DOCUMENT RESUME

ED 481 122 | RC 024 187

AUTHOR	Henry, Mark; Barkley, David; Li, Haizhen
TITLE	Education and Nonmetropolitan Income Growth in the South.
PUB DATE	2003-08-08
NOTE	31p.; Revised version of a paper presented at the conference "Promoting the Economic and Social Vitality of Rural America: The Role of Education" (New Orleans, LA, April 14-15, 2003).
PUB TYPE	Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE	EDRS Price MF01/PC02 Plus Postage.
DESCRIPTORS	Counties; *Economic Development; Economics of Education; Educational Attainment; Elementary Secondary Education; *Human Capital; *Models; *Nonmetropolitan Areas; Rural Development; *Rural Economics; Rural Education
IDENTIFIERS	*United States (South)

ABSTRACT

Investigations of the linkages between improved schools and local economic development are rare. This paper considers several models that introduce human capital as a potential source of economic growth in the rural South. Results from various econometric models indicate that across the South, county per capita income growth rates from 1970 to 2000 were affected by the initial stock of human capital (percentage of adults with at least some college). The human capital influences were entered in standard growth regressions that were modified to capture spatial economic structure at the county level, thus including spatial lags and spatial error adjustments. For all nonmetro counties in the South, a standard-deviation increase in human capital stock in 1970 increased the real per capita income growth rate by 4 percent for the period 1970-2000 and 8 percent for 1980-2000. Increases in the initial human capital stock had the greatest influence on income growth in service-based counties and the least influence in mining counties. (Contains 28 references and many statistical equations and data tables) (SV)

Education and Nonmetropolitan Income Growth in the South

Mark Henry, David Barkley, and Haizhen Li
Department of Applied Economics and Statistics
Clemson University
Clemson, SC 29634

Paper at the Conference, "Promoting the Economic and Social Vitality of Rural America: The Role of Education"

New Orleans, April 14-15, 2003

Revised 8-8-03

Please refer comments or questions to mhenry@clemson.edu

Education and Nonmetropolitan Income Growth in the South

1. INTRODUCTION

The role of education in local, regional, and national economic development and how to finance schools have become central public policy issues in recent years. School finance is one of the most widely debated public policy issues across all levels of government. Much of this debate, in the post-*Serrano* era, has focused on ways and needs to revamp funding sources – increasing the state share and reducing local shares of school funding – in attempts to "equalize" funding per student across rich and poor school districts. Recent work has focused on effects that aging of the population might have on school funding (Ladd and Murray, 2001; Harris et al. 2001 and Poterba 1997).

However, investigation of the linkages between improved schools and local economic development are rare. Rural localities, in particular, which typically have lower education levels among the adult population than urban areas, may view increased educational investments as an important component of an economic development strategy. At the same time, rural communities are sensitive to the "leakage" of human capital investments to other areas with better education and job opportunities.

Improved educational attainment in a rural county may translate into a higher quality local labor force that in turn stimulates local economic development through enhanced entrepreneurial activity and labor force productivity. In addition, school quality may be important insofar as it *signals* prospective employers that the local labor force has good basic academic/analytical skills and will be more adaptive to new technology, thus reducing the unit labor costs to prospective employers.

Alternatively, a local pool of native talent may be relatively unimportant to rural development in the South. In this view; economic growth depends not on the size and quality of the labor force in a commuting area around the rural community but on the attractiveness of the local area, especially its natural and cultural amenities. Perceived school quality is just one of those amenities (and may be critical only where natural amenities are insufficient to attract labor force from outside the region).

In the next section of the paper, we consider several models that can be used to introduce human capital as a potential source of economic growth in the rural South. Since rural counties comprise the focus of concern, models of small region growth will need to reflect economic linkages that rural areas may have with proximate counties -- labor commuting, for example -- to estimate the relationship between added quantity and quality of local schooling and local economic growth in rural counties of the South.

2. SELECTED MACRO GROWTH MODELS WITH HUMAN CAPITAL

Incorporating human capital into macro growth models (education and/ or learning by doing) falls into two main camps (see Krueger and Lindahl, KL, 2001 for a review). In the first camp, neoclassical growth models of the Solow-Swan or Ramsey-Cass-Koopmans types introduce human capital as an exogenous factor in aggregate production functions to help explain growth of per capita GDP (or income). These models have been used extensively to test hypotheses about convergence of incomes (relative to their steady states) across countries. Examples include Mankiw, Romer and Weil (MRW 1992), Trondl (2001) and Barro and Sala-i-Martin (1995). MRW provide a test of the textbook Solow model augmented by human capital. While cross-*county* tests for convergence are rare, in one case, Rappaport (1999) finds real income convergence across U.S. counties.[1]

The second strand of macro growth models treats human capital as endogenously determined. In this camp, some view the *accumulation of human capital* as the key to sustained economic growth, as in Lucas (1988). To others, growth is attributable to the existing or *initial stock of human capital* – the source of innovations (Romer 1990) or "ability to imitate" and adopt innovations from outside the local economy (Nelson and Phelps 1966). In both the Lucas and Romer versions of the endogenous growth models human capital leads to sustained technological progress and growth (KL 2001:1108-1109) but convergence to a steady state is not predicted by these models.

A prototype empirical model following Benhabib and Spiegel (1994) takes the form of equation (1) (KL: 1112):

$$\Delta \log Yit = \beta 0 + \beta 1 \log Yit\text{-}1 + \beta 2\, Sit\text{-}1 + \delta \Delta S + Zit\text{-}1\, \beta 3 + \varepsilon \qquad (1)$$

where,

ΔlogYit = annualized change in log real income (or earnings) per capita from year t-1 to t in place i: (Ln Yit – Ln Yit-1)/ T where T is the number of years from t -1 to t.[2] This is equivalent to the compounded annual rate of growth from t-1 to t.

Sit-1 = Average years of schooling in the population in the initial year, (or share of population with college degrees).

Δ S = Change in the level of schooling between t and t-1 divided by the number of years in the period

Yit-1 = initial real income per capita,

Zit-1 = other "conditioning" variables (Δ workforce, Δ capital, etc.)

---

[1] Beeson-DeJong (2002) investigate convergence of population growth rates across counties of the U.S. while Simon-Nardinelli (2002) focus on employment growth in U.S. cities/MSAs.

[2] The growth rate, g, is found as: $Yt = Yt\text{-}1\, e^{gT}$ or $\ln Yt - \ln Yt\text{-}1 = gT$ and $g = (\ln Yt - \ln Yt\text{-}1)/T$.

βi = regression parameters to be estimated

ε = random error term

Schooling can be entered in linear (Mincer style) or in logs and in beginning period and/or changes. KL (p. 1119) find that, across countries, change in schooling has little effect on GDP growth over short time periods (five years) but that *both* initial levels and change in schooling over longer time periods (10 to 20 years) have positive effects on economic growth. This supports both models that contend it is the educational effect on the ability to innovate and adopt that matters to growth as well as models that argue that it is the added human capital as a separate factor of production that boosts economic growth

2.1 Some Data and Econometric Issues

The mountain of empirical work on estimating parameters of macro growth models across countries, and to a lesser extent across regions (e.g., states) reveals a variety of caveats and suggestions for an estimation strategy. Starting with KL's review, we note two principal issues that are pertinent to our problem of estimation of county level models:[3] controls for capital stock and spatial dependence.

