Human Capital and Growth in the Post-Bellum South: A Separate but Unequal Story *

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Abstract:

This paper tests the importance of human capital in explaining convergence across states of the United States from 1880 to 1950. Human capital levels matter not only to a state's income level but also to its growth rate through technological diffusion. There is a unique pattern in the South, whose overwhelmingly agricultural society relied more heavily on work experience than formal education, and whose racial discrimination in school resource allocation played a crucial role in lowering human capital accumulation of *both* blacks and whites. The South's low overall human capital levels immediately after the Civil War, combined with its active resistance in the Post-Bellum period to educating its population, played an important role in reducing the speed of Southern conditional convergence toward the rest of the nation after the Civil War.

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I. Introduction

Both the convergence literature on regions within the United States and the literature on the evolution of the Southern economy have highlighted the need for an explanation for the slow convergence of Southern per capita income to that of the rest of the United States after the Civil War.

Mitchener and McLean (1999) identify the West and the South as key regions in explaining the convergence pattern of the United States from 1880 to 1980. The West began as the highest income region due to resource abundance and recent settlement. The South began as the lowest income region due to the negative effects of the Civil War and slavery. Together, these two regions accounted for a majority of the initial income inequality in the U.S. in 1880. Much of the initial convergence in income in the U.S. after 1880 is accounted for by the West, which simply grew more slowly, thereby allowing other regions to catch up to it from 1880 to 1940.[1] Conversely, Mitchener and McLean find that the South did not contribute significantly to convergence in the U.S. until after 1940.[2] Further, they suggest that "…the slow catch-up of the South (relative to the national average) appears attributable to changes in productivity rather than to price or labor input effects."[3] In other words, price or gender/age characteristics, which the literature has found are important in explaining convergence patterns both across regions and across countries (Mitchener and McLean 1999, Williamson 1998, Williamson and Lindert 1980), are not sufficient to explain the convergence pattern of Southern states to the rest of the nation after the Civil War.

Instead, one must explain the relatively low productivity in the South in the post-bellum period as well as gradual convergence in productivity to that of the rest of the

[1] Mitchener and McLean (1999), p. 1021.

[2] Of the observed convergence between Southern and Northern average service income between 1880 and 1950, Caselli and Coleman (2001) show that up to 81 percent is attributable to structural transformation. For the 1940 to 1990 period, structural transformation is empirically less important than in the earlier period, but still accounts for approximately 57 percent of the measured convergence between the two regions. The remainder is explained by within sector North-South wage convergence. Caselli and Coleman therefore focus on modeling the Southern structural transformation caused by labor movement out of agriculture and the subsequent rise in agricultural wages relative to manufacturing wages. This insightful model is able, in positive terms, to explain the role of structural transformation in the observed pattern of service income convergence. The key assumption generating this structural transformation is a long-run decline in the relative costs of acquiring nonagricultural skills in both regions.

[3] Ibid, p. 1030.

nation to explain Southern convergence (Margo 2002). Clearly, many factors contributed to this relatively low productivity.[4] Within a significant literature focusing on this question, Wright (1986) stresses the lack of a sufficiently skilled labor force and generally low levels of education as major obstacles to the process of industrialization in the South. In this paper, I focus empirically on human capital levels to explain the relatively low productivity in the post-bellum South. To accomplish this, I create both education based and experience based decadal human capital estimates for 48 states of the United States from 1880 to 1950. The education based measure controls not only for interstate migration but also for relative price levels across states. The importance of human capital, particularly in explaining the lack of Southern convergence from 1880 to 1950, can be seen in Figure 1. There we see the strong positive contemporaneous relationship between education based human capital per worker and income per worker in the North Atlantic (NA), North Central (NC), South Atlantic (SA), South Central (SC) and Western (W) states of the United States in 1880, 1900, 1920, and 1950.[5] We also see that the conditional convergence of the South Atlantic and South Central regions appears to have depended heavily on convergence in their human capital levels towards that of the rest of the United States.

Given the strong relationship present in Figure 1, I test the contribution of human capital to both income levels and growth in 48 states of the United States from 1880 to 1950. Controlling for possible reverse-causality, I find that along with physical capital, a state's human capital stock significantly contributes to its income both in level and in growth terms. Moreover, I am able to consider the theory that racial discrimination in Southern education was a primary contributor to the low levels of human capital, not only for Southern blacks, but for Southern whites as well.

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[4] A wide range of factors have been proposed to explain the South's relative stagnation in the post-bellum period. Wright (1974) focuses on poor world demand for cotton, Ransom and Sutch (1977) on the reduced agricultural labor supply, and Carlton and Coclanis (1989) on the lack of adequate capital for industrialization.

[5] The regions are defined as follows: North Atlantic: Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont; North Central: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin; South Atlantic: Delaware, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia; South Central: Alabama, Arkansas, Kentucky, Louisiana, Mississippi, Oklahoma, Tennessee, Texas; and

The paper is organized as follows. Section II reviews the framework provided by growth theory within which one can consider the Southern experience after the Civil war. Section III provides an historical description of initial labor conditions, racial discrimination in educational policies, the lack of investment in human capital for both races in the South during the post-bellum period, as well as "core and periphery" issues between the Non-South and the South. Section IV presents the growth accounting specification and Section V describes the data used in the regressions of Section VI. Section VII concludes.

II. Growth Theory

Solow's (1957) neoclassical growth model predicts convergence in income per capita among countries *conditional* on identical production functions, savings rates, and labor force growth rates, without requiring factor mobility. Barro and Sala-i-Martin (1991 and 1992) show that the South did conditionally converge in personal income to the rest of the nation from 1840 to 1963. However, the question central to this paper concerns the speed with which the South converged with the rest of the nation, and how Southern educational policies affected the steady-state income level to which the South was converging.

The answer to this question may lie in human capital differences across states within the United States. In human capital models of endogenous growth, growth is driven by the accumulation of human capital, broadly defined as an individual's skill level accumulated through formal education or through on the job learning-by-doing (Uzawa 1965, Lucas 1988, Romer 1986, Romer 1990). If there are any positive externalities due to human capital that are not taken into account in the individual's utility maximization, market equilibrium levels of investment in human capital will fall short of socially optimal levels.

Since human capital accumulation is the driving force in these models, absolute convergence will not necessarily occur between countries with different initial levels of human and physical capital, unless factor mobility forces convergence. Between 1880

Western: Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming.

and 1900, Southern income per capita grew at about the national rate. It did not greatly converge with the rest of the nation until after the turn of the century, when labor mobility increased, and educational and skill differentials began narrowing (Wright 1986). A majority of the convergence actually occurred after World War II. Thus, while both the South and the nation grew at approximately the same rate until the 1900's, level differences were roughly maintained, due to level differences in human capital. Southern labor market segmentation (Wright 1986, Rosenbloom 1990 and 1996) and low levels of education and industrial skill in the post-bellum South did little to improve the South's human capital stock and had much to do with the slow convergence of the South to national standards.

III. Historical Setting

Four factors contributed to the South's emergence at the turn of the century as a low wage, low skill region specializing in labor-intensive industries. They include the South's plantation legacy, its active resistance to educating its workforce, both black and white, the relative isolation of its labor market, and "backwash" effects of being a latecomer to industrialization.

The legacy of slavery and reliance on a plantation economy left the South without a significant industrial structure or labor force capable of quickly adapting to industrialization after the Civil War. Weiman (1990) argues that slavery and labor-intensive plantation technology in the South resulted in both reduced investment in physical capital and a reduced labor supply for prospective Southern manufacturing industries prior to the Civil War. Moreover, Wright (1986) and Beatty (1987) point to the lack of an indigenous technological community to explain the South's reliance on Northern technology, and its inability to quickly industrialize after the Civil War.

The plantation legacy also left the South with very little human capital relative to the rest of the nation immediately after the Civil War. The reasons for this are quite straightforward. By 1835, there existed a uniform legal proscription across the South against the formal education of slaves as a result of slave insurrections earlier in the nineteenth century. Consequently, 95 percent of the black Southern population was completely illiterate at the beginning of the Civil War. Furthermore, the lagged effect of older generations tended to slow educational improvements for younger generations (Smith 1984, Margo 1990). As Margo explains, children of illiterate parents not only could not seek help from their parents when learning to read and write, but also tended to be drawn away from school to help their families on the farm or in the market.[6] Figure 2 shows the strong racial divide in literacy rates within the South continuing into the 1930s.

