*The Effect of Cultural Values on Economic Development: Theory, Hypotheses, and Some Empirical Tests**

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Theory: Cultural variables are incorporated into a baseline endogenous economic growth model.
Hypotheses: Cultural attitudes toward achievement and thrift have a positive effect on economic growth. Cultural attitudes concerning postmaterialism have a negative effect on economic growth.
Methods: Ordinary least squares regression is used to test economic and cultural models of growth on a cross section of 25 countries. The *encompassing* principle is used to resolve competing theoretical specifications and to generate a final parsimonious model. A variant of Leamer's Extreme Bounds Analysis (EBA) is used to evaluate the sensitivity of parameter estimates. The conclusions are further supported by nonparametric methods including robust regression and bootstrap resampling. The data for the analysis are from the World Values Survey (1990) and from Levine and Renelt (1992).
Results: An empirical model that incorporates both cultural and economic variables is superior to an explanation emphasizing one set of these variables. The final model is robust to: (1) alterations in the conditioning set of variables; (2) elimination of influential cases; and (3) variations in estimation procedures.

Introduction

Do cultural factors influence economic development? If so, can they be measured and their effect compared with that of standard economic factors such as savings and investment? This article examines the explanatory power of the standard endogenous growth model and compares it with that of two types of cultural variables capturing motivational factors—achievement motivation and postmaterialist values. We believe that it is not an either/or proposition: cultural and economic factors play complementary roles. This belief is borne out empirically; we use recently developed econometric techniques to assess the relative merits of these alternative explanations.

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Cultural factors alone do not explain all of the cross-national variation in economic growth rates. Every economy experiences significant fluctuations in growth rates from year to year as a result of short-term factors such as technological shocks or unforeseen circumstances that affect output. These could not be attributed to cultural factors, which change gradually. A society's economic and political institutions also make a difference. For example, prior to 1945, North Korea and South Korea had a common culture, but South Korea's economic performance has been far superior.

On the other hand, the evidence suggests that cultural differences are an important part of the story. Over the past five decades, the Confucian-influenced economies of East Asia outperformed the rest of the world by a wide margin. This holds true despite the fact that they are shaped by a wide variety of economic and political institutions. Conversely, during the same period most African economies experienced low growth rates. Both societal-level and individual-level evidence suggests that a society's economic and political institutions are not the only factors determining economic development; cultural factors are also important.

Traditionally, the literature presents culture and economic determinants of growth as distinct. Political economists and political sociologists view their respective approaches as mutually exclusive. One reason lies in the level of analysis employed and with this the underlying assumptions about human behavior. Another reason is that we have had inadequate measures of cultural factors. Previous attempts to establish the role of culture either infer culture from economic performance or estimate cultural factors from impressionistic historical evidence. Both factors could be important, but until cultural factors are entered into a quantitative analysis, this possibility could not be tested.

By *culture,* we refer to a system of basic common values that help shape the behavior of the people in a given society. In most preindustrial societies, this value system takes the form of a religion and changes very slowly; but with industrialization and accompanying processes of modernization, these worldviews tend to become more secular, rational, and open to change.

For reasons discussed below, the cultures of virtually all preindustrial societies are hostile to social mobility and individual economic accumulation. Thus, both medieval Christianity and traditional Confucian culture stigmatized profit-making and entrepreneurship. But, (as Weber argues) a Protestant version of Christianity played a key role in the rise of capitalism—and much later—a modernized version of Confucian society encourages economic growth, through its support of education and achievement.

The theory and evidence presented in this paper is organized as follows: section one discusses theories that deal with the effect of culture on eco-

nomic development. This literature emphasizes the importance of motivational factors in the growth process. Section two introduces the data. This data, based on representative national surveys of basic values, enable us to construct two measures of culture—achievement motivation and postmaterialist values. Section three discusses the baseline endogenous growth model. We draw upon a recent paper by Levine and Renelt (1992) to specify this model, and we augment it with cultural variables. Section four is the multivariate analysis. Economic and cultural variables each explain unique aspects of the cross-national variation in economic growth. Using the *encompassing* principle we find that an improved and parsimonious explanation for economic growth comes from a model that includes both economic and cultural variables. Section four also examines the robustness of this economic-cultural model and finds that the specification is robust to alterations in the conditioning set of information, the elimination of influential cases, and variations in estimation procedure. Section five concludes.

Culture, Motivational Factors, and Economic Growth

We first discuss the literature that views achievement motivation as an essential component in the process of economic development, and then we explore how cultural measures from the World Values Survey can be used to examine the effect of motivation on growth.

The motivational literature stresses the role of cultural emphasis on economic achievement. It grows out of Weber's (1904–1905) Protestant Ethic thesis. This school of thought gave rise to the historical research of Tawney (1926, 1955), case studies by Harrison (1992), and empirical work by McClelland et al. (1953) and McClelland (1961) on achievement motivation. Inglehart (1971, 1977, 1990) extends this work by examining the shift from materialist to postmaterialist value priorities. Although previous work mainly focuses on the political consequences of these values, their emergence represents a shift away from emphasis on economic accumulation and growth. These "new" values could be viewed as the erosion of the Protestant Ethic among populations that experience high levels of economic security.

We suggest that Weber is correct in arguing that the rise of Protestantism is a crucial event in modernizing Europe. He emphasizes that the Calvinist version of Protestantism encourages norms favorable to economic achievement. But we view the rise of Protestantism as one case of a more general phenomenon. It is important, not only because of the specific content of early Protestant beliefs, but because this belief system undermines a set of religious norms that inhibit economic achievement and are common to most preindustrial societies.

Preindustrial economies are zero-sum systems: they are characterized

by little or no economic growth which implies that upward social mobility only comes at the expense of someone else. A society's cultural system generally reflects this fact. Social status is hereditary rather than achieved, and social norms encourage one to accept one's social position in this life. Aspirations toward social mobility are sternly repressed. Such value systems help to maintain social solidarity but discourage economic accumulation.

Weber's emphasis on the role of Protestantism seems to capture an important part of reality. The Protestant Reformation combined with the emergence of scientific logic broke the grip of the medieval Christian Worldview on a significant part of Europe. Prior to the Reformation, Southern Europe was economically more advanced than Northern Europe. During the three centuries after the Reformation, capitalism emerged, mainly among the Protestant regions of Europe and the Protestant minorities in Catholic countries. Within this cultural context, individual economic accumulation was no longer rejected.