2.1.1 The Stock of Physical Capital

While the use of a capital stock variable would seem highly desirable given the aggregate production function perspective of many macro growth models, there are several econometric and data issues to consider. KL specify four concerns:

[3] Much of the KL review concerns quality of data and measurement problems in cross-country estimation. As KL (2001:1131) suggest, measurement problems are likely to much less severe across regions of the US than across countries – even suggesting that regional studies might be superior to cross country analyses for that reason.

"1. Some authors argue that capital is endogenously determined in growth equations because investment is a choice variable and shocks to output are likely to influence the optimal level of investment…." 2. ".because of capital-skill complementarity, countries may attract more investment if they raise their level of education." 3. "..the growth in capital could in part pick up the effect of endogenous technological change." and 4. "Reliable capital stock data over time and countries may not be available." KL (2001: 1118)

One practical choice is to simply eliminate the change in capital per worker (or beginning period capital per worker) from the model. *This can be justified in the Solow type models if a Cobb-Douglas production function is assumed and capital's share is assumed to be constant overtime and invariant across countries* (KL 2001:1124). This seems unlikely for small regions like counties and as KL note "positive correlation between education and capital would imply that some of the increased output attributed to education …should be attributed to capital" (KL 2001:1124). This is the problem of capital-skills complementarity.

In sum, KL posit "lessons learned" from the growth regression literature:

1. "..change in capital has an enormous effect on a GDP growth equation, probably because of endogeneity bias." 2. "the impact of both the level and change in schooling on economic growth is sensitive to whether the change in capital is included in the growth equation *and* allowed to have a coefficient that greatly exceeds capital's share." 3..."controlling for capital exacerbates measurement error problems" and 4. "..when the coefficient on capital growth is constrained to equal a plausible value, changes in years of schooling are positively related to economic growth" KL(2001:1126).

Fortunately, the use of county data in the U.S. ameliorates the problem of measurement error compared to data from countries with less robust national economic accounting and census data. On one front, this makes us more sanguine about proceeding with empirical estimates than KL (2001:1126). On the other hand, measures of capital at the county level are not available necessitating strong assumptions about fixed capital shares across types of rural counties. In our case, we control for county economic base type to reflect differing aggregate production functions and the implied role of physical capital. For example, manufacturing based rural counties might be expected to have larger stocks of physical capital per worker than service based economies.

2.1.2 County Spatial Dependence

Spatial dependence between counties means that estimates from an econometric model without a spatial lag or error correction may be biased and inconsistent if the specification fails to capture spatial structural information (Anselin 1988). One solution to the problem of spatial dependence is to construct a spatially lagged variable that can account for spatial dependence. A typical spatial autoregressive model is[4]:

$$Y = \rho WY + X\eta + e \qquad (2)$$

where ρ is the spatial autoregressive parameter. Y is a random variable with a spatial autoregressive structure. W is a row standardized spatial weight matrix. WY represents the spatial lag of the dependent variable Y, and X is a vector of explanatory variables that are assumed to be uncorrelated with the error term; η is a vector of regression parameters and e is the random error term. If tests reveal spatial autocorrelation in the residuals after inclusion of the spatial lag, then an option is to estimate a general spatial model that includes an error term, λWu, in equation (2) under the assumption that the remaining errors, e, are normally and independently distributed with mean zero and constant variance.

We address the potential for spatial dependence in equation (1) by including a spatial lag, $W\Delta \log Yit$, since county growth can be affected by the fortunes of nearby

[4] Rearranging (2): $(I-\rho W)Y = X\eta + e$ or $Y = (I-\rho W)^{-1} X\eta + (I-\rho W)^{-1} e$ for the general spatial autoregressive model which allows the spatial data generating process to work through known variables, $X\eta$, and the unobserved variables, e.(See LeSage, 1999 for a discussion).

counties.[5] For example, substantial commuting activity across proximate counties means that income by place of residence can be associated with growth or decline in nearby local labor markets. In addition, earnings by place of work will reflect both the vitality of local labor markets in a county and backward and forward linkages that county businesses might have with businesses in proximate counties.

3. INCOME GROWTH REGRESSIONS

Like Benhabib and Spiegel(1994), MRW propose that both the growth rate of human capital and the level of human capital can be used to capture the effect of human capital on output growth.[6] An MRW-type model adjusted for county level regressions is summarized in equation (3).[7]

$$\Delta \log Yit = a + \rho \, W\Delta \log Yit + b \log Yit\text{-}1 + X \beta + \varepsilon \qquad (3)$$

where,

ΔlogYit = annualized change in log real income per capita from year t-1 to t in county i.

WΔlogYit = the mean growth rate in per capita income in counties that are contiguous to county i. This is the spatial lag with the matrix W formed as a n by n matrix with elements wij = 1 (except that wii = 0) for contiguous counties and wij = 0 elsewhere; n is the number of counties in the regressions. The W matrix is row standardized resulting in a simple mean growth rate across contiguous counties.

Yit-1 = initial real income per capita,

The X vector includes the following *county* control variables:

---

[5] Alternatively spatial dependence may be present only in the error term as we discuss in the empirical sections below.

[6] In one variation of the MRW growth regressions, a test for convergence provides evidence that the Solow model, augmented by human capital, is consistent with the patterns of growth in per capita GDP across countries.

[7] Alternative models are developed for population growth following Beeson and DeJong (2002), Rappaport (1999) and, for employment growth as suggested in Simon and Nardinelli (2002) in Henry etal 2003). Results including growth of Human Capital (HK) on the right hand side suggest strong HK effects on both population and employment growth across counties. However reverse causation is likely. Dropping HK growth as a regressor reduces the impacts of beginning period HK on rural growth rates.

Log Sit-1 = Log Share of the "25 Plus" population in the initial year with at least some college,[8]

Zi = other control variables: dominant economic base, transfer payments as a share of income, and a natural amenities index.

$(n+g+\delta)$ = n is the annual average growth rate of the working age population from t-1 to t. The rate of technical progress, g, and depreciation, δ, are assumed to be .05 following MRW.

$\varepsilon = \lambda W u + e$ for the general spatial and spatial error models reported below; Wu is the spatially autocorrelated residual vector; λ is the spatial error autocorrelation parameter; e is a vector of normally and independently distributed errors with mean zero and constant variance.

There are four main adjustments to prototype empirical model in (1). First, growth equation (1) is revised to capture controls for spatial dependence shown in (2).[9] Second, tests of the joint effect of initial stocks of human capital and its accumulation over time show substantial impacts on real income growth from both HK measures (see Henry et al 2003). However, concerns over feedbacks from higher income growth to higher rates of HK accumulation (reverse causation) motivated deletion of the HK growth variable.

Third, to test for the effect that human capital might have *on rural growth*, we modify equation (3) to include both a rural intercept adjustment and a slope shifter for the

---

[8] Use of college shares as a proxy for human capital attainment at the county level is suggested by Simon and Nardinelli (2002:64) who experimented at the county level with alternative measures "percent high school graduates and median year of education." They found that "Percent college graduates was the most robust predictor of growth overall, especially for earlier years in our sample." Rappaport (1999) also found % of adults with college is strongly and positively associated with county per capita income growth while % with only high school not to affect per capita income growth. In regressions with high school and above as the human capital proxy, we found little change in our parameter estimates.

