The impact of the Civil War on capital intensity and labor productivity in southern manufacturing ☆

William K. Hutchinson [a,*], Robert A. Margo [b]

[a] *Department of Economics, Vanderbilt University, Station B #351809, Nashville, TN 37235-1809, USA*
[b] *Boston University, USA*

Abstract

After the Civil War wages fell in the South relative to the non-South, but interest rates and other measures of the costs of capital increased. Using archival data for manufacturing establishments, we show that capital–output and capital–labor ratios in southern manufacturing declined relative to non-southern manufacturing after the War, precisely in the direction implied by the regional shifts in factor prices. Labor productivity in southern manufacturing also declined, and a significant portion of this decline can be attributed to the reduction in capital intensity.
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1. Introduction

Recent work by economic historians has established that the Civil War resulted in a structural break in the regional pattern of wages: relative to the non-South, wages in the South fell sharply after the War. However not all factor prices moved

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downward in the post-bellum South relative to other regions; in particular, measures of capital costs increased in the South relative to the non-South.

Although previous work has documented these post-bellum shifts in the regional pattern of factor prices and has suggested a number of plausible causes, there has been limited attention paid to the economic consequences. This paper uses archival data at the establishment level to study regional differences in capital use in manufacturing before and after the Civil War. Relative to other parts of the country, manufacturing establishments in the South used less capital per unit of output and less capital per worker after the War than compared with before the War. These changes in regional patterns of capital use are precisely in the direction that standard economic models of factor choice would predict, assuming no offsetting changes in technology.

We also demonstrate that output per worker in Southern manufacturing fell relative to output per worker in Northern manufacturing after the War, and that a significant portion of decline in relative labor productivity can be accounted for by the decline in relative capital intensity. Economic historians have long known that per capita incomes in the South fell, absolutely and relative to the non-South, after the War (Engerman, 1966, 1971). Debate over the causes of the relative decline in southern per capita income has concentrated primarily on the demise of the gang system and its attendant effects on labor productivity in Southern agriculture, among other causes (Fogel and Engerman, 1974; Ransom and Sutch, 1977; Goldin, 1979; Moen, 1992; Wright, 1986). This paper demonstrates that relative Southern incomes also fell because of reductions in capital intensity in a sector—manufacturing—in which slavery was comparatively unimportant before the War and in which the gang system played essentially no role.

2. Wages, the cost of capital, and the civil war

The United States in the early nineteenth century was characterized by large regional imbalances in factor intensities; in particular, labor and capital were relatively abundant in the East while raw land was relatively abundant in the West. As internal transport costs fell with the development of canals and (later) railroads (Cole, 1938; Taylor, 1951; Fishlow, 1965) a significant geographic re-allocation of capital and labor took place. For the most part, the re-allocation of labor occurred within, rather than between, the North and the South, because a substantial portion of the southern labor force—slaves—was not able to migrate freely; but capital was not so significantly constrained, and did move across the Mason–Dixon line.

Notwithstanding the effects of slavery, for the most part labor and capital moved from areas where factor prices were relatively low to where they were relatively high, and rates of mobility were of a sufficient magnitude that regional differences in factor prices narrowed as a consequence. For example, real wages were initially higher in the Midwest than in the Northeast but as labor moved westward, real wage differences declined (Margo, 2000). Bodenhorn and Rockoff (1992) provide extensive evidence showing that regional differences in the cost of capital declined before the Civil War.

The Civil War was by far the largest shock experienced by the nineteenth century American economy. At the aggregate level, the War was an economic disaster;

national output grew considerably more slowly in the 1860s than in surrounding decades (Engerman, 1966). In both relative and absolute terms, however, Southerners bore a much larger share of the costs of war—directly, and in the form of foregone consumption (Goldin and Lewis, 1975). The upshot was that per capita income fell in the South between 1860 and 1870, absolutely and relative to the rest of the United States (Engerman, 1966; Goldin, 1979).

By definition, per capita income y can be written as an identity function of factor prices and per capita factor supplies as, for example, in

$$y = [w + i \times (K/L) + r \times (T/L)] \times (L/P) \tag{1}$$

Here w is the wage, L/P is the labor force participation rate, i is the rental price of capital, K/L is capital per worker, r is the rental price of land, and T/L is land per worker. Letting $k = K/L$, $t = T/L$, and $l = L/P$, the ratio of southern to northern per capita income is shown in

$$y_S/y_N = [\psi_L(w_S/w_N) + \psi_K[(i_S/i_N) \times (k_S/k_N)] + \psi_T[(r_S/r_N) \times (t_S/t_N)] \times (l_S/l_N) \tag{2}$$

The ψ's are non-southern values of labor (L), capital (K), and land (T) shares and $\sum \psi = 1$. According to Eq. (2), if the South experienced a decline in per capita income relative to other regions after the Civil War, it must be the case that relative factor prices (for example, w_S/w_N) or factor intensities (for example, k_S/k_N), or both, diverged in ways to cumulatively produce such a decline.

