THE PRODUCTIVITY OF U.S. STATES SINCE 1880

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ABSTRACT

This study identifies the determinants of interstate variation in labor productivity levels at twenty-year intervals between 1880 and 1980. Focusing on fundamental rather than proximate influences, we find that institutional characteristics, physical geography, and resource abundance can account for a high proportion of the differences in state productivity levels. States with navigable waterways, a large minerals endowment, and no slaves in 1860, on average, had higher labor productivity levels throughout the sample period. No consistent support was found for two other influences given prominence in cross-country analyses of differences in incomes or productivity levels: climate and the quality of government.

Keywords: economic growth, productivity levels, slavery, natural resources

JEL Classification: N1, O4, Q32, R11

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1. Introduction

The impressive growth of the American economy over the long run has powerfully influenced policies aimed at lifting productivity and living standards in much of the world for much of the past century. Yet important questions concerning the bases of that success are lacking persuasive answers, or the suggested answers remain controversial. This outcome arises partly because growth theory provides the empirical growth economist with limited guidance, and partly because arriving at a persuasive account of the causes of the wealth of nations has been perhaps the most challenging problem in economics since posed by Adam Smith. Recent responses to this challenge have included the development of endogenous growth theories, and an expanded coverage of empirical growth analyses to include nearly all countries. However, this paper draws on other features of the recent growth literature to explain U.S. experience. It extends the list of explanatory factors beyond the proximate influences of physical and human capital and adopts a regional level of analysis. And its objective is to account for differences in levels of productivity rather than rates of growth.

In 1880 the United States was poised to overtake Britain as the most efficient industrial economy, and become the century-long benchmark against which all other economies' productivity performance would be compared. Yet in that year it contained an extraordinary range in productivity levels across states (Figure 1). Labor productivity in the least productive state (North Carolina) was a mere 18 percent of that in the most productive (Nevada). Excluding the case of Nevada because of its early stage of settlement and very small population, a comparison with the second and third most productive states, California and New York, indicates North Carolina as being only 23.6 and 24.4 percent as productive, respectively.[1] Differences of such magnitude between countries would today only be found in comparisons between developed and developing economies.[2] Until 1940 this wide range of productivity levels narrowed only gradually, when the least productive state had a level of labor productivity 25 percent that of the most productive. Thereafter the gap narrowed more rapidly, with the least productive state reaching 61 percent of the level of the most productive in 1980. Just as the existence of large productivity gaps between countries constitutes a major analytical and policy challenge to growth economists, accounting for the wide disparities in state productivity differences in the late nineteenth century United States, and their persistence well into the twentieth century, poses a related challenge, and one that has not been directly addressed.[3]

In this paper we offer a novel approach for understanding the productivity experience of the United States by identifying the determinants of interstate variation in labor productivity levels at twenty-year intervals between 1880 and 1980. We focus on possible fundamental sources of that variation (such as geography or institutional arrangements) rather than the proximate influences (such as investment in physical and human capital) typically employed in studies explaining variations in rates of growth of income or productivity. Institutional characteristics, physical geography, and resource abundance can account for a high proportion of the variation in state productivity level differences, especially at the beginning of the period studied. No consistent support was found for two other influences given prominence in the cross-country regressions of income or productivity levels in recent years: climate and the quality of government. By focusing on data within a country, we have controlled for institutional differences that have been difficult to properly account for in many cross-country studies. Nevertheless, institutions still play a prominent role: the legacy of slavery has a strong and persistent effect on productivity levels across U.S. states.

Following a review of literature and a discussion of our conceptual framework in the next section, section 3 explains the selection of our hypothesized key determinants of differences in productivity levels across states, drawing particularly on the insights embedded in American economic historiography as well as recent growth analyses. Section 4 discusses the data and also presents the empirical results, together with an assessment of their robustness by considering alternative proxies for the explanatory variables. We then explore issues of endogeneity and possible omitted variable bias (section 5). In section 6 we extend the analysis by further exploration of some implications of our results. The main contributions and wider significance of our study are summarized in a concluding section.

2. Literature and Conceptual Framework

The problem of economic development is widely acknowledged as one of "accounting for the observed pattern, across countries and across times, in levels and rates of growth of per capita income" (Lucas, 1988, p.3). However, recent theoretical and empirical research has primarily focused on the second half of this agenda – growth *rates*.[4] There have been few attempts (discussed below) to explain formally why the substantial dispersion in per capita income or productivity *levels* exists. Differences across countries in productivity levels usually result from the cumulative effect of a host of prior influences operating gradually and over long periods of time. Thus it is often difficult to detect the effects of such variables on growth rates, which may be imperceptible in the short to medium term, even though their eventual impact on levels can be large. Yet, because growth rates over the very long run have been uneven, these level differences between countries are increasing.[5]

To be sure, economic historians have long been aware of these differences in income and productivity levels, and participated in the search for a framework within which to explain them – whether in the context of Gerschenkron's (1962) identification of leader and follower countries and degrees of "backwardness" in 19th century Europe, or in Landes' (1990) quest for an answer to the fundamental economic question – "Why are We so Rich and They so Poor?"[6] Much of the focus in this historical literature is on causal factors omitted from most growth models, especially institutional, geographic, cultural and policy explanations of the gaps between high and low income or productivity economies.

A similar focus is evident in cross-country studies of income and productivity levels. Gallup, Sachs and Mellinger (1999) argue that the variation in the level of per capita income is determined by geographical factors (tropical diseases, natural resource endowment per capita, distance from world markets, and the proportion of population near coasts), and political and institutional factors (quality of government institutions, openness to trade, and legacy of colonial rule). They report that the four geographic explanatory variables alone account for 69 per cent of the variation in per capita income levels across 83 countries in 1995.

In a study of cross-country levels of output per worker for 1988, Hall and Jones (1999) first show that differences in physical and human capital across countries leave much of the variation in output per worker unexplained. They then demonstrate that physical capital per worker, human capital per worker, and the Solow residual (and hence output per worker) can be accounted for by "social infrastructure." Their measure of social infrastructure is an index covering several aspects of quality of government as well as the openness of the country to international trade. Since social infrastructure is endogenous, they use measures of the historical extent of western European influence as instruments for the quality of government (distance from the equator, and the extent to which English or a major

European language is spoken), and a measure of predicted trade share (based on population and geography) as the instrument for openness. Most of the observed variation in levels of output per worker is accounted for by social infrastructure.[7]

The central task of this paper is to account for the substantial differences in *levels* of labor productivity across U.S. states in 1880 and at twenty-year intervals thereafter, and for this purpose we adopt an approach that is explicit in some of the "levels" studies and implicit in historians' writings on long-run growth. Rather than focusing on proximate determinants such as human and physical capital, we identify fundamental (and exogenous) influences and proceed directly to estimate the relationship between output per worker and these hypothesized determinants. Such an approach will indicate either of two possibilities: that a limited number of deeper determinants account for most level differences across time and place (a result comforting to the economist's desire to develop parsimonious models of general applicability) or that these deeper determinants are more numerous, and vary by period or place.

In the absence of clear guidance from theory, our selection of deeper (exogenous) explanatory variables draws partly on the empirical growth literature, which suggests that certain fundamental influences on productivity levels might apply fairly generally.[8] One is locational advantage (or disadvantage), as reflected in such geographic features as access to a coast or navigable waterway, or distance to some relevantly defined point in the national or international economies. A second is climate, especially the advantage of temperate over tropical zones in terms of disease environment, soil fertility, and working conditions. Another is the natural resource endowment, especially (but not limited to) minerals and fuels.

Several of our hypotheses are also based on evidence and debates that have been exhaustively evaluated by historians. From this rich literature we draw especially on one old and one new theme. The well-established theme is that in a major region of the economy, the South, income levels that were depressed during the Civil War did not converge on those in the rest of the country until after the 1930s. The reasons for this delayed catch-up appear rooted in the institutional arrangements in the South dating from the end of slavery.[9] The new theme concerns the importance of natural resource abundance. Agricultural land was abundant in the 13 colonies, and the westward territorial expansion of the United States reinforced this favorable feature of the economy. However, Wright (1990) has argued that a related phenomenon, the discovery and exploitation of mineral resources, was significant in underpinning industrial development until 1940.[10]

3. Determinants of Productivity Levels

This paper tests the view that the variation in regional U.S. productivity levels over the past century can be accounted for by a small number of fundamental and exogenous determinants. Our aim is to include only those deeper determinants that have persisting rather than transitory effects; hence we are not searching for that "model" which necessarily best fits each year in the study, considering that year in isolation.