[9] In the human capital-augmented Solow model, with the annualized rate of income growth as the dependent variable, the annual speed of convergence to steady state is found as $\theta = -[\log(1-b)]$ where b is the parameter on beginning period income per capita in the growth regression. The "half life" of convergence to the steady state – half the time between initial period Y_0 and Y^* (the steady state level) is found as Ln (2) / θ (see Tondl 2001:46 or Barro and Sala-i-Martin 1995: 37). In contrast to the Solow model, endogenous growth models can have divergence across per capita income levels that persist even if "countries have the same saving and population growth rates" (MRW, p. 423).

human capital variable as shown in equations (4) and (5). The rural test in equation (4) adds an intercept dummy variable for nonmetropolitan counties (NM=1 for nonmetro counties; 0 for metro counties) in the South and an interaction term between beginning period human capital and the nonmetro dummy.

Fourth, the other control variables differ from the country level models in (1). Investment share of local income is a component of the MRW model but since this is not available at the county level, we take this as a fixed share *across counties with the same dominant economic base.* We assume that this influence is captured in equation (5) through economic base intercept dummies that reflect alternative aggregate production functions. Further rationale for deleting investment, as KL find, is that inclusion of investment as a regressor is likely to lead to simultaneity bias in growth regressions on real income growth. We use share of transfer payments in personal income as a control for beginning period socioeconomic conditions – persistent poverty counties, retirement payments to the elderly, etc. Finally, we use an amenity index that captures dozens of physical and geographical features of each county (see McGranahan, 1999).

Adding these adjustments, except for type of nonmetro county economic base, to the MRW cross-country model yields equation (4).

$$\Delta \log Yit = a1 + a2\, NM + \rho\, W\Delta \log Yit + b \log Yi\, t\text{-}1 + \beta 1 \log Si,t\text{-}1 + \beta 2\, NM * \log Si,t\text{-}1 + \Sigma\, B5j\, Zij + \varepsilon \qquad (4)$$

If human capital endowments enhance income growth, we expect to see positive estimate for $\beta 1$. Moreover, if real income growth is faster in nonmetro than in metro counties *from the same initial level of human capital*, then we would find positive parameter estimates for $\beta 2$. A positive parameter on the nonmetro intercept dummy suggests that other forces (often interpreted as technical change in growth regressions) yield higher returns in nonmetro counties, given the initial level of income, human capital and other control variables.

Since rural counties – especially in the South -- often lag urban places in educational attainment, one might expect a larger boost to per capita incomes in rural areas than in urban areas from a given change in human capital. Moreover, the dominant economic base in a rural county might be expected to affect the ability to translate added human capital into faster real income growth – via an enhanced ability to adapt to new technology, improved learning by doing, etc. For example, rural counties dominated by farming with large shares of college educated residents might more readily adapt innovations in seed, chemicals, and machinery to generate higher net farm income compared to farm counties with few residents with a college education. In contrast, rural counties dominated by government (military bases, for example) might find real incomes that are closely tied to slow but steady adjustments in government pay scales regardless of the human capital resources in the county. If so, government counties' income growth would be less responsive to added human capital than farm counties.

To test for rural economic base effects on real income growth, we interact human capital with dummies for six economic base types defined by ERS in equation (5).[10] These include nonmetro counties that have as a dominant economic base of type k (EBk): Farming, Mining, Manufacturing, Government, Services or are broadly based, and "Non-specialized". Metro counties form the base of comparison for each type of rural economic base so one can detect differences in the human capital impacts on real income

[10] ERS economic base typologies cover each rural county. See Cook and Mizer (1994).

growth by inspection of the β2k parameter estimates and their corresponding statistical significance.

$$\Delta \log Yit = a1 + \Sigma a2k\ EBk + \rho W \Delta \log Yit + b\ \log Yi\ t\text{-}1 + \beta 1\ \log Si,t\text{-}1 + \Sigma\ \beta 2k\ EBk^{*}\ \log Si,t\text{-}1 + \Sigma\ B5j\ Zij\ + \varepsilon \quad (5)$$

4. EMPIRICAL RESULTS

4.1 Data

We estimate equations 4 and 5 using annualized rates of real income changes from 1970 to 2000, and over the period 1980 to 2000 using a lag on initial human capital as a second test for potential feedback effects.[11] The selection of the 1980 to 2000 period also permits us to test whether education's role on rural income growth differed in the time period sometimes thought of as the beginning of the "New" or "Global" economy. Data are from Census years, 1970, 1980 and 2000. Observations include all counties in fifteen southern states for each Census year. Data are from various Census files as compiled by the Inter-university Consortium for Political and Social Research (ICPSR), University of Michigan; from the Regional Economic Information System (REIS), Bureau of Economic Analysis, and U.S. Department of Commerce; and from the Economic Research Service (ERS), U.S. Department of Agriculture. Variable definitions, means and standard deviations are presented in Table 1.

Spatial econometric models are estimated using Anselin's *Spacestat 1.90* for the OLS, instrumental variable (IV) spatial lag models and the generalized method of

[11] While contemporaneous growth in HK is not included as a regressor, it is still possible that counties with higher rates of real per capita income growth from 1970 to 2000 attracted people with higher levels of HK by 1970, if these individuals anticipated the faster growth rates from 1970 to 2000. By looking at income

moments (GMM) spatial error models. LeSage (1999) public domain programs for MATLAB 6.5 are used to estimate the ML estimates of spatial autoregressive, spatial error, and general spatial models. Results on key parameters vary across spatial econometric models but typically not in dramatic fashion.

4.2 Regression Results

Results from estimating equation (4) are displayed in Table 2a. Like MRW, we find conditional convergence of real per capital income growth across counties (b = -0.0197 on the initial income variable in the General Spatial model (implying a half-life transition to the steady state of about 25 to 30 years). We also find that the spatial lag on income growth is consistently positive and highly significant in all the estimations suggesting that spatial autoregressive dependence is present in ΔlogYit. Both the GMM and ML estimates of the spatial error model indicate spatially autocorrelated residuals. Again, failure to adjust for the spatial lag may lead to biased parameter estimates in models that do not include a spatial lag variable. While we did not detect substantial variation in parameters across models estimated in Table 2a, the general spatial model results reveal that the spatial lag parameter, rho, and the spatial error autocorrelation parameter, lambda, are both highly significant. Accordingly, we focus our discussion on results from the general spatial model -- with both spatial lags and spatial error terms.

---

growth from 1980 to 2000 with 1970 HK stocks, we reduce the likelihood of this kind of potential feedback.