Recent work by economic historians provides strong evidence that the Civil War not only arrested the process of regional factor price convergence underway before the Civil War but also produced a significant short-to-medium run divergence in regional factor prices. In particular, wages in the South declined while the cost of capital increased (Wright, 1986; Margo, 2004; Bodenhorn and Rockoff, 1992; Bodenhorn, 2000, p. 154; Legler and Sylla, 2003; Margo, 2004).[1] Hence, the wage–rental ratio in the South fell relative to the North after the War.[2] Table 1 presents some representative evidence. The figures in the table are regression coefficients of a dummy variable taking the value

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[1] As will become clear in the next section, we focus on the wages relative to the cost of capital because we are interested in examining the change in capital intensity in southern versus non-southern manufacturing after the War. This does not imply, however, that the only factor prices to change were wages and interest rates. In particular, Moen (1992) uses the Parker–Gallman (1860) and Ransom–Sutch (1880) samples to demonstrate that the asset price of land declined sharply in southern agriculture between 1860 and 1880. Because there is as yet no sample of northern farms in 1880 comparable to the Ransom–Sutch sample of southern farms, it is not possible to replicate Moen's analysis for northern agriculture. However, a regression of per acre land values using published census data (Eq. (3)) produces an estimate of $\theta = -0.468$ (s.e. = 0.097), indicating a relative decline in southern land prices.

[2] The rental price of capital, i, can be approximated by the expression $r = (j + d - \mathrm{d}V/\mathrm{d}t)V$, where j = interest rate, d = depreciation, V is the asset price, and $\mathrm{d}V/\mathrm{d}t$ is the change in the asset price (capital gains or losses). This expression makes clear that interest rates are a component of the cost of capital, not the cost itself. However, we know of no reasons why d should have fallen in the South relative to the non-South after the War or dp/dt to have increased. Certain capital goods in manufacturing, such as steam engines, were in use throughout the United States and it is reasonable to presume that trends in V did not vary regionally (see Atack et al., 1980). See also Moen (1992) who makes a very similar argument to infer changes in capital costs in southern agriculture after the War.

Table 1
The "Treatment Effect" of the Civil War on farm wages, the return on bank capital and the wage: rental ratio: estimates of θ

Factor price	Estimate of θ
Monthly farm wage with	−0.346
Value of board imputed	(0.044)
Return on bank capital	0.209
	(0.096)
Wage–rental ratio	−0.556
	(0.108)

Source. See text for regression specification. Dependent variables are measured in logarithms. The wage–rental ratio is the ratio of the farm wage (row #1) and the return on bank capital (row #2). Post-bellum sample period is 1866–1890. Return on bank capital is the net rate of return for non-reserve city banks in the post bellum period. Data for 1850 and 1860 are net rates of return for reporting banks. Davis (1965), Bodenhorn and Rockoff (1992), respectively. Monthly farm wage: see Margo (2004). The wage data pertain to labor contracts for which workers received a monthly money wage plus board. It is possible, however, to impute a value to the board portion of the contract and this is added to the money wage (the logarithm of the sum of the money wage plus the value of board is the dependent variable in the regression). Robust standard errors are shown in parentheses.

1 if the observation pertains to the South after the War. The regression specification is as follows:

$$\mathrm{Ln}\, p_{jt} = \alpha_j + \delta_t + \theta\, (\mathrm{South} = 1 \quad \mathrm{and} \quad \mathrm{Year} > 1865) + \varepsilon_{jt} \tag{3}$$

Here p refers to a factor price (for example, the monthly wage of farm labor) or ratio of factor prices in location j in year t; the α_j are coefficients of location dummies; the δs are coefficients of time dummies; and ε is the error term. The unit of observation is a census region average, the sample covers the South and the North, and the data span the pre and post-bellum periods.[3] Thus, if θ is positive, the factor price (or ratio of factor prices) was higher in the South relative to the North after the Civil War than before; and conversely, if θ is negative. Later in the paper we use a similar specification to examine the "treatment effect" of the War on factor intensities in manufacturing.

As shown in Table 1, when the regression pertains to the return on bank capital, the estimate of θ is positive and statistically significant; that is, capital costs in the South relative to the North were higher after the War than before the War. When the regression pertains to farm wages the coefficient is negative (and significant); wages in the South relative to the North were lower after the War than before the War.[4] Consequently, the ratio of wages to interest rates, which we take as a proxy

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[3] In all regressions reported in this paper West Virginia and the District of Columbia are treated as part of the South, but the substantive findings would not change if these were re-classified as non-Southern.