Moreover, while state funds were allocated on a per pupil basis independently of race, within the segregated schooling system (and aided by disfranchisement after 1877), states diverted funds at the local district level from black schools in favor of white schools (Bond 1934, Margo 1986 and 1990, Gerber 1986). Since redistribution occurred at the county or school district level, the severity of redistribution depended on the concentration of blacks in that county. In a county with fewer blacks, fewer resources were available for diversion towards white pupils. Conversely, in predominantly black counties, huge amounts of funds could be redirected towards relatively few white students. For example, in white counties in Mississippi in 1907, $3.50 was spent on black children per member of the school age population relative to $5.60 on white children. In black counties, $2.50 was spent on black children, versus $80.00 on white children.[7] This discrimination continued well into the 1930s as seen in the ratio of school expenditures per black pupil relative to the total state allocation per pupil in Southern states (Figure 3). The 12 Southern states on average spent only 37 percent of what should have been spent on black students had an equal distribution of educational expenditures been made across all students regardless of race (Bond 1934).

The significant quality differences between black and white schools in the South were marked by lower teacher salaries, higher student to teacher ratios, shorter terms, and lower educational levels of teachers.[8] Donohue, Heckman and Todd (2002) find that absolute improvements in the quality of Southern black schools occurred from 1910 to the mid 1930s (due largely to Northern Philanthropy). Still, there were little gains

[6] Using data from the 1910 Census, Margo (1990) finds that school attendance rates rose 4.2 percent with a 10 percent reduction in adult illiteracy.

[7] Gerber (1986), pp. 9, 13.

[8] For example, in 1911 in Georgia, black teachers earned less than half of what white teachers earned, black schools generally had twenty more students per class relative to white schools, the school term was

relative to white schools, except for in attendance rates. Conversely, from the late 1930s to 1960, there were both absolute and relative improvements in black school quality in the South (due primarily to legal actions on the part of the NAACP). Looking at Southern born men born between 1900 and 1949, Card and Krueger (1992) find that these improvements in the relative quality of black schools explain 20 percent of the reduction in the overall black-white earnings gap between 1960 and 1980.

In the prewar era, there is ample evidence of selective migration of more educated blacks out of the South (Margo 1988 and 1990, Vigdor 2002b). This is evident in Figure 4, where Southern born blacks with above average education levels for their birth and state cohort were between 2 to almost 5 times more likely to have left the South then their peers with below average education levels (Vigdor 2002b).

Using U.S. Census microdata on blacks, Vigdor (2002a) demonstrates positive intergenerational effects between the education level of parents who migrated between 1940 and 1970 and educational attainment of their children in 1970 and 1990. While his study focuses on a later time period than that of this paper, Vigdor's evidence of positive intergenerational effects, as well as Smith (1984) and Margo's (1990) evidence of intergenerational effects in earlier periods, suggest that selective migration patterns of blacks from the South not only led to an immediate drop in black human capital levels in the South, but also had compounding intergenerational effects since the South lost the positive intergenerational effects that more educated blacks would have yielded had they remained in the South.

The large fraction of the labor force comprised of blacks (about 46 and 58 percent of the South Central and South Atlantic populations respectively in 1890),[9] combined with severe racial discrimination in schooling and selective migration of more educated blacks out of the South, are sufficient to lower Southern human capital levels relative to the rest of the nation. Still, educational levels, even for whites, were much lower in the South than in the North. Of Southern whites born between 1870 and 1880, fewer than twenty percent ever received a high school diploma and only thirty percent ever went

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three to four weeks shorter and only 16 percent of black teachers had at least two years of postsecondary education, relative to 35 percent of white teachers (Donohue, Heckman and Todd 2002, p. 229).

[9] Abstract of the Twelfth Census, 1900, (1904), p. 41.

beyond elementary school (Smith 1984). Even after the Civil War, large North-South educational differences were maintained and even increased as a result of Southern educational policies. This is evident in the divergence in North-South schooling levels for both races after 1870 (Figure 5).

Even abstracting from issues of racial discrimination, the South had a historical legacy of low education norms. Gerber (1986) points to the lack of property tax use for public education to explain the limited resources for public education in the South prior to Reconstruction. So while most of the United States was moving towards public education in the antebellum period, the South stood apart from this movement. The Reconstruction period in the South led to several improvements in the education system in the South between 1865 and 1877. They included the set up of school revenue systems, based primarily on state land taxes, laws to establish centralized state administrations for the schools, and the mandate that both blacks and white students have access to schools. Unfortunately, after the Reconstruction period, a period of backlash occurred, severely curtailing support for public education, including legislation in many Southern states that prohibited local taxation for schools.[10]

Using 1940 U.S. census data, Gerber (1986) finds that between 20 and 25 percent of lower individual incomes of all Southern men were attributable to lower educational attainment. When considering only white men, education accounted for 5 to 17 percent of the lower individual income levels in Southern states.[11] Hence, while much of the 1940 income differences due to educational disparities were born by Southern blacks, Southern whites also suffered from lower educational attainment.

Still, it could be argued that the widespread discrimination against blacks in the South may have resulted in depressed support for public education in general because of the inability of lower-class whites to join political forces with blacks in support for public education. Gerber explains:

> In the case of school finance, the gulf between black and white Southerners was exacerbated by the racist propaganda that attempted to convince lower-class whites that state school revenues derived from white

[10] Gerber (1986), pp. 5-8.
[11] Ibid, pp. 30, 33-34.

> citizens were going to black schools. Given the inadequacy of white schools in many areas, this argument raised racial tensions and prevented, or at least hindered, a unified front of poor whites and blacks from demanding better schools. Those whites who benefited saw no need to support campaigns for higher taxes for schools: they could always raid the funds intended for black schooling when they desired more revenue. … Even though this type of discrimination was aimed ostensibly at the black population, it may have affected lower-class whites as well, much in the same manner that disfranchisement removed the vote from significant numbers of poor and illiterate whites.[12]

Along these lines, Gerber finds that, for Southern states, the higher the percentage of blacks in the state population, the higher the level of *white* schooling inequality.[13]

Using the education based measure of human capital per worker, it is possible to indirectly consider the hypothesis that, within the South, higher percentages of blacks in the population would have led to easier redistribution of school resources towards white pupils, and therefore to lower incentives for politicians to argue in favor of greater overall resource allocation towards public education. Since the education-based measure of human capital (described in detail in Section V) is based on school expenditures, it lends itself well to this question. I therefore run a state level panel regression for 1880, 1900, 1920, and 1950 of education based human capital per worker on income levels and the percentage of the state population that was black.[14] If higher percentages of the population being black led to greater opportunities for diversion of schooling resources and lower incentives to raise overall schooling expenditures, this discrimination variable should enter negatively in Southern states.

This admittedly simple regression is intended to see if there is support for the notion that racial discrimination contributed significantly to lower educational standards for *the average Southerner* (rather than just for the average black Southerner). Since state income is clearly a primary determinant in resources potentially available for education, it is included to control for the fact that Southern states were also lower income states. The results from this simple regression are intriguing. Column 1 of Table

[12] Ibid, p. 99.

[13] This was not the case for non-Southern states. Gerber (1986), pp. 115, 126.

[14] Data on the percentage of state populations that are black come from Gibson and Jung (2002).

1 presents the results using fixed effects (*FE*) estimation for all states of the U.S.[15] We see firstly that higher state incomes did indeed lead to higher state human capital levels. Still, controlling for income, a higher percentage of blacks in the state population (implying greater opportunities for discriminatory school resource allocation) led to lower human capital levels. Separating the coefficient on this discrimination variable into a general component and the marginal change when considering a Southern state (see column 2), we see that the finding of column 1 is purely driven by the Southern states. Specifically, the marginal contribution to this elasticity when a state is in the South is -.117 and highly significant, whereas the general component is not statistically significant. Hence, the finding that higher percentages of blacks in the population led to overall lower levels of human capital (for the average pupil, and not just the black pupil) holds only in the South.[16] These results support the argument that racial discrimination occurring at the local level in Southern schooling led not only to lower human capital levels for Southern blacks, but also for Southern whites through its depressing effects on overall support for public education.

Finally, there was strong opposition from both industrial employers and planters to educating the common laborer, whether black or white, for fear that educated workers would leave the South (Wright 1986). The mere fact that the South was still a primarily plantation economy within a traditional (versus modernizing) environment led to active resistance to education. A traditional environment is defined as using primitive technology or traditional farming practices and crops and either little innovation or little exposure to innovation.[17] Consequently, among the plantations there was high demand for unskilled labor, little demand for skilled labor, and a fear that increases in education would drive workers out of the plantation sector thus threatening its labor supply.[18]

[15] *FE* estimation treats unobservable latent individual effects as fixed and focuses on deviations of states over time from their individual means. This is identical to having a dummy for each state in the regression. Further descriptions of this estimation technique are provided in section IV.

[16] When the regression is run only for the South, the discrimination variable is statistically significant and negative, whereas when run only for non-Southern states, the discrimination variable is not significant.

[17] Evidence, such as the slowness with which the South adopted mechanization in cotton, suggests that the Southern plantation system was relatively traditional and not modernizing relative to the rest of the nation, even compared to other agricultural regions (Gerber 1986).