Table 1. Data Description, Means and Standard Deviations for Sourth State Counties

	1970		1980		2000	
	MEAN	**STD**	**MEAN**	**STD**	**MEAN**	**STD**
population	44,492	107,154	53,647	130,110	71,549	183,527
real income per capita ($,1982-84 price index)	7,374	1,700	9,125	2,033	12,360	2,861
persons w/ some coll.+ as % of pop 25+	13.47	5.94	20.92	7.79	37.70	10.47
metro	0.27	0.45	0.27	0.45	0.27	0.45
nonmetro	0.73	0.45	0.73	0.45	0.73	0.45
farm (ERS typology)	0.12	0.33	0.12	0.33	0.12	0.33
government (ERS typology)	0.08	0.27	0.08	0.27	0.08	0.27
manufacture (ERS typology)	0.22	0.42	0.22	0.42	0.22	0.42
mining (ERS typopogy)	0.06	0.23	0.06	0.23	0.06	0.23
service (ERS typology)	0.08	0.27	0.08	0.27	0.08	0.27
nonspecialized (ERS typology)	0.17	0.38	0.17	0.38	0.17	0.38
transfer payments as % of income	12.66	4.77	16.33	5.41	20.69	6.90
natural amenity scale	0.38	1.38	0.38	1.38	0.38	1.38
Note: All counties match ERS code. Fips 48301 (Loving County, Texas) is deleted since its number of persons w/ at least some college degree, which is a key variable and takes lag form in our analysis, equals zero in year 1970.						

In equation (4) we capture the role of human capital (HK) in real income growth from the effect of beginning period HK in both metro and nonmetro counties. HK is entered either as a "linear in the logs" variable.[12] As shown in Table 2a, our log measure of initial HK has a positive, statistically significant impact on the real income growth rate in both metro counties (the parameter on the "log schooling..." variable, Sit-1 in Table 2a) and in nonmetro counties (the sum of the parameters on the Sit-1 and NM*Sit-1 variables). In addition, higher initial shares of transfer payments reduce the rate of real income growth and faster income growth in proximate counties stimulates "own" county income growth (see General Spatial model). However, other variables do not have an important impact on real income growth after controlling for initial income, the human capital variables and growth in proximate counties.

[12] In the linear-log model (Ramanathan 2002:235), the effect that increasing the share of college graduates in 1970 (X1) has on the income growth rate (Y) is found as $\Delta Y = \beta 1 (\Delta X/X)$ or $(\beta 1 / 100)$ x percent change in X1 where $\beta 1$ is the partial regression parameter on the share of college in 1970. If $\beta 1$ is positive, the marginal effect of increasing X1 on the income growth rate declines as X1 increases. We assume a simple linear relationship between the growth rates. As KL (p. 1112) note, HK accumulation may be associated with faster "anticipated" real income growth -- raising a reverse causality bias problem. Bils and Klenow (2000) find this problem for cross country models accounts for about 1/2 of the HK effect on growth.

le 2a . Per Capita Income Growth: Metro vs. Nonmetro Counties in the South

Dep. Var.: County Annual Growth Rates in Income 1970 to 2000, in the South

Model	Base		Spatial Lag				Spatial Error				General Spatial	
Estimation Method	OLS		IV (2SLS)		ML		GMM (iterated)		ML		ML	
	coeff.	p-value	coeff.	p-value	coeff.	p-value	coeff.	p-value	coeff.	p-value	coeff.	p-value
intercept	0.1552	0.00	0.1220	0.00	0.1176	0.00	0.1484	0.00	0.1433	0.00	0.1243	0.00
log initial income	-0.0156	0.00	-0.0128	0.00	-0.0124	0.00	-0.0155	0.00	-0.0149	0.00	-0.0131	0.00
growth and depreciation factor	0.0008	0.05	0.0004	0.25	0.0004	0.14	0.0005	0.17	0.0004	0.17	0.0004	0.19
log schooling-pop share w/ college, initia	0.0032	0.00	0.0030	0.00	0.0030	0.00	0.0041	0.00	0.0038	0.00	0.0031	0.00
*log initial schooling*nonmetro*	-0.0026	0.00	-0.0018	0.00	-0.0017	0.00	-0.0016	0.01	-0.0014	0.01	-0.0016	0.00
nonmetro=1, metro=0	0.0032	0.07	0.0019	0.24	0.0018	0.06	0.0016	0.32	0.0012	0.43	0.0015	0.30
log transfer payments as share of income	-0.0014	0.00	-0.0009	0.04	-0.0009	0.01	-0.0003	0.59	-0.0001	0.81	-0.0009	0.02
natural amenity scale	-0.0002	0.01	-0.0001	0.32	-0.0001	0.18	-0.0001	0.64	-0.0001	0.42	-0.0001	0.17
rho			0.3932	0.00	0.4380	0.00					0.3950	0.00
lambda							0.4780	0.00	0.5270	0.00	0.0780	0.00
R2-adj.	0.2797				0.2769				0.4135		0.3982	
Sq.Corr.			0.3855				0.2620					
Test for Spatial Dependence												
	test stat.	p-value	test stat.	p-value								
LM (error)	217.60	0.00	0.12	0.73								
Robust LM (error)	20.29	0.00										
LM (lag)	205.50	0.00										
Robust LM (lag)	8.18	0.00										

le 2b. Per Capita Income Growth: Metro vs. Types of Nonmetro Counties In the South

Dep. Var.: County Annual Growth Rates in Income 1970 to 2000, in the South

Model	Base		Spatial Lag				Spatial Error				General Spatial	
Estimation Method	OLS		IV (2SLS)		ML		GMM (iterated)		ML		ML	
	coeff.	p-value	coeff.	p-value	coeff.	p-value	coeff.	p-value	coeff.	p-value	coeff.	p-valu
intercept	0.1548	0.00	0.1200	0.00	0.1227	0.00	0.1541	0.00	0.1487	0.00	0.1307	0.0
log initial income	-0.0155	0.00	-0.0127	0.00	-0.0129	0.00	-0.0160	0.00	-0.0154	0.00	-0.0137	0.0
growth and depreciation factor	0.0005	0.16	0.0003	0.48	0.0003	0.31	0.0005	0.19	0.0004	0.17	0.0003	0.1
log schooling-pop share w/ college, initial	0.0031	0.00	0.0030	0.00	0.0030	0.00	0.0039	0.00	0.0037	0.00	0.0031	0.0
log schooling farm*	-0.0043	0.00	-0.0025	0.01	-0.0028	0.00	-0.0038	0.00	-0.0037	0.00	-0.0029	0.0
*log schooling * mining*	-0.0054	0.00	-0.0031	0.01	-0.0032	0.00	-0.0030	0.01	-0.0025	0.04	-0.0033	0.0
*log schooling * manufacturing*	-0.0015	0.11	-0.0015	0.10	-0.0015	0.07	-0.0013	0.15	-0.0011	0.24	-0.0014	0.1
log schooling government*	-0.0001	0.92	-0.0003	0.76	-0.0003	0.77	-0.0007	0.49	-0.0005	0.64	-0.0003	0.7
*log schooling * service*	0.0001	0.92	0.0008	0.53	0.0006	0.63	0.0015	0.26	0.0012	0.37	0.0009	0.4
log schooling nonspec*	-0.0033	0.00	-0.0025	0.01	-0.0026	0.00	-0.0024	0.01	-0.0024	0.01	-0.0025	0.0
farming	0.0065	0.01	0.0035	0.17	0.0039	0.07	0.0061	0.02	0.0057	0.03	0.0041	0.0
mining	0.0083	0.01	0.0044	0.16	0.0045	0.11	0.0042	0.18	0.0032	0.32	0.0046	0.1
manufacturing	0.0018	0.47	0.0017	0.44	0.0016	0.41	0.0013	0.57	0.0008	0.74	0.0013	0.5
government	-0.0039	0.14	-0.0026	0.31	-0.0028	0.24	-0.0017	0.50	-0.0021	0.41	-0.0027	0.2
service	-0.0022	0.54	-0.0037	0.29	-0.0032	0.33	-0.0053	0.12	-0.0048	0.16	-0.0039	0.2
nonspecialized	0.0053	0.03	0.0039	0.10	0.0040	0.05	0.0035	0.13	0.0034	0.15	0.0037	0.0
log transfer payments as share of income	-0.0015	0.00	-0.0010	0.03	-0.0010	0.01	-0.0006	0.28	-0.0004	0.34	-0.0011	0.0
natural amenity scale	-0.0002	0.01	-0.0001	0.47	-0.0001	0.17	-0.0001	0.46	-0.0001	0.26	-0.0001	0.1
rho			0.4404	0.00	0.3950	0.00					0.3400	0.0
lambda							0.4491	0.00	0.4710	0.00	0.0800	0.0
R2-adj.	0.3171				0.3147				0.4135		0.4046	
Sq.Corr.			0.4035				0.3029					
Test for Spatial Dependence												
	test stat.	p-value	test stat.	p-value								
LM (error)	143.75	0.00	0.66	0.41								
Robust LM (error)	11.99	0.00										
LM (lag)	139.64	0.00										
Robust LM (lag)	7.87	0.01										

