One Giant Leap:
Emancipation and Aggregate Productivity Growth[*]

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Abstract

We re-characterize American slavery as inefficient and unproductive, whereby emancipation caused a 35% increase in US aggregate productivity. Production during enslavement came at immensely large costs imposed upon enslaved people that reduced aggregate productivity, or the total value of output minus total costs incurred. Coercive labor markets were severely distorted, with the social marginal cost of labor substantially above its marginal benefit. Emancipation then launched US aggregate productivity, illustrating the substantial potential for aggregate productivity growth in the presence of severe misallocation.

The widespread enslavement of Black people in the United States is universally recognized to have been morally wrong, but there is an enduring view of slavery as "economically productive." American slavery produced high crop yields and generated substantial income and wealth for enslavers (Conrad and Meyer, 1958; Yasuba, 1961; Bergstrom, 1971; Fogel and Engerman, 1974; Baptist, 2014; Berry, 2017; Hilt, 2020). Some views emphasize the "efficiency" of markets during enslavement, in which enslaved labor was traded and allocated across tasks and locations to achieve high levels of output per worker (Fogel and Engerman, 1977; Beckert, 2014; Naidu, 2020). After emancipation, there were substantial declines in crop yields and output value as production in the South adapted to the change in labor institutions (Ransom and Sutch, 1977).

Characterizations of slavery as efficient and productive reflect the benefits and costs for slave owners, with market transactions oriented around extracting value from enslaved people. In this paper, we challenge this view. We re-characterize slavery as economically inefficient because there was a massive externality whose implications have been under-explored: enslavers considered their own private marginal benefits and private marginal costs of slave labor when making production decisions in the antebellum era, but they did not internalize the costs slavery imposed on enslaved people. When including costs incurred by enslaved people themselves, the tremendous inefficiency of slavery becomes apparent because the value extracted by enslavers was substantially less than the costs imposed on enslaved people. Focusing on the cost of enslavement in our framework shows that slavery was a market failure in addition to a moral failure.

Since American slavery was economically inefficient and unproductive, emancipation generated a roughly 35% increase in US "aggregate productivity" (the total value of output minus total costs incurred). Aggregate productivity is measured using prices that reflect peoples' valuations, and so is closely related to aggregate welfare (Solow, 1957; Weitzman, 1976; Basu and Fernald, 2002), but we do not impose a social welfare function that would weight the well-being of enslavers and the enslaved. Aggregate productivity experienced a one-time increase after emancipation, and remained higher, because the economic value produced through the institution of slavery came at immensely large costs imposed upon enslaved people. Given there were 4 million enslaved people in the United States on the eve of the Civil War, or 13% of the total population, the aggregate productivity gains from emancipation were substantial. While output declined substantially in the South after emancipation, total input costs declined so significantly that emancipation represents by far the largest annual increase in aggregate productivity in American history.

Approximating the increase in aggregate productivity from emancipation requires approximating the total cost of slavery imposed on enslaved people. This cost to enslaved people is

inherently difficult to conceptualize, which is related to the difficulty in considering the cost of threats to peoples' lives. The horrors of American chattel slavery were not hypothetical, however, so difficulties in measuring this total cost should not preclude its consideration. Such a calculation could include compensating enslaved people for the value of their time, and other aspects of enslavement, which have been considered in analyses of reparations payment magnitudes (Craemer et al., 2020). Our preferred estimates draw on approximate magnitudes associated with people's valuation of mortality risk, rather than attempt to quantify the costs of particular aspects of slavery. Some might consider the substantial market value of enslaved people, but this reflects the value extracted by enslavers rather than the cost imposed on enslaved people. These rough numbers imply only approximate magnitudes for the impact of emancipation on aggregate productivity, but illustrate the paradigm shift in characterizing American slavery and the economic impacts of emancipation.

The last section of the paper explains how our analysis departs from the literature on American slavery. Prior economic history literature on slavery has looked to characterize various aspects of the slave economy. This analysis and discussion has largely engaged with the "economics of slavery" on its own terms, from the perspective of its operation as a business. This focus neglects the coercive aspect of enslavement that we view as central in analyzing its economic implications. We emphasize that prior focus on the trees has missed the forest: that coercion induced a deep inefficiency, which was corrected through emancipation, and which dramatically increased aggregate productivity that reflects an increase in the social value of production minus the social costs of production. This is a theoretical departure, in how people should think about economic production and its costs, which illustrates the substantial potential for economic growth in contexts with coercion or other sources of severe misallocation.

Our analysis thereby connects the literature on slavery with a recent literature that highlights how misallocation impacts aggregate productivity (Hsieh and Klenow, 2009; Petrin and Levinsohn, 2012; Hsieh et al., 2019; Findeisen et al., 2021; Hornbeck and Rotemberg, 2022). We characterize the institution of slavery as creating an extreme case of labor misallocation.[1] Enslavement was an assigned social identity, with supporting coercive institutions, which shapes the economic impacts of emancipation. Prior economic history literature has implicitly assumed efficient labor allocation, focusing on the "expropriation rate" or the share of enslaved peoples' marginal product that went to enslavers (Fogel and Engerman, 1974; Ransom and Sutch, 1977). We highlight that even if enslaved people had received

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[1]To the extent that enslaved people functioned as capital (similar to mules), this would reflect an extreme case of capital misallocation as well but people do not typically think about the costs incurred by capital beyond the costs internalized by capital owners (e.g., depreciation).

100% of what they produced, that compensation would be substantially less than the costs of slavery incurred by enslaved people. This is the inefficiency of slavery: enslaved people were coerced to work and live under conditions with immense costs to themselves, which exceeded the marginal value of output they produced.