[18] Gerber (1986), pp. 91-93.

Although school expenditures always rely upon the contemporaneous economic situation, this negative attitude towards education both due to employer pressures and racial discrimination was largely responsible for the fall in real Southern school expenditures per pupil in the post-bellum period (Figure 6). No concerted effort was made to change the quality of the Southern educational system at least until the turn of the century. There was significant improvement in the percentage of school-aged children in the South who attended school.[19] Still, these students were attending schools with shorter school terms and less well trained teachers. The relative scarcity of skilled labor in the South, as well as the isolation of the Southern labor market (particularly for unskilled workers), is reflected in the large and increasing North-South real wage gaps for unskilled workers between 1880 and 1914 (Wright 1986).[20]

A final consideration for the South during this period is its position as a periphery region relative to the core of the North. Specifically, the appearance of a more national product market during this time period offered new opportunities, but also placed the South in a latecomer position relative to the North and even the West. One can view the Southern experience of industrialization as suffering from both Hirschman's (1958) "polarization" and Myrdal's (1957) "backwash" effects, whereby in early periods of development market forces accentuate initial disparities across regions. A core region develops initially and becomes well endowed with skilled labor and capital. The high productivity of the core relative to the periphery, leads to further reallocation of skills and capital towards the core and away from the periphery (polarization) and overtaking of the national market by more efficient producers in the core (backwash) (Williamson 1965, Carlton 1990, Carlton and Coclanis 1995). As Williamson (1965) suggests within the context of cross-country patterns of initially increasing regional inequality, the take-off of one region often leads to the selective interregional migration of the more skilled, educated, entrepreneurial and young, and to reallocation of capital towards the core region. This is due to agglomeration effects in the core, in contrast to high risk premiums, a lack of entrepreneurial abilities, and immature capital markets in the

[19] The Report of the Commissioner of Education, U.S. Bureau of Education, 1893, p. 36 and 1911, p. 694.

periphery. Only later in the development process do internal factor flows (including technological flows, greater and less selective labor migration and the development of more efficient capital markets) occur sufficiently as to offset the polarization and backwash effects that tend to increase regional inequality in earlier stages.[21] From this perspective, the South of the United States may have been following a more general regional development pattern observed in many countries.

Evidence of these effects was present in the South, as demonstrated by selective migration patterns for blacks that later become less selective, and selective choices for industrialization. Carlton (1990) describes the Southern choices for industrialization as limited by the lack of entrepreneurial expertise and labor skills, leading the region "…to compensate by developing or attracting industries at advanced stages in the product cycle, industries in which skills have been largely 'built in' to their basic technology and structure."[22]

This also implies that capital goods industries will locate in areas with a sufficient stock of skilled labor and demand for specialized products. In turn, once situated, these industries will attract and expand the local mass of skilled workers (Carlton and Coclanis 1995). Using patent data, Carlton and Coclanis (1995) try to explain the relative lack of innovating activity in the South. Controlling for urbanization, the percentage of the workforce in capital goods manufacturing, and school attendance, they find that the South did not generally appear to have a distinct cultural pattern separating itself from the nation in terms of inventiveness. Moreover, they emphasize that the South's education gap and patenting gap were reflections of these backwash effects: "If the South, as a technologically backward region beset by 'backwash' effects, chose to industrialize by importing its technology, thus minimizing its investment in invention, the region also tended to choose technology that would minimize the need to develop the skills of its workforce."[23]

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[20] Wright argues that these wage gaps for unskilled labor were not merely the result of racial discrimination. Although racial discrimination occurred, and racial wage gaps existed, the North-South wage gap for unskilled labor was significantly larger than the racial gap.

[21] Williamson (1965), pp. 5-9.

[22] Carlton (1990), p. 473.

[23] Carlton and Coclanis (1995), pp. 321-322.

In line with the theories of polarization and backwash effects, Sukkoo Kim (1995) empirically demonstrates the importance of factor proportions to the location of industries in the U.S. He shows that changes in the relative mobility of factors and changes in scale economies can explain U.S. patterns of regional specialization in manufacturing. As transportation costs fell in the late nineteenth century and turn of the twentieth century, firms adopted large scale production intensive in relatively immobile resources. As a consequence, regions became more specialized. However, as factors of production later became more mobile, regional factor proportions became more similar, leading to reduced specialization after World War II. In turn, Kim (1998) demonstrates that differences in regional industrial structures played a key role in the patterns of U.S. regional income divergence and convergence between the nineteenth and twentieth centuries. In other words, growing economic integration in the U.S. initially led to greater regional specialization in manufacturing in the mid-nineteenth and early twentieth centuries, and then with greater factor mobility, the trend reversed itself in the second half of the twentieth century.[24] With greater differences in factor proportions, initial divergence in industrial structures led to initial divergence in income levels that were later reversed as factor mobility increased.[25]

Both issues of low investment in education, primarily for blacks but also for whites, and of core and periphery rely on increased labor mobility for final resolution of the inequalities across regions. Hence, greater levels of labor movement between the South and the rest of the nation were necessarily part of the final conditional convergence of the South to national norms.

A key part of the migration story relies on the migration pattern of Southern blacks. Immediately after emancipation blacks began to shift locations, but the movement was generally local (i.e. within the county of origin or between contiguous

[24] Kim (1998), p. 660-61.

[25] Kim notes that the primary cause of income divergence in the U.S. between 1840 and 1900 was the relative decline in Southern per capita income "…caused by the region's growing unfavorable industry-mix and lower wages relative to other regions." He calculates that Southern income per capita would have risen by as much as 20 percent had its industrial structure converged towards that of the national average (Kim 1998, p. 672).

counties).[26] Hence, there was general stability in the regional distribution of the black population from 1865-1914.[27]

Only after the drastic reduction of foreign immigration to the U.S. beginning around 1920 and peaking in the late 1920s and early 1930s,[28] did employment opportunities in the North increase for blacks, leading to greater (non-selective) black migration Northward.[29] Colberg (1965) further argues that it is the exporting of abundant unskilled labor and the importing of scarce educated labor in the 1940s and 50s that led to the final convergence of the South with the rest of the nation.

In summary, the plantation legacy, combined with low educational standards, labor market isolation, and periphery effects, left the South to industrialize almost completely without the aid of an indigenous technical community. Consequently, Southern firms were dependent upon Northern technology, but lacked a sufficiently educated labor force to aid in the adoption or possible adaptation of Northern technology to Southern needs.[30]

As suggested by Nelson and Phelps (1966), human capital increases the rate at which existing technology can be applied for practical uses. Hence, if Southern workers' educational levels had been higher, the speed of the adoption of Northern technology in the South, as well as the general productivity of the workers, would likely have been greater. The ultimate result of Southern educational policies was the emergence of the South as a low wage, low skill region, characterized by labor-intensive industries with low value-added (Wright 1986). In turn, specialization in low value-added industries led to less human capital accumulation by the workers employed in Southern industries.

IV. Growth Accounting

[26] To the extent that there was longer distance migration of blacks it tended to occur in a westerly direction within the South (Higgs 1977, pp. 24, 26).

[27] In both 1860 and 1910 approximately nine-tenths of the black population lived in the South. This held despite positive net migration of blacks to the North because of higher fertility and lower mortality in the South than in the North (Higgs 1977, p. 28).

[28] Lebergott (1964), pp. 29, 163, and Easterlin (1968), p.187-188.

[29] Higgs, p. 26.

[30] For striking examples of this in the textile industry see Beatty (1987).

The regressions undertaken here draw from growth accounting. I first consider level regressions similar to those in Mankiw, Romer and Weil (1992) and then comparable growth regressions along the lines of Benhabib and Spiegel (1994).