The requirement that these determinants be non-transitory, fundamental, and exogenous shortens the list of candidates. Many institutional factors canvassed in the cross-country growth literature (for example, language, culture, religion, legal system, or political system) are not likely to be paramount in an inquiry confined within the borders of the United States. On the other hand, some factors found to be of importance in cross-country studies are potentially relevant to the explanation of differences in productivity levels across U.S. states (for example, natural resource endowments, climate, and certain geographic features).

3.1. Minerals Endowment

Economists have reached no consensus as to whether resource abundance spurs or inhibits growth. Sachs and Warner (1995b) have shown that, since 1960, resource-abundant countries (defined by measures such as natural resource exports as a percentage of GDP) have experienced lower growth rates, suggesting that it is a curse rather than a blessing to be resource rich. One hypothesis in support of this empirical evidence is that resource-based development is likely to be accompanied by heavy government involvement, and the political process encourages wasteful rent seeking.[11] On the other hand, Wright (1990) has argued that much of the industrial success of the United States in the late nineteenth and early twentieth century was based on its ability to exploit quickly and efficiently its mineral resource base.[12] It may therefore be the case that natural resources confer some sort of initial advantage for developing economies. Particularly in frontier economies, where labor and capital are often in scarce supply, having a large initial endowment of resources may improve the opportunities for economic agents to acquire scarce factors quickly – to grow extensively, acquiring more capital and labor so the resource base can be further exploited.[13] This suggests that a region rich in readily extractable natural resources may record higher levels of output per worker.[14]

To test for the influence of resource endowment on productivity it would be ideal to have a measure of total natural resource stocks by state. It is the endowment (per capita or per worker) that leads to the level effect we here are seeking to identify. However, state-level data on resource stocks are unavailable, and production data for some minerals and years are difficult to assign by state. Hence we use the share of employment in mining as a measure of natural resource abundance in a state.[15] (Summary statistics of this and other explanatory variables are reported in Table 1.) A positive sign would be consistent with the frontier economy and Wright hypotheses.

3.2. Climate

In an era where air conditioning, heating, and climate control are standard in the workplace, it is difficult to think that climate significantly reduces any state's average labor productivity. In 1880, however, weather may have severely altered both the hours worked and the level of efficiency at which one worked. For example, snowstorms or late spells of cold weather may have affected the timing of planting crops (small grains) on the Great Plains, and, without climate control, the pace of work in factories or textile mills may have been hampered by summer heat.

U.S. statistics on weather and temperature at the state level are actually quite detailed, so we can assess the climate hypothesis more explicitly than has been possible in many cross-country studies. We used the average annual number of cooling degree days as our initial climate proxy – a measure which NOAA uses to determine the need for air conditioning in buildings.[16] Using this measure of climate, Maine records the lowest value, while Arizona has the highest. If heat impaired labor productivity, then the expected sign on this variable will be negative (reflecting the disadvantages of working without air conditioning); moreover, it will decline in importance over the sample period especially after 1940 as the use of air conditioning diffuses.

3.3. The Legacy of Slavery

The trajectory of the Southern economy was disrupted by important political and social events in the mid-nineteenth century. The Civil War (a negative shock) ushered in a well-known process of relative stagnation and delayed convergence from below. From 1860 to 1880, income levels in the South fell relative to the rest of the country and relative to its own 1860 level; incomes only began to converge rapidly in the post-WWII period. Emancipation triggered post-bellum institutional changes that altered the relationships between factors of production that may have had a negative impact on the efficiency of production and hence on southern levels of income per capita. For example, former slave-owners could no longer determine the number of hours worked and the type of work carried out by the free blacks, nor could they necessarily influence the efficiency of production through the control of nutrition and health. Furthermore, in both the workplace and southern society at large, discrimination and legal restrictions placed on ex-slaves may have limited their access to education or their ability to secure either physical capital or land. Denying productive agents these economic opportunities may have decreased the efficiency of production in the post-bellum era. The heterogeneous institutional response to the demise of slavery throughout the South therefore might be an important underlying determinant of differences in the observed productivity levels across states. And this negative influence on efficiency may have persisted for many decades, as the economic catch-up of the southern states began only in the 1930s.[17]

To proxy the legacy of slavery, we use the percentage of the state population in 1860 that were slaves.[18] As slavery has been associated with a host of factors detrimental to productivity levels long after emancipation, the expected sign on this variable would be negative. States with a higher percentage of slaves in 1860 may have been more resistant to opening up economic opportunities to emancipated slaves through ownership of land and access to education and jobs; that is, these states may have exhibited higher degrees of social and legal discrimination, foregone economic efficiency, and hence lower productivity levels.

3.4. Geography

In country studies, the growth rate and the level of per capita income are both shown to be positively related to the openness of the economy, conventionally measured as the ratio of total trade (exports plus imports) to income.[19] Other cross-country studies have emphasized physical impediments to trade.[20] Between U.S. states there exists only natural barriers to trade as opposed to politically imposed impediments; thus transport costs likely play a significant role in determining the level of interregional trade. Additionally, ideas that improved the efficiency of production may more easily have been transmitted if a state was well served by transportation and information networks.

The historical literature, especially for the period before the completion of the national railroad network, emphasizes the advantages accruing to locations with access to navigable waterways. During this time, freight rates for water transport were significantly lower than those for land, with ocean rates the lowest of all. Interstate trade, especially between non-contiguous states, was clearly facilitated by access to navigable water – as illustrated by the trade along the Atlantic seaboard from colonial times on, and the trade in raw materials on the Great Lakes (Taylor, 1951). International trade would also be favored in coastal states or those with ocean-navigable rivers compared to those where geographical obstacles imposed cost barriers to participation in the world economy. Even when innovations in land transportation eroded these natural advantages, path dependence may have ensured that the advantages to states with navigable waterways persisted. Cities which grew up because of natural harbors, or at strategic points on navigable rivers, and brought favorable external economies with their commercial and industrial development, did not relocate following the completion of the interstate railroad and highway systems.

The hypothesis tested here is that an efficiency advantage accrued to states with natural water access in the late-nineteenth century, and that this advantage persisted despite the revolution in land transport wrought by the railroad and highway. What constitutes a navigable waterway (or access to the ocean) is not straightforward, and may be influenced by investment (e.g. in canals, locks, river-deepening), or by technological change (e.g. in riverboat design). Both of these may, in turn, be more likely to be undertaken in higher productivity regions or economies.[21] Given the possibility of reverse causation, we define navigable waterways in such a way that we can assume exogeneity. We capture the productivity effects of location and openness to interstate and foreign commerce by including a dummy variable where positive values indicate states that are coastal or border the Great Lakes. We expect that this dummy variable will be positively related to the level of labor productivity.

4. Data and Analysis of Determinants

The dependent variable in this study, what we call labor productivity, is derived from estimates of personal income per capita for each state. To calculate labor productivity, the personal income data were first adjusted for differences in price levels across states, for each of six census years between 1880 (the first year data for western states are available) and 1980 using "relative" price indexes. This produced price-adjusted personal income per capita estimates that are calculated relative to U.S. average prices for a given year. These estimates were then further adjusted to a per worker basis using the employment-population ratio (or labor input per capita) in each state. The labor productivity measure is thus (log) price-adjusted income per worker.[22]

The data set includes 47 states for 1880 and 48 for years thereafter.[23] We obtained data on our underlying determinants as well as state productivity for the six selected census years from 1880 to 1980 such that we could also measure how the effects of various factors change over a long period of time, something that previous cross-country studies examining labor productivity levels have not reported.