The impact of emancipation provides a stark illustration of how labor misallocation can substantively impact aggregate productivity, and we present a new fact of American history: emancipation led to the single greatest annual increase in aggregate productivity, by far, in American history. Dismantling the "peculiar institution" of slavery brought about benefits that imply a substantially different cost-benefit impact of the Civil War (Goldin and Lewis, 1975). The aggregate productivity gains of emancipation are also larger than revised-upward impacts of the railroads when allowing for misallocation (Hornbeck and Rotemberg, 2022), which itself makes a related departure from prior analysis that assumes efficient labor allocation (Fogel, 1964; Donaldson and Hornbeck, 2016).

Emancipation increased aggregate productivity by reducing social costs of production that were not being internalized. To illustrate this point, consider carbon emissions that are another cost that is not deducted from the value of output. If a new technology could remove all carbon emissions from the atmosphere, costlessly, it would be a substantial technological innovation but it would not directly increase aggregate productivity when the costs of annual carbon emissions are not deducted from world GDP. Assigning a social cost of carbon, this technological innovation would substantially increase aggregate productivity. Assigning a social cost of enslavement, which reflects costs incurred by enslaved people, our estimated aggregate productivity impact of emancipation is over 7 times greater than the implied US aggregate productivity gain from the hypothetical elimination of *all* annual US carbon emissions.

Recent debates about the role of enslavement in American political and economic development highlight the ways in which America's institutional development was influenced by enslavement. This discussion, as many others, has not focused on the enslaved themselves. We show that turning the focus of economic analysis to the enslaved, and the cost of enslavement incurred by them, reveals that ending America's slave regime did not precipitate a period of economic struggle to be endured; rather, emancipation led to an immediate and miraculous increase in aggregate productivity.

We revisit this topic now, despite all that has been written about slavery, for several reasons. Re-characterizing the economics of American slavery sees this "peculiar institution" as foundational in the country's development, but negatively so, such that emancipation unleashed aggregate productivity growth in the American south and nationwide. Slavery and emancipation then illustrate how aggregate productivity growth can be substantively

influenced by market distortions that misallocate workers. Coercion creates an order-of-magnitude degree of misallocation that better puts into context the sorts of inefficiencies that can arise in voluntary market-oriented transactions. Finally, if the moral failure of slavery was indeed an economic success (Fogel and Engerman, 1974; Baptist, 2014), it would cast doubt on the social value of economic success itself.

I Emancipation and Aggregate Productivity: Theory

We start with a model to clarify how we view emancipation impacting aggregate productivity in the United States. The model captures the core inefficiency of slavery: that landowners consider their private costs of employing enslaved people and free people, and the private cost of employing enslaved people is less than the cost imposed on enslaved people. This is the fundamental difference from voluntary labor markets, in which people choose to work only when their compensation is at minimum their cost of working. The model then motivates our calculations in Section II.

I.A Model Setup

We assume that individual landowners produce a commodity output Y with fixed price.[2] There are two sectors: a slave sector s and a free sector f. In the slave sector, landowners/enslavers pay for enslaved people at a total private cost r. This total private cost includes labor payments that are received by enslaved people (their consumption) and labor payments expropriated by enslavers (captured in the annualized market price of enslaved people).[3] In the free sector, landowners/employers pay for free people at wage w. This wage reflects the market cost of free workers, including wage labor or sharecropping or other contractual arrangements, and we set aside ways in which enslavement could affect market wages (Merritt, 2017; Clegg, 2020).

Output in each sector is a function of labor and other inputs, $Y^s = F^s(L, X)$ and $Y^f = F^f(L, X)$. The production function varies by sector, reflecting a greater intensity of work in the slave sector and thereby higher output per person. We assume that markets are efficient, from the enslavers' and employers' perspectives, such that the value marginal product of labor equals its marginal cost. In the slave sector, the additional value produced by an additional enslaved person is equal to the total private cost r ($\frac{dF^s}{dL} = r$). In the free sector, the additional value produced by a free person is equal to the wage w ($\frac{dF^f}{dL} = w$).

We define aggregate productivity as the total value of output minus the total cost of

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[2]We use "landowner" here for exposition, but note that enslavers were also involved in production outside of agriculture and that enslavers leveraged the value of enslaved people to secure credit and other non-agricultural economic activities (González et al., 2017).

[3]See Stelzner and Beckert (2023) for a recent example of using the prices of enslaved people to consider the contribution of enslavement to US GDP growth.

inputs, which Jorgenson and Griliches (1967) describe as the "conventional" definition of productivity. Importantly, we define the total cost of labor inputs as the total cost incurred by people (and not only the private cost paid by enslavers or employers). In the free sector, the wage paid is equal to costs incurred by a free person. In the slave sector, we define c as the costs incurred by an enslaved person.

I.B   Changes in Aggregate Productivity from Emancipation

We now consider the change in aggregate productivity from emancipating one person, who moves from the slave sector to the free sector.[4] The value of output increases in the free sector ($\frac{dF^f}{dL}$) and decreases in the slave sector ($\frac{dF^s}{dL}$), with a decline in aggregate output because enslaved people are coerced to produce more than free people. Aggregate input costs also decline, however, with a decline in labor costs in the slave sector (c) and an increase in labor costs in the free sector (w). Emancipating one person results in aggregate productivity growth (APG) equal to the externality in the slave sector ($c - r$):

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\begin{aligned}
(1) \qquad APG &= \left[\frac{dF^f}{dL} - \frac{dF^s}{dL} \right] - [w - c] \\
&= \left[\frac{dF^f}{dL} - w \right] - \left[\frac{dF^s}{dL} - r \right] + [c - r] \\
&= c - r
\end{aligned}
$$

This expression, $c - r$, reflects the gap between the total cost of labor and the private cost of labor in the slave sector. The effect of emancipation on aggregate productivity reflects this gap multiplied by the number of emancipated people. Emancipation may also induce changes in other inputs X, but the value marginal product of these other inputs is assumed to be equal to their marginal cost so induced changes in other inputs do not have first-order impacts on aggregate productivity. If the slave sector and/or free sector were not privately efficient, then there would be additional terms corresponding to the relative magnitudes of private inefficiencies in both sectors, but we focus on the main inefficiency: that enslavers consider only the private cost of using enslaved labor and not the total cost imposed on enslaved people.