BEST COPY AVAILABLE

The estimates of equation (5) are displayed in Table 2b. In this model, a proxy for physical capital – the dominant economic base type – is used in two ways to capture variation in real income growth process across types of local economies. First, different aggregate production functions are allowed through intercept dummies for each type of rural county type with metro counties serving as the "diversified" excluded category. Second, the interaction terms between each county type and initial schooling should reflect the relative importance of HK to the different economic bases on the rural counties (or to differing aggregate production functions).

Focusing on the General Spatial model results, we find conditional convergence and a positive spatial lag. Transfer payment shares still matter while other non-HK variables do not – as in Table 2a. The key parameter on the initial HK variable for metro counties is about the same (0.0031) as before. Interestingly, the nonmetro county economic base interactions with initial HK reveal substantial variation across the rural South in how HK affects real per capita income growth. The net effect on each of these interactions is summarized in Table 2c. Using the results from the General Spatial model (though other spatial models generally yield similar results) we find that the growth rate effect of a unit increase in initial HK is 0.0031 in metro counties but falls to .0014 in the overall nonmetro area.

Interactions of HK with the dominant economic base (alternative aggregate production function) show no significant initial HK effect in mining, farming, and nonspecialized rural counties. However, service based counties have a HK real per capita income growth impact that exceeds the metro effects (0.0039). Other types of rural counties have somewhat smaller growth effects from added initial HK than metro

19

Table 2c. Per Capita Income Growth: Metro and Nonmetro Counties in the South			
LR test for the statistical significance of the HK variables			
Dep. Var.: County Annual Growth Rates in Income 1970 to 2000, in the South			
Model	General Spatial		
Estimation Method	ML		
	coeff.	LR	sig. level
model w/ metro and nonmetro			
log initial schooling-pop share w/ college -metro	0.0031	---------	****
log initial schooling-pop share w/ college -nonmetro	0.0014	11.40	****
model w/ economic bases			
log initial schooling-pop share w/ college -metro	0.0031	---------	****
log initial schooling-pop share w/ college -farm	0.0001	0.09	*
log initial schooling-pop share w/ college -mining	-0.0003	0.09	*
log initial schooling-pop share w/ college -manufacturing	0.0017	4.78	***
log initial schooling-pop share w/ college -government	0.0028	10.72	****
log initial schooling-pop share w/ college -service	0.0039	9.99	****
log initial schooling-pop share w/ college -nonspec.	0.0006	0.43	*
*significant level>10%			
**5%<Significant level<10%			
***1%<significant level<5%			
****Significnat level<1%			
LR: likelihood ratio test statistic			

Likelihood Ratio (LR) test [13]

[13] The LR test statistic = $-2Ln(L_R/L_U) \sim \chi^2$ with degree of freedom = 1 in our case, where L_R and L_U are the likelihood from restricted and unrestricted model estimations respectively. For the model with metro-nonmetro category, the unrestricted model estimated: $\Delta \log Y_{it} = \beta_0 + \beta_1 \log Y_{it-1} + \beta_2 S_{it-1} + \beta_3(S_{it-1} *NONMETRO) + \beta_4 Z_{it-1} + \varepsilon$. To test the significance of schooling effect on income growth for nonmetro area, we define the null hypothesis $\beta_2 + \beta_3 = 0$ vs. $\beta_2 + \beta_3 \neq 0$. The null can also be defined: $\beta_2 = -\beta_3$. So the restricted model estimated is, $\Delta \log Y_{it} = \beta_0 + \beta_1 \log Y_{it-1} + \beta_{23} (S_{it-1} - S_{it-1}*NONMETRO) + \beta_4 Z_{it-1} + \varepsilon$ If LR test static is large enough to reject the null, we can conclude that schooling has an important role in income growth for nonmetro area.

The similar test procedures are used for models with economic base category counties – but they are still statistically significant. HK boosts income growth by .0017 in manufacturing counties and by 0.0028 in government dominated counties of the South.

4.3 Marginal Impacts on Income Growth from Higher Levels of HK.

In Table 2d, we report marginal effects on income growth rates from a one standard deviation (SD) increase in initial HK stock across county types. The top of Table 2d shows the results for the models described above for the 1970 to 2000 period while the lower part of the table lists results for the 1980 to 2000 period (see the Appendix for detailed results) – each using 1970 as the initial year for the HK stock variable. As Simon and Nardinelli (2002) suggest, there is the possibility of feedback effects even using only initial stocks of HK if people with higher levels of HK anticipated where the faster growth counties would be and were drawn to those places. Using lagged HK (1970 levels for 1980 to 2000 growth rates) should ameliorate this problem, if it exists.

From 1970 to 2000, the annual growth rate in metro county income is increased by .13 percentage points for a one SD increase in the share of the population with at least some college in 1970. The mean college "plus" share was 17.18% across all metro counties in the South in 1970 with a standard deviation of 7.28%. This means that a one standard deviation increase in log college share represents a 42 % increase. This would boost the annual metro real per capita income growth rate from 1.72 % per year to 1.85%

Table 2d. Marginal impacts of Schooling (% of pop 25+ with at least some college degree) on Income Growth

(standard deviation change, schooling)

Year 1970-2000	Metro	Nonmetro	Farm	Mining	Manu	Gov	Service	Nonspec
mean (schooling, 1970)	17.18	12.09	12.53	12.43	11.02	13.24	13.66	11.83
I standard deviation (schooling, 1970)	7.28	4.61	4.67	5.48	3.49	6.63	4.39	4.18
% change, Std vs.Mean (schooling,1970)	42.36	38.10	37.31	44.09	31.65	50.09	32.12	35.38
regression coefficient on log year70 schooling	0.0031	0.0014	0.0001	-0.0003	0.0017	0.0028	0.0039	0.0006
income growth rate(%), 1970-2000	1.72	1.54	1.20	1.31	1.75	1.54	1.63	1.56
change in income growth rate(%)	0.13	0.05	0.01	-0.01	0.05	0.14	0.13	0.02
new income growth rate(%)	1.85	1.60	1.20	1.30	1.81	1.67	1.75	1.58
% change in income growth rate(%)	7.51	3.54	0.45	-0.88	3.09	8.96	7.79	1.27

