HAVE PRODUCTIVITY LEVELS CONVERGED?: PRODUCTIVITY GROWTH, CONVERGENCE, AND WELFARE IN THE VERY LONG RUN

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February, 1988

Economists have always expected the "convergence" of national productivity levels. The theoretical logic behind this belief is powerful. The per capita income edge of the West is based on its application of the storehouse of industrial and administrative technology of the Industrial Revolution. This storehouse is open: modern technology is a public good. The benefits of tapping this storehouse are great, and so nations will strain every nerve to assimilate modern technology and their incomes will converge to those of industrial nations.

William Baumol (1986) argues that convergence has shown itself strongly in the growth of industrial nations since 1870.[1] According to Baumol, those nations positioned to industrialize are

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*Boston University, Boston, MA 02215, and National Bureau of Economic Research. I would like to thank Moses Abramovitz, Paul David, Christina Romer, David Romer, Paul Romer, Peter Temin, Robert Waldmann, Jeffrey Williamson, and especially William Baumol for helpful comments.

[1]Consider Baumol (1986): "Among the main observations...is the remarkable convergence.... [T]here is a strong inverse correlation between a country's productivity... in 1870 and its... productivity growth since then," and Baumol (1987): "Even more remarkable... is the convergence in...living standards of the leading industrial countries....In 1870... productivity in Australia, the leader, was 8 times...Japan's (the laggard). By 1979, the ratio ... had fallen to about two."

much closer together in productivity now than a century ago. He bases this conclusion on a regression of growth since 1870 on 1870 productivity for sixteen countries covered by Angus Maddison (1982).[2]

Baumol's finding of convergence might -- even though Baumol himself does not believe that it should -- naturally be read to support two further conclusions. First, slow relative growth in the U.S. since WWII was inevitable: convergence implies that in the long run divergent national cultures, institutions, or policies cannot sustain significant productivity edges over the rest of the developed world.[3] Second, one can be optimistic about future development. Maddison's sixteen all assimilated modern technology and converged: perhaps all developing nations will converge to Western living standards once they acquire a foundation of technological literacy.[4]

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[2]Moses Abramovitz (1986) follows the behavior of these sixteen nations over time and notes that even among these nations "convergence" is almost entirely a post-World War II phenomenon. Abramovitz' remarks on how the absence of the "social capability" to grasp the benefits of the Industrial Revolution may prevent even nations that could benefit greatly from industrializing are well worth reading. Also very good on the possible determinants of the social capability to assimilate technology are Irma Adelman and Cynthia Taft Morris (1980), Gregory Clark (1987), and Richard Easterlin (1981).

[3]Baumol (1987): "America's [post World War II] lag in productivity growth... is very real.... But we can see this in new perspective as a necessary consequence of convergence." Baumol (1986): "The convergence of productivity levels in industrial nations inevitably condemned those with high 1870 productivity levels to relatively slow productivity growth since then."

[4]Nineteenth century economists like John Stuart Mill [1848] (1970) and Karl Marx [1853] (1973) were extremely optimistic about future convergence. Twentieth century economic historians like Gerschenkron (1962) stress the extremely rapid growth possible for a latecomer to development, which can accomplish in one generation what took earlier developers four. Baumol (1986) is not so

But when properly interpreted Baumol's finding is less informative than one might think. For Baumol's regression uses an ex post sample of countries that are now rich and have successfully developed. By Maddison's choice, those nations that have not converged are excluded from his sample because of their resulting present relative poverty. Convergence is thus all but guaranteed in Baumol's regression, which tells us little about the strength of the forces making for convergence among nations that in 1870 belonged to what Baumol calls the "convergence club."

Only a regression run on an ex ante sample, a sample not of nations that have converged but of nations that seemed in 1870 likely to converge, can tell us whether growth since 1870 exhibits "convergence." The answer to this ex ante question -- have those nations that a century ago appeared well placed to appropriate and utilize industrial technology converged? -- is no. An unbiased sample of nations relatively rich, well-integrated into the world economy, and thus well-positioned to utilize modern technology as of 1870 have not converged.[5]

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optimistic and so does not draw out this second implication. After examining post-WWII data, he writes that "the poorer less developed countries are still largely barred from the homogenization process.... [P]art of the explanation may well be related to produce mix and education. A less developed country that produces no cars cannot benefit from the invention... of a better car producing robot... [or] from the factor-price equalization effects of the accompanying investments."

[5]Baumol accepts the validity of this basic criticism of Baumol (1986). Baumol and Wolff (1988) and Wolff (1988) show that one can find a small number n so that an ex ante sample of the richest n nations does exhibit convergence. More striking is their documentation of strong convergence among European nations since 1950. Poor European nations have grown much faster than middle-income Latin American nations.

Maddison (1982) compiles long run national income and aggregate productivity data for sixteen successful capitalist nations.[6] Because he focuses on nations which (a) have a rich data base for the contruction of historical national accounts and (b) have successfully developed, the nations in Maddison's sixteen are among the richest nations in the world today. Baumol regresses the average rate of annual labor productivity growth over 1870-1979 on a constant and on the log of labor productivity in 1870 for this sample. He finds the inverse relationship of the first line of table 1. The slope is large enough to erase by 1979 almost all initial income gaps, and the residual variance is small.

Regressing the log difference in per capita income between 1870 and 1979 on a constant and the log of per capita income in 1870 provides a slightly stronger case for convergence, as detailed in the second line of table 1 and in figure 1. The logarithmic income specification offers two advantages. The slope has the intuitive interpretation that a value of minus one means that 1979 and 1870 relative incomes are uncorrelated, and extension of the sample to include additional nations becomes easier.

Baumol's regression line tells us little about the strength of forces making for convergence since 1870 among industrial nations. The sample suffers from selection bias, and the independent variable is unavoidably measured with error. Both of these create the appearance of convergence whether or not it exists in reality. Sample selection bias arises because any nations relatively rich in 1870 that have not converged fail to make it into Maddison's sixteen. Maddison's sixteen thus include Norway but not Spain, Canada but not Argentina, and Italy but not Ireland.

A fair test of convergence requires not an ex post sample of countries that have converged but an ex ante sample of countries that in 1870 looked likely to converge. Moreover, least squares is not a satisfactory estimation technique because of errors in measuring 1870 incomes. Such errors induce

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[6]Maddison's focus on nations that have been economically successful is deliberate; his aim in (1964), (1982), and (1987) is to investigate the features of successful capitalist development. In works like Maddison (1970, 1983) he has analyzed the long run growth and development of less successful nations.

opposite errors in 1870-1979 growth and bias the regression slope toward -1. As Baumol notes, such errors can produce the illusion of an inverse relationship between income in 1870 and growth since.

The unbiased sample used here meets three criteria. First, it is made up of nations that had high potential for economic growth as of 1870, in which modern economic growth had begun to take hold by the middle of the nineteenth century. Second, inclusion in the sample is not conditional on subsequent rapid growth. Third, the sample matches Baumol's as closely as possible, both because the best data exist for Maddison's sixteen and because analyzing an unbiased sample close to Baumol's shows that different conclusions arise not from different estimates but from removing sample selection and errors in variables biases.

Per capita income in 1870 is an obvious measure of whether a nation was sufficiently technologically literate and integrated into world trade in 1870 to be counted among the potential convergers. Nations with high incomes in 1870 were nations with the material and human resources to industrialize. Modern economic growth had already pushed real incomes far above the levels of the preindustrial world. And such a sample does not exclude nations which had good industrialization prospects in 1870 that have not since fulfilled their potential.[7]

The construction of this sample requires judgment. Per capita income in 1870 must be estimated for nations in the extended sample but not in Maddison's sixteen. The estimation of 1870 income is discussed in the appendix.[8] Changes in national boundaries must be dealt with; this paper

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[7]Alternative measures of prospects for development in 1870, such as per capita industrial production or the proportion of the labor force in agriculture, would serve as well but would make little quantitative difference. The correlations for the sample of Maddison's sixteen between 1870 per capita GNP and 1870 labor productivity and share of the labor force in agriculture are .98 and .84, respectively.