In using equation 1 to quantify the effect of emancipation on aggregate productivity, the main challenge is quantifying the total cost incurred by enslaved people (c). Formerly-enslaved people required a substantial wage premium to work under the intensive gang labor system, used under slavery to increase output per person. Even this substantial wage premium would not be compensation for all conditions of slavery, however, that were inex-

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[4]We leave aside the calculation one could perform for pre- Civil War emancipations, including self-emancipations.

tricably linked to labor coercion and the extraction of economic value from enslaved people. Rather than attempt to quantify specific costs of life under slavery, our preferred estimates will draw on the "value of statistical life" literature to approximate the economic value lost by enslaved people.[5]

From equation 1, the effect of emancipation on aggregate productivity also depends on enslavers' private cost of labor (r). This private cost includes the annualized market value of enslaved people, which reflects the value produced by enslaved people in excess of enslavers' other private costs. This market value of enslaved people is not directly connected to the costs incurred by enslaved people. For example, suppose that enslaved people were paid their full marginal product in-kind and there was no surplus value reflected in positive prices for enslaved people. In this case, enslaved people were still coerced to live and work under conditions such that their marginal product of labor was less than the costs incurred by them. Similarly, an enslaved person with little market value, such as a young child or elderly person, would receive substantial value from emancipation. The market value of enslaved people reflects the "effectiveness" of expropriation, and would decrease with the costs of enforcing coercion, which is distinct from the costs incurred by enslaved people.

The economic inefficiency of slavery is not that enslavers extracted substantial value from enslaved people; rather, the economic inefficiency is that enslavers only captured a portion of the total costs imposed on enslaved people. It is uncontroversial that slavery was morally wrong, and the economic value produced was received by the wrong people, but this economic inefficiency highlights the costs incurred by enslaved people beyond what value was received by enslavers. Slavery was not only a substantial transfer of value from enslaved people to enslavers, it was also an inefficient mechanism of transferring value.

To be sure, there are other inefficiencies of slavery that are not the focus of our analysis. Enslavers incurred costs to provide food, housing, and other consumption goods to enslaved people, though enslaved people would prefer their own consumption choices if they received the wage value of those in-kind transfers. In the free sector, landowner expenditures on labor are fully received by free people in the form of wages; in the slave sector, however, much of landowner expenditure is "lost" and not received by enslaved people. Similarly, public and private expenditures on the enforcement of slavery represent further losses in aggregate productivity. Acemoglu and Wolitzky (2011) focus on inefficiencies from these costs of coercion itself, and consider the endogenous determination of coercion levels, whereas we focus on the inefficiency from the labor market distortion, even when coercion is free,

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[5]We view this as both a reasonable means of avoiding the inherent complications of valuing all aspects of enslavement while also resulting in a conservative estimate of c because it focuses only on the first-generation of emancipated people.

and the aggregate productivity impacts from emancipation. Earlier literature explores the Pareto optimality of slavery (Bergstrom, 1971; Findlay, 1975; Canarella and Tomaske, 1975), with an appeal to Coase (1960), but the externality we emphasize can not be internalized due to legal frictions, borrowing constraints, and other transaction costs.

II Emancipation and Aggregate Productivity: Calculations

To begin assessing the approximate magnitude of aggregate productivity growth from emancipation, we assign $40 to be free farms' annual agricultural labor income per person in 1860. This number comes from the Parker-Gallman samples on agricultural output for free farms in the South in 1859/1860, and prices from Towne and Rasmussen, as calculated by Fogel and Engerman. This number reflects the total value of agricultural output, multiplied by a 0.58 labor share, and divided by the number of people. For consistency, we report all numbers on a per capita basis that includes all adults and children.

We then assign $60 to be enslaver farms' annual agricultural labor income per person in 1860, which corresponds to r in equation 1. This is consistent with the consumption of enslaved people being roughly $30 per capita and enslaved people receiving roughly 50% of their output (Ransom and Sutch, 1977). The remaining $30 would be capitalized into the market value of enslaved people, which at a 7% rate of return implies an average per-capita market value of $430 for enslaved people. Estimated per-capita market values of enslaved people in 1860 are somewhat higher ($750 from Wright (2006)), but cotton prices were increasing rapidly in the 1850s and market values of enslaved people in 1860 also reflected expected growth in their value as cotton production expanded Westward (Ransom and Sutch, 1977; Pritchett and Freudenberger, 1992; Pritchett and Chamberlain, 1993; Calomiris and Pritchett, 2016; Rosenthal, 2018; Berry, 2017). This $60 number also reflects labor productivity of enslaved people being 50% greater than if they were free, which is at the upper range of estimated productivity differences due to greater intensity of work under enslavement (Fogel and Engerman, 1977).

We now consider the cost of slavery incurred by enslaved people, which corresponds to c in equation 1. These costs are inherently difficult to assess. Our numbers represent only approximate magnitudes, but the challenges of considering these costs should not distract from their central importance to understanding the consequences of emancipation.