[4] See Margo (2004) for additional evidence on non-farm wages. In general, non-farm wages in the South appear to have declined less than farm wages, but the difference in the rate of decline between the two was relatively small; see Margo (2004, p. 329) and Footnote 20.

for the wage–rental ratio, fell sharply in the South relative to the North after the War ($\theta = -0.556$) compared with pre-war levels.[5]

Why did wages decline and the cost of capital rise in the South relative to the North after the War? The Civil War was an enormously complex event, and identifying all of the causal mechanisms at work is daunting task. For the purposes at hand, however, it is possible to sketch out a list of the plausible conduits through which the changes in capital costs and wages occurred.

The Civil War was destructive of infrastructure and much of this destruction occurred on southern soil (Goldin and Lewis, 1975). On a per capita basis, human and capital resources diverted to fighting were greater in the South, and these were, by definition, resources that did not flow towards replacement of the existing capital stock (depreciation) or new investment while the War was raging. Although some of the infrastructure was rebuilt after the War, it is plausible that the per capita stock of capital in the South did not fully recover from where it would have been in the absence of the War, causing capital costs in the South to rise relative to those in other regions.

Second, the South was hit by financial shocks that led to a dramatic reduction in the number of banks and in the money supply on a per capita basis. One such shock was the loss of the War itself; the Confederate government collapsed and Confederate money and government bonds were worthless. In addition the National Bank Act of 1865 imposed an annual tax of 10% on state bank note issues after July 1 of 1866. Partly as a consequence of the Act, the number of state banks in the South in 1866 was only one-third those that existed on the eve of the Civil War, while the total number of banks stood at 60% of the pre-Civil War number.[6] By 1880 the total number of banks in the South exceeded the pre-Civil War count in absolute numbers, but state banks remained approximately 50% of the total; and on a per capita basis, the total number of banks was below the pre-war level (Ransom and Sutch, 1977).[7] In Virginia, for example, the number of banks in operation in the late 1870s was only slightly more than half as large as on the eve of the Civil War.[8] The extent of the decline in per capita money is astonishing; the South went from a region that, on the eve of War, held per capita money some 30% above the national average to a region where per capita money in the immediate aftermath of the War was more than 90% below the national average. While some of the decline in banks (and money)

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[5] We have also estimated the wage regression with state instead of regional dummies; with this specification, $\theta = -0.291$ (SE = 0.096). If the wage–rental ratio regression is re-estimated with an alternative post-bellum interest rate series pertaining to reserve city banks, the estimate of θ is smaller in magnitude but still large in absolute value and highly significant statistically ($\theta = -0.392$, SE = 0.130).

[6] Money is defined as currency plus bank deposits, where currency includes state bank notes per capita before the Civil War and National Bank notes after the Civil War. Deposits refer to total bank deposits at state banks before the Civil War and at both state and national banks after the Civil War.

[7] See Knox (1900) for detailed information on the number and location of banks.

[8] See Knox (1900). Declines in the absolute number of banks also occurred in North and South Carolina and Tennessee.

per capita in the South may have been an endogenous response to the decline in per capita income, it seems highly likely that the ability of the banking system as a whole to function as intermediaries, directing investment to the most productive uses, was disrupted.[9] Credit became increasingly costly to obtain, as indicated by the rise in interest rates.

Economic historians have considered a variety of explanations for the relative decline in southern wages. Possibly the most prominent explanation, although not the only one possible, is the loss of economies of scale in southern agriculture due to the demise of the gang system (Fogel and Engerman, 1974; Goldin, 1979; Moen, 1992).[10] According to this explanation, the loss of economies of scale reduced labor productivity in southern agriculture and with it the demand for labor. Assuming that labor supply in the South was inelastic in the short run, a decline in labor demand would clearly reduce wages.

The primary goal of this paper, as discussed in the next section, is to examine how factor intensities in the South relative to other regions responded to the relative decline in the wage–rental ratio. As the manufacturing data we examine extend only to 1880, our empirical analysis is necessarily short-to-medium run in nature. However, it is important to note that, while the Civil War itself was a "transitory" event, the effects on factor prices appear to have persisted; certainly this was true of wages (Wright, 1986; Margo, 2004. Davis (1965, p. 368) remarks that in 1914 bank rates of return in the South "appeared more typical of western than of eastern rates"— that is, much higher. Indeed, his data indicate that rates of return for banks and rates of discount used by banks remained 20–30% higher in the South than in the North as late as 1910.