[8]The estimates of 1870 per capita income arrived at in the appendix are not precise enough to be used for assessing the history and development of any individual country. They do, however, serve adequately as the raw material for a comparative exercise like that carried out here in which explicit

uses modern boundaries throughout. The level of 1870 income to serve as a cutoff for inclusion in the sample must be set. The choice of cutoff level itself requires balancing three goals: including only nations which really did in 1870 possess the social capability for rapid industrialization; including as many nations in Baumol's sample as possible; and building as large a sample as possible.

One cannot proceed by pursuing this last goal at the expense of the others: one should not form a regression sample by including all nations for which 1870 income estimates can be generated. Few would argue that the failure of, say, India to converge is evidence against the convergence hypothesis. Even if nations that were not seen as having high growth potential are removed, an all-inclusive sample suffers from selection bias. Long run national accounts are luxuries. Nations likely to have the historians and archives necessary to construct such accounts are nations that have converged.

If the convergence club membership cutoff is set low enough to include all Maddison's sixteen, then nations with 1870 incomes above 300 1975 dollars are included. This sample covers half the world. All Europe including Russia, all of South America, and perhaps others (Mexico and Cuba?) were richer than Japan in 1870. This sample does not provide a fair test of convergence. The Japanese miracle is a miracle largely because there was little sign in 1870 that Japan -- or any nation as poor as Japan -- was a candidate for rapid industrialization.

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econometric correction is made for errors in variables and in which errors in measuring nineteenth century per capita income for any one nation can have only a limited effect.

The second poorest of Maddison's sixteen in 1870 was Finland. Taking Finland's 1870 income as a cutoff leads to a sample in which Japan is removed, while Argentina, Chile, East Germany,[9] Ireland, New Zealand, Portugal and Spain are added. Growth and initial per capita income levels for this resulting "once-rich twenty-two" sample are plotted in figure 2.[10]

All the additional nations have strong claims to belong to the 1870 convergence club. All were well integrated into the Europe-based international economy. All had bright development prospects as of 1870. Saxony-Silesia was not much inferior to the Ruhr in industrialization.[11] Argentina, Chile,

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[9]Perhaps only nations that have remained capitalist should be included in the sample, for occupation by the Red Army and subsequent relative economic stagnation has no bearing on whether the forces making for convergence among industrial capitalist economies are strong. There is only one centrally planned economy in the unbiased sample, and its removal has negligible quantitative effects on the estimated degree of convergence.

[10]A strong case can be made for including Czechoslovakia and Hungary in this extended sample even though estimates of their 1870 per capita GNP fall just below that of Finland. Bohemia was industrializing at a pace equal to that of Austria (see Ivan Berend and György Ránki (1974), David Good (1984, 1986), and Nachum Gross (1973)). William Ashworth (1977) and John Komlos (1983) believe respectively that the areas that were to become Czechoslovakia and Hungary grew faster than the area around Vienna over 1870 to 1914. It is this rapid growth that, combined with Bairoch's (1981) estimate of the relative income gap between Austria on the one hand and Czechoslovakia and Hungary on the other, places their estimated 1870 per capita income below Finland's and so leads to their exclusion from the sample.

[11]In fact, Saxony was more industrialized than the Ruhr until a surprisingly late date. By 1850 Saxony exported textiles, textile machinery, steam engines, and locomotives. Even in 1925 Saxony was still more densely settled than any country in the world. See Sidney Pollard (1981).

and New Zealand were grouped in the nineteenth century with Australia and Canada as countries with temperate climates, richly endowed with natural resources, attracting large scale immigration and investment, and exporting large quantities of raw and processed agricultural commodities. They were all seen as natural candidates for the next wave of industrialization.[12]

Ireland's economy was closely integrated with the most industrialized economy in the world. Spain and Portugal had been the technological leaders of Europe during the initial centuries of overseas expansion -- their per capita incomes were still above the European mean in the 1830's (Bairoch (1981)) -- and had retained close trading links with the heart of industrial Europe. Coke was used to smelt iron in Asturias in the 1850's, and by 1877 3,950 miles of railroad had been built in Spain. It is difficult to see how one could exclude Portugal and Spain from the convergence club without also excluding nations like Sweden and Finland.[13]

Baumol's sample failed to include those nations that should have belonged to any hypothetical convergence club but that nevertheless did not converge. The enlarged sample might include nations not in the 1870 convergence club. Consider Kuwait today: Kuwait is rich, yet few would take its failure to maintain its relative standard of living over the next fifty years as evidence against convergence. For Kuwait's present wealth does not necessarily carry with it the institutional capability to turn oil wealth into next generation's industrial wealth.

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[12]The first essay of Carlos Díaz-Alejandro (1970) is very instructive. It attempts to recall the days before 1930 when Argentina would have indisputably been considered part of the first world. This point is also made by W. Arthur Lewis (1978).

[13]See Pollard (1981). Pollard makes the parallel between the situations of Iberia and Scandinavia explicit.

No nation in the once-rich twenty-two is in the same class as Kuwait.[14] The prosperity of the temperate settler colonies -- Argentina, Chile, and New Zealand -- was built on European capital, labor, and skills at least as much as on natural resources. And the economic links from East Germany, Ireland, Portugal, and Spain on the one hand to the world's industrial core on the other were all strong enough in 1870 to make them natural candidates for rapid industrialization .

The volume of overseas investment poured into the additional nations by investors from London and Paris between 1870 and 1913 tells us that investors thought these nations' development prospects good. Herbert Feis' (1930)[15] standard estimates of French and British overseas investment

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[14]Except possibly for Australia. Maddison's estimate of Australian 1870 per capita income places Australia 43 percent higher than the next most prosperous nation, Britain. Yet Australia did not have the most technologically sophisticated economy in the world in 1870. Australia's prosperity was built on its abundant and fertile land and the European demand for sheep, just as Kuwait's prosperity today is built on the European demand for oil. Should the failure of Australia to maintain its 50 percent per capita income edge over the cluster of next most prosperous nations count as strong evidence for convergence? I would suspect not, yet in the regressions Australia delivers the strongest single impact in favor of convergence of any nation. In the text, Australia is kept in the once-rich twenty-two sample in order to avoid the suspicion of ex post sample reselection. The appendix considers the effect of removing Australia from the sample.

[15]Which still remains the standard source on overseas investment. See Edelstein (1982). The only major point possibly at issue is whether the London capital market channelled just British or a much wider pool of savings into international investments.

show the six non-European nations among the top ten[16] recipients of investment per capita from France and Britain, and four of the five top recipients of investment belong to the once-rich twenty-two.[17] Every pound or franc invested is an explicit bet that the recipient country's rate of profit will remain high and an implicit bet that its rate of economic growth will be rapid. The coincidence of the nations added on a per capita income basis and the nations that would have been added on a foreign investment basis is powerful evidence that these nations do belong in the potential convergence club.[18]

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[16]The foreign investment figures do provide a powerful argument for adding other Latin American nations -- Mexico, Brazil, and Cuba -- to the sample of those that ought to have been in the convergence club. Inclusion of these nations would weigh heavily against convergence.

[17]Japan would not merit inclusion in the 1870 convergence club on the basis of foreign investment before WWI, for Japanese industrialization was not financed by British capital. Foreign investors' taste for Japan was much less, investment being equal to about one pound sterling per head and far below investment in such nations as Venezuela, Russia, Turkey, and Egypt. Admittedly, Japan was far away and not well known. But who would have predicted that Japan would have five times the measured per capita GNP of Argentina by 1979?