Protestant Europe manifested a subsequent economic dynamism that moved it far ahead of Catholic Europe. Shifting trade patterns, declining food production in Southern Europe and other factors also contributed to this shift, but the evidence suggests that cultural factors played a major role. Throughout the first 150 years of the Industrial Revolution, industrial development took place almost entirely within the Protestant regions of Europe, and the Protestant portions of the New World. It was only during the second half of the twentieth century that an entrepreneurial outlook emerged in Catholic Europe and in the Far East. Both now show higher rates of economic growth than Protestant Europe. In short, the concept of the Protestant Ethic would be outdated if we take it to mean something that exists in historically Protestant countries. But Weber's more general concept, that certain cultural factors influence economic growth, is an important and valid insight.

McClelland et al. (1953) and McClelland's (1961) work on achievement motivation builds on the Weberian thesis but focuses on the values that were encouraged in children by their parents, schools, and other agencies of socialization. He hypothesizes that some societies emphasize economic achievement as a positive goal while others give it little emphasis. Since it was not feasible for him to measure directly the values emphasized in given societies through representative national surveys, McClelland attempts to measure them indirectly, through content analysis of the stories and school books used to educate children. He finds that some cultures emphasize achievement in their school books more heavily than others—and that the former showed considerably higher rates of economic growth than did the latter.

McClelland's work is criticized on various grounds. It is questioned whether his approach really measures the values taught to children, or simply those of textbook writers. Subsequently, writers of the dependency school argue that any attempt to trace differences in economic growth rates to factors within a given culture, rather than to global capitalist exploitation, is simply a means of justifying exploitation of the peripheral economies. Such criticism tends to discredit this type of research but is hardly an empirical refutation.

Survey research by Lenski (1963) and Alwin (1986) find that Catholics and Protestants in the United States show significant differences in the values they emphasize as the most important things to teach children. These differences are more or less along the lines of the Protestant Ethic thesis. Alwin also demonstrates that these differences erode over time, with Protestants and Catholics gradually converging toward a common belief system.

The Data

The World Values Survey asks representative national samples of the publics in a number of societies, "Here is a list of qualities which children can be encouraged to learn at home. Which, if any, do you consider to be especially important?" This list includes qualities that reflect emphasis on autonomy and economic achievement, such as "thrift," "saving money and things," and "determination." Other items on the list reflect emphasis on conformity to traditional social norms, such as "obedience," and "religious faith."

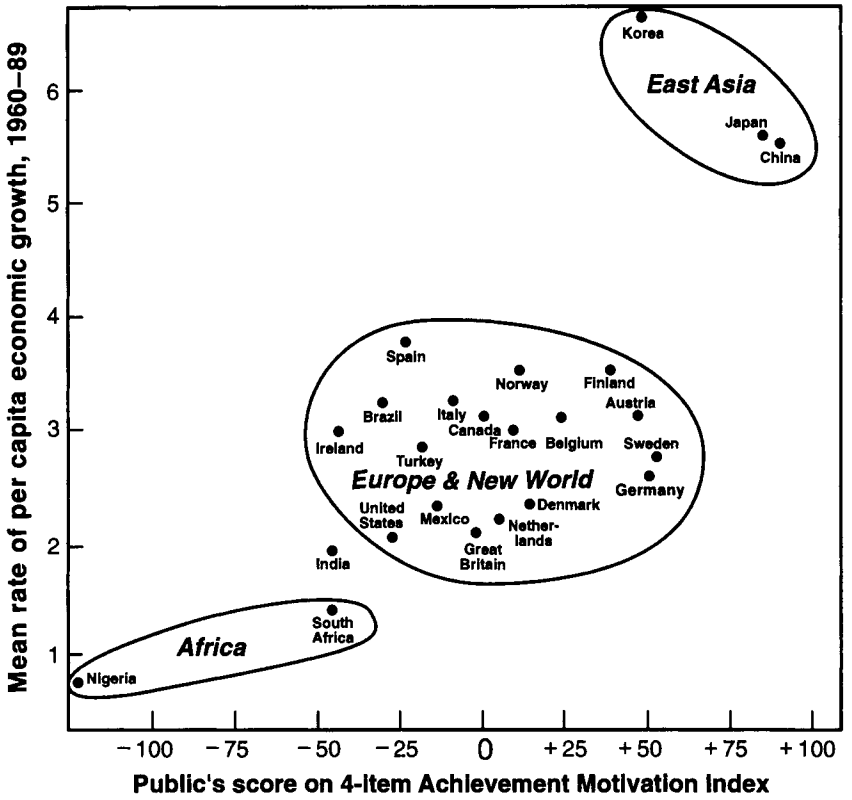
We construct an index of achievement motivation that sums up the percentage in each country emphasizing the first two goals minus the percentage emphasizing the latter two goals. This method of index construction controls for the tendency of respondents in some societies to place relatively heavy emphasis on all of these goals, while respondents in other countries mention relatively few of them.

Figure 1 shows the simple bivariate relationship between this index and rates of per capita economic growth between 1960 and 1989.[1] The zero-point on the achievement motivation index reflects the point where exactly as many people emphasize obedience and religion, as emphasize thrift and determination. As we move to the right, the latter values are given increasing emphasis. A given society's emphasis on thrift and determination *over* obedience and religious faith has a strong bivariate linkage with its rate of economic growth over the past three decades ($r = .66$; $p = .001$).

Though often stereotyped as having authoritarian cultures, Japan, China, and South Korea emerge near the pole that emphasizes thrift more

[1] Data sources and variable descriptions are contained in Appendix Table 1.

Figure 1. Economic growth rate by achievement motivation scores of publics.



Note: Achievement Motivation index is based on the percentage in each society who emphasized "Thrift" and "Determination" as important things for a child to learn, *minus* the percentage emphasizing "Obedience" and "Religious Faith."

heavily than obedience. The three East Asian societies rank highest on that dimension, while the two African societies included in this survey rank near the opposite end of the continuum, emphasizing obedience and religious faith.

