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Essays on the Economic History of Slavery

by

Chad Dacus

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APPROVED, THESIS COMMITTEE:

Robin C. Sickles, Chair
Professor of Economics

Bryan W. Brown
Professor of Economics

Rick K. Wilson
Professor of Political Science

HOUSTON, TEXAS

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Abstract

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In the first chapter of this dissertation, rates of return derived from the institution of slavery are adjusted for risk and compared with other antebellum investments through the directional distance function. Since multiple investments often occupy the efficient frontier, bootstrap confidence intervals of the directional distances fail to indicate a statistically significant difference between the investments unless one choice dominates in both risk and return or more restrictive assumptions concerning the relationship between risk and rate of return are adopted. Through the use of super-efficiency scores, we find that the institution of slavery outperformed the other investments for the periods 1830-1835 and 1848-1860, but slavery did not perform as well as the other investments during the severe economic downturn following the Panic of 1837. We conclude that the institution of slavery was a superior antebellum investment but was more cyclical than other investments.

In the second chapter, the number of bidders in New Orleans slave auctions is estimated by period. Auctions were legally required in New Orleans estate sales during the 1800s. Since records of slave transactions were carefully documented, we are afforded the opportunity to test whether the number of bidders increased or decreased
during this period using well-developed empirical methods. Auction theory tells us that the winning bid in a private-value auction will increase if an additional bidder is added. Therefore, if the number of bidders increased between 1840 and 1860, this would suggest that westward expansion was influential in the increase in average price of slaves during the same period. If the number of bidders decreased, the only remaining argument would be that slaves were simply becoming more valuable assets. We find that the number of bidders did not increase over the period, so we can argue that slaves were becoming more valuable and that the increase in price was not merely a frontier effect that could not be sustained. Our results fortify the conclusion that slavery was not going to die due to economic obsolescence, and that the Civil War was a necessity to settle the future of slavery in the United States.
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My parents set high standards for me, but they always demonstrated a quiet confidence that saw me through any rough patches. I thank them for believing in me and for being such remarkable role models. I admire them.

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Preface

The primary goal of this dissertation is to utilize modern quantitative methods from finance and economics to shed new light on the economic history of slavery. For the first time, yearly rates of return realized from antebellum manufacturing enterprises are also included in the analysis to yield a more varied profile for alternative investments. Antebellum investments are systematically compared to one another using both the Sharpe index and the directional distance function (DDF) approach. This approach differs markedly from previous research in that the differing levels of risk inherent in the various antebellum investments are explicitly considered. Although more descriptive than summary rates of return, the Sharpe index uses information on the first two moments of the distribution exclusively. Meanwhile, the DDF-risk-adjusted rate of return (DDF-RAROR) approach incorporates information concerning covariance and avoids the benchmark error since it is a non-parametric approach.

DDF-RAROR identifies the efficient and inefficient investments for each period, but super-efficiency scores are necessary to choose a winner when more than one investment occupies the efficient frontier. In this context, super-efficiency algorithms allow the efficient investments to lie beyond the efficient frontier. The investment with the highest super-efficiency score overshoots the efficient frontier of the other investments by the largest amount and can be considered the best-performing investment of the period. The institution of slavery performs well, but bootstrap confidence intervals indicate that no investment dominates over the entire 31-year period. The institution of
slavery is found to be dominant during the period 1845-1860 using the Wilcoxon rank-sum test, and for 1851-1860 using bootstrap confidence intervals.

After demonstrating that the institution of slavery was a strong investment in chapter one, we examine possible causes of slavery's strength during the last half of the period in chapter two. Prices of slaves were generally increasing during this period, providing more evidence that this was not an institution in decline. We construct a data set consisting entirely of auction data in order to pursue whether westward expansion was the cause of the price increase. We estimate the number of bidders in New Orleans slave auctions for various antebellum years from a structural econometric model. The model is estimated using Laffont, Ossard, and Vuong's (1995) simulated non-linear least squares (SNLLS) method. We find that the number of bidders was generally decreasing, and maximum likelihood estimation yields similar results. The evidence indicates that westward expansion was most pronounced during the first half of the period, so this effect was not the primary driving force behind the price increase seen in the last decade before the Civil War. Overall, we find that the institution of slavery was economically healthy and its stellar performance was not being driven primarily by an unsustainable expansion of the land devoted to cotton production. These results fortify the conclusion, reached by Fogel and Engerman (1974) and others, that slavery was not a moribund institution being propped up despite its inefficiency to preserve the plantation lifestyle. The owning of slaves was a relatively profitable proposition for the majority of the antebellum period, and its end was not in sight. A political solution was required since slavery would not likely end soon due to economic stagnation.
Chapter 1