Exactly why the effects persisted is a matter of debate among economic historians. According to Wright (1986), the South developed a "separate" labor market from the North after the Civil War, the North became part of an Atlantic labor market that the South was largely excluded from. Other scholars hypothesize that labor immobility may have been impeded by the growth of institutions like sharecropping and debt peonage in southern agriculture after the War and by low levels of schooling (Ransom and Sutch, 1977; Margo, 1990).[11] Econometric analysis reveals that per capita income differences across states converged at about the same rate within the North and South as did per capita differences across the North and South, before

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[9] On the other hand, money demand may have increased, due to reduced availability of intermediaries and the increased level of economic uncertainty. Such increased money demand in the presence of limited elasticity of the money supply would produce a leftward shift of the *LM* curve, resulting in higher interest rates as well as lower aggregate demand and prices.

[10] Ransom and Sutch (1977) document a decline in labor force participation rates in the South after the War, which they attribute to an exogenous decrease in labor supply of former slaves. Whatever the merit of their explanation it is clear that labor demand in the South must have decreased to a greater extent, because wages fell; if labor demand had remained constant while labor supply decreased, wages would have increased.

[11] Another possibility is that the South was hit by recurrent negative shocks to labor demand; see Margo (2004).

and after the Civil War, suggesting that the primary culprit was the magnitude of the shock itself (Margo, 1995). That is, any region subjected to a negative economic shock of a magnitude similar to the Civil War in the mid-to-late nineteenth century would have experienced a decline in per capita income that would have persisted long after the shock had dissipated.

3. Data and results

In the previous section we argued that the South experienced a rise in the cost of capital relative to other regions after the Civil War, but a pronounced decline in relative wages. It is clear from inspection of Eq. (2) that, ceteris paribus, a relative rise in the cost of capital together with a decline in relative wages would not necessarily cause a reduction in relative per capita incomes. However, this outcome presumes that relative factor intensities remained unchanged, whereas basic economic theory predicts that changes in factor prices generally should affect factor use in production. As a point of departure, imagine two firms engaged in producing a specific product, one firm located in the South, the other in the North. For simplicity, we assume that both firms face the same output price normalized at unity; however, factor markets are ''regional'' and, therefore, the firms face (possibly) different factor prices. Both firms use the same technology which, for expository purposes, we assume is a Cobb–Douglas function with constant returns to scale

$$Q = AL^\alpha K^{1-\alpha} \tag{4}$$

If the firms maximize profits, the first-order condition for the optimal choice of the capital input is

$$i = (1 - \alpha) \times Q/K \tag{5}$$

The optimal choice of the capital–labor ratio is

$$w/i = [\alpha/(1 - \alpha)] \times K/L \tag{6}$$

The North–South ratios are

$$(K/Q)_N/(K/Q)_S = i_S/i_N \tag{7}$$

and

$$(K/L)_S/(K/L)_N = (w/i)_S/(w/i)_N \tag{8}$$

There are three empirical implications of these first-order conditions. First, as the cost of capital increased in the South relative to the North—an increase in i_S/i_N—the capital-to-output ratio (K/Q) should have declined in the southern firm relative to the northern firm. Second, as the wage–rental ratio in the South fell relative to the North, the capital–labor ratio in the southern firm should have fallen relative to the northern firm. Third, the reduction in the relative capital–labor ratio should have been larger than in the capital–output ratio because, proportionately, the

decline in the wage–rental ratio in the South was larger than the rise in the relative cost of capital.[12]

Our empirical analysis uses random samples drawn from the manuscript schedules of the 1850-80 federal censuses of manufactures for the United States (Atack and Bateman, 1999). These schedules record the original responses of manufacturers (or their knowledgeable representatives) to questions posed by the census enumerators and the samples are nationally representative of the surviving manuscripts.

We use data on manufacturing for substantive and practical reasons. The substantive reason is that the technology of agricultural production in the South differed from that of the North prior to the War—the South utilized slave labor and, in certain crops, the gang system—and slavery was ended by the War. Consequently, identification of the causal channels in the case of agriculture is complicated by the fact that the technology changed which, by itself could affect the optimal choice of capital intensity, independent of any farm-level response to changing factor price ratios (see, however, Moen, 1992; and Section 4). Although slaves were used in southern manufacturing before the War, their use was relatively minor and, more importantly, there is little reason to believe that the technology of manufacturing production was altered by the use of slave labor. The practical reason is that census data for manufacturing establishments spanning the ante-bellum and post-bellum periods for both the South and North are currently available, while analogous farm-level data for agriculture are not.[13] Establishment level data are preferable to aggregate state-level data because the establishment-level data allow us to control for a variety of attributes of firms that may affect capital use but which cannot be controlled for using published census information.