The publics of India and the United States also fall toward the latter end of the scale. This is *not* an authoritarianism dimension. It reflects the balance between emphasis on two types of values. One set of values—thrift and determination—support economic achievement; while the

other—obedience and religious faith—tend to discourage it, emphasizing conformity to traditional authority and group norms. These two types of values are not necessarily incompatible: some societies rank relatively high on both, while others rank relatively low on both. But, the relative *priority* given to them is strongly related to its growth rate.

Do cultural factors lead to economic growth, or does economic growth lead to cultural change? We believe that the causal flow can work in both directions. For example, there is strong evidence that postmaterialist values emerges when a society attains relatively high levels of economic security. In this case, economic change reshapes culture. On the other hand, once these values become widespread, they are linked with relatively low subsequent rates of economic growth. Here, culture seems to be shaping economics—a parallel to the Weberian thesis, except that what is happening here is, in a sense, the rise of the Protestant Ethic in reverse.

Demonstrating causal connections is always difficult. In connection with our achievement motivation index, the obvious interpretation would be that emphasis on thrift and hard work, rather than on obedience and respect is conducive to economic growth. The two most sensitive indicators of this dimension are thrift, on the one hand, and obedience on the other. For some time, economists have been aware that a nation's rate of gross domestic investment is a major influence on its long term growth rate. Investment, in turn, depends on savings. Thus, a society that emphasizes thrift, produces savings, which leads to investment, and later to economic growth. We provide evidence below that this is probably the case. This does not rule out the possibility that economic growth might be conducive to thrift but this linkage is less obvious.

Emphasis on obedience is negatively linked with economic growth, for a converse reason. In preindustrial societies, obedience means conformity to traditional norms, which de-emphasize and even stigmatize economic accumulation. Obedience, respect for others, and religious faith all emphasize obligations to share with and support one's relatives, friends and neighbors. Such communal obligations are strongly felt in preindustrial societies. But from the perspective of a bureaucratized rational-legal society, these norms are antithetical to capital accumulation and conducive to nepotism. Furthermore, conformity to authority inhibits innovation and entrepreneurship.

The motivational component is also tapped by materialist/postmaterialist values, with postmaterialism having a negative relationship with economic growth. The achievement motivation variable is only modestly correlated with the materialist/postmaterialist dimension ($r = -.39$; $p = .0581$). Though both dimensions have significant linkages with economic growth, they affect it in different ways. The achievement motivation

dimension seems to tap the transition from preindustrial to industrial values systems, linked with the modernization process.

The materialist/postmaterialist dimension reflects the transition to post-industrial society, linked with a shift away from emphasis on economic growth, toward increasing emphasis on protection of the environment and on the quality of life more generally. Previous research demonstrates that: (1) a gradual shift from materialist toward postmaterialist goals has been taking place throughout advanced industrial society; (2) that this shift is strongly related to the emergence of democracy ($r = .71$); but (3) that it has a tendency to be negatively linked with economic growth (Abramson and Inglehart 1995).

Baseline Endogenous Growth Model

Neoclassical growth models today owe much to the work of Solow (1956) and Swan (1956). The essential feature of these models is their focus on savings, population growth, and shifts in technology. Production functions depend on shifts in these "exogenous" variables. For example, one could trace the economic growth consequences resulting from a shift in the rate of saving, the population growth rate, or technology. The weakness in these models, however, is that they show a paradoxical steady state result. In these models aggregate savings produce a level of capital formation such that gross investment exceeds depreciation, and thereby increases capital per worker. Consequently, at the limit, the marginal product of capital declines to the point where the savings (revenue) generated by the capital falls to a level just large enough to replace old equipment and provide machines for new workers. The steady state result is an unchanging standard of living.[2]

This latter result is clearly not supported by evidence from the real world. In time economists began searching for ways to augment the neoclassical model that would allow sustainable growth and increases in the standard of living. These models have been termed *endogenous growth* models. At the heart of the endogenous growth literature is an emphasis on the productivity of the population (Lucas 1988; Romer 1990). Unlike the "old" neoclassical models, endogenous growth models show that reproducible capital need not have decreasing returns to scale. Growth can be sustained in endogenous growth models. In particular, they assume constant returns to scale to a broad range of reproducible inputs, including human capital.

The two leading schools of thought, however, differ in their emphasis.

[2]This result was based on an assumption of constant returns to scale and fixed technology.

Romer (1990), argues that Research and Development (R&D) spending is the key to new technological developments, which result in increasing social returns to social knowledge. Alternatively, Lucas (1988) argues that expansion of human capital in terms of both education and "learning by doing," also plays a pivotal role in economic growth.

Empirical endogenous growth models invariably are of the following form:

$$Y_i = \beta I_{i,0} + \prod X_i + \varepsilon_i \quad [1]$$

where Y_i is output growth (per capita) for country i, $I_{i,0}$ is a set of economic variables measured at the beginning of the time period for country i. These variables include initial levels of wealth and investment in human capital, and are included because studies by Barro (1991), Helliwell (1994), Levine and Renelt (1992), and Mankiw, Romer, and Weil (1992) all find that they have a robust and positive partial correlation with economic growth. X_i is a set of "other variables" including a constant, physical capital investment rates (as a percent of GDP usually), and whatever other variables the investigator is interested in exploring.[3] Obviously, given the discussion in section one, our X variables will include achievement motivation and postmaterialism.

We have a great deal of confidence in the selection of these economic variables. Levine and Renelt (1992) find that the initial level of per capita income, the initial level of human capital investment, and the period share of investment to GDP have robust correlations with economic growth. Their investigation uses a variant of Leamer's (1983) Extreme Bounds Analysis (EBA) where the emphasis is on the "stability" of various "focus" parameters when variables are removed or added. They find that most other exogenous variables are fragile to alterations in the conditioning set of information. Thus, the conclusions of most empirical work rest on parameter estimates that fluctuate at a magnitude large enough to make scholars wary. Levine and Renelt's (1992) work is also informative in that they provide a straightforward way to evaluate the sensitivity of the cultural variables. We implement this procedure below.