The Relative Profitability of the Institution of Slavery: 1830-1860

1.1. Introductory Comments

Although many authors have attempted to measure the rate of return of slavery in the antebellum South, a systematic ranking of investments in this period has not been undertaken. Slavery is best viewed as an institution rather than an industry, and this fact lessens the impact of any financial study. That is, some in the South were trying to save slavery more for political (states' rights, for instance) reasons than for financial reasons. Evidence of this can be seen in the vitriolic struggles over tariff policy as well as slavery. In light of this consideration (and others, see Evans, 1962), this ranking may not completely answer the question of whether slavery was going to survive in the absence of the Civil War, but it should help answer the question of whether the plantation economy was underperforming compared to other investments in both the South and North. If slavery was indeed underperforming, even the stoutest of political considerations would not have saved it for perpetuity. In this paper, we intend to investigate whether the owning of slaves was an underperforming investment through modern portfolio evaluation measures.

The outline of this chapter is as follows. In section 1.2, we discuss the availability of data and the general methodology we will utilize. Conventional methods of measuring risk-adjusted rate of return (RAROR) are presented in section 1.3. In section 1.4, the general framework of data envelopment analysis is reviewed. We critique previous estimates of rate of return on slaves and present the modifications we will employ for our
own estimates in section 1.5. The historical setting for this research effort and its implications for the financial instruments in our comparison set are introduced in section 1.6. In sections 1.7 and 1.8, we discuss antebellum manufacturing and, more specifically, the New England textile manufacturing industry. In section 1.9, we present results from a calculation of the Sharpe ratio for each investment. In section 1.10, we develop the directional distance function, explain our estimation technique, and present the results of statistical tests based on the estimation. Data envelopment analysis (DEA) bootstrapping methodology and results are exposed in section 1.11. The theory of calculating super-efficiency scores and our associated empirical results are discussed in section 1.12. Section 1.13 concludes and provides transition to chapter 2.

1.2. Discussion of the Comparison Set and Methods of Analysis

We must first determine how we will rank the investments of the period. The primary consideration in answering this question is the availability of data for the various types of investments. Data on manufacturing concerns is quite limited since earnings records for closely-held firms are generally unavailable (Martin, 1898). However, it is possible to obtain rates of return on a variety of financial assets such as sixty- and ninety-day bills. In addition, we can obtain records concerning the rates of return of commercial money issued during this period. Finally, we possess rates of return for selected New England textile manufacturing stocks. Since textile manufacturing is the only industry for which we have a reasonably accurate and complete set of returns, we will evaluate whether these returns are representative of the antebellum period.

The question becomes how to compare physical assets and financial assets in risk-return terms. An obvious choice would be to utilize measures of the performance of
financial assets, except that relative liquidity of the physical asset versus the financial assets can become a major concern. Stated differently, the physical asset may be much more difficult to resell, so the investor may feel much more 'locked in' with regard to an investment in a physical asset. In that case, any meaningful comparison of risk is elusive. This is not much of a concern in the case of slaves. Since the importation of slaves was banned in 1808, an active secondary market is a given. In fact, Kotlikoff (1979) states that more than 135,000 slaves were sold between 1804 and 1862 in New Orleans. Furthermore, it is a certainty that financial markets were not as liquid in the 1800s as they are today. Gross discrepancies in the liquidities of the assets under discussion are unlikely, but some discrepancy here is unavoidable. Markets were simply not as efficient almost 150 years ago as they are today. However, the inefficiency of a market does not render modern financial ratios uninformative because the purpose of the analysis is comparison of investments rather than arriving at an informative measure in absolute terms. It is far from a settled fact that today's markets are efficient, and that does not stop the prevalent use of modern financial ratios based on benchmarks. Since we have concluded that we should treat all of the investments in the comparison set as financial instruments, we must determine whether to utilize measures based on fixed-income investments or stock-based investments.

Since the majority of the instruments in our comparison universe are fixed-income instruments, this would appear to be an appealing choice. However, slaves and their output definitely were not fixed-income physical assets. Although this mode of analysis would be helpful in analyzing the majority of the comparison set, the entire
purpose of this paper is to evaluate investment in slaves versus other representative investments of the day. Clearly, fixed-income analysis is implausible.

The only plausible manner in which to analyze these diverse assets is through the use of modern stock-portfolio measures. Risk-adjusted rate of return (RAROR) is the dominant methodology for analysis of a stock's performance. Although this approach is not without its issues when used for such diverse assets, this is the only realistic option for what we would like to accomplish. Applying the RAROR approach, we are able to evaluate both the rate of return to slavery and its attendant risks - placing proper weight on each. In addition, we will be able to construct a ranking of some of the investments available during the period compared to investment in slaves. Therefore, we should now turn our attention to the various measures of RAROR and which of these measures might be appropriate for the scant data we have at hand.