Growth accounting regressions are generally based on the following Cobb Douglas production function:

$$(1) \qquad Y_t = A_t K_t^{\alpha} H_t^{\beta} L_t^{\gamma} \mu_t \,,$$

where Y is real state income, A is the technology level, K is the real capital stock, H is the human capital stock, and L is the number of employed workers in the state. In per worker terms, equation (1) becomes

$$(2) \qquad y_t = A_t k_t^{\alpha} h_t^{\beta} L_t^{\gamma+\alpha+\beta-1} \mu_t \,,$$

where all lower case letters are the original variables expressed in per worker terms. In natural logarithmic form, for each state, i, equation (2) becomes

$$(3) \qquad \ln y_{it} = \ln A_{it} + \alpha \ln k_{it} + \beta \ln h_{it} + (\gamma + \alpha + \beta - 1) \ln L_{it} + \ln \mu_{it} \,,$$

This equation likely neglects certain unobservable state specific effects. Hence, the regressions to follow test equation (3) with a one-factor error term, μ_{it}, where $\mu_{it} = \alpha_i + \varepsilon_{it}$, i = 1...48, and t =1...3. Following Hausman and Taylor (1981), α_i represents an unobservable latent individual state effect. The α_i are assumed to be time-invariant, and independently distributed across individual states with variance, σ_{α}^2. The ε_{it} are assumed to be identically, independently distributed with zero mean and constant variance, σ_{ε}^2, conditional on the explanatory variables. While the ε_{it} are assumed to be uncorrelated with the explanatory variables, there may be correlation between the latent individual effects, α_i, and the explanatory variables k_{it} and h_{it}. For example, the capital stock of a state should vary according to the type of industry present in the state, in addition to depending on whether the state is primarily agricultural or industrial. Similarly, a state's culture and policy environment affect funding and administrative decisions for public schools. Since such state specific characteristics are not included as independent variables, their effects will be captured in the latent individual effects, α_i, and are likely to be correlated with the independent variables included in the regression. Hence, there is an *a priori* reason to think that fixed effects estimation is the appropriate specification.[31]

In addition to the basic relationship in equation (3), growth regressions are run on equation (3) using natural log differences. These growth regressions are further supplemented following a methodology similar to that of Benhabib and Spiegel (1994). They specify a model, based on the Nelson and Phelps (1966) model of technological diffusion, in which total factor productivity growth depends on the level of human capital in a country. Specifically, Nelson and Phelps argue that human capital increases the rate at which applied technology catches up with theoretical knowledge. This concept can easily be adapted to consider the diffusion of technology from more advanced states to less advanced states within the United States. I therefore adopt the structural specification of by Benhabib and Spiegel (1994), in which the growth rate of total factor productivity in state *i* is

$$(4) \qquad \ln A_{i,t+1} - \ln A_{it} = c + g(h_i) + m\left[h_i\left(\frac{\max_j y_{jt} - y_{it}}{y_{it}}\right)\right], \qquad i=1,\ldots,n,$$

where c reflects exogenous technological progress, $g(h_i)$ reflects endogenous technological process within the state, and $m[h_i(y_{max}-y_i)/y_i]$ embodies the notion of technological diffusion or catch-up to the most advanced state. Both $g(\cdot)$ and $m(\cdot)$, are nondecreasing functions of h_i. We can regroup the h_i terms and write (4) as

[31]Estimation by Ordinary Least Squares (*OLS*) assumes no latent individual effects. Hence, *OLS* will be inefficient if such effects are present. Fixed effects (*FE*) estimation treats latent individual effects as fixed, focusing on deviations of states over time from their individual means. *FE* estimation also yields inefficient estimates. However, by treating the α_t as fixed, the *FE* estimates will be unbiased and consistent regardless of whether or not there is correlation between the individual effects and the explanatory variables. Random effects (*RE*) estimation allows for random latent individual effects and represents a weighted average of both cross-sectional and within-group variance. In the absence of correlation between the α_t and the explanatory variables, *RE* estimation will be *BLUE*. If however, such correlation is present, then its results will not be consistent. Since such correlation affects *FE* and *RE* estimators differently, differences in the estimated coefficients suggest possible correlation (Hausman 1978). Accordingly, rejection of the null hypothesis of no correlation suggests that the *FE* estimates are the only consistent estimates.

$$(4') \qquad \ln A_{i,t+1} - \ln A_{it} = c + (g-m)(h_i) + m\left[h_i\left(\frac{\max_j y_{jt}}{y_{it}}\right)\right], \qquad i=1,\ldots, n,$$

The catch-up term in (4') should depend on relative technology levels, rather than relative income levels. However, Benhabib and Spiegel use y as a proxy for A in the catch-up term, as the technology level is inherently difficult to measure. The technology level is even more difficult to quantify for individual states from 1880 to 1950. I therefore also use y as a proxy for A in the diffusion term. Applying (4'), the growth accounting specification with catch-up becomes

$$(5) \qquad \begin{aligned}(\ln y_{i,t+1} - \ln y_{it}) &= c + (g-m)h_i + m\left[h_i\left(\frac{y_{\max}}{y_i}\right)\right] + \alpha(\ln k_{i,t+1} - \ln k_{it}) \\ &+ (\gamma + \alpha + \beta - 1)(\ln L_{i,t+1} - \ln L_{it}) + (\ln \mu_{i,t+1} - \ln \mu_{it}),\end{aligned}$$

where I use natural logs for the level of h_i and the catch-up term.

V. Data

The model is tested using panel data from forty-eight states in 1880, 1900, 1920, and 1950. These are the only years for which both capital stock and income data are available by state. Data on each state's capital stock (except for 1950), workforce, and personal income for these years are from estimates by various authors in *Population Redistribution and Economic Growth: United States, 1870 - 1950*, edited by Kuznets and Thomas (1957). I create a 1950 capital stock estimate to supplement the existing series using data from various issues of the *Annual Survey of Manufactures*, Romans (1965) and Kendrick (1961). These series are described in the appendix.

I also create two estimates for the human capital stock in each state from 1880 to 1950. This first reflects human capital accumulated through formal education, while the second reflects human capital accumulated through work experience. I first consider the two types of human capital separately, and then interact the two measures to create a more comprehensive human capital term.

Formal education can be measured in terms of quantity of education (for example, years of education) or in terms of quality of education (*i.e.* school expenditures, teacher salaries, teacher education, and teacher-pupil ratios). However, Margo (1986b) argues that yearly school attainment data before 1910 are biased because of the interpretation that a year of schooling in an ungraded Southern school, with shorter school terms and less trained teachers, was measured as being equal to one grade level in the rest of the nation. Furthermore, as summarized by Rizzuto and Wachtel (1980), the existing schooling literature has found that the quantity and quality of schooling can be considered substitutes and that "...societies' marginal rate of return to investment in school quality is at least as large as its marginal return to investment in additional years of schooling."[32] Additionally, school expenditures per pupil have been found to positively affect a student's educational attainment level. For these reasons, I focus on measures of school quality rather than quantity.

When examining the effect of school quality on individual earnings, two issues arise. The first is whether school inputs, as a measure of school quality, actually have any effect on earnings. Julian Betts (1996) provides a comprehensive survey of the relevant empirical studies and shows that studies focusing on individuals educated after 1960 tend to find little or no role for school inputs in explaining student earnings. However, studies that focus on school resources measured at the state level or on individuals educated before the 1960's find a strong link between school inputs and individual earnings. The second issue is which of the school input measures best reflect the quality of schooling. According to Betts (1996), studies that use state data from the *Biennial Survey of the Commissioner of Education* on average find that teacher education, expenditures per pupil, length of school year, teacher salary, and teacher-pupil ratios are respectively significant in 100, 69, 54, 54, and 19 percent of the surveyed regressions.[33] Data on teacher education are not available during the period under consideration. Hence, as a measure of investment in human capital, I rely on total school expenditures. This measure also has the advantage of incorporating other measures of school quality. For example, higher teacher salaries, longer school terms, and higher teacher-pupil ratios all lead to greater total school expenditures. I therefore estimate the education based human capital stock per worker for each state from real annual school

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[32] Rizzuto and Wachtel (1980), p. 241.

[33] These are simple cross-study averages of the percentage of the reported regressions in each study where the stated school input is significant at the 5% confidence level. Betts (1996), Table 6-1, pp.144-145.

expenditures based on the perpetual inventory model.[34] These estimates are then adjusted for interstate migration, as derived by Lee (1957).

For the experience based human capital measure, I use data on the age profile of the workforce for each state from Ann Miller and Carol Brainerd's labor force estimates presented in Kuznets and Thomas (1957) along with years of schooling and literacy data for annual birth cohorts by state of residency created from the 1920, 1940, and 1960 U.S. Censuses (Ruggles, Sobek et. al., 1997) to create a proxy for the average work experience of a worker in each state. The primary drawback to this measure is the fact that the years of schooling data necessary to create a work experience measure are not available for the earliest birth cohorts I consider. Since literacy data are available for these birth cohorts and there are overlapping data on literacy and years of schooling for many birth cohorts, I use the literacy data to predict the years of schooling for the early cohorts that do not report years of schooling. A detailed description of the creation (and limitations) of this measure is presented in the appendix.

All data (except for the experience based human capital measure) are first converted to real terms (1967 dollars) using a national consumer price index (*CPI*).[35] They are then adjusted using state relative prices constructed by Mitchener and McLean (1999) to better reflect differences in costs of living across states.[36]

In interpreting the results that follow it is also important to stress the fact that the data used are estimates constructed from survey or census data from 1870 to 1950. Given the dates of the surveys, there is likely a great deal of measurement error in the raw data, as well as possible biases due to the procedures used to create time consistent series.

VI. Results

Level Regressions

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[34] The school expenditure data come from annual reports from 1870 to 1915 and from biennial reports until the 1950s by the U.S. Commissioner of Education. A detailed description of the perpetual inventory method is given in the appendix.