Year 1980-2000	Metro	Nonmetro	Farm	Mining	Manu	Gov	Service	Nonspec
mean (schooling, 1970)	17.18	12.09	12.53	12.43	11.02	13.24	13.66	11.83
I standard deviation (schooling, 1970)	7.28	4.61	4.67	5.48	3.49	6.63	4.39	4.18
% change, Std vs.Mean (schooling,1970)	42.36	38.10	37.31	44.09	31.65	50.09	32.12	35.38
regression coefficient on log year70 schooling	0.0054	0.0033	0.0026	0.0017	0.0032	0.0036	0.0077	0.0016
income growth rate(%), 1980-2000	1.54	1.51	1.62	0.61	1.69	1.51	1.45	1.51
change in income growth rate(%)	0.23	0.12	0.10	0.08	0.10	0.18	0.25	0.06
new income growth rate(%)	1.77	1.63	1.71	0.68	1.79	1.69	1.70	1.57
% change in income growth rate(%)	14.77	8.30	5.96	12.57	5.91	11.83	17.14	3.82

per year, evaluated at the mean income growth rate – about a 8% increase in the growth rate.[14]

For the average rural county in the South, the sum of the parameters on the Sit-1 and NM*Sit-1 variables is .0014. A one standard deviation increase in the share of the population with at least some college in 1970 (4.61%) added to the nonmetro mean of 12.09 % increases annual rural growth rates, evaluated at the overall mean, from 1.54% to 1.60% -- about a 3.5 % increase in the growth rate.

These increases in real income growth rates provide support that the initial level of HK matters to subsequent growth. Moreover, rural counties have smaller shares of HK than metro counties so achieving a larger percentage increase in college share is facilitated by the low 1970 base share. For example, a metro county with 40% of the "25 plus" population with some college could double its college share but a rural county that has 1.8% share with some college is more likely to double its share of 'at least some college' residents.

4.4 Rural Economic Base Effects

Since rural counties are often dominated by a few basic industries – farming, manufacturing, mining, etc., we hypothesized that HK impacts might differ by type of economic base. As noted above, this is also consistent with the notion that the aggregate production function may vary substantially across counties with differing economic bases.

Economic base alters the effect that HK has on income growth as shown in Table 2d. At one extreme, a one SD increase in initial HK in nonmetro counties dominated by mining has no effect on real per capita income growth rates while rural counties with services as the dominant base get the largest growth boost – from 1.63% to 1.75 %, an 7.79 % increase- a bit larger than

[14] Simon and Nardinelli (2002:74) find a one SD increase in college graduates increased city employment growth

the metro effect. In between, government counties obtain a 8.96% "return" while manufacturing (3.09 %), nonspecialized (1.27%) and farming (0.45%) fall between the extremes.

Results for the 1980 to 2000 growth regressions with 1970 HK stock, shown in the bottom of Table 2d, reinforce the findings for the 1970 to 2000 period. In fact, there are larger growth premiums from beginning 1970 HK stock from 1980 to 2000 than for the earlier period. This suggests that HK endowments have become increasingly important to real per capita income growth in the rural South in more recent decades.

4.5 How do the county results compare to cross-country findings?

Krueger and Lindahl, in cross country regressions when physical capital and workforce variables are excluded from the model, find for the 1965-85 period that the initial log HK parameter is 0.026 and the change in log HK parameter estimate is 0.614. Adding physical capital and labor to the regression, the initial HK parameter estimate drops to 0.01 and the change in log HK parameter declines to .178 – suggesting the need to account for physical capital and labor. We attempt to account for physical capital and labor in equation (5) by including county population growth rates and a proxy for physical capital -- the dominant economic base in the county. [15]

When we delete the growth rate of HK accumulation, we still find that the initial stock of HK still is important to real per capita income growth both in metro and nonmetro counties – with the exception of mining dependent counties – in the South. If the economic base typologies are not a good proxy for physical capital variation across types of rural counties, some of the HK

---

rates by about 38 % across the US from 1900 to 1986.

[15] Results in Henry et al (2003), that include growth in HK as a regressor strongly mirror those of the basic KL growth regressions. Moreover, parameter estimates are consistent with the MRW findings. Deletion of the HK

effects may reflect omitted physical capital as suggested by KL. However, the potential for reverse causality has been purged from the estimates in Henry et al (2003) by deleting the growth rate of HK and in estimates with lagged initial HK.[16]

5. SUMMARY

County per capita income growth rates from 1970 to 2000 across the South are affected by the initial stock of human capital (HK). The share of the "25 plus" population in a county that has at least some college is our proxy for initial levels of HK. The HK influences are entered in standard growth regressions that are modified to capture spatial economic structure at the county level. Thus, they include spatial lags and spatial error adjustments. As is the custom in growth regressions, beginning period real income is used to test for conditional convergence (which we also fail to reject across all models).

The growth regressions show that added 1970 levels of HK boosts real per capita income growth from 1970 to 2000 and from 1980 to 2000. While metro counties consistently get more of a growth "premium" from a given increment to HK, nonmetro counties also grow faster with more HK. Generally, rural growth impacts from added HK are about one-half to two thirds of the metro growth premiums. Within the rural South, service based counties generally fare best from added HK while mining based counties gain the least.

growth variable, however, reduces the magnitude of the initial HK impact on income growth rates in our sample of counties.

[16] In Temple's (1999:142) review of the MRW type model, he notes: "Most recent growth researchers have included population growth as a variable of subsidiary interest, perhaps I the manner suggested by MRW, and then noted a weak negative correlation between it and growth of per capita income. This raises some endogeneity concerns, although one might think of causality running to population growth from the level of per capita income rather than its rate of growth." Since we use the rate of growth of per capita income as the dependent variable rather than its level, endogeneity problems seem unlikely with our use of population growth as a regressor.

25

The results generally confirm that HK in rural areas is a key factor in real per capita income growth. One standard deviation (SD) increases in beginning period (1970) HK *in the nonmetro counties of the South,* yields a 4% (1970-2000) to 8% (1980-2000) faster real per capita income growth rate. Controlling for the dominant economic base in the rural county, we find no effect from added HK on real per capita income growth from 1970 to 2000 in *mining* counties but the impact is substantial over the 1980 to 2000 sub period (13%). S*ervice*-based counties expand from 8% (1970-2000) to 20% (1980-2000) faster from a 17% addition to HK stock in 1970. A standard deviation increase in HK stock in 1970 boosts real per capita income growth rates in *farm* counties by .5% to 6%, in *manufacturing* counties from 3% to 6%, in *government* counties by 9% to 12%, and in *nonspecialized* counties by 1.2% to 4%. These are significant returns to added education in the rural South, especially during the "New Economy" period of 1980 to 2000. Alternative measures of HK that reflect 'quality' need to be considered. Still, it is fair to speculate that added HK investment in the rural South is more than the usual political hyperbole – it looks like HK is, in fact, a key to success in the rural South.

References:

Aghion, P. and P. Howitt. 1998. *Endogenous Growth Theory.* Cambridge: MIT Press.

Anselin, L. 1988. Spatial Econometrics: Methods and Models. Dordrect: Kluwer Academic Publishers.