1.3. Conventional Measures of RAROR and Their Relevance for the 1800s

The most commonly utilized measure of risk-adjusted return is the Sharpe ratio (Sharpe, 1966). The Sharpe ratio has the advantage of being exceptionally easy to calculate and interpret:

\[
\text{Sharpe ratio} = \frac{(\bar{r}_i - r_f)}{\sigma_i} = \frac{\text{average excess return of asset}}{\text{std. deviation of asset's excess return}}
\]

The only two informational requirements here are historical returns of the asset, the \( r_b \), and the risk-free rate of return, \( r_f \). As one might imagine, we already run into trouble using the ratio in the 1800s because of the lack of a remotely risk-free security. Modern-day Treasury bills did not exist during this time period. As Officer (2005) reveals, federal funds series are available beginning in 1855. Data is available on ten-year Treasury bonds for antebellum years except for the period of 1835-1842. A good
substitute rate can be found for the missing years, but the rate on these bonds cannot be considered completely risk free due to interest-rate risk alone. In order to utilize Sharpe's ratio, we can adopt the rate of return on ten-year Treasury bonds as our risk-free rate with a slight abuse of the term. Although Sharpe's ratio is problematic, we will see that it is by far the most reasonably adapted ratio to the finance of the 1830s through 1860s. We will compare the Sharpe ratio for investment in slaves to other investments of the period in section 1.9.

As has been mentioned often in the literature (for example, Simons, 1998), the Sharpe ratio lacks an intuitive interpretation for the average investor. Modigliani and Modigliani (1997) propose a measure that is closely related to the Sharpe Index but is measured as an excess return rather than excess return over standard deviation. In equation format, it is:

\[
\text{Modigliani measure} = \frac{(\bar{r}_i - r_f)\sigma_{\text{index}}}{\sigma_i} = (\text{Sharpe ratio}) \times (\text{std. dev. of index excess return}).
\]

As pointed out by Simons (1998), "the Modigliani measure is equivalent to the return the fund would have achieved if it had the same risk as the market index" (emphasis in original). This index should be a broadly-based index such as today's S&P 500. Even then, the S&P 500 is but a proxy for the market portfolio. This is a problem with almost all of the popular measures of RAROR: a broad-based index is needed. We do not have enough information to construct such an index for the period under study.

Almost all of the popular measures of RAROR are based on the capital asset pricing model (CAPM) which is given by

\[
r_i = r_f + \beta_i (r_M - r_f) + \epsilon_i + \alpha_i,
\]
where $e_i$ is a firm-specific disturbance with a mean of zero and $\alpha_i$ is the expected abnormal return (Sharpe, 1964 and Lintner, 1965). The coefficient $\beta_i$ can be thought of as the non-systematic risk of the security. That is, $\beta_i$ can be thought of as the risk that is remaining after diversification or the risk specific to the security itself as part of a diversified portfolio. This is not a plausible framework for studying the economy of the 19th century. Table 1.1 lists some of the more popular remaining RAROR measures that are based, in some way, on the CAPM. Their dependence on the CAPM will make it impossible to utilize them as meaningful measures of the risk-return relationship in the 1800s.

Table 1.1. Conventional RAROR based on the CAPM

<table>
<thead>
<tr>
<th>MEASURE</th>
<th>FORMULA</th>
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<tbody>
<tr>
<td>Jensen's alpha</td>
<td>$\alpha_i = (\bar{r}_i - r_f) - \beta_i(\bar{r}_M - r_f)$</td>
</tr>
<tr>
<td>Treynor's ratio</td>
<td>$T_i = (\bar{r}_i - r_f)/\beta_i$</td>
</tr>
<tr>
<td>Appraisal Ratio</td>
<td>$A_i = \alpha_i/\sigma(e_i)$</td>
</tr>
</tbody>
</table>

As can be seen from its formula, Jensen's alpha (Jensen, 1968) is simply a restatement of the CAPM formula with the zero-mean quantity removed. This measure brings with it all of the restrictive assumptions of the CAPM. The Treynor ratio (Treynor, 1966) is a restatement of the Sharpe ratio with a non-systematic risk term rather than the standard deviation of the firm's excess return. Meanwhile, the appraisal ratio (Treynor and Black, 1973) is simply Jensen's alpha divided by standard deviation of the firm-specific disturbance. In other words, the appraisal ratio can be thought of as Sharpe's Index under the CAPM, and Jensen's alpha is somewhat analogous to Modigliani's measure in that it
is more easily interpreted. All of these suffer from the benchmark error (Roll, 1978) and are not plausible for the present study. A reasonable market portfolio cannot be constructed with available data, much less held by an investor. For the purposes of our study, it appears as if the Sharpe ratio is the only plausible measure of investment performance from the set of conventional RAROR measures since an appropriate benchmark is not available.

Another option would be to implement selection procedures based on the entire return distribution. Sengupta (1991) and Sengupta and Park (1993) suggest such a methodology. These approaches are based on stochastic dominance and are very appealing if one has enough data to perform rigorous tests. Our dataset will consist of, at most, 31 observations for each investment. This is not likely to result in a test of sufficient power to be useful. Moreover, without such a test, these techniques are not as useful because they do not yield results that can be easily explained to those not technically trained in finance. We will utilize directional distance techniques which avoid the need for a benchmark portfolio and any distributional assumptions.