We make the identifying assumption that the fundamental determinants are uncorrelated with the random element of our measure of labor productivity, and then use ordinary least squares to estimate the parameters of the relation. This identifying assumption seems reasonable. Certainly climatic factors are exogenous, as is slavery, and the location of a state with respect to navigable water. A strong justification (as discussed in the next section) can also been made for the exogeneity of mining activity in a state.

The results of the regressions are reported in Table 2. In 1880, 1900, 1920 and 1940, the four identified determinants explain about 70 percent of the variation in productivity levels across states (using the adjusted R-squared). Figure 2 displays the overall fit of the equation for 1880 when the variation in state productivity levels was greatest. States above the 45-degree line produce more price-adjusted output per worker than our specification predicts, while states below the 45-degree line produce less than predicted. In the post-World War II period our model is somewhat less successful, accounting for less than half of the variation in productivity in 1960 and 1980. This result may be due in part to the decline in the dispersion of labor productivity across states. Less variation in the dependent variable may make it more difficult to discriminate between competing hypotheses as to why the variation in levels existed. It is also possible that one or more factors omitted from our specification emerged as having a significant impact on productivity levels across states only after 1940 or that underlying factors that drove economic development in its early stages (such as natural resource abundance or geographical advantages) are less important for explaining differences today. In a study designed in part to provide an historical perspective on the more recent work by growth and regional economists, our priority here is to see how far a simple general model could explain the reasons for variation in state productivity levels at six widely separated dates.

4.1. Minerals Endowment

The coefficient on the measure of mineral endowment has the expected positive sign in all years, though it falls below conventional significance levels in 1940 and 1960. Except in these two years, states obtained a productivity advantage from their mining industry after controlling for other influences in our model. In 1880, for example, 27 states had less than one percent of their workforce in mining while seven states had more than 10 percent. An increase of 10 percentage points in the share of mining in a state's employment was, in that year, associated with an increase of 11 percent in labor productivity in that state. Moreover, the coefficient on mining employment is positive and economically significant despite the fact that our measure of labor productivity adjusts the data for state-level differences in demographic characteristics. That is, it was possible that the estimated relationship between mining and labor productivity would be zero since our measure of labor productivity accounts for the high labor input per capita that the mining sector typically attracted.[24] Our result, however, is consistent with what Bernard and Jones' (1996) find for the 1980s. We interpret the positive coefficient as evidence that there were indeed productivity effects of mineral abundance in addition to the boost to income per capita that came from the favorable demography and workforce characteristics associated with mining. In the context of the development of U.S. states, to be mineral rich led to higher productivity levels.

4.2. Climate

It was anticipated that the coefficient on number of cooling-degree days would have a negative sign, reflecting that climates requiring more air conditioning have lower levels of productivity or income. There is no support for this proposition in our basic model. Indeed, in 1980, the only year in which a statistically significant relationship is recorded, the sign is the opposite to that hypothesized. Alternative proxies (the number of heating degree days or the sum of heating degree days and cooling degree days) were considered to check the robustness of our climate variable; none of these substitutions yielded support for the existence of any hypothesized relationship with productivity levels, considering either sign or significance.[25] Climate therefore appears not to account for any of the variation in productivity levels across states in any of the years in the study once the other independent influences have been included in the model.

Our approach to understanding the relationship between climate and productivity has thus far focused on the benefits from controlling climate, but there are other hypotheses concerning this relationship that warrant consideration. Disease ecology and agronomic processes can be influenced by climate and may, in turn, alter productivity; this has led Gallup, Sachs, and Mellinger (1999) to conclude that temperate climates are more productive.[26] Masters and McMillan (2000) suggest that ecological zones experiencing frosts have higher crop yields because frost episodes alter plant respiration, water-evaporation rates, crop spoilage, topsoil availability, and the presence of pests and parasites. Similarly, vector and waterborne diseases that flourish in warmer climates, and which affect human health and productivity if endemic, are frustrated by frosts. To test for these relationships, we considered two other alternative proxies that emphasize the importance of climate's effects through health and agronomic systems: total accumulation of snow and ice pellets and the number of days in a year when the minimum temperature was at or below 32F.[27]

The results (not shown) indicated that there is still no systematic relationship between climate and productivity across ecological zones in the U.S.

4.3. Legacy of Slavery

The regressions in Table 2 strongly confirm the hypothesis that slavery is associated with lower levels of productivity.[28] Our expectation was that any measurable impact of the legacy of slavery in 1880 would fade as the institutions inhibiting more efficient economic arrangements in the post-bellum South underwent gradual change. Surprisingly, our proxy measure exerts a negative and significant influence on interstate variation in labor productivity through 1960, although the magnitude of the coefficients on this variable decline across the century. The estimates in Table 2 indicate that as late as 1940, more than seven decades after emancipation, a state whose population was 10 percent slaves in 1860 would have a 15 percent lower level of productivity. Only in 1980 does the coefficient become insignificant. Since our data are at 20-year intervals, some caution should be exercised in terms of pinpointing the precise decline in this variable's influence. But there is support here for the view that only in recent decades has the distinct and independent drag on southern economic efficiency, originating in the slave-plantation era, finally lifted (Wright, 1987).

To check the robustness of our legacy of slavery variable, we considered an alternative measure: the number of slaves owned by slaveholders with 20 or more slaves in 1860 as a percent of the total state population.[29] This proxy captures the relative importance of plantation slaveholding, recognizing the debate about the productivity consequences of scale economies in antebellum agriculture (see, for example, Irwin (1994)). If the greatest dislocation to the institutional arrangements in the post-bellum South was associated with the end of the plantation system, then this alternative measure of the legacy of slavery may more precisely capture its impact on productivity levels in 1880. In Appendix 1, the relationship between productivity and deeper determinants is re-estimated using this alternative proxy for the legacy of slavery. A comparison with the results from Table 2 shows almost no change to the results in any year, with the exception that in 1980 the coefficient on the plantation slave variable is significant at the 5 percent level, whereas in the original specification it was not.

To test whether the legacy of slavery variable is simply capturing a "southern effect" instead of a measure of the intensity of slavery in a state, we re-estimated the relationship in Table 2 including interaction effects. Specifically, in Table 3 we interact a dummy variable (where one indicates a slaveholding state) with each of the (non-slave) explanatory variables and include these with the other explanatory variables used in the original analysis. Since none of the slope dummies has a coefficient that is significant at conventional levels, we can reject the hypothesis that the legacy of slavery variable is standing in for a generic "southern effect."

4.4. Geography

Finally, there is strong support for the proposition that geography can be an important, and statistically significant, independent influence on productivity levels. States that border the sea or Great Lakes have significantly higher productivity in all years in this study. In 1880 the advantage is a 24 percent lift in labor productivity; this advantage fluctuates (without discernible trend) in the other years in the study between 12 and 34 percent. This result is consistent with the findings of cross-country studies of the income or productivity level effects of access to navigable waterways. As was suggested in the previous section – despite the ascendancy of rail, road, and air transport and the corresponding erosion of cost advantages associated with direct access to navigable waterways – there is no evidence of any decline in locational advantage. Having access to a navigable waterway appears to lock in long-term productivity advantages that persist despite technological change.

Here again, we subjected our results to sensitivity analysis, by restricting the definition of access to navigable water to those states with a seacoast (Appendix 2). A comparison of the results reported with those in Table 2 indicates that the removal of the states bordering the Great Lakes reduces the significance of this geographic variable below the 10 percent significance level in both 1880 and 1980, but otherwise does not affect the performance of the original specification. We conclude that access to the Great Lakes is important to the explanation of state productivity levels.[30]

5. Endogeneity and Omitted Variables

The methodology employed here requires that the hypothesized determinants of productivity levels in each state be exogenous. With three of the four independent variables (climate, slavery, and geography), proxy measures have been chosen that are unambiguously independent of the level of productivity (or of economic development more generally) in 1880 and later years. However, the possible endogeneity of our mining proxy must be considered further.

In principle, the natural resource endowment would seem unambiguously exogenous to the level of productivity: a region either possesses gold, oil, or copper or it does not. Moreover, the endowment of minerals is not evenly spread across the globe - or across political units. Yet the search and exploitation stages of mineral development may require levels of investment and technology that are positively related to the level of economic development. If the resource exists, the probability of its discovery and exploitation may be positively related to the level of development in a country, although as the history of Middle East oil production illustrates, the operations of multinational resource firms blur even this generalization.