After emancipation, there was a substantial decline in labor supplied by formerly-enslaved people (Ransom and Sutch, 1977; Litwack, 1979; Foner, 1988). Landowners considered paying people a substantial premium to continue working under the "gang labor" system, which had organized enslaved people into high-intensity work groups that generated greater output per person (Fogel and Engerman, 1980). This wage premium was generally insufficient

compensation for the greater intensity of work, however, and these labor arrangements were uncommon (Genovese, 1976; Foner, 1988; Litwack, 1979; Seagrave, 1971). Given a roughly 2.5x income premium for gang labor contracts after emancipation (Seagrave, 1971), and a $40 annual agricultural labor income per free person, this implies the cost of enslaved labor exceeded $100 per person. Fogel and Engerman (1974, 1977) also consider costs imposed by the gang system, along with smaller gains to cotton consumers, but working in the gang labor system represented only one component of the costs incurred by enslaved people and a more comprehensive accounting is necessary.

Enslaved people lost control of their lives for the entire year (8,760 hours), and research on reparations payment magnitudes has valued this additional time at the free labor wage rate (Craemer et al., 2020). Inflating the $40 free labor income by a factor of 3, to represent payment for the entire year as a ratio of approximate "working hours," and adding the gang labor wage premium gives an enslaved labor cost of $180 per person. One might question whether sleeping hours should be compensated, but enslaved people gave up year-round control over where they would sleep, how much they would sleep, and faced separation from their spouse and children, such that non-working hours should not be considered "leisure" in the typical sense of free people. There is also little to adjust these numbers for the physical violence endured, fear and mental strain, and general loss of agency over one's own life. Ransom and Sutch (1977) discuss gains for emancipated workers, which build on calculations for the value of time from post-emancipation declines in Black labor supply, yet maintain focus on economic struggles of the South after the Civil War and difficulties faced by Black people.

Rather than attempt to assess the financial cost associated with particular abuses endured under slavery, we consider a more comprehensive measure of the valuation that people attach to their lives. There is little evidence on people's willingness to risk enslavement, but there is a substantial literature on people's willingness to risk their lives (Viscusi, 1993). For example, if a person is indifferent to accepting another job with 0.1% higher annual mortality risk and 15% higher annual salary, then their "value of statistical life" (VSL) is approximately 150 times their annual income.

Estimates of the "value of statistical life" (VSL) can vary substantially across contexts and people's preferences, but typical values are roughly 100-200 times annual income and we assume an income elasticity of one (Viscusi and Masterman, 2017). For an annual income of $40 and VSL multiplier of 150, this implies a VSL of $6,000 for enslaved people. We use the annual income for free people, as the annual consumption of enslaved people is artificially suppressed through coercion and their free lives are not worth less to themselves because they receive less in-kind consumption under enslavement.

An enslaved person's VSL is not precisely their value of freedom, but it is not obvious that the VSL exceeds the value of freedom. Formerly-enslaved people describe enduring worse than their own death to support their family and lived for the hope of freedom, in which attempts to escape were generally unsuccessful, and failure resulted in punishment for themselves and their family (Stampp, 1956; Blassingame, 1972). Enslaved people had severely restricted opportunity to purchase their freedom, including impediments to borrowing against future earnings and reducing future consumption below subsistence levels to finance their freedom (Conrad and Meyer, 1958). Restricted ability to pay for freedom does not imply a willingness to accept enslavement, and the imposed cost of enslavement on otherwise free people is the realized cost of enslavement. Patrick Henry's quote ("give me liberty or give me death") is perhaps rhetorical, but revolutionaries have risked death for freedom from comparatively mild oppression despite Henry invoking imagery of the chains of slavery.[6] We also do not directly consider the value of emancipation to future generations, beyond how the lives of future generations are reflected in peoples' valuation of their own lives.

Enslaver farms used the lives of enslaved people, with an implied annualized cost to enslaved people of $420 that was unpaid but nonetheless incurred ($6,000 VSL multiplied by a 7% interest rate). This imposed cost exceeds the private cost to enslavers of $60, such that the externality in equation 1 ($c - r$) is roughly $360 per person. Multiplying by 4 million enslaved people is $1.44 billion, or 35% of total US GDP ($4.17 billion in 1860, Gallman (1966)).

Emancipation increased aggregate productivity by 35% of US GDP through substantially reducing the cost of inputs, even as the value of output declined. Annual technological innovation in this era was roughly 0.5% (Abramovitz and David, 1973), so emancipation was worth roughly 60 years of technology growth (compounded). One further implication of our analysis is that technological innovations that expanded the use of slavery, such as the cotton gin, would have substantially decreased aggregate productivity because the resulting increase in the cost to enslaved people exceeded the gain in output.

In the modern United States, the economic cost of annual US carbon emissions is also not deducted from GDP despite the imposed current and future costs of CO_2 emissions. The introduction of a new technology that costlessly absorbs all US carbon emissions would then not directly increase GDP, but would increase actual US aggregate productivity by reducing these unaccounted-for costs. For an estimated social cost of carbon of $51 per ton (EPA 2023), removing all 6.3 billion tons of US annual carbon emissions would be worth 1.2% of US GDP (26 trillion in 2022, BEA). For a higher $185 social cost of carbon (Rennert et al.,

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[6]The full speech is available here: `https://avalon.law.yale.edu/18th_century/patrick.asp`.

2022), eliminating all US carbon emissions is worth 4.5% of US GDP. These impacts are substantially less than the impacts from eliminating the use of enslaved labor in the US.

The aggregate productivity gains from emancipation are more than double the substantial direct costs of the Civil War. The Civil War had an estimated $6.7 billion direct cost, including war expenditures by the Union and Confederate governments and the destruction of human and physical capital (Goldin and Lewis, 1975). These direct costs include lost wages of those killed; for comparability, we replace the calculated $1.6 billion in lost wages with a $6,000 VSL associated with 618,000 deaths, and calculate a new adjusted total direct cost of $8.8 billion ($616 million annualized). We set aside potential indirect effects of the Civil War on economic growth, other than noting the decline in Southern output by enslaved people is already included in its impact on aggregate productivity. Emancipation could also have been achieved at lower cost, through compensation to enslavers (Goldin, 1973), though gradual emancipation would have prolonged the substantial costs of enslavement that was not only a redistribution of wealth between enslavers and the enslaved.