1.4. Data Envelopment Analysis Portfolio Efficiency Index (DPEI)

The most problematic feature of the conventional RAROR models is the need for a benchmark for the market portfolio. As previously discussed, this is not realistic for the period under study. Murthi et al. (1997) dispense with the need for a benchmark portfolio by developing a comparison procedure based on data envelopment analysis (DEA). In addition, transaction costs are included in this analysis.

DPEI can be specified as
\[ \text{max } DPEI = \frac{r_0}{\sum_{i=1}^{n} w_i x_i + \nu \sigma_i} \]

s.t. \( \frac{r_j}{\sum_{i=1}^{m} w_i x_i + \nu \sigma_j} \leq 1 \quad j = 1, \ldots, n. \)

In the numerator, we have the excess return of the security. In the denominator, measures of both risk and transaction costs are included.

DPEI is non-parametric (the other measures discussed so far require normality for statistical testing) and incorporates transaction costs. This is very advantageous for an actively-managed portfolio. The costs of managing the funds can easily be weighed against the benefits of this management.

Despite DPEI's important advantages over the conventional measures of RAROR, its data requirements are cumbersome for the purposes of this research effort. Transaction costs are not measurable on slave transactions, which have been taken from a secondary source. In addition, the comparison investments' transaction costs have not been explicitly measured. Our methodology in calculating directional distance will be similar to the algorithm utilized in determining DPEI.

1.5. Returns to the Institution of Slavery

Some of the more influential early works were Phillips (1929), Gray (1958), and Ramsdell (1929). These works were completed before the advent of modern econometric methods and rely primarily on anecdotal evidence. These studies are useful primarily due to their summarization of data from primary sources. In addition, their theories serve as a starting point for the works to be described in this section.
The work of Conrad and Meyer (1958) utilized basic econometric and financial tools to arrive at their estimates of the rate of return on the investment in slaves. Their methodology is intuitively appealing because they start from the first principle of a production function. We begin with the presumption that their methodology should be employed, and we will abandon that assumption only if it can be shown that the problems inherent in the analysis cannot be overcome with the available data.

The first problem with Conrad and Meyer’s work is that they assume that all slaves realized the median life expectancy. As discussed by Evans (1962), this causes their return estimates to be too high due to the high number of slave children who did not live to maturity. An obvious solution here is to more carefully consider the demographic data for death rates before maturity. While exact mortality results are not available, this shortcoming can be largely alleviated. Conrad and Meyer also assume that slaves are sold at precisely the age of eighteen. The authors implicitly assume the existence of ‘breeding states’ by relying solely on demographic data to reach this conclusion. As Fogel and Engerman (1974a) point out, differing demographics for the Old South in comparison to the New South do not make for a convincing argument of systematic intervention in the reproduction of slaves; it would be much better to produce actual bills of sale indicating movement of slaves from plantations in the Old South to those in the New South. Since such records do not exist in the quantity needed, it remains unclear whether such intervention was a major factor in Old South profits.

A more troublesome aspect of Conrad and Meyer’s research is their estimation of land costs. One would expect much different returns from poor land in Alabama compared to prime cleared land in Mississippi. This leads to an estimate of land costs of
between $90 and $1,400 per hand. Such a wide range of possibilities is unacceptable for econometric purposes. The authors state that the vast majority of costs were bracketed by the costs of $180 and $600, but, in the end they state that 'a typical case' involved a land investment of $450 per hand without justifying their estimate through econometric analysis. The great variation in land costs leads one to suggest the alternative of sampling representative plantations to determine rates of return. This reveals the primary difficulty in Conrad and Meyer's approach: such records do not exist for enough individual plantations to allow for a systematic study. In addition, as detailed in Fogel and Engerman (1974), Conrad and Meyer also had difficulties in estimating the costs of capital such as plows, gins, and wagons.

Estimating the productivity of slaves is another major concern. Fogel and Engerman (1974) assert that Conrad and Meyer's productivity estimates are too low. It is difficult to see that this criticism is warranted because Conrad and Meyer estimate the rate of return throughout a wide range of productivities.¹ In any case, the rates of return could be easily adjusted with an accurate estimation of productivity. It is not clear which estimate of productivity should be chosen; this is another concern that would be alleviated with an investigation of individual plantations instead of attempting to generalize to a level that is not justified by the available data.

Although Conrad and Meyer's methodology is intuitively appealing, we find too many difficulties in estimation due to the dearth of quality data. The analysis should be undertaken with a focus on individual plantations, but this is not possible with existing information. A different approach will be necessary.