The censuses of manufacturing reported the value of "real and personal" capital invested in the establishment, along with information about each plant's outputs and inputs. The specifics of what was reported varied somewhat from census to census. All of them reported the value of outputs and raw materials. In 1850 and 1860, the number of male and female employees was reported but child workers were not separately identified. In 1870 and 1880, the number of adult males (over age 16), adult females (over age 15), and children were given.

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[12] This prediction is sensitive to the assumption that the two firms face the same output price, despite being in different regions. If, instead, the output were non-traded, it is possible that p_S/p_N might decline, in which case the proportionate rise in the real rental price of capital could be of the same order of magnitude as the decline in the wage–rental ratio. In fact, although the evidence is scanty, what there is suggests non-traded goods prices did fall in the South relative to the North (see Margo, 2004). If this effect were the dominant one, the capital–output ratio, as we measure it, might have risen in the South relative to the non-South. Empirically, however, what we observe is that capital–output ratios fell in the South relative to the non-South, and the magnitude of the decline was smaller in percentage terms than the decline in capital intensity. It is possible, however, that a decline in relative non-traded goods prices might explain some of the fall in relative labor productivity in Southern manufacturing, see Footnote 18.

[13] Farm-level samples for both the South (Parker–Gallman) and North (Bateman–Faust) in 1860 are available, as is a farm-level sample for the South (Ransom–Sutch) in 1880 but, to our knowledge, there is no farm-level sample presently available for the North in 1880, nor are there samples for either region for 1870.

Although the census samples are a valuable and under-utilized data source on nineteenth century manufacturing, there is no question that the information is problematic, particularly that for capital. Census enumerators were given no guidance, as far as we can tell, as to whether "value" meant book value or market value. However, the leading authority on the United States capital stock in the 19th century, Gallman (1986, 1987), argued that book value was uncommon at the time and that the capital figures refer typically to market value.

It is unclear how—if at all—the censuses treated working capital. Although there is both circumstantial and direct evidence that working capital was not wholly omitted in 1880, it is possible that, on average, working capital was under-reported.[14] Working capital, however, was definitely enumerated and its value reported separately in 1890. Later in the paper we use the 1890 data to impute estimates of working capital as part of a sensitivity analysis (see below). There have also been questions raised regarding whether or not the employment figures recorded by the census enumerators included the owner–operator or not. To allow for this possibility we follow previous practice (Sokoloff, 1984) and add one to the number of workers employed in our sensitivity analysis (see below).[15]

Although the samples analyzed in this paper are nationally representative of the surviving manuscript schedules, they are not necessarily nationally representative of all manufacturing establishments. Some establishments were missed by careless enumerators or have not survived. However, with one exception—1880—we can presume that such failures were random and, hence, do not bias the results. In that year, certain industries were assigned to special agents who were more knowledgeable about the industry than the average census enumerator. For reasons that are not known, these enumerations were not deposited with the other census data—perhaps they were retained by the enumerators as they wrote their reports (many of which appear in the 1880 census volume on manufacturing)—and the records have yet to be found (Delle Donne, 1973). However, some establishments from the "special agent" industries were, in fact, enumerated by regular census agents and (some of) these appear in the 1880 sample. Because the 1880 totals (for example, employment) in the special agent industries were published, it is possible to re-weight the 1880 sample so that it is, in principle, nationally representative.[16]

We examine the empirical implications of the two equations given above by estimating regressions of the log of the capital–output ratio and the log of capital intensity. The capital output ratio is measured as the ratio of the reported value of capital

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[14] It was the belief that working capital was under-reported that prompted the inclusion of a separate inquiry on working capital in the 1890 census. However, Sokoloff (1986, p. 713) argues that "a major component" of working capital was included in the pre-Civil War censuses. Later in the paper we consider an imputation for working capital based on information reported in 1890.

[15] The substantive results, however, remain the same if the imputation for the entrepreneurial labor input is not made.

[16] Details of the weighting procedure are available from the authors on request; see also Atack et al. (2004).

to value added (value of outputs minus the value of raw materials).[17] Capital intensity is the value of capital divided by total reported employment (the sum of male and female employees in 1850 and 1860, and the sum of male, female, and child employees in 1870 and 1880). Later, we modify these definitions in particular ways as part of a sensitivity analysis.

To be included in the regression samples establishments had to report positive values of capital, value added, value of raw materials, and employment. We also excluded observations whose industry was not reported and for whom an estimated rate of return to capital invested was unusually high or unusually low, on grounds that capital in such firms was (probably) incorrectly reported.