[18]European outmigration was also overwhelmingly directed to nations in the once-rich twenty-two. Between 1860 and 1920, some twenty-five million (gross) departed Europe for the U.S., some five million each for Canada and Argentina, more than four million for Australia and New Zealand, and more than three million for Brazil. See Ashworth (1987).

Errors in estimating 1870 income are unavoidable and produce equal and opposite errors in 1870-1979 growth. These errors therefore create the appearance of convergence where it does not exist in reality.[19] If 1870 income is measured with error, the appropriate regression model is not:

(1) (1979 Income) - (1870 Income) = $\alpha + \beta$(1870 Income) + ε_i

where ε_i is a random error, but:

(2) (1979 Income) - (True 1870 Income) = $\alpha + \beta$(True 1870 Income) + ε_i

(3) (Estimated 1870 Income) = (True 1870 Income) + η_i

where η_i is a second random error and where true 1870 per capita income is not observed. The system composed of (2) and (3) is not identified under standard assumptions unless instruments are available. In this case instruments cannot be found: a variable correlated with 1870 income is one of the sources used to construct the estimates of 1870 income. The model is identified if one assumes that the errors ε and η are uncorrelated and fixes a value for the ratio of the error variances ρ (Malinvaud (1966)):[20]

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[19]By contrast, errors in measuring 1979 per capita income induce no systematic bias in the relationship between standard of living in 1870 and growth since, although they do diminish the precision of coefficient estimates.

[20]Letting y_i represent the log of estimated initial 1870 income, x_i represent the log of true initial 1870 income, and g_i represent estimated growth, the maximum likelihood estimates of "true" 1870 per capita income $\hat{x}_i$ and of the slope coefficient $\hat{\beta}$ solve the system:

$$(5) \quad (\hat{x})_i = \frac{(1 + \rho + \rho\hat{\beta})y_i + \rho(1 + \hat{\beta})g_i}{1 + \rho(1 + \hat{\beta})^2}$$

$$(6) \quad \hat{\beta} = \frac{\sum (\hat{x})_i (y_i + g_i)}{\sum (\hat{x})_i^2} - 1$$

$$(4) \qquad \rho = \left(\frac{\sigma^2_{\eta}}{\sigma^2_{\varepsilon}} \right)$$

A reasonable central value to fix for ρ is one, which implies that measurement error in 1870 income is equal in size to the regression disturbance. This if anything overestimates the precision of 1870 income estimates. Any believer in convergence is, moreover, committed to the position that ρ is large, for convergence requires not only a negative slope β but also a small variance of the regression disturbance ε. Nations have not converged if the spread of their relative incomes remains large, even if leaders now were followers a century ago.

Taking ρ equal to one as a central case is far more reasonable than the implicit fixing of ρ equal to zero of ordinary least squares. Below in table 3 and figure 3 results are reported for Baumol's regression, using the once-rich twenty-two sample over the period 1870-1979, for ρ equal to zero[21], to one-half, to one (the central case), to two, and to infinity.[22] Reporting results for this range of ρ values summarizes how beliefs about data quality map into conclusions about convergence.

From one point of view, the relatively poor quality of much of the nineteenth century data is not a severe liability for this paper. Only if there is less measurement error than allowed for will the results be biased against convergence. A more direct check on the importance of measurement error can be performed by examining convergence starting at some later date for which income estimates are

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[21]The ordinary least squares regression case in which measurement error in the independent variable is assumed nonexistent.

[22]This corresponds to the inverse regression in which ordinary least squares is used but the roles of dependent and independent variables are switched.

based on a firmer foundation. A natural such date is 1913.[23] The relationship between initial income and subsequent growth is examined for the period 1913-1979 in table 4 and figure 4.

The longer 1870-1979 sample of table 3 and figure 3 is slightly more hospitable to convergence than is the 1913-1979 sample, but for neither sample do the regression lines reveal a significant inverse relationship between initial income and subsequent growth. When it is assumed that there is no measurement error in 1870 income, there is a large negative slope to the regression line. But even in this case the residual disturbance term is large. When measurement error variance is assumed equal to half disturbance variance, the slope is slightly but not significantly negative.

For the central case of equal variances, growth since 1870 is unrelated to income in 1870. There is no convergence. Those countries with income edges have on average maintained them. If measurement error is assumed larger than the regression disturbance there is not convergence but divergence. Nations rich in 1870 or 1913 have subsequently widened relative income gaps. The evidence can be presented in other ways. The standard deviations of log income are given in table 5. Maddison's sixteen do converge: the standard deviation of log income in 1979 is only thirty-five percent of its 1870 value. But the appearance of convergence is due to selection bias: the once-rich twenty-two have as wide a spread of relative incomes today as in 1870.

The failure of convergence to emerge for nations rich in 1870 is due to the nations -- Chile, Argentina, Spain, and Portugal -- in the bottom left corner of figures 2 through 4. In the early

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[23]The data for 1913 is much more plentiful and solid than for other years in the early years of the twentieth century because of the concentration of historians' efforts on obtaining a pre-World War I benchmark. Beginning the sample at 1913 does mean that changes in country's "social capability" for development as a result of World War I appear in the error term in the regression. If those nations that suffered most badly in World War I were nations relatively poor in World War I, there would be cause for alarm that the choice of 1913 had biased the sample against finding convergence when it was really present. But the major battlefields of World War I lay in and the largest proportional casualties were suffered by relatively rich nations at the core of industrial Europe.

1970's none of these was a democracy. Perhaps only industrial nations with democratic political systems converge. A dummy variable for democracy over 1950-1980 is significant in the central (ρ=1) case in the once-rich twenty-two regression in a at the one percent level, as detailed in table 6.

But whether a nation is a democracy over 1950-1980 is not exogenous but is partly determined by growth over the preceding century. As of 1870 it was not at all clear which nations would become stable democracies. Of the once-rich twenty-two, France, Austria (including Czechoslovakia), and Germany were empires; Britain had a restricted franchise; Spain and Portugal were semi-constitutional monarchies; the US had just undergone a civil war; and Ireland was under foreign occupation. That all of these countries would be stable democracies by 1950 seems ex ante unlikely. Table 7 shows that shifting to an ex ante measure of democracy[24] removes the correlation. Whether a nation's politics are democratic in 1870 has little to do with growth since. The elective affinity of democracy and opulence is not one way with democracy as cause and opulence as effect.

There is one striking ex ante association between growth over 1870-1979 and a predetermined variable: a nation's dominant religious establishment. As table 8 shows, a religious establishment variable that is one for Protestant, one-half for mixed, and zero for Catholic nations is significantly correlated with growth as long as measurement error variance is not too high.[25]

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[24]Defined as inclusion in the electorate of more than half the adult male population.

[25]The once-rich twenty-two are split into nations that had Protestant religious establishments in 1870 (Australia, Denmark, Finland, E. Germany, Netherlands, New Zealand, Norway, Sweden, U.K., and U.S.), intermediate nations -- nations that either were split in established religion in 1870 or that had undergone violent and prolonged religious wars between Protestants and Catholics in the centuries after the Protestant Reformation -- (Belgium, Canada, France, West Germany, and Switzerland), and nations that had solid Catholic religious establishments in 1870 (Argentina, Austria, Chile, Ireland, Italy, Portugal, and Spain). This classification is judgmental and a matter of taste: are the Netherlands one of the heartlands of the Protestant Ethic or are they one of the few nations tolerant and pluralistic on matters of religion in the seventeenth century?