The expansion of U.S. mining in the nineteenth century, relative to that in other countries, led to American dominance in world production of most economically important minerals by early this century (Wright, 1990). David and Wright (1997) have advanced the view that this achievement resulted in part from the American lead in relevant scientific and technological knowledge, which in turn was the product of high U.S. incomes. However, their view is not relevant to an examination of the experience of states and regions *within* the United States. There were no barriers to the flow of capital and technology across state boundaries, and firms and individuals could take their investment and talents wherever they saw the opportunity for the highest potential return.[31] In mining, this is likely to have been where the prospect of mineral discovery was greatest, or where some prior mining activity existed.[32] In this context, our proxy for the endowment of minerals (the share of mining employment in a state) is likely to be exogenous. Indeed, mineral discoveries famously precede economic development in many states in the Mountain and Pacific regions.

The methodology employed here also requires special attention be given to the appropriate specification of the model. There is understandable concern in empirical work of this type that the results may be highly sensitive to the choices made in selecting explanatory variables (Levine and Renelt 1992). First, it should be noted that our model has been run over six separate data sets (on six years, 20 years apart), and we obtain similar results. The cross-country growth regressions are unable to perform this type of sensitivity analysis. And second, we investigated two possibly omitted influences on the variation in productivity levels across states.

One candidate variable we have not included is the extent of urbanization. Of course, it is not at all clear that economic density is strictly exogenous to productivity levels. High economic density or urbanization levels are symptoms or features of a high productivity economy rather than (or as well as) being fundamental determinants. Nevertheless, growth theorists and regional economists have drawn attention to agglomeration and congestion effects associated with the density of economic activity, where density is often defined as the measured amount of capital and labor in a fixed area. Economic density affects productivity positively through increasing returns in production technologies, positive externalities linked to the nearness of productive activity, and higher degrees of beneficial specialization. Ciccone and Hall (1996) develop and test a density index using 1988 U.S. data that is based on employment effects at the national, state, and county levels. Their model suggests that if agglomeration effects outweigh congestion effects, then states with higher density levels will have higher levels of productivity.

There are, however, two serious problems in incorporating their theoretical approach into our framework. First, there is the issue of constructing a similar measure of density without comparable county-level data, and then identifying appropriate instruments for dealing with the endogeneity of density. Many of their instruments date 120 years prior to their sample period. Analogous instruments in our study would require identifying factors that existed prior to the formation of the United States; one might question how appropriate such instruments would be. As an attempt to resolve both the construction and endogeneity issues, we computed a measure of density based on the proportion of the state's population that lived in cities with populations greater than 100,000 in 1860. That is, a lag of varying years applied, ranging from 20 in 1880 to 120 in 1980.

We found evidence in most years of a positive relationship between our constructed measure of density and productivity levels, and there was little change to the signs or significance of other explanatory variables. However, we are cautious about emphasizing this result given the limitations of our data and the difficulty of locating appropriate instruments. Moreover, underlying Ciccone and Hall's empirical work is a modelling assumption that all land is equally productive. This means that they exclude U.S. data on the agricultural and mining sectors when they empirically test their density index. They also drop those states where mining output contributes more than 15 percent to total output. To be consistent with their theoretical assumptions would require abandoning our interest in the relationship between productivity differences and natural resource endowment, and dropping many high-productivity states from our sample. Moreover, such an approach would necessitate ignoring the empirical evidence that suggests that resource endowments are positively associated with productivity levels across U.S. states.[33]

Another candidate variable we have possibly omitted is the quality of state government institutions. Many institutions and rules are non-rival and non-excludable, thus government can be important in fostering a legal and political environment that is conducive to productive enterprise. Olson (1982) and North (1990) are two of many authors who have pointed out how the role of the government could affect productivity levels. Of course, applying the insights of this literature to late-19th and early-20th century U.S. regions requires care. One caveat is that differences in the role of government may be unimportant within a country since there are more marked differences across countries in their institutional arrangements than across U.S. states. But the general importance of a well-functioning state bureaucracy, clearly defined property rights and enforcement procedures, limited corruption, and other government attributes favorable to investment and enterprise is increasingly recognized.[34]

In the context of this study, the most likely period in which the quality of government institutions varied greatly by state, and may have impacted significantly on efficiency, would be at the time of their establishment. Frontier lawlessness as well as schemes like wildcat banking may have been symptomatic of weak enforcement of property rights. Institutions were developed to protect individual output and property from diversion through thievery, squatting, and expropriation. Thus it is possible that incorporation into the United States itself prevented the emergence of regional institutional arrangements inimical to growth and productivity enhancement, and that the subsequent establishment of administrative structures raised efficiency.

The first states admitted to the union were, of course, the original 13 colonies on the Eastern seaboard of the United States, while the last of the lower 48 states to be admitted in 1912 were New Mexico and Arizona. We therefore used as a proxy the year admitted to the union as a state. The original thirteen colonies will therefore have the lowest values of our government proxy while the two southwestern states will have the highest values. If being part of the United States conferred benefits in the form of stronger enforcement of property rights and more stable political institutions, then the expected sign would be negative. The date of statehood is clearly exogenous for most states as it depended on revolution (the original 13); acquisition by the United States by purchase, war, or other means; or the satisfaction of minimum population requirements (as with states entering under the Northwest Ordinance of 1787). Remaining states were admitted under differing economic conditions, in which the level of income or productivity played no obvious role.[35]

It was anticipated that if the quality of government institutions had any impact on the variation in productivity levels it would be in 1880, when the largest number of state administrations were relatively new or were yet to graduate from territory status.

The regression for 1880 indeed suggests (Appendix 3) the possible existence of such an impact, and with the predicted negative sign. As anticipated, in later years (with the anomalous exception of 1940) there is no significant relation between the measure of government quality and state productivity levels. To test the sensitivity of our results with respect to our proxy for the quality of government, we consider an alternative variable: the year of admission to the union as a territory.[36] There are many cases of lengthy intervals between acquisition of territorial status and statehood – over 60 years for New Mexico, for example – and the likely efficiency advantages from acquiring a defined government and administration, discussed earlier, may well have begun from the date of the former rather than of the latter. However, the substitution of year of territorial status for year of statehood (not shown) does not change the expected negative sign on the coefficient for 1880, but reduces its significance.

6. Extensions and Discussion

In the previous sections we have offered a simple framework for understanding the differences in levels of labor productivity across U.S. states and over time; and we have tested whether a core set of underlying exogenous determinants provides insight into this issue. Having now identified several fundamental determinants which are useful in accounting for these productivity differences, in this section we further analyze two of these factors in more detail with the aim of disentangling rival explanations canvassed in the literature on empirical growth and U.S. economic development.

6.1. What Explains the Legacy of Slavery?

We have identified the importance of slavery to interstate differences in productivity, and underscored that its negative impact on economic performance persisted for many decades following emancipation. Can we go further and contribute to the debates about what, more precisely, explains the persistence of this influence, and thus why it eventually waned during the rise of the "new" South?

Explanations for the convergence of the South on national levels of income and productivity in the second half of the 20th century are wide-ranging. One prominent theory is that the demise of sharecropping, an inefficient institutional arrangement, led to productivity improvements in the South. Several explanations, in turn, have been advanced to explain the demise of sharecropping, including increases in the federal minimum wage and the mechanization of cotton harvesting. Here, we focus on the importance of the latter in explaining sharecropping's decline, in part due to the emphasis economic historians have placed on this explanation and also because the wide variation in cotton mechanization rates across U.S. states is suited to our state-level analysis.[37] Since cotton production remained especially important in the ex-slave states at the time mechanization occurred, the possibility arises of a direct impact on measured productivity levels via the demise in sharecropping and the introduction of superior technology.