Following the Civil War, there was consideration given to providing formerly-enslaved people 40 acres of land per household. In contrast to the substantial costs that had been imposed on enslaved people, this transfer would have cost roughly 12.5% of GDP as a one-time cost or 0.87% of GDP on an annualized basis. This calculation reflects average 1870 land values of $13 per acre in Kansas (a typical destination among Black Exodusters), 1 million households of the formerly-enslaved (4 people per household), and the cost annualized at a 7% interest rate.

These land transfers were not made, and the value would be substantially larger now compounded at 7% interest. This would be worth $400,000 for each of the estimated 40 million descendants of people enslaved in the US. This is larger than the modern racial wealth gap of $160,000 per person, which is a focus in research on reparations payment magnitudes (Darity and Mullen, 2020). However, the total annualized cost of these $400,000 payments is "only" 4.4% of GDP and substantially smaller than the gains from emancipation as a share of GDP. These payments are also a transfer, rather than an actual lost "cost," in contrast to the lost aggregate value through inefficient transfers under enslavement.

We do not consider general equilibrium effects from emancipation. Such a large reallocation of people, from the slave sector to free sector, would have a variety of further economic and political consequences. Increased production in the free sector would generate more gains if input-use was otherwise distorted below efficient levels (Hornbeck and Rotemberg, 2022), but we focus on the direct distortion from enslavers not internalizing the costs imposed on enslaved people. We also focus on the contemporaneous gains to enslaved people and do not consider gains to future generations.

The above calculations reflect averages over the total enslaved population, but these differences between private costs and social costs are particularly apparent in the case of enslaved children. Enslaved children were of relatively small value to slave owners, but were of great value to their parents. That is, the gap between private value and social cost was especially large for enslaved children. Consistent with this substantial difference in valuations, mortality rates were very high for enslaved children and declined substantially after emancipation.

III Shifting the Literature on American Slavery

III.A The "Efficiency" and "Productivity" of Slavery

This section discusses how our characterization of American slavery overlaps with and departs from the prior literature. We focus on the literature that has been largely instrumental in the continuing debates in the economic history of slavery for the last several decades, as it is most concerned with the technical and substantive issues related to our approach. Our main departure comes from emphasizing the perspective of enslaved people in considering economic concepts like efficiency and productivity, which has different implications for characterizing the economic impacts of emancipation. We draw on a modern literature that highlights the connection between misallocation and aggregate economic growth (Hsieh and Klenow, 2009), rather than focus on the distribution of output by enslaved people (e.g., Fogel and Engerman (1974); Ransom and Sutch (1977)), which also then illustrates how extreme misallocation can create the potential for extreme economic growth.

Historical debates on the economics of slavery have explored many issues, including the profitability of slavery and the material well-being of enslaved people relative to free wage laborers. These debates precede the Civil War (Estes, 1846; Fitzhugh, 1857), with origins in abolitionist and pro-slavery writings, and have continued through later writings (e.g., Stampp, 1956; Conrad and Meyer, 1958; Fogel and Engerman, 1974; Gutman, 1976; Genovese, 1976; Baptist, 2014).

Slavery was profitable, from the perspective of enslavers, because the labor income generated by enslaved people was higher than the financial costs of maintaining an enslaved person. These profits were capitalized in the substantial market value of enslaved people. This view is largely accepted despite abolitionist arguments that slavery was a backward unprofitable institution (see Wright (2006)) and arguments that unprofitable slave labor existed more as a social institution (as in Philips (1918)) A more-contested issue, outside our focus, is whether slavery discouraged Southern economic growth more generally, as suggested by comparisons at the border (Bleakley and Rhode, 2022), or whether slavery broadly encouraged US economic growth (Baptist, 2014; Beckert, 2014; Hilt, 2020; Wright, 2022).

Particularly controversial has been estimating the material well-being of enslaved people, which has included estimating the "rate of expropriation" or the share of enslaved people's marginal output that enslaved people did not receive. Ransom and Sutch (1977) estimate that enslaved people received 50% of their output, an upward revision to the 90% estimate by Fogel and Engerman (1974). This "rate of expropriation" does not reflect what was truly taken from enslaved people, however, when the value marginal product of enslaved people's output is not equal to its marginal cost (i.e., misallocation). Enslaved people could have received all of their marginal output, or even more than they produced, but still incurred costs of enslavement that substantially exceeded what they received. The expropriation rate is about the distribution of output, which is distinct from costs, and then misses the core inefficiency of slavery and its implications. An alternative calculation would be the output received by enslaved people ($30), as a share of the costs incurred ($420), which we estimate at 7%.

Characterizations of slavery as "efficient" reflect enslaved people working within a market economy, from the perspective of enslavers, whereby enslavers sought to maximize their own profits by equating the marginal product of labor with their private marginal cost of labor. We emphasize an aggregate perspective that includes all input costs, and not only those internalized by enslavers, whereby enslavement is inefficient because it did not equate the marginal product of labor with the social marginal cost of labor that includes further costs incurred by enslaved people. Free labor markets generally do not have this issue because the costs incurred by free workers are reflected in the wages they accept voluntarily. Coercion makes enslavement distinct from increased factory discipline, for example, which is reflected in compensating wage differentials. Similarly, while early economic growth may have come at health costs, such as increasing urban mortality through the industrial revolution (Beach and Hanlon, 2017; Antman, 2022; Alsan and Goldin, 2019), peoples' choice of material well-being creates more presumption that the gains exceed the costs in contrast to when that decision is coerced.

