the disfavored, pessimism)?

Burkett *et al.* suggest more optimistic answers. Pre-modern development differed across regions not because of exogenous differences in culture or genes, but for imperfectly understood reasons of climate, natural resources, and geography. Differences in pre-modern development, and in the density-type variables that serve as indicators of that development, are only ultimate, not proximate, causes of the differences in recent rates of growth, they argue. The proximate causes are aspects of each society's stock of broad human capital that position them differentially to embark on modern growth. Although our evidence suggests that legacies of past centuries have strongly influenced the human capital bases inherited by countries in the century now ending, the head-start on modernization enjoyed by some societies need not be permanently decisive. Particular histories may have facilitated the modernization of some societies more than others in the past century, but the possibility for social modernization is in principle available to all. Indeed, some of the more historically disadvantaged countries, for instance in sub-Saharan Africa, may have made considerable progress in closing the gap in pre-conditions for development during the same post-War decades in which their per capita GDP growth lagged so dramatically. If enough such progress has been made, then the negative implication that slow post-War growth may have been "foreordained" may be less important than the optimistic implication that accelerated growth is now a real possibility. But a careful assessment of that progress, using direct measurements of literacy, skills, and so on, rather than population density (which does not move with social capability once

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the modern period begins), is called for before definite conclusions can be reached.

Formal education is surely one of the requirements for closing the gap in developmental potential. The differences in educational achievement remain large and are highly correlated with development levels, even though correlations between changes in education and rates of growth are more difficult to detect. It has been argued that the reason we fail to detect a stable and significant correlation with economic growth is that economically backward nations in the second half of the twentieth century have indeed registered increases in human capital stocks without appreciable improvements in economic performance. However, a look at the available data shows, for instance, that sub-Saharan African countries have lagged decidedly behind East Asia and the Americas in formal education at all levels throughout the period 1960–90, and that this is projected to remain the case well into this century. Sub-Saharan education levels in 1990 were in several respects still behind those attained by East Asia in 1940 and the Americas in the 1950s. Sub-Saharan countries also lagged far behind the other two regions in such professional training areas as law and engineering even when programs similar to a bachelor's level or below are included. Recent trends as reported by UNESCO suggest that the gap is on the way to closing in a few categories only.<sup>47</sup>

But if there is merit in our emphasis on learning-by-doing and on capabilities that are societal as opposed to individual in nature, then it is just as important that progress takes place with respect to experiential and informal dimensions of human capital. Neither social nor technological capabilities flow across international boundaries in the frictionless fashion sometimes postulated, not only because of differences in command of formal knowledge, but also because in a world of bounded rationality, culture, attitudes, and routine mediate the flow of ideas. Greater emphasis on development in some of the broader senses touched upon above may therefore bear as much fruit, in the long run, as will the standard policy

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<sup>47</sup> These and other conclusions and evidence are presented in Chanda and Putterman, 1998. An explanation of why the impact of education on growth has been difficult to measure may lie in the way in which we model that impact. One can think of human capital's role as one that facilitates the "development of capabilities," which is quite different from mechanically entering human capital into a production function. The question then arises as to how exactly human capital should influence capabilities. To understand, absorb, modify or create institutions necessary for successful and stable growth, there may need to be a sufficient magnitude of human capital in the economy, but this could be a necessary rather than a sufficient condition. The spread of education may be just as important as the magnitude of the per capita stock of education.

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prescriptions, including boosting formal training. The argument is thus consistent with the emphasis placed by the World Bank and the UNDP in the 1990s on “capacity building” as a key to development.<sup>48</sup> But it implies that “capacity” should be understood not only in the context of professional training and formal organizations, but in a broader sense that embraces all of economic life.

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<sup>48</sup> See, for example, UNDP (1993).

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