The national proportion of upland cotton harvested mechanically rose from six percent in 1949 to 100 percent in 1972.[38] We thus re-estimated our core regression model for 1960 with the addition of a variable that reflected the extent of mechanization of the cotton harvest in that year.[39] However, as shown in Appendix 4, the coefficient on the cotton-mechanization variable was not significantly different from zero, while the signs and significance on other independent variables remained unchanged. Whatever role the substitution of machinery for hand harvesting of cotton played in the demise of sharecropping and rising rural labor productivity, it does not seem to have been large enough independently to influence state-wide average productivity levels in 1960.

6.2. On Latitude and Climate

Earlier, we justified including a measure of climate as an explanatory variable because of its potential impact on hours of work and the level of efficiency at which one works, and its influence on diseases and soil fertility. A number of cross-country studies have also found latitude to be an important factor in accounting for differences in cross-country income growth rates and income or labor productivity levels. Hall and Jones (1996, 1999) argue that national economies located in temperate zones tend to be more successful than those in tropical regions; using the distance from the equator as a proxy for climate, they find that temperate climates favor productivity.[40] On the other hand, Nordhaus (1994) finds that latitude contributes only small, but measurable differences in income across countries.

We did not focus on latitude as a measure of climate in earlier sections of this paper partly because we had reliable climate statistics that were suited for the tests of climate hypotheses. Moreover, latitude is highly correlated with our legacy of slavery variable, and we had solid grounds for retaining a direct measure of the regional productivity effect of the legacy of slavery. However, given the prominence it has been assigned in related studies, it is valuable to assess whether latitude is a good proxy for climate - at least for the case of U.S. states.

The latitude (degrees from the equator) was chosen as that of the largest city in the state in the relevant year, so this varied (slightly) between the years in this study. The values of the other climate measures did not vary, as they are based on city data (usually for multiple cities) using meteorological observations averaged over many years. In Table 4 the direct correlation is displayed between latitude and each of the five other measures of climate. The correlation with latitude varies according to the selected measure of climate, but all the correlations are quite strong. This leaves open the question of which climatic feature is most relevant to the determination of productivity levels, and does not rule out the possibility that latitude is a good proxy for the effect of a region's climate on its level of productive efficiency.[41]

7. Conclusion

In the search for convincing explanations for the persistence of massive differences in productivity levels, and hence of living standards, we find in the historical experience of the United States a fruitful natural extension to the cross-country approach. Indeed, the analysis of states may offer a more fertile testing ground for competing hypotheses because, unlike countries, states share a common language, a similar culture, and likely have the same access to new technologies. Such features have often been difficult to control for properly in cross-country analysis.

This paper was motivated by the empirical observation that labor productivity levels showed considerable variation across U.S. states at six census years from 1880 to 1980. In 1880 the differences were quite substantial, with the lowest-ranked state having a level of labor productivity only 18 per cent of that of the highest-ranked; whereas by 1980 the lowest-ranked state had risen to 60 percent of the top performer.

To account for this productivity dispersion, we have tested a number of hypotheses drawn from both the growth and economic history literatures. Our results suggest that a small number of exogenous variables (institutional, resource, and geographic characteristics) do extremely well in capturing the variation in productivity levels across states for 100 years of U.S. history. The relationship is especially strong through 1940, where our specification accounts for approximately 70 percent of the variation in productivity levels across states.

Consistent with historians' emphasis on institutional impediments, we find that the legacy of slavery has a persistently pernicious effect on productivity levels well into the 20th century. On the other hand, productivity levels were positively associated with both mineral abundance and geographic features suited to transportation. While some studies have found growth *rates* to be negatively correlated with natural resource abundance*,* our positive relationship with productivity *levels* seems quite plausible; particularly in frontier economies, having a large initial endowment of resources may have propelled the acquisition of scare factors (capital and labor), and permitted further exploitation of resources. Over the course of development, states may have been able to overcome the tyranny of geography by constructing locks and deepening rivers; nevertheless, we find that states initially blessed with a seaport or located on the Great Lakes possessed a built-in advantage for trade (and settlement), which resulted in long-term benefits to their productivity levels. Finally, in contrast to the cross-country literature, we find no systematic role for either climate or governmental institutions. In part, this may reflect the smaller degree of variation of these factors *within* a country.

We have contributed to the analysis of why levels of labor productivity differ across space and time, complementing the more orthodox economic analysis of the reasons for variation in rates of growth. We have argued the case for a direct attack on the deeper determinants of levels of productivity, though we recognize the difficulty of the task given the paucity of clear theoretical guidance in the growth literature, and are aware of the ensuing methodological limitations. The challenge facing growth economists is to better explain why there are high- and low-productivity economies, and hence rich and poor societies. In responding to this challenge, we have suggested that the historical experience of U.S. states offers a valuable source of pertinent evidence for developing models that explain these differences. Our cross-state and historical approach thus complements the cross-country studies relating to recent years.

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Table 1 **. Sample descriptive statistics**

	Mean	Standard deviation	Minimum	Maximum
Percentage of workforce in mining				
1880	5.20	9.80	0.00	38.50
1900	4.00	5.50	0.00	18.90
1920	3.20	4.40	0.00	21.00
1940	2.90	4.20	0.10	21.70
1960	1.60	2.20	0.00	11.00
1980	1.70	2.70	0.10	14.90
Average number of cooling degree days (100's)	11.59	8.49	2.68	41.62
Percentage of 1860 population in slavery	10.50	17.90	0.00	57.20
Percentage of 1860 population in slavery on large plantations	5.20	10.90	0.00	38.50
Percentage of cotton harvested mechanically in 1960	12.56	23.83	0.00	87.00
Year statehood status acquired	1835	41.91	1787	1912

	Number of States
Access to ocean or Great Lakes	28
Access to ocean	21

Notes:
See text for sources and details. Access to ocean or Great Lakes refers to those states that border an ocean or one of the Grat Lakes.

Table 2 **. Explaining Productivity Levels Across U.S. States**
Dependent Variable: Log Price-Adjusted Income per Worker

Independent Variable	**1880**	**1900**	**1920**	**1940**	**1960**	**1980**
Constant	6.106**	6.166**	7.308**	7.032**	8.529**	9.682**
	(0.075)	(0.065)	(0.038)	(0.059)	(0.040)	(0.046)
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Percentage of workforce in mining	0.011*	0.014*	0.010*	0.013	0.010	0.016**
	(0.005)	(0.006)	(0.004)	(0.009)	(0.008)	(0.006)
	[0.039]	[0.035]	[0.039]	[0.178]	[0.160]	[0.009]
Average number of cooling degree days (100's)	-0.0001	0.003	0.002	0.003	0.005	0.008*
	(0.004)	(0.004)	(0.002)	(0.003)	(0.003)	(0.003)
	[0.979]	[0.441]	[0.380]	[0.447]	[0.125]	[0.026]
Percentage of 1860 population in slavery	-0.019**	-0.021**	-0.016**	-0.015**	-0.007**	-0.004*
	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)	(0.001)
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.012]
Access to ocean or Great Lakes	0.238**	0.200**	0.182**	0.344**	0.123**	0.117**
	(0.072)	(0.065)	(0.039)	(0.054)	(0.032)	(0.035)
	[0.002]	[0.004]	[0.000]	[0.000]	[0.000]	[0.002]
Adjusted R-Squared	0.71	0.77	0.78	0.68	0.45	0.22
Number of observations	47	48	48	48	48	48

Notes:
White's consistent covariance estimator is used. Standard errors are shown in parentheses. P-values are shown in square brackets. One or two stars on coefficient indicate significance 5-percent and 1-percent levels, respectively. See text for sources and definitions of variables.