Slavery was "productive," in the sense that enslaved people produced high levels of output, and total factor productivity (TFP) declined after emancipation reflecting lower output relative to workers, capital, and land (Ransom and Sutch, 1977). Declining TFP does not reflect people forgetting production methods after emancipation; rather, formerly-enslaved people could not be paid enough to endure such conditions, which indicates those methods produced less than the costs incurred. While sharecropping produced less than plantation methods, observers found that formerly-enslaved people "appear to be willing to work, but are decisive in their expressions, to work for no one but themselves" (Litwack 1979, p. 446).

This now generally accepted view of slavery as productive is in contrast to Adam Smith and Von Mises (2002), among others, who argued that people not working on their own account had less incentive and would therefore be less productive. Hummel (2012) reviews this literature, with a focus on the "deadweight loss" output consequences of slavery from misaligned incentives for work and innovation, along with reference to costs of enforcement (Acemoglu and Wolitzky, 2011) and costs imposed by gang labor Fogel and Engerman (1974).

Slavery increased output through imposing "non-pecuniary" costs on enslaved people (Baptist, 2014; Naidu, 2020), but these were only "non-pecuniary" because enslavers used coercion to avoid paying those costs. These costs were still incurred, in practice, and emancipated people required substantial payment to endure such conditions. Aggregate productivity is the value of output minus the value of costs, and these costs should be subtracted from output value to characterize aggregate productivity under slavery. We characterize emancipation as not only a transfer of measured income into this unmeasured non-pecuniary income (Atack et al., 1994), but something more because the non-pecuniary costs were greater than the income gains. This makes emancipation an efficiency-enhancing transfer reflected by the growth in aggregate productivity.

Output declined after emancipation, with particular declines in child and female labor (Ransom and Sutch, 1977; Litwack, 1979; Jones, 1985), but these voluntary declines in labor force participation indicate the costs of working exceeded the return from working.[7] There were also changes in the geographic allocation of workers, where enslaved people could be allocated to places where their marginal product was highest (Naidu, 2020), but the strong desire of formerly-enslaved people to relocate and connect with family members illustrates that higher marginal product came at even higher marginal costs. From the perspective of maximizing aggregate output value minus aggregate costs, including costs to enslaved people, their geographic and occupational mobility suggests they had been forced to live in the wrong places under the wrong conditions. Similarly, Goldin (1973) emphasizes the private efficiency from inducing enslaved people to work in agriculture where they produced relatively more, in contrast to urban sectors in which free labor and enslaved labor was more similarly productive, but this is about their relative private marginal products for enslavers rather than their marginal products relative to marginal cost inclusive of their costs incurred.

Post-emancipation production exhibited greater dispersion in marginal products that can indicate lower allocative efficiency (Naidu, 2020), but this reflects closer alignment between marginal products and marginal costs under (more) voluntary labor markets. The post-reconstruction economy was characterized by various efforts to restrict black labor mobility and extract additional value (Naidu, 2010), but these reflect milder coercion than under

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[7]We leave aside the decline in child labor due to schooling.

enslavement. Market frictions after emancipation are also in part a legacy of slavery. The formerly-enslaved had reason to distrust contracts signed with people who only a short time earlier had commanded their labor. Former enslavers also proved themselves to be untrustworthy: "a Tennessee planter promised, they would be awarded a share of the crop... But when the two freedmen stood before their former master to obtain the promised shares, he refused to pay them anything, declared he could no longer support them, and ordered them off his land" (Litwack 1979, p. 420).

The general notion of loss after the Civil War, and what is "gone with the wind," is in sharp contrast to the gains from emancipation that should be celebrated as an economic miracle. While there were certainly problems in Southern agriculture after emancipation (see Wright (1978); Brinkley (1997)), we emphasize that the main problem was that the antebellum economy used enslaved labor far beyond what would equate marginal value and marginal cost and that problem was solved through emancipation. Wright (1997) focuses on Southern economic struggles after the Civil War, which reflects the perspective of output, but the Southern economy had actually just experienced dramatic growth from the perspective of difference between output and costs.

We are characterizing changes in "aggregate productivity" after emancipation, which is distinct from changes in social welfare under some social welfare function, though aggregate productivity is closely connected to welfare (Solow, 1957; Weitzman, 1976; Basu and Fernald, 2002; Jorgenson, 2018). Economic analyses of slavery generally presume that emancipation increased welfare of enslaved people, transferring material consumption from enslavers to the formerly-enslaved with a decline in total consumption. Declining output and total consumption then represents the price paid for abolishing slavery, an uncontroversial moral wrong, but efficient markets maximize the difference between output and costs rather than output itself.

Aggregate productivity growth is meaningful for society because there is more output without correspondingly more use of inputs. If output only increases because labor inputs increase, then there are not more resources for society to consume net of the value of labor. If the value marginal product of labor is lower than its marginal cost, then aggregate productivity declines as labor inputs increase. When the value marginal product of labor is substantially below its marginal cost in one sector (the slave sector) and more approximately equal to its marginal cost in another sector (the free sector), then aggregate productivity increases when reallocating workers from the slave sector to the free sector through emancipation. This is an under-appreciated implication of input misallocation, which has substantial implications for aggregate productivity growth (Hsieh and Klenow, 2009), and emancipation provides a clear illustration of the potential aggregate economic gains from reallocating

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inputs in the presence of severe misallocation.

Enslavement was not a market economy, from the perspective of enslaved people who were coerced to work without a direct relationship between the value of their labor and cost of providing that labor, so there would be no presumption that market forces would direct production toward efficient outcomes. Whether this system was "capitalist" depends on the definition of capitalism, but historians and economists have focused on the market-aspects of the slave economy from the perspective of enslavers in adopting various definitions (Baptist, 2014; Hilt, 2020).