Anselin, L. 1999. Spatial Data Analysis with Spacestat and ArcView: Workbook(3rd Edition). Dept. of Agricultural and Consumer Economics, University of Illinois, Urbana, Illinois.

Barkley, David L. and Mark S. Henry. 1998. "The Role of Local School Quality in Rural Employment and Population Growth." *Review of Regional Studies.* 28 (1): 81-102.

Barro, Robert J. 2001. "Human Capital and Growth." *American Economic Review.* 91(2): 12-17.

Barro, R and X. Sala-i-Martin. 1995. *Economic Growth.* NY: McGraw-Hill.

Beeson, P. and D. Dejong. 2002. "Divergence." *Contributions to Macroeconomics.* Vol 2: No.1:Article 6. http://www.bepress.com/bejm

Benhabib, J. and M. Spiegel. 1994. "The Role of Human Capital in Economic Development: Evidence from Aggregate Cross–Country Data." Journal of Monetary Economics. Vol 34: 143-173.

Bils, M. and P. Klenow, 2000. "Does Schooling Cause Growth?" *American Economic Review.* 90 (1160-83).

Cook, P. and K. Mizer. 1994. *Revised ERS County Typology: An Overview* ERSRDRR89 RDRR89. 12/1/94 ERS, USDA. Washington DC:

Glaeser, E., Scheinkman. J and Shleifer, A. 1995. "Economic Growth in a Cross-Section of Cities. *Journal of Monetary Economics.* Vol 36: 117-143.

Harris, Amy Rehder; Evans, William N.; and Schwab, Robert M 2001. "Education Spending in an Aging America", *Journal of Public Economics.* 81:1: 449-472.

Henry, M., D. Barkley and H. Li. 2003. "Education and Nonmetropolitan Development in the South."Paper for the Conference Promoting the Economic and Social Vitality of Rural America: The Role of Education, New Orleans, LA. April 14-15

Krueger, A. and M. Lindhal. 2001. "Education for Growth: Why and For Whom?"

27

Journal of Economic Literature. Vol XXXIX: 1101-1136.

Ladd, Helen F and Murray, Sheila E. 2001. "Intergenerational Conflict Reconsidered: County Demographic Structure and the Demand for Public Education", *Economics of Education Review*, Vol. 20, 2001, 343-357.

LeSage, James P. 1999. *The Theory and Practice of Spatial Econometrics*, unpublished manuscript available at: http://www.spatial-econometrics.com

Lucas, R. 1988. "On the Mechanics of Economic Development." *Journal of Monetary Economics.* Vol. 22: 3-42.

Mankiw, G., D. Romer and D. Weil. 1992. "A Contribution to The Empirics of Economic Growth." *Quarterly Journal of Economics*. Vol 107:407-437.

McGranahan, D. 1999. "Natural Amenities Drive Population Change." Agr. Econ. Report 781. Economic Research Service, USDA, Washington, DC. September.

Nelson, R. and E. Phelps. 1966. "Investment in Humans, Technological Diffusion, and Economic Growth." *American Economic Review.* Vol 61: 69-75.

Poterba, James M., "Demographic Struture and the Political Economy of Public Education", *Journal of Policy Analysis and Management*, Vol. 16, 1997, 48-66.

Ramanathan, R. 2002. *Introductory Econometrics with Applications*. Fifth Ed. NY: Harcourt.

Rappaport, J. 1999. "Local Growth Empirics." *CID Working Paper No. 23.* Center for International Development, Harvard University

Romer, D. 2001. *Advanced Macroeconomics.* Boston: McGraw Hill.

Romer, P. 1990. "Endogenous Technological Change. *Journal of Political Economy.* Vol.98: part 2: 71-102.

Simon, C. J. and C. Nardinelli.2002. "Human Capital and the Rise of American Cities." *Regional Science and Urban Economics.* 32(59-96).

Temple, J. 1999. "The New Growth Evidence." *Journal of Economic Literature.* 37(112-156).

Trondl. G. 2001. *Convergence After Divergence? Regional Growth in Europe*. NY: Springer Verlag

APPENDIX: GROWTH REGRESSIONS FOR THE 1980 –2000 PERIOD WITH 1970 HUMAN CAPITAL

Table A-1. Per Capita Income Growth: Metro vs. Nonmetro Counties in the South												
Dep. Var.: County Annual Growth Rates in Income 1980 to 2000, in the South												
Model	Base		Spatial Lag				Spatial Error				General Spati	
Estimation Method	OLS		IV (2SLS)		ML		GMM (iterated)		ML		ML	
	coeff.	p-value	coeff.	p-value	coeff.	p-value	coeff.	p-value	coeff.	p-value	coeff.	p-v
intercept	0.2524	0.00	0.1701	0.00	0.1766	0.00	0.2086	0.00	0.2076	0.00	0.1835	
log initial income	-0.0254	0.00	-0.0184	0.00	-0.0190	0.00	-0.0226	0.00	-0.0224	0.00	-0.0197	
growth and depreciation factor	0.0044	0.00	0.0011	0.20	0.0015	0.01	-0.0002	0.80	-0.0001	0.90	0.0013	
log year1970 schooling	0.0061	0.00	0.0052	0.00	0.0053	0.00	0.0064	0.00	0.0061	0.00	0.0054	
*log year1970 schooling*nonmetro*	-0.0031	0.00	-0.0020	0.02	-0.0021	0.02	-0.0019	0.03	-0.0017	0.04	-0.0021	
nonmetro=1, metro=0	0.0049	0.07	0.0026	0.27	0.0028	0.27	0.0024	0.32	0.0018	0.44	0.0026	
log transfer payments as share of income	-0.0024	0.00	-0.0016	0.04	-0.0016	0.02	-0.0011	0.20	-0.0011	0.18	-0.0016	
natural amenity scale	-0.0006	0.00	-0.0001	0.28	-0.0002	0.06	-0.0001	0.73	-0.0002	0.38	-0.0002	
rho			0.5583	0.00	0.5280	0.00					0.4920	
lambda							0.5586	0.00	0.5920	0.00	0.0680	
R2-adj.	0.2688				0.2696				0.4556		0.4426	
Sq.Corr.			0.4496				0.2349					
Test for Spatial Dependence												
	test stat.	p_value	test stat.	p_value								
LM (error)	345.34	0.00	1.04	0.31								
Robust LM (error)	13.14	0.00										
LM (lag)	362.95	0.00										
Robust LM (lag)	30.76	0.00										

Table A-2. Per Capita Income Growth: Metro vs. Type of Nonmetro Counties in the South