[35] *Historical Statistics of the United States: Colonial Times to 1970*, (1989), pp. 210-211.

[36] I thank Kris Mitchener and Ian McLean for providing me with their data.

In Table 2, fixed effects (*FE*) estimation results are presented for equation (3).[37] These results are compared with random effects (*RE*) estimation results using the Hausman (1978) specification test. When looking only at the South, the Hausman test fails to reject the hypothesis of no correlation between the independent variables and the latent individual effect. In that case, the Hausman test suggests that *FE* estimation is not necessary, implying that the more efficient *RE* estimation is preferable. For all other regressions, however, the Hausman test favors *FE* estimation. For consistency, the *FE* estimates are presented in the body of the paper, while the *RE* estimates are given in Tables A2 and A3 in the appendix.

The first three columns of Table 2 present results from *FE* estimation of equation (3) respectively for the U.S., the South and the non-South, in 1880, 1900, 1920, and 1950 jointly, when the two human capital measures are considered separately. All variables are in natural logs. The results are good. In the three level regressions, all of the explanatory variables have the expected signs and are statistically significant, with the exception of the experience based human capital measure, which is not significant for the U.S. and is negative for non-Southern states. For the U.S. as a whole, the coefficient estimates for education based human capital and physical capital are .35 and .06 respectively. The coefficient estimate for education based human capital is statistically significant in all three regressions and yields similar estimates for the two regions and the nation as a whole. On the other hand, findings for the experience based human capital measure vary greatly across regions. Only in the South does this proxy for on the job training show up positively and significantly. Moreover, for the Southern states, the coefficient estimate for experience based human capital is 1.27, relative to the .39 coefficient on education based human capital. This result is in line with the observation that a majority of the workforce in Southern agricultural society had little to no formal education, and hence output relied heavily on learning gained through work experience. The result further underscores a potential inflexibility within Southern states in shifting to new types of industry since on the job training is less likely to be useful for a worker

[37] *OLS* regressions with robust standard errors were also undertaken for the four time periods separately. The results are consistent with the panel regression results of Table 2 and suggest a fair amount of stability over time.

shifting from an agricultural job to an job in industry than is learning based on formal education that will serve the worker in all work settings.

The effects of migration are captured within the education based human capital estimate, which is adjusted for migration. In order to directly consider the effects of migration, the same regression was run including the education based human capital measure without the migration adjustment and the natural log difference in this measure when migration is taken into account. Both the raw human capital term and the migration adjustment are statistically significant. The elasticity of real income with respect to the raw education based human capital stock is .17 and with respect to the migration adjustment is .26. This suggests that migration, or more specifically migration of the human capital embodied in individuals, played a very important role in determining per worker income levels across states. Moreover, since the migration adjustment used here assigns the average education based human capital stock to an individual based on their state of birth, the measured effect of migration is likely underestimated. Given the previously discussed evidence of educational selectivity of individuals choosing to migrate, the true effects of migration are likely larger than those documented here.

Columns (4) through (6) of Table 2 present the same regression for the U.S., the South, and the Non-South using an interacted education and experience human capital stock measure.[38] This interacted term reflects the notion that the benefit of experience may be greater with higher education levels (or similarly that greater experience enhances the benefits of education). Since these measures are at the state level, this may not mean that the benefit from the laborer's experience depends necessarily on his own education, but perhaps on that of their manager or average co-worker with whom they work and who likely disseminate information to him. The coefficient estimate for the interacted human capital measure ranges from .3 for the Non-South to .4 for the South. Relative to the coefficient estimates for human capital from formal education, which were not statistically different across the regions, the regional estimates for the interacted

[38] To control for possible technological progress, the national regression was run first using a time trend and then using time dummies. The time trend is not significant and leaves the remainder of the regression

human capital term are statistically significantly different from that for the U.S. as a whole. In particular, the Southern coefficient is significantly higher than the U.S. coefficient estimate. This is perhaps not surprising considering the extremely different findings for experience in the regions. Taking the U.S. coefficient estimate for interacted human capital of .34, implies that a ten percent increase in a state's per capita stock of human capital would have led to a 3.4 percent increase in its per capita income level during this time period, all else equal. For the South, the increase in income would have been over four percent. This evidence suggests that the South would have gained even more than the nation as a whole from marginal investments in human capital.

There is of course an issue of possible reverse causality between income and investment in human capital, which could be driving the results. To control for the possibility of dual directions of causation, three different regressions are considered. Firstly, a panel instrumental variable regression was run using lagged human capital levels as an instrument for the human capital term. The results from this regression follow those of column 4, Table 2 extremely closely. The only differences are a slightly higher R^2 (.93), a larger coefficient (.44) on the interacted human capital term, and fewer observations (since the use of a lagged variable as an instrument prevents the use of observations from 1880). Secondly, the regression was again run for the 1900 to 1950 time periods, including 1880 state income per worker as an explanatory variable. Thirdly, in a slightly stronger test, lagged income levels are included as independent variables. If high investment in human capital (through school expenditures) is solely the consequence of high state wealth, then the human capital stock coefficient should become insignificant once initial income, or lagged income is included. In the separate regressions, both initial 1880 income and lagged income are statistically significant and positive, with coefficient estimates of .07 and .2 respectively.[39] Still in both regressions the overall results of Table 2 stand. Specifically, the coefficient estimates for the interacted human capital term are again significant at the 1% confidence level and have

results basically unchanged. Only the time dummy for 1950 is significant (and positive) in the *FE* regression. Again the results presented in Table 2 remain.

[39] The *RE* estimate for 1880 income is presented since *FE* estimation cannot estimate a constant variable.

even slightly higher coefficient estimates of .44 and .43 in the two regressions. Hence, the findings for human capital are not driven purely by income levels.

A final issue to consider is that of omitted variables. It is possible that there are omitted variables that may be correlated with human and physical capital stock variables.[40] However, *FE* estimation explicitly controls for such state specific factors so long as they are time-invariant. Additionally, the inclusion of initial 1880 income in the regression mentioned above captures many of the state specific characteristics that might otherwise positively bias the estimated human and physical capital coefficients.

[40] For example, a state's policy environment is likely to be correlated with its investment in human and physical capital, leading to a positive bias on the human and physical capital coefficients if ignored.

Growth Regressions

Table 3 presents growth regression results for the U.S., the South and the Non-South from 1880 to 1950, following the Benhabib and Spiegel catch-up specification of equation (5). It is worth highlighting the interpretation of the coefficient estimates on h_i and the catch-up term. Specifically, g reflects possible endogenous technological progress, while m reflects the catch-up component due to technological diffusion. If one looks at national patent data, we see that innovative activity is concentrated in only a handful of countries. This pattern is likely to also hold within a country. *I.e.* if most endogenous technological progress is occurring in a few lead states and then diffusing to the rest of the nation, one should expect that m will be greater than g. Note also that the concept of conditional convergence is embodied in the notion of technological diffusion; That is, conditional convergence, if present, is occurring through technological diffusion and will be evidenced by a positive and statistically significant estimate for m. Moreover, it is important that the estimate for g be less than that for m since if g were greater than m throughout the U.S., endogenous technological progress would exceed diffusion, implying divergence in technology and income levels across states. This implies that the coefficient estimate (g-m) on ln h_i should be negative.

The results are presented in Table 3. Both the growth of physical and interacted education and experience human capital contribute to income growth per worker, with statistically significant coefficients of .08 and .4 respectively.[41] For the South, the estimated coefficient for human capital growth is .58, although it is not statistically significantly different from that of the U.S. as a whole. The results also confirm that in addition to the growth of human capital, the level of human capital in a state is crucial to its growth because of its contribution to technological diffusion. For the U.S. as a whole, the statistically significant coefficient estimate for m is .03, suggesting that technological diffusion was occurring. The coefficient estimate for (g-m) is -.014, suggesting an estimate for g of .016. The finding that m is much larger than g is not surprising since it is likely that very little endogenous technological progress was occurring in a majority of

[41] The finding that human capital growth matters to income growth demonstrates an important role for human capital as an input into production itself, which Benhabib and Spiegel (1994) do not find in their 1965-1980 cross-sectional country regressions.

the states. Taken together, these results are consistent with the notion of conditional convergence through technological diffusion.

Capital Stock

The lack of available capital is often cited as having limited the speed of Southern industrialization (Carlton and Coclanis 1989, Wright 1986). However, it is likely that the scarcity of human capital able to productively use and maintain physical capital, may have significantly contributed to the lack of physical capital accumulation in the South.[42] Running a regression for the determinants of physical capital accumulation based on human capital levels, physical capital levels, and workforce levels yield interesting results. For the South, the level of interacted human capital positively affects physical capital accumulation with a statistically significant coefficient of .012.[43] More interestingly, if education and experience based human capital are considered separately for the South, the education based human capital term is positive (.014) and significant at the 1% confidence level, while the experience based human capital coefficient is not statistically significant. This is consistent with the notion that while the South relied heavily on experience based human capital for production, this is not necessarily the type of human capital which encourages investment, especially in industries in which the South did not have great previous experience. Instead, human capital gained through formal education appears to have had been a positive determinant of physical capital accumulation in the South, as one might expect given the transferability/applicability of this type of human capital to a broader range of industries.