Fogel (1989) argues that the "material success" of slavery should be held in contrast to its moral horror and exploitation (p. 9). We propose an alternative comparison, in which slavery was also an aggregate economic failure because it produced much less than the costs it induced. The key paradigm shift is treating enslaved people and their costs incurred as part of the aggregate economy, rather than focusing on aggregate output or aggregate output net of costs incurred by enslavers. Even the material well-being of enslaved people, often focused on in the literature, is not particularly informative about aggregate well-being because people do not directly maximize their caloric intake, overall nutrition, or height. The immorality of slavery becomes more-reflected in the economics of slavery once the costs are appropriately included. Emancipation brought economic prosperity, as abolitionists had hoped, when economic prosperity is defined to include the value of enslaved peoples' lives as they valued them.

David and Temin (1974) argue that Fogel and Engerman (1974) "overlook the economic essence of slavery, namely, that the slaves lost the freedom to exercise choices as producers and consumers." David and Temin (1974, 1979) then focus on welfare, and the inability of economic analysis of material well-being to inform the broader question of social welfare. We re-focus on aggregate productivity, which is distinct from welfare because enslavement would always reduce aggregate welfare if enslaved people receive sufficient weight in the social welfare function. Enslavement could increase aggregate productivity, in principle, if the work of free people is constrained such that their value marginal product of labor is greater than its marginal cost. We calculate that aggregate productivity increases following emancipation, however, because of the substantial costs of enslavement.

III.B   Centering the Costs of Slavery

Our framework connects economic analysis of slavery with the broad more-qualitative literature that highlights the myriad substantial costs imposed on enslaved people. These costs were not tangential to "economic production;" rather, enslavers' extraction of value from enslaved people was inextricably linked to the all-encompassing control of enslaved people's

lives. Enslaved peoples' journal entries note many deaths as overworked, undernourished, and likely dehydrated people perished as they labored (Steckel, 1986a,b). Through coercion, enslaved people were induced to work until to the point of heatstrokes, fainting, and ligament and muscle tears. Enslavers remarked that maintaining a productive slave system required fear of severe punishment or death (Stampp, 1956). Overseers were incentivized to induce additional output, and contemporaries noted how the profit motive lay behind the harsh overwork of enslaved people. One Mississippian told Olmsted "I'd ruther be dead than be a nigger on one of these big plantations" (Stampp 1956, p. 85).

While enslaved people had some influence over their work (Blassingame, 1972; Genovese, 1976), these were insufficient checks from the perspective of enslavers fully internalizing the costs imposed on enslaved people. There was a general rule that work on Sundays was forbidden, which reflected practical limits to what enslavers could extract. If work was required on Sunday, Louisiana law stated that "slaves are entitled to the produce of their labor on Sunday; even the master is bound to remunerate them [the enslaved], if he employs them" (Genovese 1976, p. 315). Extreme mistreatment of enslaved people was also limited by the market itself, particularly the rising prices of enslaved people. One enslaver in 1849 noted "The time has been that the farmer could kill up and wear out one Negro and buy another; but it is not so now. Negroes are too high in proportion to the price of cotton, and it behooves those who own them to make them last as long as possible" (Stampp 1956, pp. 81). Indeed, the Alabama agricultural society noted that attention to crop yields was related to enslaved people being overworked, with excess mortality and infant mortality explicitly noted (Stampp, 1956). This check on extreme work reflects limits comparable to the use of a machine or mule that might break down, rather than additional costs borne by the machine or animal itself.

Enslavement extended far beyond a labor relationship to impact every feature of enslaved peoples' lives. The typical plantation was not a farm business as much as a combined agricultural and socially policed operation (Stampp, 1956; Blassingame, 1972; Genovese, 1976; Baptist, 2014; Rosenthal, 2018). The enslaved were constantly monitored and counted daily, enslaved individuals were to have as little contact as possible with free Blacks, could not work without direct approval, and had to obey strict requirements on conduct at all times. The nature of the autonomous and isolated plantation severely limited the social lives of the enslaved. Religious songs with hopeful aspirations have been elevated in the narrative, highlighting hopes for freedom and an end to misery, but songs also featured family breakup and violence at the hands of enslavers (Levine, 2007). Enslavers encouraged Christian practices among the enslaved, but religious practices were overseen by enslavers to maintain control (Franklin and Higginbotham, 1947; Genovese, 1976; Levine, 2007; Jones, 1985), and

the post-emancipation ability to organize freely and worship without white supervision was a critical and highly-valued component in early post-emancipation life (Sernett, 1999).

Enslavement substantially disrupted enslaved peoples' family form, function, and relationships (Gutman, 1976; Frazier, 1939). Characterizations have varied on the rates of family breakup, bans on legal acknowledgement of relationships, and enslaver control over intimate family behavior have varied (Franklin and Higginbotham, 1947; Fogel and Engerman, 1974; Pritchett and Logan, 2018), but such relations were manipulated for the purpose of labor coercion. After the Civil War, the narrative record describes formerly enslaved people searching for family members separated by enslavers (Litwack, 1979; Foner, 1988; Gutman, 1976). Emancipation and the ability to form and manage households of one's choosing, along with the free agency to manage daily mundane tasks, was highly valued in these WPA narratives, contemporaneous slave narratives, interviews, and media reports. The coercion under enslavement that existed outside of work times was necessary to ensure labor coercion. During enslavement, the two were related and inseparable in forming a culture and social relations which governed plantation life (Genovese, 1976; Stampp, 1956; Blassingame, 1972; Jones, 1985).

Slavery treated enslaved people, and even their biological products such as breastmilk, as commodities or capital that were traded and used within that market system (Berry, 2017; Jones-Rogers, 2019). Enslavers' accounting practices even formed the basis of modern accounting methods (Rosenthal, 2018), but from the narrow perspective of enslavers' profit maximization. The consideration of aggregate productivity under enslavement, and the impacts of emancipation, requires a different accounting of the costs imposed on enslaved people than that considered by enslavers in making their production decisions. While enslaved people were treated like capital, the costs imposed on them are distinct from the costs of using capital goods. These further costs of enslavement are well-known in the historical record, but have been neglected in considering their implications for aggregate productivity growth after emancipation.