Dep. Var.: County Annual Growth Rates in Income 1980 to 2000, in the South

Model	Base		Spatial Lag				Spatial Error				General S
Estimation Method	OLS		IV (2SLS)		ML		GMM (iterated)		ML		ML
	coeff.	p-value	coeff.	p-value	coeff.	p-value	coeff.	p-value	coeff.	p-value	coeff.
intercept	0.2484	0.00	0.1564	0.00	0.1793	0.00	0.2111	0.00	0.2082	0.00	0.1876
log initial income	-0.0251	0.00	-0.0172	0.00	-0.0192	0.00	-0.0228	0.00	-0.0224	0.00	-0.0201
growth and depreciation factor	0.0033	0.00	0.0001	0.93	0.0010	0.12	-0.0006	0.52	-0.0004	0.58	0.0008
log year1970 schooling	0.0058	0.00	0.0049	0.00	0.0051	0.00	0.0062	0.00	0.0059	0.00	0.0052
log year1970 schooling farm*	-0.0029	0.06	-0.0021	0.12	-0.0025	0.06	-0.0039	0.01	-0.0037	0.01	-0.0027
*log year1970 schooling * mining*	-0.0054	0.01	-0.0030	0.08	-0.0035	0.04	-0.0022	0.23	-0.0014	0.43	-0.0035
*log year1970 schooling * manufacturing*	-0.0026	0.08	-0.0022	0.09	-0.0022	0.08	-0.0018	0.18	-0.0013	0.32	-0.0021
log year1970 schooling government*	-0.0015	0.36	-0.0015	0.28	-0.0016	0.24	-0.0020	0.15	-0.0017	0.21	-0.0017
*log year1970 schooling * service*	0.0018	0.41	0.0024	0.21	0.0022	0.24	0.0033	0.08	0.0030	0.10	0.0025
log year1970 schooling nonspec*	-0.0054	0.00	-0.0031	0.02	-0.0036	0.00	-0.0029	0.03	-0.0028	0.03	-0.0036
farming	0.0049	0.22	0.0038	0.29	0.0042	0.22	0.0073	0.05	0.0069	0.06	0.0044
mining	0.0054	0.28	0.0029	0.51	0.0031	0.48	0.0002	0.96	-0.0012	0.79	0.0029
manufacturing	0.0051	0.17	0.0034	0.30	0.0036	0.25	0.0024	0.47	0.0013	0.70	0.0032
government	-0.0016	0.70	0.0004	0.92	0.0001	0.98	0.0015	0.67	0.0010	0.77	0.0003
service	-0.0066	0.24	-0.0074	0.14	-0.0072	0.14	-0.0097	0.05	-0.0093	0.05	-0.0080
nonspecialized	0.0101	0.01	0.0049	0.15	0.0061	0.06	0.0044	0.20	0.0041	0.23	0.0060
log transfer payments as share of income	-0.0029	0.00	-0.0017	0.02	-0.0020	0.00	-0.0015	0.09	-0.0013	0.10	-0.0021
natural amenity scale	-0.0005	0.00	-0.0001	0.63	-0.0002	0.07	-0.0001	0.69	-0.0002	0.35	-0.0002
rho			0.6443	0.00	0.4970	0.00					0.4490
lambda							0.5450	0.00	0.5860	0.00	0.0710
R2-adj.	0.3096				0.3214				0.4615		0.451
Sq.Corr.			0.4665				0.2734				
Test for Spatial Dependence											
	test stat.	p_value	test stat.	p_value							
LM (error)	242.01	0.00	0.46	0.00							
Robust LM (error)	1.89	0.17									
LM (lag)	292.14	0.00									
Robust LM (lag)	52.02	0.00									

Table A-3. Per Capita Income Growth: Metro and Nonmetro Counties in the South

LR tests for the statistical significance of the HK variables

Dep. Var.: County Annual Growth Rates in Income 1980 to 2000, in the South

Model		General Spatial		
Estimation Method		ML		
		coeff.	LR	sig. level
model w/ metro and nonmetro				
log year1970 schooling-pop share w/ college	*-metro*	0.0054	------	****
log year1970 schooling-pop share w/ college	*-nonmetro*	0.0033	34.28	****
model w/ economic bases				
log year1970 schooling-pop share w/ college	*-metro*	0.0052	------	****
log year1970 schooling-pop share w/ college	*-farm*	0.0026	4.56	***
log year1970 schooling-pop share w/ college	*-mining*	0.0017	1.25	*
log year1970 schooling-pop share w/ college	*-manufacturing*	0.0032	8.19	****
log year1970 schooling-pop share w/ college	*-government*	0.0036	8.56	****
log year1970 schooling-pop share w/ college	*-service*	0.0077	18.64	****
log year1970 schooling-pop share w/ college	*-nonspec.*	0.0016	2.55	*

*significant level>10%
**5%<Significant level<10%
***1%<significant level<5%
****Significnat level<1%
LR: likelihood ratio test statistic

U.S. Department of Education
Office of Educational Research and Improvement (OERI)
National Library of Education (NLE)
Educational Resources Information Center (ERIC)

ERIC REPRODUCTION RELEASE

I. Document Identification:

Title: Education and Nonmetropolitan Income Growth in the South

Author: Mark Henry, David Barkley, and Haizhen Li

Corporate Source: Paper at the Conference, "Promoting the Economic and Social Vitality of Rural America: The Role of Education" New Orleans, LA

Publication Date: April 14-15, 2003

II. Reproduction Release:

In order to disseminate as widely as possible timely and significant materials of interest to the educational community, documents announced in the monthly abstract journal of the ERIC system, Resources in Education (RIE), are usually made available to users in microfiche, reproduced paper copy, and electronic media, and sold through the ERIC Document Reproduction Service (EDRS). Credit is given to the source of each document, and, if reproduction release is granted, one of the following notices is affixed to the document.

If permission is granted to reproduce and disseminate the identified document, please check one of the following three options and sign the release form.

X Level 1 - Permitting reproduction and dissemination in microfiche or other ERIC archival media (e.g. electronic) and paper copy.

____ Level 2A - Permitting reproduction and dissemination in microfiche and in electronic media for ERIC archival collection subscribers only.

____ Level 2B - Permitting reproduction and dissemination in microfiche only.

Documents will be processed as indicated provided reproduction quality permits. If permission to reproduce is granted, but no option is marked, documents will be processed at Level 1.

Sign Here: "I hereby grant to the Educational Resources Information Center (ERIC) nonexclusive permission to reproduce and disseminate this document as indicated above. Reproduction from the ERIC microfiche or electronic media by persons other than ERIC employees and its system contractors requires permission from the copyright holder. Exception is made for non-profit reproduction by libraries and other service agencies to satisfy information needs of educators in response to discrete inquiries."

Signature: MeHy

Printed Name: Mark Henry

Address: Barre Hall 254

Position: Professor of Applied Economics and Statistics

Organization: Clemson University

Telephone No: 864 656 5774

Date: 11/7/03

III. Document Availability Information (from Non-ERIC Source):

If permission to reproduce is not granted to ERIC, or, if you wish ERIC to cite the availability of the document from another source, please provide the following information regarding the availability of the document. (ERIC will not announce a document unless it is publicly available, and a dependable source can be specified. Contributors should also be aware that ERIC selection criteria are significantly more stringent for documents that cannot be made available through EDRS.)

Publisher/Distributor:

Address:

Price per copy: Quantity price:

IV. Referral of ERIC to Copyright/Reproduction Rights Holder:

If the right to grant this reproduction release is held by someone other than the addressee, please complete the following:

Name:

Address:

V. Attach this form to the document being submitted and send both to:

Robert Hagerman, Acquisitions Coordinator
ERIC Clearinghouse on Rural Education and Small Schools
P.O. Box 1348
1031 Quarrier Street
Charleston, WV 25325-1348

Phone and electronic mail numbers:

800-624-9120 (Clearinghouse toll-free number)
304-347-0467 (Clearinghouse FAX number)
hagermar@ael.org