We pool the samples and estimate regressions similar to the factor price regressions in Table 1

$$\ln y = \alpha_s + \alpha_t + \alpha_j + X\beta + \theta \times (\text{South} = 1 \text{ and Year} > 1865) + \varepsilon \qquad (9)$$

Here, y is an outcome variable (for example, capital–labor ratio). The α's are coefficients of dummy variables for states (s), time period (t), and industry (j); the Xs are additional controls included in some regressions; and ε is a random error.[18] If, as the data in Section 2 indicate, capital costs increased in the South relative to the North after the Civil War, while wages fell and firms responded to these factor price changes as economic theory predicts, capital use in the southern manufacturing should have declined relative to capital use in non-southern manufacturing—that is, θ should be negative.

Panel A of Table 2 reports the regressions of the log of the capital-to-value added ratio. In the first column, the regression includes dummy variables for states, industries, and years, and the post-bellum South interaction term, but no additional controls.[19] The estimate of θ is −0.190, and is highly significant statistically. In the next column we add controls for urban status; dummies for firm size, as measured by employment; and the percentage of workers who were female. Urban status might have influenced capital choice through differences in other factor prices (such as land prices) or because of differential access to financial markets. Differences in female intensity or in firm size may have mattered because these variables were correlated with differences in technology and organizational form, which were also potentially associated with differences in capital use (Goldin and Sokoloff, 1982; Atack et al., 2004). Controlling for these additional variables improves the fit of the regression but has virtually no effect on the estimate of θ (−0.189) or its statistical significance.

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[17] We use value added because the physical quantity of output was not consistently reported in all of the census samples; see Atack and Bateman (1999).

[18] The use of state dummies permits a finer degree of control for geographic variation than regional dummies. However, the substantive results are not affected if we substitute regional dummies for state dummies (as in Table 1).

[19] Preliminary regressions revealed significant improvements in the fit of the regressions (as revealed by adjusted R^2's) with the inclusion of industry dummies. This is not surprising because capital use clearly varied across industries for purely technological reasons; and industry composition differed between the South and the non-South.

In Panel B of Table 2 we report regressions of the log of the capital–labor ratio. The specification of the regressions is the same as in Panel A. In percentage terms we expect to see a larger decline in capital–labor ratios than in capital–output ratios because, as documented in Section 2, the wage–rental ratio fell sharply in the South after the War. That is what we observe: the impact on capital intensity is considerably larger that the impact on the capital-value added ratio—in log terms, a decrease of −0.34 (29%). Adding controls for urban status, firm size, or the use of female labor, as in Panel A, improves the fit of the regression but has no substantive effect on the estimate of θ.[20]

We conducted four sensitivity analyses of the regressions in Panels A and B, the results of which are reported in Table A.1. For this purpose, we use the regression specification with state and industry controls (column of Panel A or B).

First, we modified the definition of the count of workers to allow for the possible under-reporting of the entrepreneurial labor input. To correct for this, we follow Sokoloff (1984, 1986) and add one to the count of workers. This adjustment affects the definition of the capital–labor ratio but not the capital–output ratio. As can be seen in Panel A of Table A.1, making this adjustment has almost no effect on the estimated value of θ. With the adjustment, the estimate is −0.342; without the adjustment, the estimate is −0.340 (from Table 2, Panel B).

Second, we modified the definition of capital to include an imputation for working capital. Our imputation is based on the 1890 census and estimates a value for working capital based on the ratio of working capital in 1890 to the gross value of output. Separate imputation ratios are used for industry-state cells, but the same ratios are used for every year (for further details, see Atack et al., 2003). This imputation affects our calculation of both the capital labor ratio and the capital-value added ratio. Including the adjustment for working capital slightly reduces the estimated magnitudes of θ—for example, the coefficient in the capital-value added regression declines in absolute value from −0.190 to −0.145. However, our substan-

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[20] Wright (1986, p. 164) suggests that the key difference between the post-bellum Southern labor market and the rest of the country was that unskilled labor was relatively cheap compared with skilled labor. However, Margo (2000) demonstrates that the skilled-unskilled wage ratio was higher in the South before the Civil War relative to the rest of the country; at issue, therefore, is whether the Civil War exacerbated the relative scarcity of skilled labor in the South. Using data on carpenters—a skilled building trade—Margo (2004) finds some evidence that skill differentials did increase in the South relative to the rest of the country after the War, but any such increase appears to be modest. Testing whether the decline in relative capital intensity in Southern manufacturing represented a decrease in capital per unskilled worker is difficult with the data at hand, because the manufacturing censuses contain no direct information on skills. We did, however, estimate two additional regressions; in the first, the dependent variable was the proportion of workers who were female, and in the second, the dependent variable took the value one if the establishment was a ''factory'', that is, employed sixteen workers or more; such establishments were intensive in the use of unskilled labor (see Sokoloff, 1984; and Atack et al., 2004). These additional regressions included state and industry dummies in addition to the post-bellum South dummy; the results were not substantively affected if we also included an urban dummy. If Wright's argument were correct, the coefficients of the post-bellum South dummy in these regressions should have been positive; however, the coefficients were negative and statistically insignificant. This test should be regarded as suggestive at best, however, because the percent female and the factory dummy are crude indicators of skill intensity.