Forms of coercion on plantations were numerous. While there were incentive systems on plantations (Fogel and Engerman, 1974), incentives were substantively rarer than punishments (Gutman, 1975). The fear of punishment is also costly, and induces more-than-optimal effort even when punishment is not applied in equilibrium. Steckel (1986a) estimates mortality rates for enslaved people that are inconsistent with "benevolent" slavery, and further showed that enslaved children were very malnourished (Steckel, 1986b). Slave narratives further detail forms of physical, emotional, and sexual abuse that came to define the American enslavement experience.

This does not imply that enslavers used violence "irrationally" or excessively from their

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own private perspective; rather, it may pay an enslaver to coerce someone into higher production, which lowers the enslaved person's health and life expectancy. Enslavers used whippings to punish adultery and discourage divorce (Stampp, 1956; Fogel and Engerman, 1974; Franklin and Higginbotham, 1947), but it would not follow this tradeoff is socially optimal. Similarly, emancipation could even reduce the material well-being of Black people (DeCanio, 1974; Downs, 2012), but caloric intake or consumption along particular dimensions is not what people optimize for themselves. Even if there was a post-emancipation increase in drunkenness, or buying of "frivolous things," there was a sharp dividing line between freedom and slavery for emancipated people (Gutman 1976, pp. 136-7).

The lives of enslaved women are particularly illustrative of coercion under enslavement and the impacts of emancipation. Enslaved women worked in the fields up to the week of the birth of their children, and were returned to the fields less than a month later (Fogel and Engerman, 1977). Relatedly, the infant and child mortality of enslaved children was particularly pronounced, with infant mortality twice the national rate and remaining at that level until age 10 (Steckel, 1986a). The coercion of enslaved women included sexual exploitation, which extended also to enslaved men (Foster, 2019). Even after giving birth, enslaved women found their biological products marketed for consumption as wet nurses (Jones-Rogers, 2019).

Labor force participation then declined considerably after emancipation, particularly for Black women. By hours worked, the decline was between 40% and 55% for Black women, while for Black men the declines were 15% to 20% (Ransom and Sutch, 1977). Even with the promise of contractually higher earnings for greater productivity, emancipated people were generally vigilant in protecting their leisure time, particular time away from the fields for women and children (Litwack, 1979). This is consistent with a significant decline in excessive labor effort due to enslavement and coercion.

The decline in labor force participation was not entirely spent in leisure, however. A significant reallocation was made to household work and childcare, particularly by Black women, as these tasks which had been centralized and/or discouraged on large plantations. Black women themselves advocated for this time, and some labor contracts after emancipation would explicit note household tasks that women were to perform and not expected to provide labor outside of the household during those times (Litwack, 1979; Jones, 1985). Forcing these women into the labor force would increase measured market output, but decrease aggregate output relative to input costs as valued by them. A similar argument can be made for children, who would be forced out of school and into the labor market.

This formulation of the productivity gain due to the end of enslavement in the United States is consistent with neoclassical arguments against slavery. Since Adam Smith, economists

maintained that enslaved labor would not be as productive as free labor. Indeed, reductions in serfdom may have improved incentives such that output increased (Markevich and Zhuravskaya, 2018). The high levels of output per capita of American slavery brought this long-held view under question. We contend that Adam Smith is ultimately correct, but for different reasons. Enslaved people in the United States were coerced to produce more output than free people, but the costs imposed on enslaved people ultimately exceeded the increase in marginal output. Enslavement in the United States primarily distorted the incentives of workers such that the marginal cost of labor far exceeded the marginal benefit, rather than enslavement reducing the incentives of enslaved people to work.

IV   Conclusion

The substantial increase in aggregate productivity from emancipation is important to highlight for several discussions. First, focusing on the cost incurred by enslaved people shifts the perspective that economic historians have taken to characterize enslavement in the United States. Second, the experience of American enslavement highlights how aggregate productivity growth can be substantively influenced by the inefficiencies in input allocation. Aggregate productivity increases when economic activity expands in places where market distortions have reduced input-use below efficient levels (e.g., Hornbeck and Rotemberg, 2022), and American slavery illustrates the opposite case in which market distortions induce input-use much above efficient levels and so reductions in input-use increase aggregate productivity. We discuss a similar case of climate change, with carbon emissions imposing social costs, but show that the aggregate productivity gains of emancipation substantially exceed the gains from eliminating carbon emissions. This approach can be applied to a wide range of settings to consider aggregate productivity effects when input-use is distorted from optimal levels.

We also reconsider American enslavement because of its foundational importance in characterizing the economic, social, and political development of the United States. Emancipation provided the largest aggregate productivity gain in American history, which arose not from technological innovation or economic policy but war and political change that ended chattel bondage. This fundamentally changes the implications of the Civil War and characterizations of Southern economic decline and its subsequent convergence. Output declined in the South, and later converged, but the costs to many people declined so substantially that this output decline itself represents a miraculous growth in aggregate productivity and the beginning of a new age in the American economy.

Free markets can be subject to a variety of distortions that reduce efficiency, but free labor markets avoid the fundamental distortion of imposing costs on coerced workers far beyond the value they produce. This episode highlights how the lack of agency among workers

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can induce substantial distortions. For slavery to be morally wrong and destructive to social welfare, but economically efficient and productive, it would imply that economic efficiency and productivity have no meaningful connection to welfare and morality. Efficiency and productivity from enslavers' perspective are not particularly meaningful concepts when divorced from the costs imposed on enslaved people and the resulting implications for aggregate efficiency and aggregate productivity. Instead, economic transactions based on voluntary labor market transactions launched aggregate productivity growth in the United States.

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