***Table 3*. Specification test for the impact of slavery**
Dependent Variable: Log Price-Adjusted Income per Worker

Independent Variable	**1880**	**1900**	**1920**	**1940**	**1960**	**1980**
Constant	6.122**	6.159**	7.317**	7.045**	8.523**	9.666**
	(0.100)	(0.079)	(0.042)	(0.065)	(0.040)	(0.050)
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Percentage of workforce in mining	0.011	0.020**	0.010*	0.014	0.013	0.018**
	(0.006)	(0.007)	(0.005)	(0.012)	(0.009)	(0.006)
	[0.104]	[0.008]	[0.050]	[0.192]	[0.140]	[0.006]
Slave dummy times percentage of workforce in mining	-0.017	-0.031*	-0.012	-0.026	0.0001	-0.008
	(0.010)	(0.015)	(0.016)	(0.020)	(0.017)	(0.014)
	[0.100]	[0.046]	[0.438]	[0.188]	[0.994]	[0.594]
Average number of cooling degree days (100's)	-0.0005	-0.002	0.001	0.001	0.004	0.007*
	(0.005)	(0.005)	(0.002)	(0.003)	(0.003)	(0.003)
	[0.933]	[0.653]	[0.660]	[0.686]	[0.179]	[0.027]
Slave dummy times average number of cooling degree days (100's)	0.001	0.0002	0.002	0.004	0.004	0.005
	(0.01)	(0.009)	(0.004)	(0.006)	(0.003)	(0.003)
	[0.906]	[0.072]	[0.609]	[0.549]	[0.282]	[0.167]
Percentage of 1860 population in slavery	-0.020**	-0.027**	-0.016**	-0.015**	-0.007**	-0.004**
	(0.003)	(0.002)	(0.001)	(0.003)	(0.001)	(0.001)
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.001]
Access to ocean or Great Lakes	0.224*	0.207*	0.166**	0.325**	0.132**	0.147**
	(0.109)	(0.084)	(0.053)	(0.067)	(0.043)	(0.049)
	[0.045]	[0.018]	[0.003]	[0.000]	[0.004]	[0.005]
Slave dummy times access to ocean or Great Lakes	0.016	0.008	0.034	0.024	-0.004	-0.063
	(0.138)	(0.121)	(0.062)	(0.086)	(0.058)	(0.069)
	[0.906]	[0.950]	[0.585]	[0.783]	[0.942]	[0.366]
Adjusted R-Squared	0.69	0.78	0.77	0.67	0.43	0.20
Number of observations	47	48	48	48	48	48

Notes:
White's consistent covariance estimator is used. Standard errors are shown in parentheses. P-values are shown in square brackets. One or two stars on coefficient indicate significance 5-percent and 1-percent levels, respectively. See text for sources and definitions of variables.

Table 4 **. The relationship between latitude and climate**
Correlation matrix

	Cooling Degree Days	Heating Degree Days	Sum of Cooling and Heating Days	Snowfall	Minimum Temperature	Latitude
Cooling Degree Days	1.00					
Heating Degree Days	-0.84	1.00				
Sum of Cooling & Heating Days	-0.63	0.95	1.00			
Snowfall	-0.72	0.87	0.84	1.00		
Minimum Temperature	-0.77	0.94	0.91	0.83	1.00	
Latitude	-0.85	0.90	0.79	0.73	0.76	1.00

Notes:
Each day that the air temperature for a day is above 65F produces one cooling degree day.
Each day that the air temperature for a day is below 32F produces one heating degree day.
If the average temperature exceeds 65F for a 30-day month, that produces 150 cooling degree days.
Snowfall refers to the average annual total accumulation of snow and ice pellets in inches.
Minimum termperature is the number of days when the minimum termperature was 32F or less.
Latitude for a state is based on the latitude for the largest city in the state.
See the text and footnotes for sources.

Appendix 1 **. Robustness test of legacy of slavery: substituting large plantation slave population**
Dependent Variable: Log Price-Adjusted Income per Worker

Independent Variable	**1880**	**1900**	**1920**	**1940**	**1960**	**1980**
Constant	6.076**	6.123**	7.290**	7.013**	8.520**	9.678**
	(0.077)	(0.071)	(0.041)	(0.060)	(0.039)	(0.046)
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Percentage of workforce in mining	0.013*	0.019**	0.012*	0.014	0.012	0.016**
	(0.005)	(0.006)	(0.005)	(0.010)	(0.008)	(0.006)
	[0.012]	[0.004]	[0.024]	[0.154]	[0.143]	[0.007]
Average number of cooling degree days (100's)	-0.003	0.00006	0.00007	0.001	0.004	0.008*
	(0.005)	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)
	[0.454]	[0.984]	[0.973]	[0.671]	[0.103]	[0.018]
Percentage of 1860 population in slavery on large plantations	-0.028**	-0.032**	-0.024**	-0.023**	-0.010**	-0.005*
	(0.005)	(0.004)	(0.003)	(0.003)	(0.002)	(0.002)
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.007]
Access to ocean or Great Lakes	0.263**	0.230**	0.195**	0.359**	0.131**	0.120**
	(0.071)	(0.070)	(0.043)	(0.055)	(0.033)	(0.036)
	[0.001]	[0.002]	[0.000]	[0.000]	[0.000]	[0.002]
Adjusted R-Squared	0.66	0.72	0.73	0.66	0.41	0.21
Number of observations	47	48	48	48	48	48

Notes:
White's consistent covariance estimator is used. Standard errors are shown in parentheses. P-values are shown in square brackets. One or two stars on coefficient indicate significance 5-percent and 1-percent levels, respectively. See text for sources and definitions of variables.

Appendix 2 **. Robustness test of access to navigable waterways**

Dependent Variable: Log Price-Adjusted Income per Worker

Independent Variable	1880	1900	1920	1940	1960	1980
Constant	6.203**	6.238**	7.343**	7.141**	8.583**	9.748**
	(0.055)	(0.046)	(0.033)	(0.058)	(0.039)	(0.043)
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Percentage of workforce in mining	0.008	0.011	0.010*	0.008	0.005	0.010
	(0.005)	(0.006)	(0.005)	(0.009)	(0.006)	(0.006)
	[0.100]	[0.062]	[0.046]	[0.364]	[0.484]	[0.127]
Average number of cooling degree days (100's)	-0.001	0.002	0.001	0.0008	0.004	0.006
	(0.004)	(0.004)	(0.002)	(0.004)	(0.003)	(0.003)
	[0.763]	[0.673]	[0.576]	[0.833]	[0.197]	[0.059]
Percentage of 1860 population in slavery	-0.020**	-0.022**	-0.016**	-0.015**	-0.006**	-0.003
	(0.003)	(0.002)	(0.001)	(0.002)	(0.001)	(0.001)
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.051]
Access to ocean	0.173*	0.169**	0.201**	0.311**	0.084*	0.050
	(0.069)	(0.061)	(0.045)	(0.061)	(0.039)	(0.042)
	[0.016]	[0.008]	[0.000]	[0.000]	[0.036]	[0.239]
Adjusted R-Squared	0.67	0.75	0.79	0.63	0.36	0.08
Number of observations	47	48	48	48	48	48

Notes:
White's consistent covariance estimator is used. Standard errors are shown in parentheses. P-values are shown in square brackets. One or two stars on coefficient indicate significance 5-percent and 1-percent levels, respectively. See text for sources and definitions of variables.

Appendix 3. Explaining Productivity Levels Across U.S. States
Dependent Variable: Log Price-Adjusted Income per Worker

Independent Variable	1880	1900	1920	1940	1960	1980
Constant	10.487**	8.108**	7.289**	9.950**	8.250**	8.492**
	(1.847)	(1.690)	(1.025)	(1.297)	(0.725)	(0.843)
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Percentage of workforce in mining	0.014*	0.017*	0.010*	0.015	0.010	0.013*
	(0.005)	(0.007)	(0.004)	(0.010)	(0.008)	(0.006)
	[0.017]	[0.030]	[0.039]	[0.147]	[0.211]	[0.039]
Average number of cooling degree days (100's)	0.002	0.004	0.002	0.005	0.005	0.007*
	(0.004)	(0.003)	(0.003)	(0.004)	(0.003)	(0.004)
	[0.612]	[0.213]	[0.405]	[0.204]	[0.144]	[0.049]
Percentage of 1860 population in slavery	-0.021**	-0.022**	-0.016**	-0.016**	-0.007**	-0.003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.057]
Year statehood status acquired	-0.002*	-0.001	0.10E-4	-0.002*	0.15E-3	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.40E-3)	(0.46E-3)
	[0.024]	[0.259]	[0.985]	[0.030]	[0.702]	[0.165]
Access to ocean or Great Lakes	0.167*	0.169*	0.182**	0.287**	0.128**	0.137**
	(0.065)	(0.065)	(0.043)	(0.052)	(0.032)	(0.037)
	[0.014]	[0.013]	[0.000]	[0.000]	[0.000]	[0.000]
Adjusted R-Squared	0.73	0.77	0.78	0.70	0.44	0.23
Number of observations	47	48	48	48	48	48

Notes:
White's consistent covariance estimator is used. Standard errors are shown in parentheses. P-values are shown in square brackets. One or two stars on coefficient indicate significance 5-percent and 1-percent levels, respectively. See text for sources and definitions of variables.