This regression is very difficult to interpret.[26] It does serve as an example of how culture may be associated with substantial divergence in growth performance. But "Protestantism" is correlated with many things -- early specialization in manufacturing (for a given level of income), a high investment ratio, and a northern latitude, to name three. Almost any view -- except a belief in convergence -- of what determines long run growth is consistent with this correlation between growth and religious establishment. Moreover, this correlation will not last: neither fast grower

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[26]The easy explanation would begin with the medieval maxim homo mercator vix aut numquam placere potest Deo: the merchant's business can never please God. Medieval religious discipline was hostile to market capitalism, the Protestant Reformation broke this discipline down in some places, and capitalism flourished most and modern economic growth took hold strongest where this breakdown of medieval discipline had been most complete.

But this easy explanation is at best incomplete. Initially the Reformation did not see a relaxation of religious control. Strong Protestantism -- Calvin's Geneva or Cromwell's Republic of the Saints -- saw theology and economy closely linked in a manner not unlike the Ayatollahs' Iran. And religious fanaticism is not often thought of as a source of economic growth.

Nevertheless the disapproval of self-interested profit-seeking by radical Protestantism went hand-in-hand with seventeenth century economic development. And by 1800 profit-seeking and accumulation for accumulation's sake had become morally praiseworthy activities in many nations with Protestant religious establishments. How was the original Protestant disapproval for the market transformed? Accounting for the evolution of the economic ethic of the Protestant West from Jean Calvin to Cotton Mather to Benjamin Franklin to Andrew Carnegie is a deep puzzle in economic history. The best analysis may still be the psychological account given by Max Weber [1905] (1958).

Japan nor fast grower Italy owes anything to the Protestant ethic.[27] The main message of table 8 is that, for the once-rich twenty-two, a country's religious establishment has been a surprisingly good proxy for the social capability to assimilate modern technology.

The long run data do not show convergence on any but the most optimistic reading. They do not support the claim that those nations that should have been able to rapidly assimilate industrial technology have all converged. Nations rich among the once-rich twenty-two in 1870 have not grown more slowly than the average of the sample. And of the nations outside this sample, only Japan has joined the industrial leaders.

This is not to say that there are are no forces pushing for convergence. Convergence does sometimes happen. Technology is a public good. Western Europe (except Iberia) and the British settlement colonies of Australia, Canada, and the United States are now all developed. Even Italy, which seemed outside the sphere of advanced capitalism two generations ago, is near the present income frontier reached by the richest nations. The convergence of Japan and Western Europe toward US standards of productivity in the years after WWII is an amazing achievement, and this does suggest that those present at the creation of the post-WWII international order did a very good job. But others -- Spain, Portugal, Ireland, Argentina, and Chile -- that one would in 1870 have thought capable of equally sharing this prosperity have not done so.[28] The capability to assimilate

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[27]But see Michio Morishima (1982).

[28]One can find good reasons -- ranging from the Red Army to landlord political dominance to the legacy of imperialism -- for the failure of each of the additional nations to have reached the world's achieved per capita income frontier in 1979. But the fact that there are good reasons for the relative economic failure of each of these seven nations casts substantial doubt on the claim that the future will see convergence, for "good reasons" for economic failure will always be widespread. It is a safe bet that in 2090 one will be able ex post to identify similar "good reasons" lying behind the relative economic decline of those nations that will have fallen out of the industrial core.

industrial technology appears to be surprisingly hard to acquire, and it may be distressingly easy to lose.[29]

The forces making for "convergence" even among industrial nations appear little stronger than the forces making for "divergence." The absence of convergence pushes us away from a belief that in the long run technology transfer both is inevitable and is the key factor in economic growth. It pushes us away from a belief that even the nations of the now industrial West will have roughly equal standards of living in 2090 or 2190. And the absence of convergence even among nations relatively rich in 1870 forces us to take seriously arguments like Romer's (1986) that the relative income gap between rich and poor may tend to widen.

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[29]Britain, the first industrial nation, is now almost as far behind today's industrial leaders in relative per capita income terms as nations like France and Germany were behind Britain in 1870. Something more than the logic of convergence may be at work.

APPENDIX

Estimates of 1979 per capita income for all nations in the sample are taken from Summers and Heston (1984), are calculated in Irving Kravis, Alan Heston, and Robert Summers' (1978) 1975 "international dollar" price measure. These 1979 estimates are not exactly equal to the estimates used by Maddison (1982) and Baumol (1986) for three reasons. First, Maddison (1982) relied on an earlier application of the United Nations International Comparison Project methodology (see Maddison (1982); Kravis, Heston, and Summers (1978); and Summers and Heston (1984)). Second, Maddison prefers to work with data in U.S. relative prices because the price structures of the other nations in his sample are becoming more and more like that of the U.S. as time passes. Third, Maddison (1982) works in 1970 prices but the natural index date for international dollars is 1975.

Since the price structures of some of the nations in the extended sample are still far from that of the U.S., I find considerable merit in the Kravis, Heston, and Summers international dollar measure. In addition, the use of U.S. relative prices would significantly increase the relative spread of incomes in the sample; use of the international dollar is therefore the choice of price weights most favorable to "convergence."

Per capita income estimates for 1870 and 1913 for the nations of Maddison's sixteen are calculated using Summers and Heston's (1984) estimates of 1979 per capita income and Maddison's (1982) estimates of 1870-1979 and 1913-1979 per capita income growth.[30] This preserves Maddison's estimates of growth rates. It is obvious that error in estimating growth rates will induce error in estimated initial per capita income. Thus allowance is made, as discussed in the text, in the statistical work for errors in the independent variable.

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[30]For an overview of the history of world development during the past century, see Pollard (1981) for Europe, Ashworth (1987), Lewis (1978), and W.W. Rostow (1978) for the world, and of course Simon Kuznets (1966).

Per capita income estimates for 1870 and 1913 for Ireland are calculated using the British per capita income estimates found in Maddison (1982) and the estimate of the relation between Irish and British per capita incomes found in R.C.O. Matthews, C.H. Feinstein, and J.C. Odling-Smee (1982; see also Feinstein (1972)). Matthews et al. estimate that Irish per capita income was fifty four percent of British in 1913 and that Irish and British per capita incomes grew at indistinguishable rates over the 1870 to 1913 period.

Per capita income estimates for 1870 and 1913 for Argentina are taken from Maddison (1970). The 1870 estimate depends heavily on Carlos Díaz-Alejandro's (1970) judgment and should not under any circumstances be cited for any purposes dealing with Argentinian development alone. The estimate is sufficiently shaky to be unacceptable for such purposes, although it is barely acceptable as an estimate for a comparative project like this one in which omission of nations for lack of acceptable data is not an option -- due to the potential generation of selection bias -- and in which errors in variables are adequately handled from a statistical point of view. The 1913 estimate is based on a considerably more solid foundation.

Per capita income estimates for Chile in 1913 are taken from Maddison (1970). Estimates of Chilean per capita income in 1870 are considerably more difficult to construct. Markos Mamalakis (1976) cites estimates of agricultural production that suggest that the agricultural sector alone produced enough to give all Chileans an annual income of more than two hundred and twenty 1975 dollars in 1841. On the assumptions that per capita income growth was constant from 1841 to 1913 and that the agricultural sector was initially three quarters of the economy, Chilean per capita income growth before 1913 was some 1.3 percent per annum, and 1870 per capita income was around 519 1975 dollars. This estimate is perhaps the shakiest of all, and places Chile close to the cutoff for inclusion in the sample. Although the volume of investment from London and Paris in Chile before 1913 strongly militates against Chile's exclusion, table A.1 reports quantitative statistical results for the basic regressions with Chile removed from the once-rich twenty-two sample.