¹ Productivities ranged from 3.75 bales per hand to 7 bales per hand. However, Conrad and Meyer adjusted the cost of capital according to productivity. This is likely the source of Fogel and Engerman's discontent.
Evans (1962) approaches the issue of the profitability of slavery through an entirely different mode of analysis. He utilizes the rates of hire for slaves as the revenue-producing activity of slaves and thus avoids many of the issues Conrad and Meyer faced. However, Evans's analysis is not without its own limitations. For example, Butlin (1971) pointed out a couple of important concerns. First, it is unclear whether the hires Evans found were representative of the time period. Second, Butlin indicates that it is entirely possible that the jobs slaves were required to do as hires were more dangerous than their chores on the plantation. Butlin does not clarify his first objection other than to suggest that the sample is too small. While this objection should be noted, a source of systematic bias in Evans's data has not been identified. As to the second critique, it has not been proven that hired slaves died in any greater frequency than plantation slaves other than an observation that slaves residing in cities experienced a higher mortality rate than those living in rural locations. More importantly, liability for the death would have to be established and financial responsibility assessed. It is mere speculation to state that risk (for slaveowners) was increased by the hiring of slaves; no data has been found to support this proposition.

The remaining concerns with Evans's methodology can be easily taken into account. Fogel and Engerman (1974a) found that brokers' fees had not been subtracted from the hiring fee. Although brokers' fees were standard at 7.5%, it is unclear what percentage of the transactions was carried out through the use of a broker. Fogel and Engerman (1974) state that these transactions were most commonly arranged through personal contact between lessee and lessor. In addition, Butlin (1971) suggested that it is unreasonable to assume that slaves would be immediately hired by a willing lessor.
Butlin's argument assumes that slaves were idle unless rented. While this may be the case for people who inherited a small number of slaves, for example, it is not likely to be true in the vast majority of rental arrangements. We impose a waiting period of 30 days for 20% of the rented slaves to allow for the marketing of slaves available for rent. Since transaction costs are unavailable for the other investments in the comparison set, and the fact that a transaction cost was not incurred for many slave rentals, we omit transaction costs from the analysis. If there is any effect due to omitting these costs, it likely results in the understatement of slave returns relative to the other investments.

Fogel and Engerman (1976) have constructed a sample of slave hires for the period 1775-1862. Their data consists of a convenience sample of over 20,000 slave hire transactions taken from probate records from various locations around the southern United States. However, the age(s) of the slave(s) being hired is(are) completely unavailable for the period 1830-1839. Furthermore, ages are not commonly reported for the years following 1839. Many slave hires are quoted at purely nominal and even negative rates. While these transactions may well be valid, this phenomenon begs the question whether these hires were carried out primarily to transfer legal responsibility or essentially constituted gifts. Even if neither one of these possibilities is correct, slaves rented for negative rates could not be characterized as in any way representative of the slave population. For these transactions, ages are absolutely vital and seldom available. If one removes slave hire transactions in which a purely nominal fee is charged for rent\(^2\) and all slave rentals in which age was not reported, the effective sample is far less than that of Evans. This renders a careful demographic study impossible, so Evans's carefully

\(^2\) Nominal is defined as less than one percent of the average price of a slave in the year the rental took place.
constructed sample is preferred since Evans chose a specific demographic group for inclusion in his sample. Indeed, Evans gathered his sample by searching a vast number of secondary sources. While his sample is admittedly nonrandom, Fogel and Engerman's sample is also a convenience sample, so it is with little reservation that we choose to work with Evans's sample.

A final concern with Evans's work is the exclusion of the demographic information of slaves during the period. That is, Evans considers the rate of return on a prime field hand which does not represent, in any meaningful sense, the rate of return the owner of a plantation of slaves might realize. One must include slaves of extreme young and old age in determining the average rate of return.³ Since such demographic information is readily available (see Conrad and Meyer), this is not a substantive criticism for our purposes and will necessitate a simple recalculation of Evans's return estimates. Evans states that his rental rates are based on a relatively healthy, but unskilled, adult male. This necessitates further adjustments. We now turn our attention to the specific adjustments to Evans's rates adopted for this study.

We construct a 'representative' plantation. First, we account for slave demographics. Given the high fertility rate of North American slaves and their low life expectancy during the antebellum period, a large proportion of the slave population was of young age. Based on this demographic information, we estimate that 50% of slaves were readily marketable in the rental market. We derive this estimate by concluding that slaves between the ages of 15 and 50 were marketable for rental. We assume that the return on the rest of the slave population is zero. Conrad and Meyer conclude that a slave

³ We include this demographic information in our analyses and employ the cost estimates of slaves of both young and old age from Conrad and Meyer (1958).
over the age of eight was productive enough to be profitable. However, the younger ages between birth and age fifteen were probably more heavily represented due to the arguments above, so the slaves in the youngest age group most likely resulted in a net loss. However, based on the limited data available from Fogel and Engerman's slave hire sample (Fogel and Engerman, 1976), slaves above the age of 50 were rented occasionally for non-trivial amounts. It is likely that the slaveowner realized a small profit from these slaves. We omit pregnant females from the analysis, since it would be quite difficult to quantify. On balance, we believe the entire non-rental population of slaves produced as much as they consumed. Each gender compromises half of the participants in the rental market. We set the rental rate for healthy, unskilled adult females to be below the sales premium for males relative to females at 75% of the male rate.