Multivariate Analysis

Our empirical approach is straightforward: we begin by estimating (via OLS) a baseline endogenous growth model that includes variables identi-

[3]The indicator for human capital investment is the number of students enrolled at primary and secondary education institutions relative to the total population of that age group. The indicator for physical capital investment is the ratio of real domestic investment to GDP. The definitions and sources for this data, which we use later, are found in Appendix Table 1.

fied by Levine and Renelt (1992) as having robust partial correlations with economic growth. Using data for 25 countries[4] we first test the endogenous growth specification (Model 1 in Table 1). Following Equation [1], a nation's rate of per capita economic growth is regressed on its initial level of per capita income and human capital investment (education spending) as well as on its rate of physical capital accumulation. As expected, the results are quite compatible with the expectations of endogenous growth theory. The results of Model 1 are summarized as follows: (1) the significant negative coefficient on the initial level of per capita income indicates that there is evidence of "conditional convergence." That is, controlling for human and physical capital investment, poorer nations grow faster than richer nations; (2) investment in human capital (education spending) has a positive and statistically significant effect on subsequent economic growth; and (3) increasing the rate of physical capital accumulation increases a nation's rate of economic growth.

Overall this baseline economic model performs well: it accounts for 55% of the variation in cross-national growth rates and is consistent with prior cross-national tests of the conditional convergence hypothesis (e.g., Barro 1991; Mankiw, Romer, and Weil 1992). Model 1 also passes all diagnostic tests, indicating that the residuals are not serially correlated[5] (*LM* test), are normally distributed (Jarque-Bera test), and homoskedastic (White test).

Model 2 in Table 1 regresses the rate of per capita economic growth on a constant and the two cultural variables. As expected, both achievement motivation and postmaterialism are significant predictors of economic growth and have the expected sign. Thus, the arguments of both Protestant Ethic and postmaterialist type theories cannot be rejected by this evidence. In addition, these variables, taken by themselves, do fairly well, accounting for 59% of the variance in growth rates. A glance at the diagnostics also indicates that the residuals are well behaved.

Comparing Competing Empirical Models: Encompassing Results

Both the economic and cultural models give similar goodness-of-fit performance. Each model's regressors are statistically significant. Yet, which model is superior? Or do both models possess explanatory factors that are missing in the other? In Table 1 the Schwarz criterion (SC) favors

[4]The nations included in the multivariate analysis are: Austria, Belgium, Brazil, Canada, China, Denmark, Finland, France, Germany, Great Britain, India, Ireland, Italy, Japan, Korea, Mexico, Netherlands, Nigeria, Norway, South Africa, Spain, Sweden, Switzerland, Turkey, United States.

[5]This is a check for spatial correlation between the errors of the cases.

Table 1. OLS Estimation of Economic Growth Models Dependent Variable: Mean Rate of Per Capita Economic Growth (1960–89)

Model Variable	Model 1	Model 2	Model 3	Model 4
Constant	−0.70	7.29*	3.16	2.40*
	(1.08)	(1.49)	(1.94)	(0.77)
Per Capita GDP in 1960	−0.63*		−0.42*	−0.43*
	(0.14)		(0.14)	(0.10)
Primary Education in 1960	2.69*		2.19*	2.09*
	(1.22)		(1.06)	(0.96)
Secondary Education in 1960	3.27*		1.21	
	(1.01)		(1.08)	
Investment	8.69*		3.09	
	(4.90)		(4.40)	
Achievement Motivation		2.07*	1.44*	1.88*
		(0.37)	(0.48)	(0.35)
Postmaterialism		−2.24*	−1.07	
		(0.77)	(1.03)	
R^2 Adjusted	.55	.59	.69	.70
SEE	.86	.83	.72	.71
LM ($\chi^2(1)$)	.42	.65	.68	.87
Jarque-Bera ($\chi^2(2)$)	.05	.30	.18	.57
White ($\chi^2(1)$)	.28	.24	.37	.18
SC	.119	−.117	−.095	−.352

Notes: Mean of dependent variable: 3.04; *N* is 25 for all models; Standard errors in parentheses.
*t test: $p < .05$.

the cultural model (Model 2), but it is more desirable to implement a research strategy that allows us to eliminate variables and explanations that are empirically unsupportable. Mizon and Richard (1986) devised the encompassing principle—a set of statistical procedures—consistent with a progressive research strategy. In this subsection we use the encompassing principle to guide us in building a theoretically parsimonious and statistically efficient model of economic growth.[6]

[6]If models under consideration are nested, or if a new model simply adds one or more variables to the original model, conventional significance tests (e.g., Wald and likelihood ratio tests) for additional parameters are sufficient for model refinement. Traditionally, a model is said to be nested if it can be obtained by imposing restrictions on an alternative model. An alternative nesting conceptualization is used here. Following Hendry and Richard (1989), since all models are necessarily reductions of a data generation process (DGP), they must necessarily be related or *minimally nested.*

A progressive research strategy requires that the test statistics employed be comparable across samples. We know that the coefficient of determination—the R^2—does not pass muster (Achen 1982). On the other hand, the residual variance (SEE) is comparable across samples and, therefore, is an appropriate encompassing test statistic. In fact, Hendry and Richard (1989) argue that a necessary condition for one model to encompass a rival is variance dominance. The superior model must be a more accurate (smaller SEE) characterization of the data generation process (DGP). Variance dominance also has meaning for superior out of sample performance. Thus, a model that encompasses a rival also has superior forecast performance.[7]

Empirical models are de facto abstractions of the DGP based on certain theoretical constructs. The encompassing principle investigates the validity of a model relative to an alternative by determining whether a model statistically accounts for the main features of a rival. Encompassing enables analysts to choose one model over another and assess the relative credibility of theoretical and empirical models.

The encompassing principle has attractive functions: it aids the research process at two different levels. Encompassing assists in the building of a parsimonious model. Because an encompassing model (denoted ξ) predicts a rival model's parameters, it is possible to determine which parameters (variables) should be eliminated, or replaced by better alternatives. Second, encompassing helps find misspecification. Since an encompassed model is merely an erroneous reparameterization of a more credible model, one can, given the latter's parameters, determine where the encompassed model went awry. Therefore, repeated applications of encompassing to a large set of models facilitates the discovery of useful models that are approximations to the DGP, but closer to the DGP than other models considered.

Encompassing's statistical analogue centers on the competing empirical models parameters and residual variances. Formal definitions and derivations of parameter and variance encompassing are found in Granato and Suzuki (N.d.).