Per capita income estimates for 1870 and 1913 for East Germany are calculated from data given in Maddison (1982), who reports German per capita income both not adjusting for changes in boundaries and adjusting for changes in boundaries (that is, calculating per capita income within the borders

of present-day West Germany). "East Germany" before WWII therefore does not have the same boundaries as post-WWII East Germany. The bias introduced by including parts of what is now Poland in the area of East Germany before WWII should be small, for the additional areas include both industrial Silesia and agricultural Prussia.

Per capita income estimates for 1870 and 1913 for New Zealand,[31] Portugal, and Spain are derived from Paul Bairoch (1976, 1981). Estimate of nineteenth century per capita income given by Bairoch are for 1860 and not, as in Maddison, for 1870. Bairoch's estimates are not in complete agreement with those of Maddison (1982), as is shown in figure A.1. The correlation between the two sets of mid-nineteenth century estimates of the log of per capita income for Maddison's sixteen is .91, and the estimated slope coefficients for the direct and reverse regressions of Maddison's estimates on Bairoch's are 1.16 and .71, respectively.

Maddison's estimates show a higher variance of log 1870 per capita income and are thus more favorable to the convergence hypothesis. For this reason, because Maddison's documentation is more complete, and because I am more comfortable with his estimates, past per capita income estimates are retained on Maddison's basis. The 1870 per capita income estimates for New Zealand, Portugal, and Spain are obtained by using the least squares regression of Maddison's estimates on Bairoch's to "predict" what Maddison would have estimated 1870 and 1913 per capita income to be had these nations fallen into his sample.

For the most part, minor adjustments of the sample by including or excluding individual nations make no perceptible difference in the quantitative results. Australia and Japan are the only exceptions, for each of these Asian outliers alone has the potential to cause noticeable shifts in the estimated degree of convergence by its inclusion or exclusion.

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[31]See J.A. Dowie (1966). Whether New Zealand should be counted as a nation is open to debate: only three hundred thousand people lived in New Zealand in 1870. Since New Zealand had an 1870 level of per capita income above the sample mean and has had relatively slow growth since, its inclusion in the sample is not hostile to convergence.

Australia is an especially troublesome case because it appears very possible that Australian income in 1870 may have been significantly lower than reported by Maddison. Bairoch's disagreement with Maddison has already been noted. Ian McLean and Jonathan Pincus (1983) believe that Australian 1870 per capita GNP has traditionally been overstated by as much as thirty three percent. David Pope (1984) reports that, on the standard estimates that serve as a basis for Maddison (1982), Australian real wages fell between 1870 and 1920. The fifty year stagnation of real incomes found in Maddison's estimates suggests that high Australian incomes in 1870 bore little relation to the dynamic of the industrial revolution and of technology driven economic growth.

The sensitivity of the empirical analysis to the inclusion of Australia is illustrated by table A.2, which reports regression results for the once-rich twenty-two sample with Australia omitted. Omitting Australia leaves a negative slope only in the case where there is not measurement error in 1870 per capita income, and in the central case where $\rho = 1.0$ creates a large degree of divergence. To make the point another way, consider the standard deviations of the once-rich twenty-two sample including and excluding Australia. Including Australia, the ratio of the standard deviations of 1979 to 1870 income is equal to 1.06. Excluding Australia, to 1.31. What would be substantial divergence in the relative spread of incomes with Australia excluded becomes no change in the relative spread with Australia included.

The addition of Japan to the once-rich twenty two has an effect roughly equal (in an opposite direction) to the subtraction of Australia, as table A.3 reveals. Although there is no ex ante warrant for including Japan in a sample of nations likely to rapidly industrialize as of 1870, its addition shifts the quantitative results toward showing convergence.

Looking back, one can find structural features that make Japan's rapid industrial success less of a surprise. Late Tokugawa Japan was a substantially urban, commercialized society. It had a relatively small proportion of its labor force in agriculture given its reported per capita income. According to Maddison, Japan had a proportion of the labor force in agriculture not that

different from Austria and Italy and almost exactly equal to Finland.[32] Yet according to Maddison Japanese per capita income in 1870 is only some forty percent of per capita income in these first nations and less than two thirds per capita income in Finland. As figure A.2 demonstrates, the relatively low share of the labor force in agriculture given Japan's estimated per capita income casts doubt on the accuracy of the per capita income estimates. Japan does not fit the relation between non-agricultural labor force share and per capita income that holds for the rest of Maddison's sixteen.[33] Throughout most of the nineteenth century a larger proportion of the Japanese population lived in the Shogun's seat of Edo than the proportion of the British population that lived in London (Seidensticker (1983)). Japanese life expectancy was high. All of these social indicators fit badly with a level as low as the 300 1975 dollars a year used by Maddison. They suggest that per capita income may be significantly mismeasured, for social indicators suggest higher standards of living than do per capita income estimates.[34]

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[32]And thus much below the agricultural share of nations with approximately Japan's 1870 per capita income.

[33]There are two other outliers that have a much lower proportion of their labor force in agriculture than one would think given their level of per capita income: Britain and Sweden. The reason for Britain's low share of the labor force in agriculture is obvious. The case of Sweden may be more akin to that of Japan; in Sweden also the social indicators suggest a much higher living standard than do the per capita income estimates.

[34]See Susan Hanley (1983), Yasukichi Yasuba (1986), but also Kazushi Ohkawa and Henry Rosovsky (1973). If per capita income was not underestimated then Japan's ability to assimilate industrial technology was very advanced for its wealth. See G.C. Allen (1981).

DATA
(in 1975 Dollars)

Nation	Per Capita Income (1870)	Per Capita Income (1913)	Per Capita Income (1979)
MADDISON'S SIXTEEN			
Australia	1922	2523	6160
Austria	751	1436	5731
Belgium	1137	1778	6078
Canada	881	2085	7527
Denmark	883	1724	6621
Finland	506	1053	5640
France	847	1658	6705
W. Germany	731	1562	6789
Italy	746	1051	4424
Japan	328	621	5749
Netherlands	1104	1591	5778
Norway	665	1162	6475
Sweden	557	1336	6594
Switzerland	1118	1866	6388
UK	1214	1864	5166
USA	1038	2462	8205

Nation	Per Capita Income (1870)	Per Capita Income (1913)	Per Capita Income (1979)
ADDITIONAL SEVEN NATIONS			
Argentina	762	1450	3119
Chile	519	1156	2337
E. Germany	741	1749	5409
Ireland	656	1007	3491
New Zealand	981	1624	4724
Portugal	637	725	2845
Spain	728	854	4246

REFERENCES

Abramovitz, Moses (1986), "Catching Up, Forging Ahead, and Falling Behind," Journal of Economic History.

Adelman, Irma, and Cynthia Taft Morris (1980), "Patterns of Industrialization in the Nineteenth and Early Twentieth Centuries," in Paul Uselding, ed., Research in Economic History vol. 5 (Greenwich: JAI Press).

Allen, G.C. (1981), The Japanese Economy (London: Weidenfeld and Nicolson).

Ashworth, William (1987), A Short History of the International Economy Since 1850, 4th ed. (London: Longman Group).

Ashworth, William (1977), "Typologies and Evidence: Has Nineteenth Century Europe a Guide to Economic Growth?" Economic History Review.

Bairoch, Paul (1981), "The Main Trends in National Economic Disparities since the Industrial Revolution," in Paul Bairoch and Maurice Lévy-Leboyer, eds., Disparities in Economic Development since the Industrial Revolution (New York: St. Martin's Press).

Bairoch, Paul (1976), "Europe's Gross National Product, 1800-1973," Journal of European Economic History.

Baumol, William (1986), "Productivity Growth, Convergence, and Welfare," American Economic Review.

Baumol, William (1987), "America's Productivity 'Crisis'," The New York Times (3:2, February 15, 1987).

Berend, Ivan, and György Ránki (1974), Economic Development in East Central Europe in the Nineteenth and Twentieth Centuries (New York: Columbia University).