A significant number of slaves possessed skills that would allow a higher rental rate to be set for their services. We select professions thought likely to be sought by prospective slave renters. Through the demographic tables in Evans (1962) and the research of Fogel and Engerman (1974), we estimate that 12% of adult male slaves were engaged in these occupations. We estimate a 20% higher rental rate for these skilled slaves. We estimate mortality based on the work of Evans and assume deaths occurred at mid-year, but the effect is quite small because cost savings would be realized on the group of slaves who were not marketable for rental.

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4 This adjustment is made since the likelihood of reproduction would not be considered for rental rates but would be an important factor in setting the sales price.
5 Occupations selected as valuable in the rental market were coachmen, pilots and sailors, carpenters, masons and bricklayers, coopers, blacksmiths, tailors, and other mechanics.
6 The 20% premium is consistent with the higher valuation of skilled slaves in Fogel and Engerman's sample of slave sales (Fogel and Engerman, 1974).
7 Of course, we assume the rental contract was null and void when the death occurred.
In summary, the work of Evans, with appropriate modification for expenses and demographic information, provides the most compelling estimates of rates of return available. We will correct these deficiencies and utilize the data Evans employed in reaching his conclusions.

We have dealt with one portion of the return from owning slaves: rental income. To arrive at an overall return for the plantation, we must consider appreciation or depreciation in the value of the slaves. We assume slaves are purchased at the beginning of the year and sold at the end of the year. This is an admittedly inappropriate assumption for such a long-term investment and likely results in an overstatement of the risk involved in owning a slave. We must pay a price for this simplified framework, but the overstatement of the risk is mitigated for the comparison period as a whole because price changes are tracked over three years. However, risk is overstated because the price change over the individual year is used to calculate the variance in rates of return. Two sources of information on slave prices are primarily used in the literature: the samples of Fogel and Engerman (2000) and Phillips (1929). Fogel and Engerman's collection is far more extensive, consisting of 76,785 slave sales between 1804 and 1862. Their records are taken from an admittedly non-random sample of notarial acts involving the sale of a slave(s) in New Orleans. As seen in Figure 2.1 on page 70, this data set has a fair degree of yearly variability in the mean. Since we assume yearly purchasing and selling, we feel that this leads to an overstatement of the true risk taken on by slaveowners. However, since this data set is so large, we will conduct the analyses using Fogel and Engerman's sample as one of our frames of reference. As discussed in Evans (1962), Phillips's estimates are based on bills of sale for over 3,000 slaves over a period of years. Bills of
sale rarely revealed desirable information for the purposes of constructing an econometric model, such as age, gender, and skills. He typically selected bills arising from the sale of adult males which makes it more likely that Phillips's sample consisting largely of the sales of prime field hands. While this is a consequential limitation of his sample, it could be of use for our purposes. Referring once again to Figure 2.1, Phillips's estimates of the mean price of slaves in a given year, while clearly too high for the population of slaves as a whole, trace roughly the same trends as found in Fogel and Engerman's sample. For our purposes, the level of prices is not as important as the trend, so Phillips's results still have value to us. We also report our results for Phillips's sample, but we grant the inherent problems involved with them and present them as an upper bound. We feel that the true risk involved in holding slaves is best represented by a compromise between the two samples. The reader should bear this in mind.

The rates of return for the institution of slavery from Evans and this study are compared in Appendix Table A.1. Evans's rates of return in the table represent the average of his Upper and Lower South estimates. It is unclear why the rates of return from the present study differ so markedly from those of Evans in some periods. The most logical reasons for Evans's higher rates of return for 1836-1840 and 1841-1846 are that Evans chose a three-year period between the purchase and sale of the slave and that Evans had more optimistic assumptions regarding the rental value of older slaves. We were unable to reproduce Evans's rates of return for these periods. The two frameworks return similar estimates of profitability for the other periods.
1.6. Historical Context and Comparison Set

The returns reported and compared in this chapter were realized during a chaotic period of American history. Consequently, no individual financial security or group of securities provides a consistently acceptable index of the going rate of interest during the antebellum period. An in-depth examination of the historical context in which investors made decisions during the antebellum period will inform our decisions concerning the comparison set of investments and allow for greater appreciation of the results of our analyses. We will discuss economic conditions and developments in a chronological fashion with primary emphasis on particularly tumultuous or otherwise exceptional periods.