Table 2
Regressions of log (capital/value added) and log (capital/labor), coefficients of post-bellum south dummy: manufacturing establishments, 1850–1880

South × year > 1865	−0.190 (0.038)	−0.189 (0.043)		
Panel A: Log of capital-value added				
Industry dummies	Yes	Yes		
Urban + establishment characteristics included?	No	Yes		
Adjusted R^2	0.268	0.276		
Panel B: Log of capital–labor ratio				
South × year > 1865	−0.340 (0.037)	−0.343 (0.037)		
Industry dummies	Yes	Yes		
Urban + establishment characteristics included?	No	Yes		
Adjusted R^2	.367	.373		
Panel C: Log of value-added per worker				
South × year > 1865	−0.149 (0.029)	−0.154 (0.028)	−0.050 (0.027)	−0.057 (0.027)
Industry dummies?	Yes	Yes	Yes	Yes
Urban + establishment characteristics included?	No	Yes	No	Yes
Log (capital/labor) included?	No	No	Yes	Yes
Adjusted R^2	.170	.207	.285	.312

Source. Atack and Bateman (1999) sample of manufacturing establishments from the 1850–1880 manuscript schedules of manufacturing. The national samples are used. To be included in the regressions establishments had to report positive values of output, capital invested, labor, and raw materials. Establishments in SIC 999 (industry unknown) and for whom an estimated rate of return was extremely high or low were also excluded. There are 20,947 establishments in the sample. Establishment characteristics are the percentage of workers who were female and dummy variables for size (6–15 workers, 16–100 workers, 100+ workers; left out dummy is 1–5 workers). All regressions include dummy variables for states and years. 1880 sample is re-weighted; see text. Standard errors are shown in parentheses.

tive conclusion remains the same: capital use fell in southern manufacturing relative to non-southern after the Civil War.

Third, we estimated the regressions by industry, rather than pooling the data and including industry dummies. The lowest level of industry aggregation available in the samples is the three-digit SIC (standard industrial classification) level. Unfortunately, sample sizes are not large enough to reliably estimate the value of θ for every industry. For six three digit industries, however, we have (approximately) 800 or more establishment level observations. Panel B of Table A.1 reports the coefficients of the post-bellum South dummy from regressions of the log of the capital labor and capital-value added ratios. In all six industries the capital–labor coefficient is negative and is statistically significant in every industry. In the case of the capital-value added regressions, the coefficient is uniformly negative, and is statistically significant in four industries. Although it would be desirable to examine the effects at the industry level further, it appears that our substantive results from industry-level regressions are the same as from aggregate regressions with industry dummy variables.

Fourth, we estimated the basic regressions (that is, without adjustments for the entrepreneurial labor input or working capital) distinguishing between the Deep and Upper South, as there is some (albeit, limited) evidence that the decline in relative factor prices was more severe in the Deep than in the Upper South, which suggests that the effects on capital use should also have been more severe (see Margo, 2004, p. 332). As displayed in Panel C of Table A.1, this appears to have been the case: decreases in relative capital–output and capital–labor ratios were much larger in the Deep than in the Upper South.

In the absence of offsetting changes in total factor productivity, decreases in capital intensity should be associated with decreases in labor productivity. In Panel C of Table 2 we present estimates of θ in regressions in which the dependent variable is the log of value added per worker. In column 1, the regression also includes industry and state dummies. In column 2, we add dummy variables for firm size, urban status, and the percent female. The estimated coefficients are negative and their magnitudes imply that output per worker in Southern manufacturing declined after the War relative to Northern manufacturing by approximately 14% among the sample observations.

In columns 3 and 4, we add the log of the capital–labor ratio to the regression specification. If there were no changes in relative (South-to-North) total factor productivity the inclusion of the capital–labor ratio should account for the relative decline in labor productivity in the South. In fact, this is not quite the case—when capital intensity is controlled for, the coefficient of the interaction term remains negative and statistically significant—but it is clear that accounting for the decline in relative capital intensity can explain a significant portion (approximately two-thirds) of the decline in relative labor productivity in southern manufacturing.[21]