Clark, Gregory (1987), "Why Isn't the Whole World Developed? Lessons from the Cotton Mills," Journal of Economic History.

Díaz-Alejandro, Carlos (1970), Essays on the Economic History of the Argentine Republic (New Haven: Yale).

Dowie, J.A. (1966), "The Course and Character of Capital Formation in New Zealand, 1871-1900," New Zealand Economic Papers.

Easterlin, Richard (1981), "Why Isn't the Whole World Developed?" Journal of Economic History.

Edelstein, Michael (1982), Overseas Investment in the Age of High Imperialism (New York: Columbia University).

Feinstein, Charles (1972), National Income, Output, and Expenditure in the United Kingdom (Cambridge, U.K.: Cambridge University Press).

Feis, Herbert (1930), Europe, the World's Banker (New Haven: Yale).

Gerschenkron, Alexander (1962), Economic Backwardness in Historical Perspective (Cambridge: Harvard University).

Good, David (1986), "Uneven Development in the Nineteenth Century," Journal of Economic History.

Good, David (1984), The Economic Rise of the Habsburg Empire (Berkeley: University of California).

Gross, Nachum (1973), "The Industrial Revolution in the Habsburg Monarchy," in Carlo Cipolla, ed., The Fontana Economic History of Europe (London: Fontana).

Hanley, Susan, "A High Standard of Living in Nineteenth Century Japan: Fact or Fantasy?" Journal of Economic History.

Komlos, John (1983), The Habsburg Monarchy as a Customs Union (Princeton: Princeton University).

Kravis, Irving, Alan Heston, and Robert Summers (1978), The United Nations International Comparison Project: Phase II; International Comparisons of Real Product and Purchasing Power (Baltimore: Johns Hopkins University).

Kuznets, Simon (1966), Modern Economic Growth: Rate, Structure, Spread (New Haven: Yale).

Lewis, W. Arthur (1978), Growth and Fluctuations, 1870-1913 (London: Allen and Unwin).

Maddison, Angus (1987), "Growth and Slowdown in Advanced Capitalist Economies," Journal of Economic Literature

Maddison, Angus (1983), "A Comparison of Levels of GDP Per Capita in Developed and Developing Countries, 1700-1980," Journal of Economic History.

Maddison, Angus (1982), Phases of Capitalist Development (Oxford: Oxford University Press).

Maddison, Angus (1970), Economic Progress and Policy in Developing Countries (London: Allen and Unwin).

Maddison, Angus (1964), Economic Growth in the West (New York: The Twentieth Century Fund).

Malinvaud, Edmond (1966), Statistical Methods of Econometrics (Amsterdam: North Holland Publishing Company).

Mamalakis, Markos J. (1976), The Growth and Structure of the Chilean Economy (New Haven: Yale).

Marx, Karl [1853] (1973), "The Future Results of British Rule in India," in Surveys from Exile (New York: Penguin).

Matthews, R.C.O., C.H. Feinstein, and J.C. Odling-Smee (1982), British Economic Growth 1856-1973 (Stanford: Stanford University).

McLean, Ian, and Jonathan Pincus (1983), "Did Australian Living Standards Stagnate between 1890 and 1940?" Journal of Economic History.

Mill, John Stuart [1848] (1970), Principles of Political Economy, with Some of Their Applications to Social Philosophy (New York: Penguin).

Ohkawa, Kazushi, and Henry Rosovsky (1973), Japanese Economic Growth (Stanford: Stanford University).

Pollard, Sidney (1981), Peaceful Conquest (Oxford: Oxford University Press).

Pope, David (1984), "Rostow's Kondratieff Cycle in Australia," Journal of Economic History.

Romer, Paul (1986), "Increasing Returns and Long Run Growth," Journal of Political Economy.

Rudolph, Richard (1976), Banking and Industrialization in Austria-Hungary (Cambridge: Cambridge University).

Seidensticker, Edward (1983), Low City, High City (New York: Knopf).

Summers, Robert and Alan Heston (1984), "Improved International Comparisons of Real Product and Its Composition, 1950-1980," Review of Income and Wealth.

Weber, Max [1905] (1958), The Protestant Ethic and the Spirit of Capitalism (New York: Scribner's).

Yasuba, Yasukichi (1986) “Standards of Living in Japan Before Industrialization,” Journal of Economic History.

TABLE 1
REGRESSIONS USING MADDISON'S SIXTEEN

Independent Variable	Dependent Variable	Constant	Slope Coefficient	Standard Error of Estimate	R^2
Natural Log of 1870 Productivity	Annual Percent Productivity Growth	5.251	-0.749 (.075)	.14	.87
Natural Log of 1870 Income	Log Difference of 1979 and 1870 Income	8.457	-0.995 (.094)	.15	.88

TABLE 2
TOP TEN RECIPIENTS OF BRITISH AND FRENCH* OVERSEAS INVESTMENT PER CAPITA AS OF 1913

Nation	Pounds Invested Per Capita	Belongs to Once-Rich Twenty-Two Sample?
Canada	86	Yes
Australia	57	Yes
New Zealand**	57	Yes
Argentina	54	Yes
South Africa	27	No
Chile	26	Yes
Cuba	17	No
Mexico	10	No
Brazil	8	No
USA	8	Yes

*French investments in Latin America allocated to nations in the same proportions as British investments.

*Not distinguished from Australia.

TABLE 3
MAXIMUM LIKELIHOOD ESTIMATION FOR THE ONCE-RICH TWENTY-TWO, 1870-1979

ρ	Slope Coefficient β	Standard Error of Slope	Standard Error of Regression	Standard Error in 1870 PCI
0.0	-.566	.144	.207	.0
0.5	-.292	.192	.192	.136
1.0	0.110	.283	.170	.170
2.0	0..669	.463	.134	.190
∞	1.381	.760	.0	.196

TABLE 4
MAXIMUM LIKELIHOOD ESTIMATION FOR THE ONCE-RICH TWENTY-TWO, 1913-1979

ρ	Slope Coefficient β	Standard Error of Slope	Standard Error of Regression	Standard Error in 1870 PCI
0.0	-.333	.116	.171	.0
0.5	-.140	.136	.151	.107
1.0	0.021	.158	.133	.133
2.0	0.206	.191	.106	.150
∞	0.444	.238	.0	.167

TABLE 5
STANDARD DEVIATIONS OF LOG OUTPUT FOR MADDISON'S SIXTEEN AND THE ONCE-RICH TWENTY-TWO

Sample	1870	1913	1979
Maddison's 16	.411	.355	.145
Once-Rich 22	.315	.324	.329

TABLE 6
DEMOCRACY OVER 1950-1980 AND LONG RUN GROWTH FOR THE ONCE-RICH TWENTY-TWO, 1870-1979

ρ	Slope Coefficient β	Standard Error of Slope	Coefficient on Democracy Variable	Standard Error	Standard Error in 1870 PCI	Standard Error of Regression
0.0	-.817	.277	.495	.085	.155	.0
0.5	-.744	.203	.476	.084	.154	.109
1.0	-.599	.208	.437	.090	.150	.150
2.0	0.104	.227	.248	.071	.131	.185
∞	1.137	.019	.044	.003	.0	.198

TABLE 7
DEMOCRACY IN 1870 AND LONG RUN GROWTH FOR THE ONCE-RICH TWENTY-TWO, 1870-1979

ρ	Slope Coefficient β	Standard Error of Slope	Coefficient on Democracy Variable	Standard Error	Standard Error in 1870 PCI	Standard Error of Regression
0.0	-.567	.342	.001	.091	.207	.0
0.5	-.272	.322	-.038	.094	.192	.136
1.0	0.164	.454	-.095	.115	.169	.169
2.0	0.742	.976	-.170	.180	.131	.155
∞	1.231	.167	-.195	.022	.0	.194