Rates of interest in the United States have been heavily influenced by English laws and customs. During the pre-colonial period, English usury laws capped interest rates on public loans at no more than six percent. This precedent clearly informed the usury laws in the colonies, since most states set the usury rate at six percent. Rates on United States Treasury bonds and New England municipal bonds never exceeded six percent between 1830 and 1860. However, technical violations of the law occurred because usury laws are generally enforced through legal action on the behalf of debtors. Commercial enterprises are decidedly unlikely to avail themselves of relief on their debts due to the need to maintain creditworthiness for future borrowing. Indeed, Boston commercial paper and New York bills often deviated from the six percent tradition during the antebellum period. Since the returns from these interest-bearing instruments dominated those of securities with longer terms throughout the period, they were

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8 The usury rate on public loans was five percent except during the reign of Queen Anne (Homer and Sylla, 1996).
included in this study's comparison set. While opportunities for realizing a rate of return above six percent via a financial instrument were limited, they were far from completely unavailable.

A few other customs warrant mentioning to set the background. During this period, banks customarily suspended specie payments in response to financial crises to prevent panic. In areas other than usury, laws generally favored creditors. Finally, during periods of low activity by the Federal Treasury, other banks would exert themselves through issuing currency. Just as in modern times, the Treasury was able to exert influence over the money supply without the influence of a central bank, but the Treasury was sometimes passive during this period due to political reasons. Appendix Table A.2 summarizes the major historical events occurring during the period 1830-1860.

The first half of the decade of the 1830s was marked by the unprecedented growth of public spending on internal improvements. While private investors were the primary catalyst for public improvements in England, public and private entities combined to sponsor the projects in the United States. It is a matter of some contention among economic historians whether private operators extracted special favors and subsidies from governments or the scale of the investment required was too massive for private concerns to cover. This government participation was to prove costly later in the decade.

The new construction of roads, canals, steamboats, and railroads was pronounced during this period. Intercity toll roads called turnpikes were largely funded by private firms. Over $25 million in private capital was invested in turnpike construction

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9 Readers interested in learning more about the disagreement should consult Goodrich (1960) and Hurst (1969).

10 Pennsylvania was a notable exception, but the state's investment accounted for only about 30 percent of the total spent in the state.
(Fishlow, 1972). Tolls were regulated and turnpikes were dominated by canals and later by railroads. Profits were disappointing; Fishlow estimated rates of return between three and four percent.

Canal building provided the impetus for the formation of the first cooperative enterprises comprised of governments and private concerns. Goodrich, Cranmer, Rubin, and Segal (1961) estimated that investment on canal construction projects during the period 1815-1844 was $31 million with over 70 percent provided by governments. Between 1844 and 1860, another $66 million was spent with the majority funded by the public. The success of the Erie Canal in driving down freight costs spurred other states to follow with their own canal-building projects. States as far west as Ohio spent in excess of $1 million on canal construction. Despite early success, canals were eventually rendered virtually obsolete by rail transportation.

Railroad construction in the United States began, in earnest, in the 1830s. Southern governments participated in railroad construction much more than their northern counterparts, as they accounted for about 50% of total expenditure versus as little as 10% in the North and Midwest (Fishlow, 1972). A reasonable interpretation of this disparity is that private enterprises anticipated a less profitable enterprise in the South. The distribution of public versus private investment across these transportation improvements, and the eventual domination of commercial and industrial transit by the railroads, suggest the private sector made sound long-range decisions while governments spent in ways that, in retrospect, were short-sighted. Events later in the decade would provide swift feedback on these decisions.
The Panic of 1837 merits special attention due to its profound effect on investments sensitive to the business cycle. During the first half of the 1830s, two efforts culminated that would play important roles in the tumult of the later half of the decade. The first was the gradual paying off of the Federal debt during the presidency of Andrew Jackson. Rates increased upon the retirement of the debt in 1835, as investors moved their money into slightly riskier securities. No long-term federal issues were offered in the years 1835 through 1841. The second effort was Jackson's successful endeavor to close the Second Bank of the United States. The Bank, a private enterprise, was prosperous when Jackson was elected, but Jackson raised concerns that the Bank was unconstitutional and favored its dissolution for personal reasons. The Bank's president, Andrew Biddle, tried unsuccessfully to obtain Jackson's support for rechartering the Bank and then obtained the support of Jackson's opponent in the 1832 presidential election, Henry Clay. Jackson won a decisive victory and immediately began withdrawing federal funds from the Bank. The end result of the Bank's closing was an upturn in inflation, as other banks increased their note issues and capital poured in from foreign speculators. In response to the devaluation of bank notes, the Specie Circular Act of 1836 required property buyers to submit payment in specie rather than bank notes. It is unclear that this played a major role in creating the Panic, but the relative lack of faith in the currency could not have improved stability.