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[42] Using a cross-country regression for 1965, Benhabib and Spiegel (1994) find that the human capital level of a nation positively affects its physical capital accumulation.

[43] Labor is positive but marginally insignificant and the current capital stock enters negatively and significantly as expected with diminishing returns to capital.

VII. Conclusion

This paper finds two crucial roles for human capital in explaining the growth and convergence pattern of states after the Civil War. In particular, human capital levels are shown to matter not only to a state's income level, but also to its growth rate, both directly as an input into production and indirectly through technological diffusion.

Still, there is a unique pattern in the South, whose overwhelmingly agricultural society relied more heavily on work experience than formal education, whose racial discrimination in school resource allocation played a crucial role in lowering human capital accumulation of both blacks and whites, and whose investment in physical capital is found to have depended on human capital accumulated through formal education rather than through work experience.

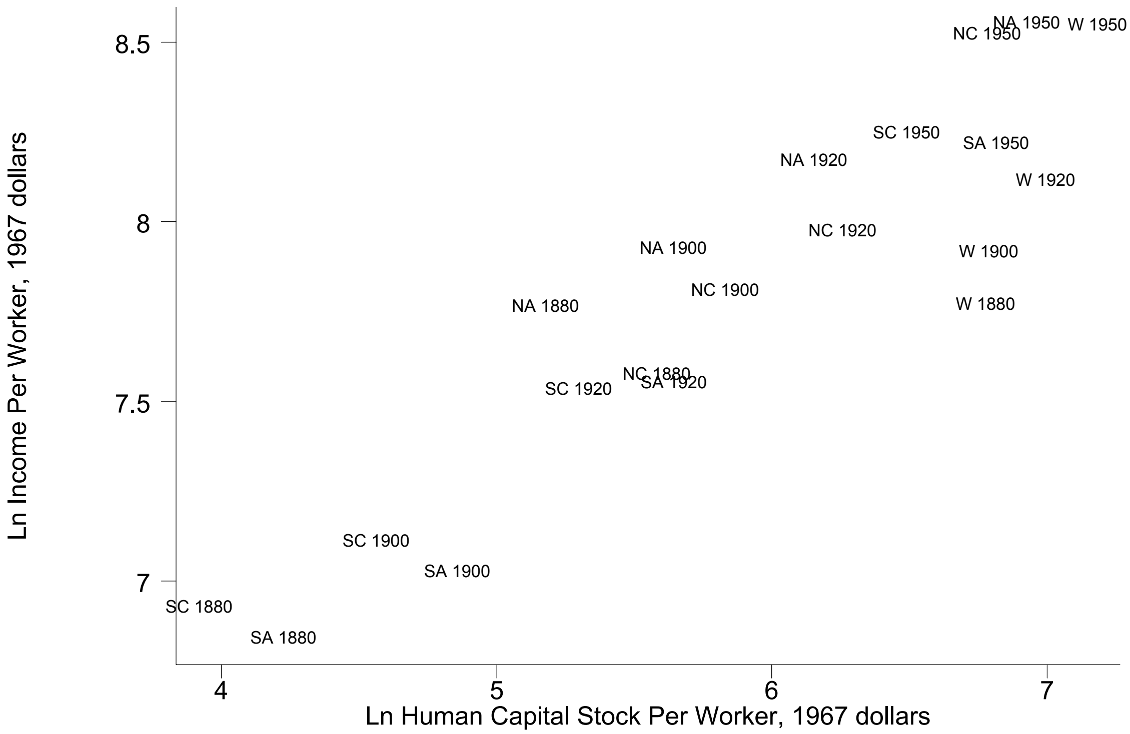
Not only is this last aspect of the Southern experience consistent with the notion that experience based human capital may be more job specific and therefore less useful than education based human capital when considering switching to new industries, but it also provides support to the argument that the South's lack of emphasis on formal education, slowed both investment and growth.

In levels, the elasticity of state income per worker in terms of interacted human capital per worker is found to be approximately 0.34. In growth terms, the elasticity of per worker income growth with respect to growth of human capital is .4 and with respect to the role of human capital in technological diffusion it is .03 times the percentage income gap relative to the richest state.

The fundamental question is: Why did the South not industrialize rapidly after the abolition of slavery? The lack of available capital is often cited as having limited the speed of Southern industrialization (Carlton and Coclanis 1989 and Wright 1986). Still, the results presented here suggest that the lack of human capital (especially that formed through formal education) may have had as much, if not more, to do with the slow pace at which the South industrialized. Racial discrimination appears to have played a crucial role in the choice of Southern politicians to not support public education for either race. Furthermore, it could be argued that the lack of capital (especially Northern capital) available in the South, may itself have been a consequence of the scarcity of education based human capital in the South.

After the Civil War, the South did not catch up with the educational standards of the rest of the nation. So long as pronounced educational and skill differences existed between the South and the rest of the United States, real Southern per capita income did not quickly converge towards the national norm. This was due to both level (productivity) effects and growth (technological diffusion) effects. Had the South been able to more quickly increase its human capital levels, particularly through formal education, it would have benefited both from a greater speed of convergence with the rest of the nation, as well as from a greater absolute convergence in income levels with the rest of the nation.

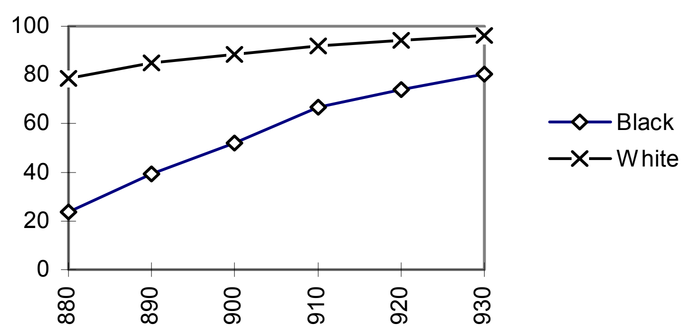
Figure 1. Education Based Human Capital



Calculations based upon: (1) Richard A. Easterlin's income estimates (1960). (2) Education data from annual issues of *The Report of the Commissioner of Education* and *Population Redistribution and Economic Growth: United States, 1870 -1950*. (3) The human capital stock measures are adjusted for migration using Lee's migration data (1957). The appendix describes the creation of this measure in detail.

Figure 2. Southern Literacy

(% of population over the age of 10)



Source: Robert A. Margo, (1990).

Figure 3. Inequality in Spending by Race in Southern States in 1930

State	Fraction of "Equal Expenditures" Received by Black Students
Alabama	.36
Arkansas	.40
Florida	.31
Georgia	.28
Louisiana	.33
Maryland	.71
Mississippi	.21
North Carolina	.48
Oklahoma	.79
South Carolina	.22
Texas	.45
For all 12 Southern States	.37

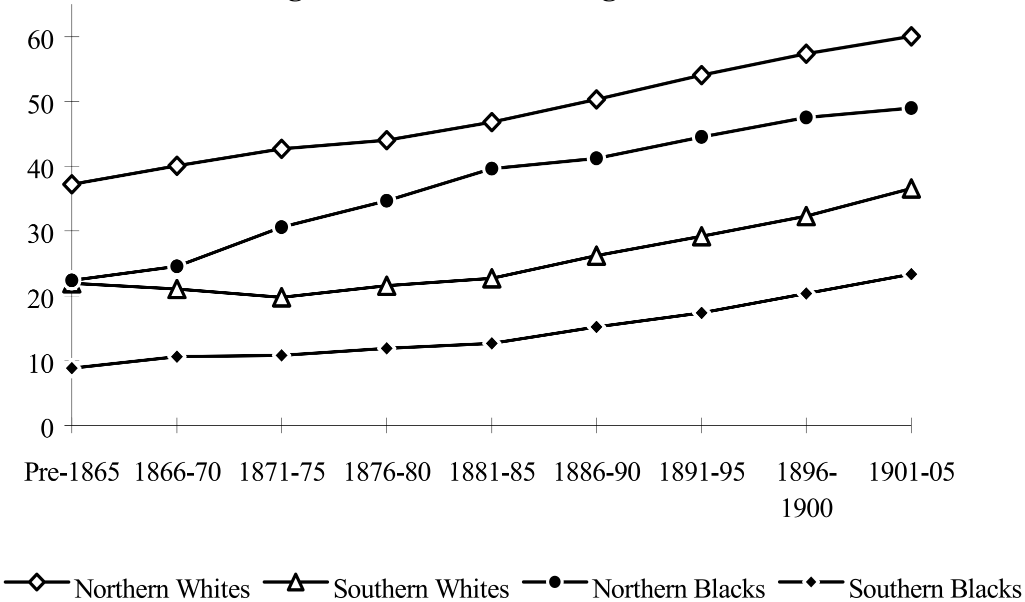
Source: Fred McCuistion (1930), p. 18 as reported by Bond (1934), p. 225.