In the former case, the concern is whether the substitution of a rival model's parameters for those in the current model are statistically (in)distin-

[7]This is not to say that goodness-of-fit statistics and attendant diagnostic tests do not have value. But, their function is to indicate a specific model's accuracy and whether the parameters are consistent and efficient. The proper use of encompassing tests and the encompassing principle depends on models which are valid approximations of the DGP (i.e., the model passes any and all diagnostic tests). Encompassing tests are not a replacement for conventional testing practices; rather, encompassing tests augment existing practice. This augmentation puts empirical work within a progressive research framework.

Table 2. Encompassing Tests

Model 1 ξ Model 2	Form	Test	Form	Model 2 ξ Model 1
3.34	$t(1)$	JA-Test	$t(1)$	2.44
5.42	$F(2,17)$	Joint Model	$F(4,17)$	2.87

Notes: * = $p > .05$.

guishable (parameter encompassing). To test for parameter encompassing we employ a joint F-test. This test combines all instruments from two competing models into a large general model (artificial nesting). Common variables are removed from the general model to avoid multicollinearity. The test imposes zero restrictions on the instruments of each (sub)model to determine if either set of instruments alters the sum of squared errors significantly from the general model (see Appendix). In a test of Model 1 ξ Model 2 accepting the null indicates the zero restrictions on Model 2 have no statistical effect on the joint model. Model 1 ξ Model 2 in this case. In a progressive research strategy context, this parameter substitution tests if one theory explains more than a rival's explanation.

Variance encompassing, on the other hand, requires that the "new" parameter restrictions be at least as efficient—in terms of the residual variance—as the original model.[8] In short, a progressive research strategy not only necessitates that new and novel facts be put forth by the superior theory, but that this theory is also a more accurate explanation.

Returning to the models in Table 1, cultural values clearly matter. With the encompassing principle in our arsenal, we compare endogenous growth and cultural explanations for economic growth. The encompassing results presented in Table 2 are definitive: The JA-test for variance encompassing is significant and indicates that both models encompass each other. Neither model is an "efficient" substitute for the other. In addition, both models' parameter encompass each other as indicated by significant F-tests. In short, both models explain aspects of growth that the rival cannot. The implication is straightforward: growth rates are best understood as a consequence of both economic and cultural factors.

What happens when we combine the economic model with the cultural model? The results of this experiment are contained in Model 3. Beginning with the endogenous growth variables, adding the variables from Model 2

[8]The encompassing principle is most commonly used for linear models. To assess variance encompassing we use the JA-test (Davidson and MacKinnon 1981) as modified by Godfrey (1984). This test involves constructing Y-hat's for two competing models, and then adding the rival Y-hat's to the right-hand side of its rival.

significantly alters the parameter estimates and standard errors on secondary education spending and physical capital investment. In fact, the coefficient on the physical capital investment variable changes dramatically. It decreases from 8.69 in Model 1 to 3.09 in Model 3. While this coefficient still has the expected sign, it is now far from significant.

Why is physical capital investment, a variable "robustly" correlated with economic growth in a number of other studies, now insignificant? Achievement motivation quite possibly is conducive to economic growth at least partly because it encourages relatively high rates of investment. Achievement motivation also has an important direct effect on economic growth rates, quite apart from its tendency to increase investment. Presumably the direct path from culture to economic growth reflects the effect of motivational factors on entrepreneurship and effort.

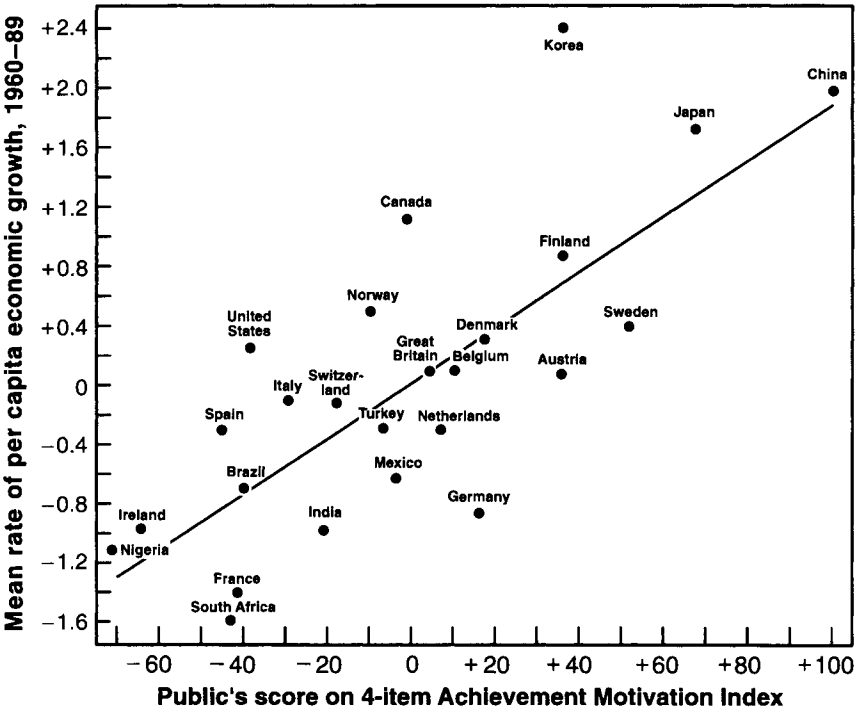
Returning to the analysis of Model 3 in Table 1, we now examine the direct effect of cultural values, particularly achievement motivation, on economic growth. As in Model 2, achievement motivation is positively and significantly related to economic growth. Combining Model 2 and Model 3 results in postmaterialism now being insignificant, however. This is probably due to the fact that countries with postmaterialist values are already fairly rich; the bivariate correlation between the initial level of wealth and postmaterialism is .75 and is significant at the .0000 level. Combining the regressors of these models (Model 3) we again have a model that does not violate any diagnostic test. In addition, the fit is more accurate (SEE).

Sensitivity Analysis

Table 1 contains an additional specification. In Model 4 we eliminate the three insignificant variables from Model 3—those for postmaterialism, investment, and secondary school enrollment—to check the stability of the remaining parameters. Model 4 is the most parsimonious and efficient model, explaining 70% of the variance in per capita growth rates with only three variables and generating a Schwarz criterion value of −.352. In addition, the residuals are well behaved and the model passes tests for serial (spatial) correlation, normality, and heteroskedasticity.