TABLE 8
DOMINANT RELIGION IN 1870 AND LONG RUN GROWTH FOR THE ONCE-RICH TWENTY-TWO, 1870-1979

ρ	Slope Coefficient β	Standard Error of Slope	Coefficient on Religion Variable	Standard Error	Standard Error in 1870 PCI	Standard Error of Regression
0.0	-.789	.252	.429	.088	.166	.0
0.5	-.688	.225	.403	.088	.164	.116
1.0	-.470	.248	.347	.098	.158	.158
2.0	0.375	.232	.132	.061	.132	.187
∞	1.199	.021	-.003	.004	.0	.197

TABLE A.1
MAXIMUM LIKELIHOOD ESTIMATION FOR THE ONCE-RICH TWENTY-TWO WITH CHILE SUBTRACTED, 1870-1979

ρ	Slope Coefficient β	Standard Error of Slope	Standard Error of Regression	Standard Error in 1870 PCI
0.0	-.723	.137	.186	.0
0.5	-.580	.175	.181	.128
1.0	-.231	.264	.169	.169
2.0	0.614	.604	.135	.191
∞	1.738	1.229	.0	.200

TABLE A.2
MAXIMUM LIKELIHOOD ESTIMATION FOR THE ONCE-RICH TWENTY-TWO WITH AUSTRALIA OMITTED, 1870-1979

ρ	Slope Coefficient β	Standard Error of Slope	Standard Error of Regression	Standard Error in 1870 PCI
0.0	-.430	.182	.208	.0
0.5	0.157	.290	.181	.128
1.0	0.769	.459	.147	.147
2.0	1.297	.650	.110	.155
∞	1.677	.779	.0	.161

TABLE A.3
MAXIMUM LIKELIHOOD ESTIMATION FOR THE ONCE-RICH TWENTY-TWO WITH JAPAN ADDED, 1870-1979

ρ	Slope Coefficient β	Standard Error of Slope	Standard Error of Regression	Standard Error in 1870 PCI
0.0	-.718	.124	.211	.0
0.5	-.580	.154	.205	.145
1.0	-.314	.216	.193	.193
2.0	0.373	.449	.158	.224
∞	1.444	.973	.0	.237