Figure 4. The Probability of Northern Residence in 1940 for Southern Born Blacks

Birth Year Cohort	Above cohort/state specific median education	Below cohort/state specific median education	Ratio of probabilities
Before 1893	0.242	0.120	2.02
1893-1902	0.327	0.145	2.26
1903-1912	0.304	0.112	2.71
1913-1922	0.260	0.055	4.73

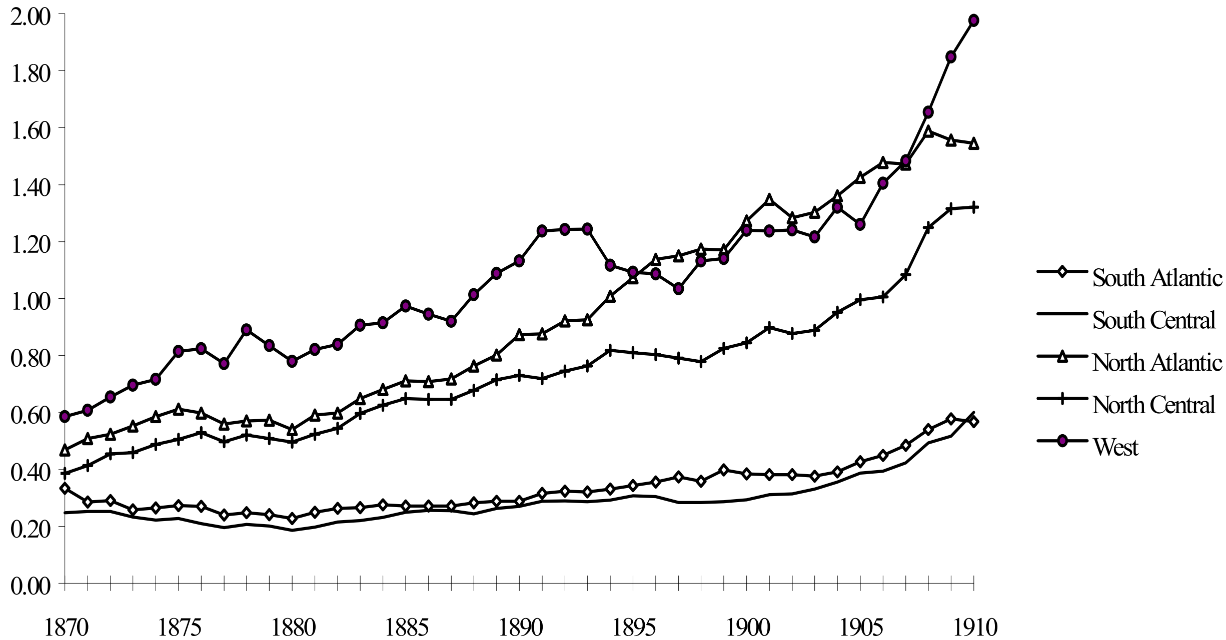
Source: Vigdor (2002), p. 394.

Figure 5. Mean Schooling Levels in Months



Estimates based on data from James Smith (1986) and The Report of the Commissioner of Education (1893 and 1911).[44]

Figure 6. Real Annual School Expenditure per Pupil (1967 dollars)



Source: *The Report of the Commissioner of Education*, (1893 and 1911).

[44] Since yearly school attainment data before 1910 are biased due to the interpretation that a year of schooling in an ungraded Southern school with shorter school terms was equal to one grade level in the rest of the nation (Margo 1986b), I adjust yearly school attainment levels from Smith (1986) using each region's average school term length when the birth cohorts began school.

Table 1. Effects of Racial Discrimination, State Level Fixed Effects Regressions, 1880-1950

Dependent Variable	**Ln of Education Based Human Capital per Worker**	
	(1)	**(2)**
Constant	-3.88** (-5.39)	-2.66** (-3.13)
Real Income per Worker	1.36** (16.2)	1.21** (12.1)
Discrimination Variable (Percent of Blacks in State Population)	-.048** (-4.48)	.052 (1.30)
Southern Dummy * Discrimination Variable		-.117** (-2.59)
Southern Dummy		◦
Observations	191	191
R^2	.78	.79
F-Statistic	248	174
Hausman Test (Prob.>χ^2) **H_o: no correl. betw. the indep. vars and the latent indiv. Effect**	.01 Reject H_o at 1% conf. level	.00 Reject H_o at 1% conf. Level

All variables are in natural logs except for the Discrimination variable, which represents a percentage.
t-statistics are in parentheses **Significant at the 1% confidence level. * 5% confidence level.
◦ Cannot be estimated using *FE*. Not significant in the *RE* regression.

Table 2. Fixed Effects Level Regressions, 1880-1950

Dependent Variable	**Ln of Real Income**					
	U.S. (1)	**South (2)**	**Non-South (3)**	**U.S. (4)**	**South (5)**	**Non-South (6)**
Constant	1.38** (2.77)	-1.37 (-1.46)	2.72** (4.64)	0.627** (2.60)	1.28 (1.81)	.922** (3.04)
Education based Human Capital Stock per worker	.345** (19.9)	.386** (14.0)	.353** (12.4)			
Experience Based Human Capital Stock per worker	.050 (0.76)	1.27** (5.56)	-.475* (-2.15)			
Interacted Human Capital Stock Per Worker				.336** (20.2)	.412** (13.6)	.296** (12.0)
Capital Stock Per Worker	.056* (2.43)	.076* (2.12)	.061* (2.01)	.064* (2.83)	.031 (0.81)	.046 (1.45)
Workforce	.282** (10.8)	.168** (2.67)	.302** (10.5)	.271** (10.7)	.185** (2.59)	.293** (9.63)
Observations	191	63	128	191	63	128
R^2	.91	.97	.87	.91	.96	.85
F-Statistic	343	365	156	449	371	182
Hausman Test (Prob.>χ^2) **H_o: no correl. betw. the indep. vars and the latent indiv. Effect**	.01 Reject H_o at 1% conf. level	.995 Cannot Reject H_o	.00 Reject H_o at 1% conf. level	.00 Reject H_o at 1% conf. level	.47 Cannot Reject H_o	.02 Reject H_o at 5% conf. Level

All variables are in natural logs. t-statistics are in parentheses
**Significant at the 1% confidence level. * 5% confidence level.

Table 3. Fixed Effects Growth Regressions
1880-1950

Dependent Variable	**Growth of Real Income**		
	U.S. **(1)**	**South** **(2)**	**Non-South** **(3)**
Constant	-.167** (-13.8)	-.159** (-4.69)	-.135** (-7.56)
Interacted Education and Experience Human Capital Stock Per Worker $\hat{g}-\hat{m}$	-.014** (-5.50)	-.005 (-0.71)	-.016** (-6.25)
implied $\hat{g}$	.016	.016	.013
Diffusion Term, $\ln\left(h_i \frac{y_{max}}{y_i}\right)$ $\hat{m}$	.030** (9.70)	.021* (2.18)	.029** (9.79)
Growth of Interacted Human Capital Stock	.402** (8.41)	.577** (5.77)	.231** (3.16)
Growth of Capital Stock	.077** (4.94)	.155** (2.79)	.072** (5.11)
Growth of Workforce	-.028 (-0.61)	.245 (1.28)	-.128* (-2.54)
Observations	143	47	96
R^2	.71	.76	.72
F-Statistic	44	17	31
Hausman Test (Prob.>χ^2)	.00	.00	.00
H_o: no correl. betw. the indep. vars and the latent indiv. Effect	Reject H_o at 1% conf. level	Reject H_o at 1% conf. level	Reject H_o at 1% conf. level

All variables are in natural logs. z-statistics are in parentheses
**Significant at the 1% confidence level. * 5% confidence level.