Are the results in Model 4 the consequence of either highly influential observations or the product of specific variables selected? We ask these questions because Jackman (1987) demonstrates that removal of even a single influential case may reduce parameter estimates to insignificance. Levine and Renelt (1992) take a different approach and show how alterations in the set of variables included in a model not only change the standard error of a variable of interest but also cause the parameter estimate to change signs. We use both of these approaches to evaluate the robustness of Model 4.

Figure 2. Partial Regression Plot of Achievement Motivation on Economic Growth.



The first robustness tests examine the influence of individual cases on the parameters of interest. Fox (1991, 21) suggests that influence can be thought of as a product of leverage and dependency. Leverage—the potential for the model as a whole to be influenced by a few large "X" values—is measured by Cook's Distance (D) and DFFITS. Discrepancy is measured by standardized and studentized residuals and indicate where larger outliers generate large residuals. Calculated values for these quantities based on Model 4 are contained in Appendix Table 2.

Figure 2 is a partial regression plot of the effect of achievement motivation on economic growth.[9] It appears Korea is quite influential. The diag-

[9]We also examine partial regression plots for the effect of per capita gross national product and primary school enrollment. These plots are available from the authors. For a discussion of partial regression plots see Bollen and Jackman (1985). For an illustrative application see Jackman (1987).

Table 3. Diagnostics on Model 4
Dependent Variable: Mean Rate of Per Capita Economic Growth (1960–89)

Model	4a Korea/U.S. Dummy	4b Korea/U.S. Omitted	4c Robust Regression	4d Bounded Influence	4e Bootstrapped 1000 reps
Variable					
Constant	2.42*	2.36*	2.29*	1.98*	2.42*
	(0.63)	(0.64)	(0.79)	(0.63)	(0.78)
Per Capita GDP in 1960	−0.44*	−0.39*	−0.41*	−0.44*	−0.43*
	(0.08)	(0.09)	(0.10)	(0.08)	(0.09)
Primary Education in 1960	1.98*	1.88*	2.09*	2.53*	2.10*
	(0.79)	(.80)	(0.98)	(0.80)	(0.96)
Achievement Motivation	1.87*	1.78*	1.81*	1.79*	1.88*
	(0.28)	(.30)	(0.35)	(0.27)	(0.33)
Korea/United States Dummy	1.43*				
	(0.43)				

Notes: Mean of dependent variable: 3.04.; N is 25 for all models except for model 4b ($N = 23$); Standard errors in parentheses.
*t test: $p < .05$.
4a estimated with a dummy variable coded 1 for Korea and the United States.
4b estimated without Korea and the United States.
4c estimated using robust regression.
4d estimated using Welsch's one step bounded influence estimator (Welsch 1980).
4e estimated using boostrap resampling of the residuals with 1,000 replications.

nostics provide more concrete evidence that Korea is an outlier. It has a standardized residual of 2.64 which is higher than the usual cutoff of ±2.0. Other cases of note are Germany (−1.85), Canada (1.66), and the United States (1.5); however, these three cases do not exceed the cutoff. Do these cases radically influence the parameter estimates?

The Cook's Distance (D) diagnostic measures influence on the model as a whole (Cook and Weisberg 1982). A case is considered influential if Cook's Distance (D_i) $> 4/n$.[10] Two cases exert influence according to this criterion: Korea ($D = .42$) and the United States ($D = .18$).[11]

We deal with this problem in a number of ways.[12] Table 3 compares

[10] Chatterjee and Hadi (1988) suggest the cutoff for Cook's Distance is defined as $D_i > 4/(n - k - 1)$. To be more cautious (due to the small sample size) we use $D_i > 4/n$.

[11] A related diagnostic, DFFITS, confirms the influence of these two observations. The DFFITS value for Korea is 1.54 and for the United States is .87. The cutoff point for DFFITS, as suggested by Bollen and Jackman (1985) is $2^* (k/n)^{1/2}$.

[12] Along with these overall measures there are diagnostics that examine the influence of individual cases on specific parameter estimates. The most popular is the DFBETA which looks at the effect on each coefficient of deleting the observations one at a time. We found that no case exerts undue influence on the variable we are primarily interested in, the four item achievement motivation index.

OLS results from Model 4 in Table 1 with a variety of estimation strategies. The first strategy is the one we like the least. This strategy involves either including a dummy variable for the influential cases (4a) or dropping the offending cases from the sample (4b). While both of these equations confirm the results in Model 4, however, they are both ad hoc and atheoretical. There is no *a priori* theoretical reason for adding additional variables to Model 4. The strategy of removing influential cases is similarly indefensible. Not only do these cases provide valuable information, but also one imagines a situation where after deleting observations and reestimating the model other influential cases are identified and are removed. This process continues until few interesting observations remain.[13]

Since we are not satisfied with strategies that either add variables or remove observations, we reestimate Model 4 using three alternative nonparameteric techniques. Equation 4c is estimated using a variant of robust regression. Robust regression uses estimators that perform well even when there are minor violations of assumptions regarding the underlying population.[14]

We still have a problem when cases have high leverage because leverage affects robust regression in the same way that it affects OLS (Hamilton 1992). In these cases, we want to constrain the influence of such cases within certain bounds. In equation 4d, we use a simple one-step bounded influence estimator suggested by Welsch (1980). The bounded-influence estimator also uses weighted least squares with the weights being determined as follows: (1) perform OLS regression and calculate DFFITS; (2) use the DFFITS values to construct a weight equal to one for |DFFITS|

[13]Even if one subscribes to this strategy there is evidence that Model 4 performs quite well. Figures 1 and 2 indicate that the countries of East Asia (China, Japan, and Korea) have cultural and growth experiences quite different from the rest of the sample. This is reason enough for us to argue against removal of these cases. When we reestimate Model 4 without China, Japan, and Korea, however, the results still support our general conclusion: the variables are all significant (albeit attenuated downward) and with the expected sign.

[14]The robust regression procedure we use comes from the family of M-estimators. Estimation proceeds as follows:

(1) Use OLS to obtain initial regression parameter estimates (to be used as starting values) and calculate the residuals. In general circumstances the first step would be to use OLS to estimate the parameters and compute Cook's Distance. Cases $D_i > 1$ are eliminated prior to calculating starting values (as Appendix Table 2 indicates, our sample does not contain any cases where $D_i > 1$).

(2) Use the residuals to calculate a set of case weights.