***Appendix 4* . The effects of mechanization of cotton harvest on 1960 productivity**
Dependent Variable: Log Price-Adjusted Income per Worker

Independent Variable			
Constant	8.534** (0.042) [0.000]	8.526** (0.041) [0.000]	8.618** (0.040) [0.000]
Percentage of workforce in mining	0.010 (0.007) [0.172]	0.012 (0.008) [0.150]	0.009 (0.007) [0.237]
Average number of cooling degree days (100's)	0.004 (0.004) [0.261]	0.004 (0.003) [0.283]	-0.006* (0.003) [0.042]
Percentage of 1860 population in slavery	-0.006** (0.001) [0.000]		
Percentage of 1860 population on large slave plantations		-0.010** (0.002) [0.000]	
Percentage of cotton harvested mechanically	0.0004 (0.0007) [0.528]	0.0005 (0.224) [0.475]	0.001 (0.001) [0.090]
Access to ocean or Great Lakes	0.123** (0.032) [0.000]	0.130** (0.033) [0.000]	0.053 (0.038) [0.167]
Adjusted R-Squared	0.44	0.41	0.05
Number of Observations	48	48	48

Notes:
White's consistent covariance estimator is used. Standard errors are shown in parentheses. P-values are shown in square brackets. One or two stars on coefficient indicate significance 5-percent and 1-percent levels, respectively. See text for sources and definitions of variables.

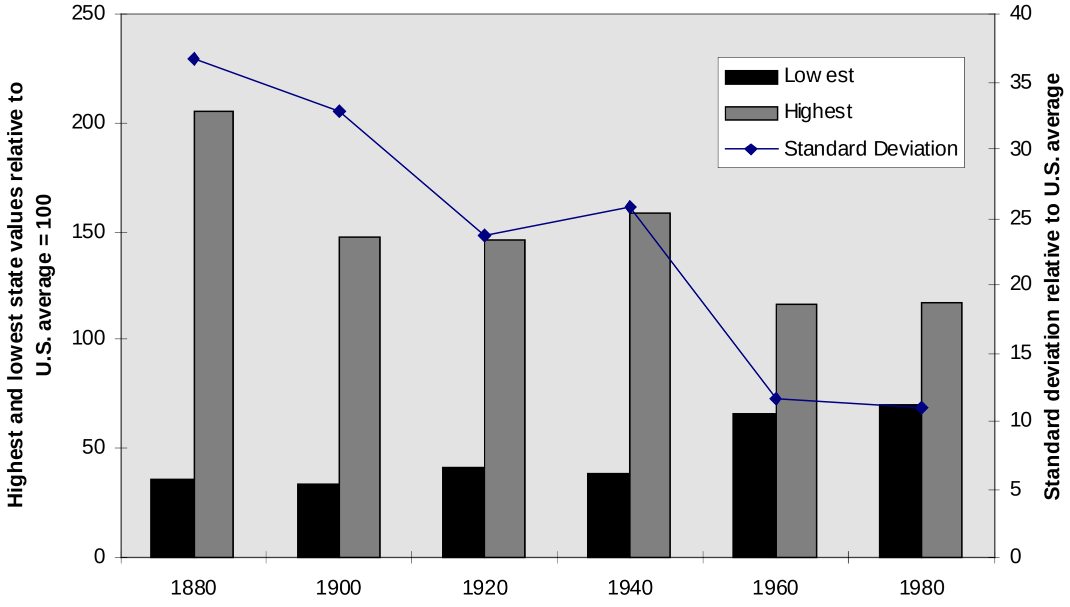

Figure 1. **Price-adjusted state income per worker**
(Relative to U.S. Average)

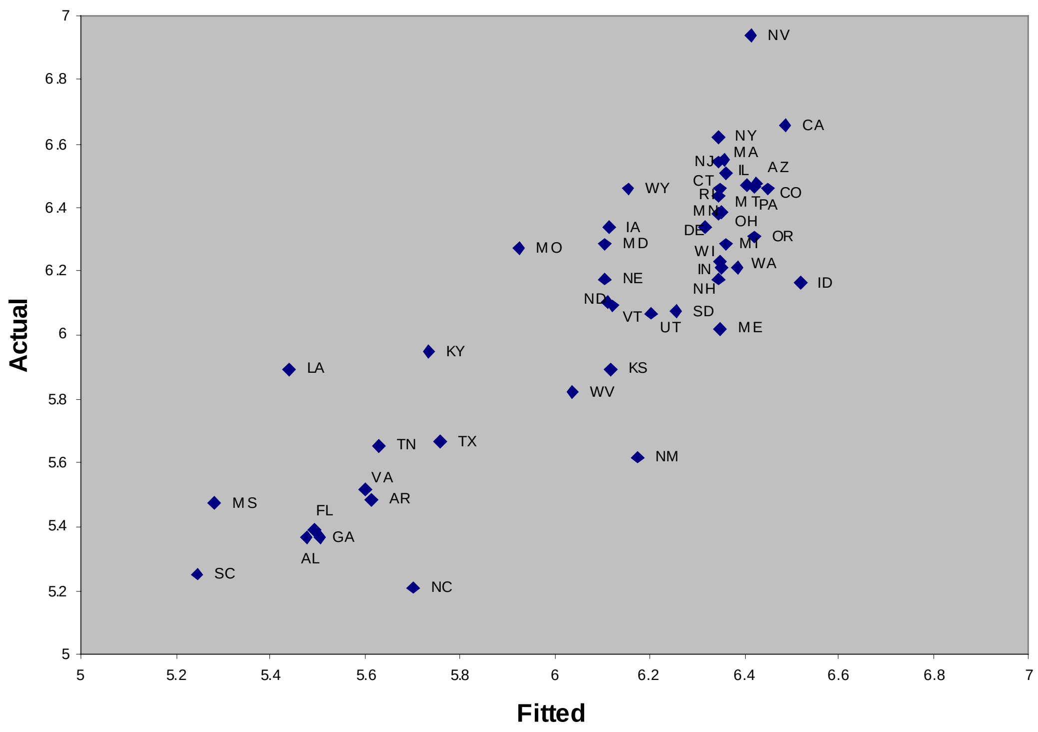

Figure 2**. Labor productivity levels in 1880: actual and predicted**
(Logs)

[1] This wide variation persists even when states are aggregated into regions. The South Atlantic region had a level of labor productivity only 38 per cent that of the Pacific region (Mitchener and McLean, 1999).

[2] For example, GDP per worker in both Morocco and Thailand was approximately 18 percent of that in the United States in 1990.

[3] Since the U.S. average level of labor productivity is the weighted sum of that of the states, no account of the sustained rise in U.S. productivity levels over the past century is going to be complete without an understanding of the forces producing the changing regional contributions to that outcome. A second reason for attempting to account for the range in productivity levels across states is that the variation in state labor productivity accounts, in turn, for the major part of the variation in their living standards. Differences in the level of nominal income per capita between states in any year can be decomposed into three elements: differences in prices, labor input per capita, and a 'residual' measure of labor productivity. Only a small portion of the variation in incomes across states in any of the six years in the study is due to variation in prices - from minus one to plus 16 percent. Variation in labor input per capita contributes between 9 and 28 percent across these dates. The remaining difference in income levels (56 to 84 per cent) is attributed to variations in the average efficiency of workers. This analysis is reported in Mitchener and McLean (1999).

[4] The relevant literature is well surveyed in Barro and Sala-i-Martin (1995) and Temple (1999).

[5] This has led to the suggestion that "divergence in relative productivity levels and living standards is the dominant feature of modern economic history" (Pritchett 1997, p.3).