The explanatory power of changes in relative capital intensity in accounting for the relative decline in southern per capita income can be explored using Engerman's (1966) estimates of the regional distribution of commodity output (agriculture plus manufacturing) for the 1860–1880 census years in conjunction with Eq. (2). According to Engerman's estimates the South-to-North ratio of commodity output per person fell by 35% between 1860 and 1880. Also according to Engerman's estimates, manufacturing's share of commodity output in the non-South averaged 0.498 over the 1860–1880 period. We re-estimated the capital intensity regressions (Table 2, Panel B, with state and industry controls) restricting the sample to the 1860–1880 census years; in this regression the estimate of θ was -0.360. Assuming a value of the output elasticity of capital equal to 0.33, the predicted decline in relative southern per capita income is -0.059 in log terms ($=0.498 \times 0.33 \times 0.36$), or 5.7 percentage points. This accounts for 16% ($=0.057/0.35$) of the decline in relative southern per

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[21] The remaining portion of the decline in relative labor productivity (about 0.05 in log terms) may represent a true decline in relative total factor productivity but it may also represent a decline in the relative price of southern output; see Margo (2004). Our regression specification controls for general trends in output prices (because we include dummy variables for census years) but not regional trends (since these would be perfectly collinear with the post-bellum South dummy).

capita income. Alternatively, we can re-estimate the labor productivity regressions with and without controlling for capital intensity and use the difference between the two estimates of θ as the measure of the decline in relative labor productivity explained by changes in capital use. If this is done, changes in capital intensity account for 15% of the reduction in relative southern per capita income.

4. Conclusion

Economic historians have documented that the Civil War was associated with a pronounced structural break in the regional pattern of factor prices. In particular, the price of labor relative to capital declined in the South relative to the North, and this decline persisted after the War was over.

Although previous work has documented these regional shifts in factor prices, the economic consequences have not been addressed explicitly. We show in this paper that, in the case of manufacturing, capital use declined in the South relative to the North, and the decline in capital intensity was responsible for a corresponding decline in relative labor productivity. Because output per worker in manufacturing is a component of per capita income, the decline in capital intensity documented in this paper was a proximate cause of the decline in southern per capita income after the War.

Our analysis in this paper has focused on manufacturing primarily because there are excellent data on this sector and because slavery did not play a major role in southern manufacturing before the Civil War. However, a careful study of farm-level data for the South indicates a decline in absolute capital–labor ratios between 1860 and 1880 (Moen, 1992, p. 339).[22] An important question that remains to be explored is the extent to which any changes in capital intensity in post-bellum southern agriculture can be linked directly to changes in factor prices versus changes in capital use that were caused by shifts in technology resulting from emancipation.

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[22] According to Moen (1992, p. 339) capital intensity in southern agriculture declined by 64% between 1860 and 1880. As Moen notes, this decrease may also reflect a shift towards off-farm ginning of cotton (Ransom and Sutch, 1977, p. 116). Because there is as yet no 1880 sample of non-southern farms comparable with the Ransom and Sutch sample, it is not possible to replicate Moen's analysis for non-southern agriculture. However, published census data indicate a rise in capital intensity in non-southern agriculture over the same period; treating agricultural implements and machinery as a measure of agricultural capital (similar to Moen), *K/L* increased by 100% in non-southern agriculture between 1860 and 1880. Details of the calculation are available from the authors on request.

Appendix A.

Table A.1
Sensitivity analyses

A. Estimates of θ: adjustment for entrepreneurial labor input and imputation for working capital

Entrepreneurial labor adjustment?	Working capital imputed?	Ln (K/L)	Ln (K/Q)
Yes	No	−0.342 (0.037)	N.A.
No	Yes	−0.294 (0.029)	−0.145 (0.025)
Yes	Yes	−0.297 (0.029)	−0.145 (0.025)

B. Industry regressions: estimates of θ

Industry	Ln (K/L)	Ln (K/Q)	Number of establishments
Blacksmithing	−0.567 (0.100)	−0.457 (0.100)	1,853
Flour milling	−0.400 (0.091)	−0.256 (0.104)	1,884
Sawmills	−0.403 (0.080)	−0.163 (0.092)	2,851
Boots and shoes	−0.456 (0.151)	−0.305 (0.154)	1,837
Wagons and carriages	−0.520 (0.189)	−0.306 (0.199)	809

C. Estimates of θ: Upper versus Deep South

	Upper	Deep
Log(K/L)	−0.250 (0.044)	−0.695 (0.076)
Log(K/Q)	−0.142 (0.041)	−0.380 (0.078)

N.A.: no adjustment necessary.
Deep South: Alabama, South Carolina, Florida, Georgia, Louisiana, Mississippi, Texas. Upper consists of all other southern states. Substantive results are not affected if Deep South states are restricted to Alabama, Florida, Georgia, Louisiana, and Mississippi.
Source to Panels A, B, and C. See Table 2. Figures shown are coefficients of post-bellum south dummy variable; see text. All regressions include state and three-digit SIC industry dummies. 1880 sample is re-weighted, see text.

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