(3) Apply weighted least squares to obtain a new set of parameter estimates and calculate new residuals.

(4) Go back to step 2 and repeat the process until the maximum difference in weights drops below .01 (Hamilton 1992).

$\leq .34$ and equal to .34/|DFFITS| for |DFFITS| $> .34$. The cutoff of .34 is used because Welsch suggests that it provides for approximately 95% asymptotic efficiency. The results of using this bounded-influence estimator are in Equation 4d. Again, we find that the parameter estimates are not much different from those obtained using OLS. Note, however, that the weights assigned by the bounded-influence estimator are a result of the value for DFFITS.

The final estimation technique we use is a nonparametric approach: the bootstrap. Bootstrap resampling treats the sample as a population and resamples the residuals with replacement a specified number of times[15] (Mooney and Duval 1993; Stine 1990). Equation 4e is based on residual resampling using 1,000 replications.[16] The parameter estimates and standard errors based on the residual resampling are very close to those obtained with OLS.

The second robustness check is concerned with the effect of other possible explanatory variables on our parameter estimates. In order to ascertain whether these parameter estimates are "robust" to alterations in the conditioning set of information, we follow Levine and Renelt (1992) and include a set of variables in Model 4 and determine whether these "conditioning variables" significantly alter the coefficients or standard errors on our variables of interest. The conditioning variables we use, as suggested by Levine and Renelt (1992), are the growth rate of domestic credit, the standard deviation of domestic credit growth, the average inflation rate, the standard deviation of the inflation rate, the growth in government consumption expenditure, the average number of revolutions and coups, and a dummy variable indicating export orientation.[17]

The findings, not reported here, indicate that while the coefficient on the four item index of achievement motivation does decrease to 1.73, it is still statistically significant ($t = 2.8$).[18] In short, we have a great deal of confidence in the parameter estimates and standard errors in Model 4.

Conclusion

The idea that economic growth is partly shaped by cultural factors has encountered considerable resistance. One reason for this resistance is be-

[15] Note that there is a significant difference between resampling with random regressors and resampling with fixed regressors. We resample residuals because we have assumed that regressors in our model are fixed in repeated samples. See Stine (1990) for a discussion.

[16] Due to the small sample size, we "fattened" the residuals by dividing by $((1 - k)/n)^{1/2}$. We also used 10,000 replications and found almost identical results.

[17] We could not include China in this exercise since data for most of these conditioning variables are not available.

[18] The specifics of this sensitivity analysis, as well as the obtained coefficient estimates and standard errors, are available from the authors upon request.

cause cultural values have been widely perceived as diffuse and permanent features of given societies: if cultural values determine economic growth, then the outlook for economic development seems hopeless, because culture cannot be changed. Another reason for opposition is that standard economic arguments supposedly suffice for international differences in savings and growth rates. For example, the standard life cycle model and not cultural arguments explains the difference in savings rates and growth rates between, say, Germany, Japan, and the United States.[19]

When we approach culture as something to be measured on a quantitative empirical basis, the illusion of diffuseness and permanence disappears. We no longer deal with gross stereotypes, such as the idea that "Germans have always been militaristic," or "Hispanic culture is unfavorable to development." We can move to the analysis of specific components of a given culture at a given time and place. Thus, we find that, from 1945 to 1975, West German political culture underwent a striking transformation from being relatively authoritarian to becoming increasingly democratic and participant (Baker, Dalton, and Hildebrandt 1981). And we find that, from 1970 to 1993, the United States and a number of West European societies experienced a gradual intergenerational shift from having predominantly materialist toward increasingly postmaterialist value priorities (Abramson and Inglehart 1995). Though these changes have been gradual, they demonstrate that central elements of culture can and do change.

Furthermore, empirical research can help identify specific components of culture that are relevant to economic development. One need not seek to change a society's entire way of life. The present findings suggest that one specific dimension—achievement motivation—is highly relevant to economic growth rates. In the short run, to change even a relatively narrow and well-defined cultural component such as this is not easy, but it should be far easier than attempting to change an entire culture. Furthermore, empirical research demonstrates that culture can and does change. Simply making parents, schools and other organizations aware of the potentially relevant factors, may be a step in the right direction.

We find that economic theory already is augmented with "social

[19] In the post-World War II period, the life cycle model argues that since Japan and Germany had a substantial portion of their capital stock destroyed, the "permanent income" of the population was going to be less than was expected at the onset of the war. The lower capital-labor ratio contributes to lower real wages and higher interest rates. In response the public raised its savings rate to "smooth" its postretirement income. The United States, on the other hand, saw a significant increase in its capital stock—as a result of the war. This had the opposite effect since the higher capital-labor ratio depresses interest rates and raises real wages. The public's savings rate falls in this case since "permanent income" increases, while current consumption rises.

norms'' and ''cultural'' factors (Cole, Malaith, and Postlewaite 1992; Elster 1989; Fershtman and Weiss 1993). Where would cultural values fit theoretically in growth models? The economics literature is replete with models of savings behavior that focus on the ''life cycle'' and, more specifically, the bequest motive. Cultural variables matter here. Since savings and investment behavior holds an important place in growth models, a determination of how cultural and motivational factors can be used to augment these existing economic models, it seems to us, is the next step to uncovering a better understanding of economic growth.[20]

In the end, however, these arguments can only be resolved on the empirical battlefield. We use ordinary least squares regression to test economic and cultural models of growth on a cross section of 25 countries. We find that economic and cultural factors affect growth. The encompassing principle is used to resolve these competing theoretical specifications and to generate a final parsimonious model. The encompassing results show that both models explain aspects of growth that the other cannot. The robustness of these results were further validated using a variant of Leamer's Extreme Bounds Analysis (EBA) and nonparametric methods including robust regression and bootstrap resampling.

The results in this article demonstrate that *both* cultural and economic arguments matter. Neither supplants the other. Future theoretical and empirical work is better served by treating these ''separate'' explanations as complementary.

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[20] Institutional factors such as regime type and property rights have also been suggested as important determinants of economic growth (Helliwell 1994; Leblang 1996).

APPENDIX

We outline the *F*-test for parameter encompassing below. Procedures should be reversed to show Model 2 ξ Model 1.