Appendix

Data

Education Based Human Capital: Annual estimates for the stock of human capital per worker generated from formal education in each state from 1870 to 1950 are based on total school expenditures data (from annual reports from 1870 to 1915 and from biennial reports until the 1950s by the U.S. Commissioner of Education) and on migration data from Lee (1957).[45] First, non-migration adjusted human capital stock estimates, $\hat{H}_t$, are constructed from real annual school expenditure data, S_t, as a measure of investment in education, using the perpetual inventory model:

$$\text{(A1)} \quad \hat{H}_t = (1-\delta)\hat{H}_{t-1} + S_{t-1},$$

where δ is a depreciation (or obsolescence) rate reflecting the fact that human capital disappears as people forget or die. A depreciation rate of 10% is used since this implies that only 1% of initial human capital is left after 44 years.[46] An initial human capital stock value for 1870 is estimated according to

$$\text{(A2)} \quad \hat{H}_0 = \frac{S^*}{g+\delta},$$

where g is the average annual growth rate (in ln differences) of real school expenditures from 1870 to 1950 and S^* is a weighted estimate of the steady-state value of investment based on the following formula:

$$\text{(A3)} \quad S^* = \left[\frac{1}{1+g} S_0 + \frac{1}{(1+g)^2} S_1 + \ldots + \frac{1}{(1+g)^{T-1}} S_T\right] \frac{1}{T}.$$

The raw human capital stock estimates are then adjusted for interstate migration using data derived by Lee (1957). The Lee data decompose the adult population in a state at a given time according to their state of origin. Hence, to create a migration-adjusted measure of a state's human capital, H_t, I took a weighted sum of the human capital stocks from the states of origin of the adult population. This assumes that an individual was educated in their state of origin before migrating. Education based human capital estimates for each decade from 1870 to 1950 are available upon request in the technical appendix.

Experience Based Human Capital: Estimates of the average work experience of laborers in each state are derived by first estimating the average work experience of people born within a specific birth cohort by state of residence using data on average

[45] Data from Dakota is used for North and South Dakota in 1880 since this territory had not yet been separated into two states at that date. Oklahoma is missing all 1880 data.

[46] Other rates such as 5% and 20% are also tested yielding generally similar regression results.

years of schooling from the 1940 and 1960 US Censuses.[47] This yields schooling estimates for birth cohorts from as early as 1840 to 1940. Schooling data are available for a majority of states from 1840 to 1850, with almost all states having observations starting with the 1850 birth cohort. For early birth cohorts not recorded in the 1940 Census, I use data on literacy from the 1920 census to predict years of schooling by running the years of schooling data from the 1940 Census on the 1920 literacy responses by annual birth cohorts and state of residency.[48] The predicted values for specific state cohorts are then used to replace the missing observations. This measure on years of schooling for each annual cohort by state is then used to estimate the average experience of the cohort by state using the following estimate:

Avg. annual cohort experience in year x = age of worker in year x – avg. years of schooling for that birth cohort – six,

where six is assumed to be the earliest age that people either go to school or work. Data on the age profile of workers in each time period and state are then used to created a weighted measure of the years of work experience of the workforce in each state in each time period. Finally, the data are put into per worker terms to reflect the work experience of the average laborer in a state. The workforce data come from Ann Miller and Carol Brainerd's labor force estimates presented in Kuznets and Thomas (1957).

The need for some predicted values for years of schooling is a strong drawback to this experience measure. Since the earliest birth cohorts rely more heavily on predicted values (i.e. generally prior to 1849), the importance of the predicted values is significant for 1880 estimates but diminishes quickly with time. For example, in the 1880 estimate of average work experience, approximately 26% of the U.S. labor force was born before 1835 (71% before 1855).[49] By 1900 only 4% of the labor force was born before 1835 (24% before 1855) and by 1920 no workers were born before 1835 (with 4 % born before 1855). This gives some sense of the strength/weakness of the experience measure. Still, the paper's results when this experience term is interacted with the education based human capital term are extremely consistent with the results obtained using only the education based human capital term.

Capital Stocks: Easterlin provides estimates for the capital stock in manufacturing for each state in 1880, 1900, and 1920. These estimates are based on census reports on the gross assets of manufacturing establishments, including land, buildings, machinery, and cash, but excluding rented capital. A detailed explanation of the construction of this series is available in Kuznets and Thomas (1957, pp. 675-678).

I supplement the Easterlin data by creating 1950 estimates according to

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47 All of the census data come from the *Integrated Public Use Microdata Series: Version 2.0* (Ruggles, Sobek et. al., 1997: http://www.ipums.org).

48 This panel regression with 3,233 observations yields a coefficient estimate of 3.98 for the literacy index (which ranges from 1 (completely illiterate) to 4 (completely literate)) with an R^2 of .36 and an Wald statistic of 964.

49 These two cutoff dates are reported here since these are the two end years for relevant birth cohort groupings reported in the age profile labor data.

(A4) $\hat{K}_{1950} = \frac{I_{1950}}{g+\delta}$,

where g is the average annual growth rate (in ln differences, using the three year averages to smooth out the endpoints) of real investment in new plant and equipment in the manufacturing sector from 1951 to 1976 based on data from the *Annual Survey of Manufactures* (ASM), various issues, and δ is a depreciation rate of 8 % (chosen to match Easterlin's assumed depreciation rate). I_{1950} should ideally be investment data in 1950. However, no data for investment in 1950 are available by state. Hence I consider three proxies for this measure. The first is Romans' (1965) estimates of investment in new plant and equipment by state in 1953, which uses ASM data appropriately adjusted to match aggregate U.S. manufacturing data from various issues of the *Survey of Current Business*. The second is 1947 investment data on investment in new and used plant, equipment, and land in manufactures from the *1947 Census of Manufactures*. The third is a steady-state measure of investment (weighted in similar fashion to equation A3) using ASM data on investment in new plant and equipment by manufacturers from 1951 to 1976. The three alternative measures are highly correlated and yield extremely similar results in the regressions. The results presented in the paper come from the first measure, which uses Romans' 1953 data as a proxy for initial investment.

Finally, estimates for the capital stock in manufacturing in each state in 1880, 1900, 1920 and 1950 are proportionately scaled up to match the time series behavior of the aggregate U.S. physical capital stock using data on the real capital stock for the U.S. private nonfarm nonresidential sector from John Kendrick (1961).

Personal Income: Personal income data come from estimates by Richard Easterlin in Kuznets and Thomas (1957). Easterlin uses annual estimates from the National Bureau of Economic Research (NBER) and the Department of Commerce for the 1919-1921 data and 1949-51 time periods, respectively. He then constructs estimates for 1880 and 1900 using estimates of service and property income. A lengthy description of the estimation procedure is given in Kuznets and Thomas (1957, pp. 703-727).

Labor Force: Ann Miller and Carol Brainerd estimate labor force data in Kuznets and Thomas (1957) using decennial censuses of the population for the period 1870-1950. A description of the estimation techniques, as well as the estimates themselves, is available in Kuznets and Thomas (1957, pp. 364-411).

Table A2. Random Effects Estimation, 1880-1950

Dependent Variable	Ln of Real Income					
	U.S. (1)	South (2)	Non-South (3)	U.S. (4)	South (5)	Non-South (6)
Constant	1.70** (3.67)	-1.58* (-1.97)	2.86** (5.44)	.849** (4.33)	1.09** (2.81)	1.17** (4.10)
Education based Human Capital Stock per worker	.380** (31.8)	.381** (16.6)	.384** (20.5)			
Experience Based Human Capital Stock per worker	.061 (0.40)	1.25** (5.56)	-.359 (-1.90)			
Interacted Human Capital Stock Per Worker				.373** (32.48)	.401** (16.2)	.350** (20.3)
Capital Stock Per Worker	.082** (5.21)	.075* (2.44)	.075** (4.11)	.087** (5.60)	.048 (1.45)	.074** (3.90)
Workforce	.222** (15.2)	.190** (5.92)	.237** (15.1)	.213** (15.3)	.197** (5.98)	.216** (14.2)
Observations	191	63	128	191	63	128
R^2	.90	.94	.83	.90	.93	.82
Wald χ^2 Statistic	1724	1468	647	1693	1101	567
Hausman Test (Prob.>χ^2)	.01	.995	.00	.00	.47	.02

Table A3. Random Effects Estimation, 1880-1950

Dependent Variable	Growth of Real Income		
	U.S. (4)	South (5)	Non-South (6)
Constant	-.030** (-3.57)	-.061** (-3.20)	.002 (0.22)
Interacted Human Capital Stock Per Worker $\hat{g}-\hat{m}$	-.008** (-4.41)	.001 (0.22)	-.014** (-6.03)
Diffusion Term, $\ln\left(h_i \frac{y_{\max}}{y_i}\right)$, $\hat{m}$	.011** (5.39)	.005 (1.17)	.015** (6.36)
Growth of Interacted Human Capital Stock	.159** (3.26)	.490** (6.30)	-.105* (-2.06)
Growth of Capital Stock	.038 (1.79)	.156** (3.11)	.037* (2.01)
Growth of Workforce	-.015 (-0.27)	.095 (0.81)	-.181** (-3.61)
Observations	143	47	96
R^2	.28	.55	.36
Wald χ^2 Statistic	53	50	51
Hausman Test (Prob.>χ^2)	.00	.00	.00

All variables are in natural logs. t-statistics are in parentheses for Table A2, z-statistics for A3
**Significant at the 1% confidence level. * 5% confidence level.

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