FIGURE 1
PER CAPITA GNP REGRESSION FOR MADDISON'S SIXTEEN

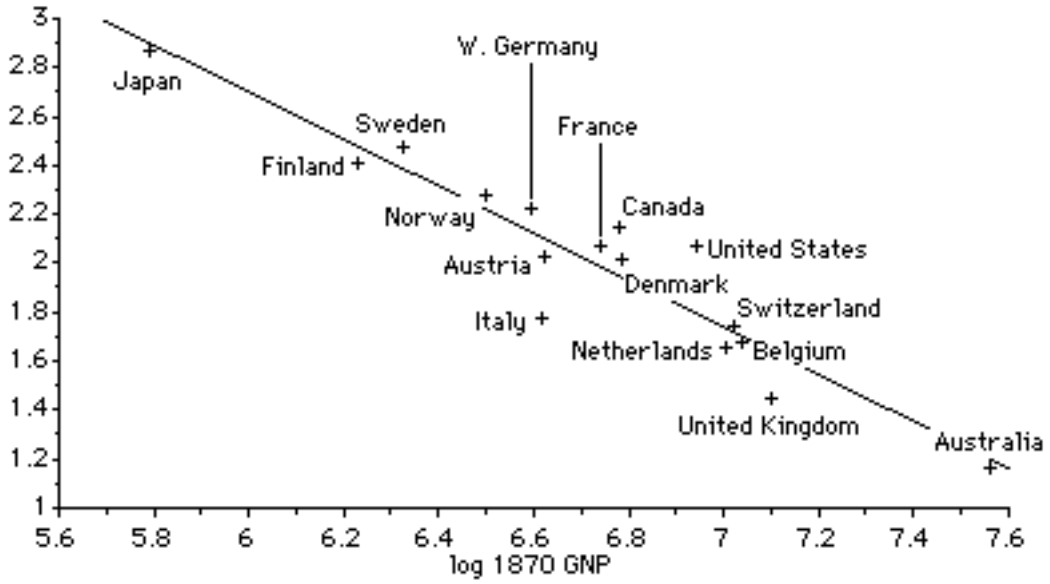


FIGURE 2
1870 PER CAPITA INCOME AND SUBSEQUENT GROWTH FOR THE ONCE-RICH TWENTY-TWO

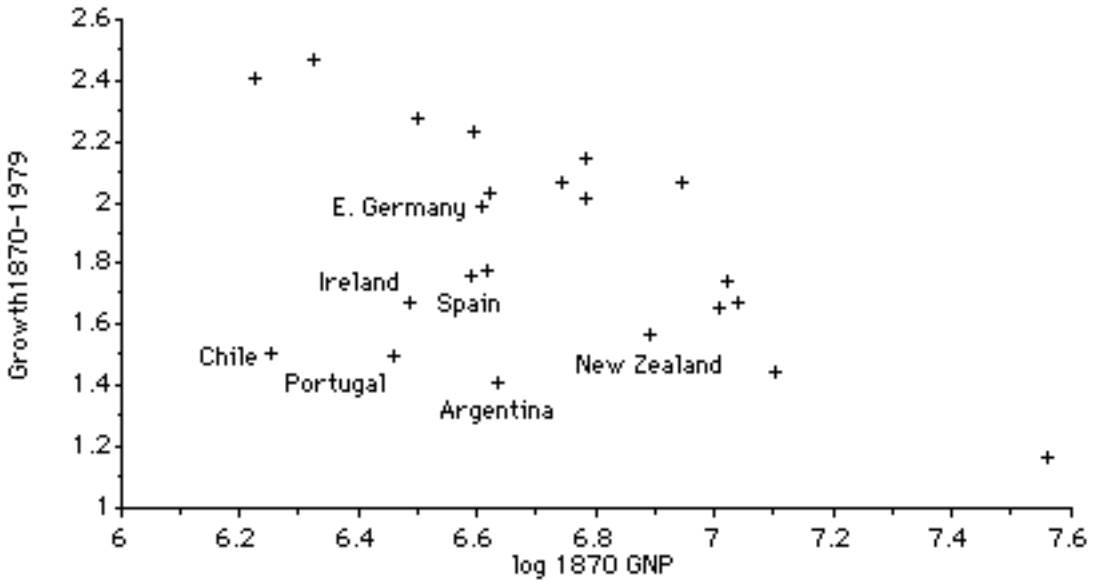


FIGURE 3
MAXIMUM LIKELIHOOD ESTIMATION FOR THE ONCE-RICH TWENTY-TWO
1870-1979

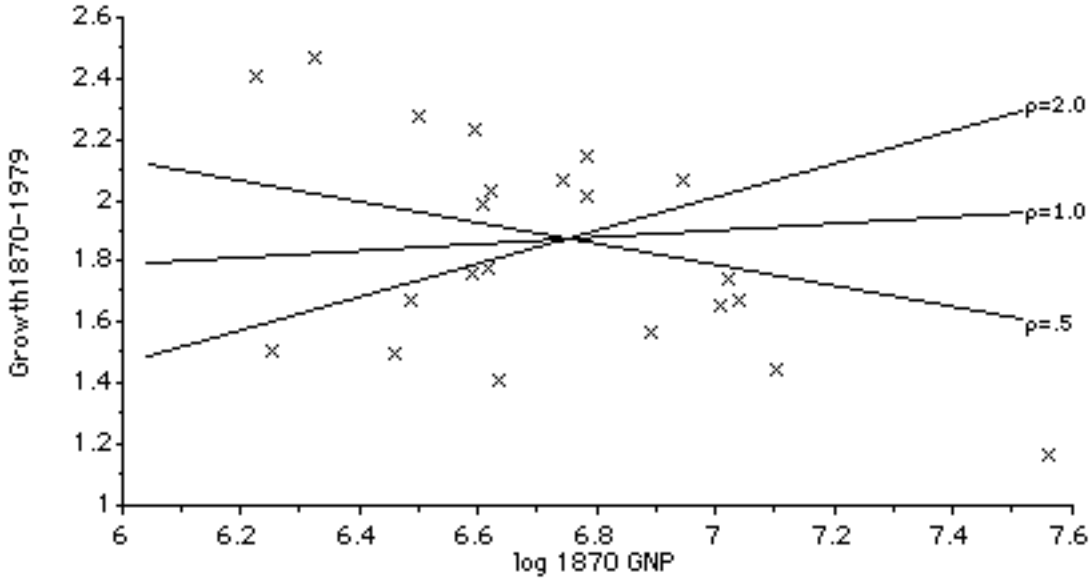


FIGURE 4
MAXIMUM LIKELIHOOD ESTIMATION FOR THE ONCE-RICH TWENTY-TWO
1913-1979

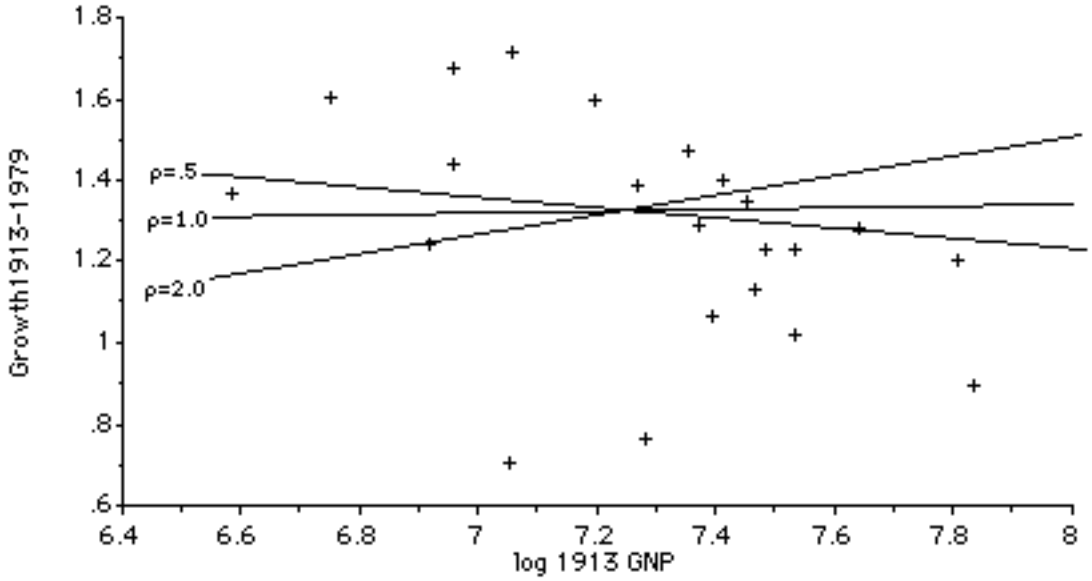


FIGURE A.1
MADDISON AND BAIROCH ESTIMATES OF NINETEENTH CENTURY PER CAPITA INCOME

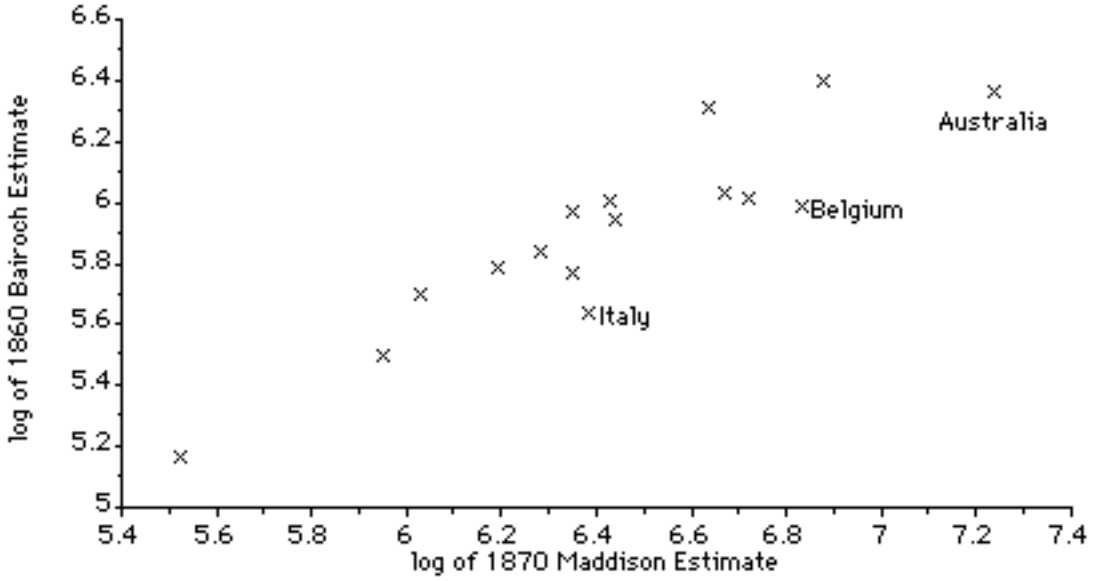
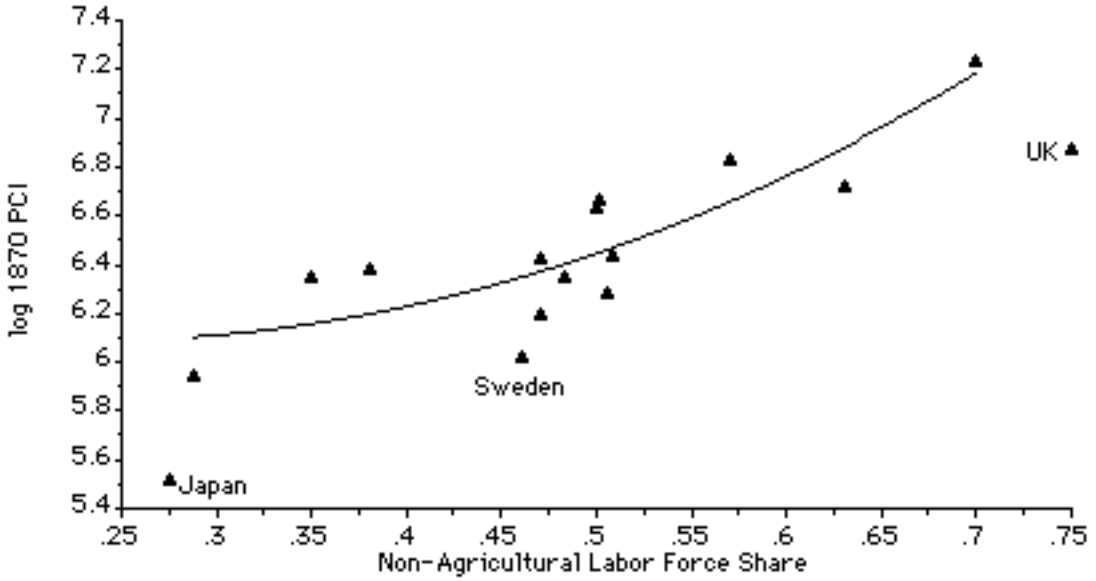


FIGURE A.2
1870 PER CAPITA INCOME AND NON-AGRICULTURAL SHARE OF LABOR FORCE FOR MADDISON'S SIXTEEN



NOTES TO CHARTS AND TABLES