The F-test

To show that Model 1 ξ Model 2 do the following:

A1) Estimate the joint specification of Model 1 and Model 2 below. Save the "unrestricted" residual sum of squares (RSS_u):

$$Y = \alpha X + \Gamma Z + \mu^*$$

A2) Estimate a "restricted" regression that sets $\Gamma = 0$. Save the "restricted" residuals (RSS_r).

A3) Calculate the *F*-test below.

$$\frac{(RSS_r - RSS_u)/k_2}{RSS_u/(n - k)} F(k_2, n - k)$$

A null finding indicates that Model 1 ξ Model 2.

APPENDIX

Table 1. Data Used in Economic Growth Regressions

Country	Growth[a]	GDP[b]	Primary[c]	Secondary[d]	Investment[e]	FourItem[f]	Postmaterial[g]
Austria	3.141	3.908	1.05	0.5	0.24373	0.46	2.11
Belgium	3.0639	4.379	1.09	0.69	0.19595	0.22	2.02
Brazil	3.2383	1.313	0.95	0.11	0.20599	−0.32	1.67
Canada	3.0608	6.069	1.04	0.52	0.201	0	2.14
China	5.5	0.567	0.75	0.41	0.20163	0.9	1.36
Denmark	2.4935	5.49	1.03	0.65	0.21627	0.2	1.99
Finland	3.5184	4.073	0.97	0.74	0.25217	0.38	2.23
France	2.9729	4.473	1.44	0.46	0.2224	0.09	2.04
Germany	2.7082	5.217	1.33	0.53	0.20923	0.52	2.14
Great Britain	2.1637	4.97	0.95	0.67	0.15317	−0.01	2
India	1.9398	0.533	0.61	0.2	0.19982	−0.46	1.58
Ireland	2.9652	2.545	1.1	0.35	0.22252	−0.44	1.96
Italy	3.5253	3.233	1.11	0.34	0.22909	−0.1	2.07
Japan	5.5539	2.239	1.03	0.74	0.31723	0.82	1.81
Korea	6.6378	0.69	0.94	0.27	0.2493	0.47	1.66
Mexico	2.26	2.157	0.8	0.11	0.20675	−0.15	1.86
Netherlands	2.3531	4.69	1.05	0.58	0.19853	0.13	2.26
Nigeria	.7517	0.552	0.36	0.03	0.147	−1.24	1.67
Norway	3.551	5.001	1.18	0.53	0.29782	0.1	1.81
South Africa	1.428	2.627	0.89	0.15	0.2555	−0.46	1.73
Spain	3.6954	2.425	1.1	0.23	0.22484	−0.24	1.94
Sweden	2.542	5.149	0.98	0.55	0.21237	0.5	2.09
Switzerland	1.9991	6.834	1.18	0.26	0.25747	−0.03	2.1
Turkey	2.8506	1.255	0.75	0.14	0.19792	−0.19	1.95
United States	2.0976	7.38	1.18	0.86	0.13906	−0.28	2.06

[a]Growth: Growth rate of real per capita GDP from 1960 to 1989. Source: Levine and Renelt (1992).
[b]GDP: The 1960 value of real per capita GDP (1980 base year). Source: Levine and Renelt (1992).
[c]Primary: The number of students enrolled in primary school grade level relative to the total population of that age group in 1960. Source: Levine and Renelt (1992).
[d]Secondary: The number of students enrolled in secondary school grade level relative to the total population of that age group in 1960. Source: Levine and Renelt (1992).
[e]Investment: Average from 1960 to 1989 of the ratio of real domestic investment (private plus public) to real GDP. Source: Levine and Renelt (1992).
[f]FourItem: Four Item Achievement Motivation Index comprised of (Thrift + Determination) − (Obedience + Religious Faith). Source: World Values Survey (1990).
[g]Postmaterialism: Mean score of postmaterialism. Source: World Values Survey (1990).

APPENDIX

Table 2. Diagnostics and Case Weights

Country	Rstandard[a]	Rstudent[b]	Cooks Dist[c]	DFFITS[d]	Robust W[e]	Bound W[f]
Austria	−0.9495	−0.947182	0.019	−0.2736804	0.9344327	1
Belgium	−0.2202	−0.2152011	0.001	−0.0504492	0.9968488	1
Brazil	0.0193	0.0188692	0.000	0.0078119	0.9990563	1
Canada	1.6618	1.740317	0.110	0.6955425	0.7999728	0.48882705
China	0.1369	0.1336649	0.003	0.1037808	0.98891	1
Denmark	−0.1206	−0.1177412	0.000	−0.0409734	0.9985626	1
Finland	0.1797	0.1755344	0.001	0.0541456	0.9949721	1
France	−1.1715	−1.182587	0.150	−0.7829324	0.9146342	0.43426483
Germany	−1.8565	−1.981786	0.146	−0.8162843	0.7501034	0.41652156
Great Britain	−0.1063	−0.1037699	0.000	−0.0342944	0.998759	1
India	−1.0073	−1.007698	0.055	−0.4691486	0.9372047	0.72471705
Ireland	0.2852	0.278949	0.005	0.1360241	0.9923928	1
Italy	0.5576	0.5483339	0.007	0.1696072	0.9692861	1
Japan	0.6540	0.6448598	0.027	0.3214996	0.946776	1
Korea	2.6414	3.154506	0.417	1.54147	0.4755642	0.22056864
Mexico	−0.8926	−0.8881056	0.015	−0.2475407	0.9416614	1
Netherlands	−0.6922	−0.6834447	0.007	−0.1679137	0.9590508	1
Nigeria	0.3351	0.3279361	0.029	0.3349275	0.994396	1
Norway	0.9402	0.9375238	0.017	0.2619067	0.9240916	1
South Africa	−1.2503	−1.268319	0.039	−.4015923	0.8742813	0.84662985
Spain	0.7417	0.7335156	0.024	.3084299	0.9493236	1
Sweden	−0.9887	−0.9882439	0.049	−0.4408704	0.9296764	0.77120165
Switzerland	0.1883	0.1839838	0.002	0.0804552	0.9991782	1
Turkey	−0.3363	−0.3291797	0.003	−0.1098775	0.9953059	1
United States	1.5000	1.549266	0.176	0.8659872	0.8714244	0.39261552

[a]Standardized Residuals
[b]Studentized Residuals
[c]Cook's Distance
[d]DFFITS
[e]Robust Regression Weights
[f]Bounded-Influence Weights

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