[6] See Landes (1998) for an extended discussion; and Olson (1996) for another perspective on Landes' question. Further examples are the attempts to account for the persisting differences in income levels between North and South American economies provided in the analysis of Engerman and Sokoloff (1997); the interpretation by Jones (1981) of the reasons for European economic dominance after 1500; and the even longer-sweeping surveys of economic perfomance by Lal (1998) and Diamond (1997).

[7] The importance of non-conventional influences has likewise been stressed in studies of the determinants of labor productivity levels across U.S. states in recent years. Bernard and Jones (1996) highlight the relative size of particular sectors, and note especially that states with the highest private non-farm labor productivity levels after 1963 were also those with the highest shares of output originating in mining. And in an investigation of the sources of inter-state variation in gross state product per worker in 1988, Ciccone and Hall (1996) report that

more than half can be attributed to the agglomeration effects arising from the density of employment. See also Ram (1999).

[8] In addition to previously cited references, see also Bloom and Sachs (1998), Collier and Gunning (1999), Masters and McMillan (2000), Mellinger, Sachs and Gallup (1999), and Temple and Johnson (1998).

[9] See Ransom and Sutch (1977) and Wright (1986).

[10] Thereafter, the basis of growth, and especially of economic leadership relative to other early-industrializing countries, shifted to knowledge-based activities (Nelson and Wright, 1992).

[11] Matsuyama (1992) proposes an alternative model which suggests that countries choosing to exploit their comparative advantage in natural resources may lock themselves into a long-run, low growth path if the neglected manufacturing sector has more favorable externalities. See also Redding (1999).

[12] For a broader historical discussion of the role of natural resource abundance in American economic growth, see Abramovitz and David (1996).

[13] Related themes are developed in Findlay (1995, Chapters 5 and 6).

[14] Some fairly direct support is reported by Bernard and Jones (1996) in their study of productivity by sector across U.S. states since 1963: those states with more than 20 percent of private non-farm product originating in mining have higher levels of labor productivity than non-mining states. Indirect support is provided by Gallup, Sachs and Mellinger (1999) who find that levels of per capita income across countries in 1995 are positively related to deposits of natural resources.

[15] Our data sources are Miller and Brainerd (1957), Perloff et al (1960), and the U.S. censuses.

[16] Each day that the air temperature for a day is above 65 degrees F produces one cooling degree day. This means that if the average temperature is five degrees above 65F for a 30-day month, then that is 150 cooling degree days. Data are from various issues of the *Statistical Abstract of the United States.*

[17] Wright (1974, 1986) has argued that the antebellum growth in the South was unsustainable, with or without the war, due to the decline in worldwide demand for cotton. Alternatively, Ransom and Sutch (1977) have focused on the labor supply effects of African Americans in response to emancipation, suggesting that the decline in Southern output is attributable to a reduction in hours worked by former slaves. These explanations, and others by Temin (1976), Fogel and Engerman (1974), Brinkley (1997), and Irwin (1994), shed light on the decline in southern per capita income after the war.

[18] Slave population data are from the U.S. Census of 1860.

[19] For a survery of postwar evidence, see Sachs and Warner (1995a).

[20] Gallup, Sachs and Mellinger (1999) find that countries with access to navigable waterways or with primarily coastal populations have higher levels of income.

[21] This applies particularly to the issue of whether states along the Mississippi river system should be classified as having access to navigable water, and which states in which years. Mellinger, Sachs and Gallup (1999, p.4) employ a definition of navigable rivers as those that can accommodate vessels with a minimum draft of three meters; they assert that anything smaller would not be considered "ocean-going."

[22] The estimation methods and data sources are provided in Mitchener and McLean (1999), especially Appendix 1 which describes the derivation of the state price relatives. Because the relative price indexes are computed at a point in time (and not over time as is the case with deflated series), the price-adjusted dollar values of the labor productivity figures across our six time periods are not directly comparable. Note also that the price variation was greatest in 1880, when a 33 percentage-point variation occurred around the U.S. average price level and, unsurprisingly, when the highest price levels were recorded in the Mountain states.

[23] Because Alaska and Hawaii only become states in 1959 and reliable data are unavailable for earlier periods, we exclude these two states from our overall analysis. No estimates for state personal income per capita are available for Oklahoma in 1880, so we exclude it from our analysis for that year. The Dakota Territories are separated out into North and South Dakota for purposes of analysis in 1880, even though they received statehood in 1889. We also refer to Montana, Washington, Idaho, Utah, Oklahoma, New Mexico, and Arizona as "states," even though they were technically still territories in 1880; their boundaries did not change between territory status and statehood.

[24] The demographic characteristics of many western states in the late nineteenth century – high masculinity ratios and a high percentage of people of working age – may reflect employment in resource-based industries (Mitchener and McLean, 1999).

[25] We also investigated whether climate influenced productivity via a quadratic relationship, but none was found.

[26] For variation in the disease ecology across states, see Brinkley (1997) and Coehlo and McGuire (1997). For a longer run perspective across countries, see Jones (1981).

[27] Data are from various issues of the *Statistical Abstract of the United States.*

[28] In a simple univariate regression for 1880, the coefficient on SLAVE is negative in sign, of a large magnitude, and is statistically significant (t-statistic = -6.94). In 1880, if a state's slave population increased by one percentage point, its relative income fell by $3.40. The mean

level of productivity in 1880 was $483.75 (SD of $184.61) and the mean level of slavery across all states was 10.5 percent. So for a state such as Mississippi, with a slave population in 1860 that is 55 percent of the total, our model predicts that its productivity level should be $151.30 lower than the mean. Mississippi's actual productivity level in 1880 was $239.18 or $244.57 below average. Slavery alone thus accounts for around 62% of Mississippi's lower productivity level.

[29] These data are also from the U.S. Census of 1860.

[30] In addition, we substituted a proxy of navigable waterway that also included states bordering navigable sections of the Mississippi river system as reported by Mellinger et al (1999). (We are grateful to Andrew Mellinger for assistance with these data.) The augmented proxy was never significant. Separately entering a proxy for states bordering navigable rivers confirmed that there is no systematic relationship with state productivity levels.

[31] The important contributions (as documented by David and Wright (1997)) made by faculty and graduates of geology or mining programs at schools such as Yale, Columbia, and Harvard to the discovery and development of minerals in the far western states, well illustrates the point.

[32] An assessment of the determinants of gold discoveries across U.S. states in the late nineteenth century is contained in Eichengreen and McLean (1994), who emphasize the importance of recent settlement (by Europeans) to the timing of such finds: few occurred in states that were long settled.

[33] Bernard and Jones (1996) suggest that the resource sector may be important for explaining productivity differences across states in the 1980s.

[34] The effect of corruption on productive efficiency is but one theme in this literature: see especially Shleifer and Vishny (1993) and Mauro (1995).

[35] Indeed, at the time of attaining statehood, some states (especially in the Midwest) had relatively low incomes while others (especially in the West) were among those with the highest per capita incomes. The exogeneity assumption for statehood appears reasonable based on this reading of history.

[36] Dates of statehood and of admission as a territory are from the *Statistical Abstract of the United States*. For Texas, we use the date of congressional annexation in 1845 to mark the official date of statehood rather than the year of 1836 when Texas gained independence from Mexico and formed a republic.

[37] See, for example, Musoke and Olmstead (1982) and Whatley (1985).

[38] The numbers are from *Statistics on Cotton and Related Data 1920-73* (Statistical Bulletin No. 535, United States Department of Agriculture, Economic Research Service, Washington

D.C.), p.218.

[39] In 1960 the national average was 51 percent, and the values for individual cotton-growing states ranged from one to 87 percent.

[40] Gallup, Sachs and Mellinger (1999) arrive at a similar conclusion with respect to climate and levels of income per capita. See also Masters and McMillan (2000), Mellinger, Sachs and Gallup (1999), and Ram (1999). Diamond (1997) claims to identify a link between longitude and latitude and productivity over the very long run.

[41] Substituting latitude for the number of cooling degree days in the model reported in Table 2 produced similar results (not reported). The use of the proxy for climate in our preferred model is due to the higher direct correlation between slavery and latitude than between slavery and cooling degree days.