The primary causes of the Panic are thought to be the bursting of a "credit bubble" resulting from the withdrawal of English funds from U.S. banks, crop failures in 1835

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11 The three investments to be included in the comparison set later in the chapter that were less sensitive to business cycles outperformed the institution of slavery and textile manufacturing only during the years affected by the Panic.

12 The deficits caused by the Panic of 1837 were financed entirely by short-term notes.
and 1837, and a fall in the price of cotton (Homer and Sylla, 1996). The Bank of England raised its deposit rate and successfully stemmed the flow of funds to the United States. As a result, security prices fell and banks suspended specie payments. Banks collapsed, and notes and deposits fell in excess of the fall in prices. The economy did not fully recover until 1845.

With a change in presidents, the Treasury began issuing long-term bonds in 1842. This series offered a higher return than previous offerings, but the strength of the bond returns was short-lived, with yields falling to around five percent between 1843 and 1845. The Mexican War of 1846-1848 brought new long-term loans, and yields spiked during this period with a high around 5.77% in 1847. By 1850, yields had returned to levels comparable to those before the Panic, and they were stable until 1860.

The economy of the latter half of the 1840s was marked by important developments both domestically and abroad. The English economy was beset by a panic in 1847 due to crop failures and a reversal in railroad speculation. Meanwhile, in the United States, the California gold rush ushered in a period of prosperity. After the Panic of 1837, banks had been rebuilt on a firm foundation, and banking expanded in the latter half of the 1840s. Railroads were constructed at over twice the pace of that during the first half of the decade, and the demand for land was strong. Sectors of the economy particularly sensitive to fluctuations in the English economy, such as textiles, did not perform well during this period. However, the overall economy was strong and prices rose. With the exception of a brief stock market panic in 1854, the economic expansion continued until 1857.
The Panic of 1857 was a relatively brief economic downturn caused by the reversal of railroad speculation, the removal of funds from the U.S. market by English investors, and a collapse in grain prices due to the end of the Crimean War. Fourteen railroads went bankrupt, and banks again suspended specie payments. Short-term interest rates decreased markedly at the end of the decade, but otherwise the rates of returns on the investments chosen for this study did not appear to be adversely affected by the downturn.

In summary, the U.S. economy of the antebellum period can be divided into four periods: 1830-1836, 1837-1844, 1845-1856, and 1857-1860. The economy was robust during the first and third of these time windows, while economic setbacks characterized the other two periods. The Panic of 1837 brought about one of the worst stints in U.S. economic history, and the rates of return for industries sensitive to the business cycle were exceptionally low. This should be kept in mind as we present our results later in the chapter. Meanwhile, the Panic of 1857 was relatively mild in comparison and reflects a more typical downturn by historical standards.

1.7. Antebellum Manufacturing

Fogel and Engerman (1974) conclude that the owning of slaves was a profitable investment and, indeed, that the institution of slavery was far from moribund given the relative sanguinity of antebellum cotton farmers. In order to test their hypothesis, it is necessary to compare the rates of return associated with slavery to those of other investments with similar risk. Unfortunately, the great majority of available data from the antebellum period consists of rates of return for financial instruments such as bonds.

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13 The reduction in British government spending resulting from the end of the Crimean War may have also played a role (Hughes and Cain, 1998).
In terms of risk profile, these types of investments are unlikely to be comparable in any meaningful sense. If these are the only investments included in the comparison set, we will be left with an incomplete view of the relative profitability of the institution of slavery. The most obvious way to combat this critique is to include the rates of return of pre-Civil War manufacturing concerns. This study marks the first time a sampling of manufacturing returns from the antebellum period are systematically compared with those realized from the slave trade.

The most credible manufacturing rates of return available are for a sample of New England textile manufacturers. The natural question arises whether these returns are likely higher or lower than those for southern manufacturers as a whole. We start by examining the southern manufacturing environment of the antebellum period to compare the relative profitability of southern and northern firms. We then turn our attention to examining how the sample and associated rates of return were chosen, and we then proceed to attempt to establish whether these returns were typical of northern manufacturing firms. Through this process, we will be able to assess whether rates of return on slave labor were competitive with those of alternative investments available to southern slaveowners.

Even though southern growth rates between 1840 and 1860 were comparable to other regions of the United States (Fogel and Engerman, 1974), southern per capita income lagged behind the North. Manufacturing "backwardness" was asserted by numerous sources. A wide variety of explanations, both reasonable and far-fetched, were advanced for the South's relatively moribund industrial environment.\textsuperscript{14} For example,

\textsuperscript{14} The interested reader should consult Clark (1909) and Genovese (1965) for a more generous sampling of claims.
Genovese (1965) claimed that "slavery so limited the purchasing power of the South that it could not sustain industry." Indeed, southern manufacturing was quite limited compared to northern standards, but we must draw conclusions based on more than anecdotal evidence.

According to the 1860 Census, the South accounted for only 11% of U.S. manufacturing despite containing about one-third of the U.S. population. Virginia was a notable exception, producing gross manufacturing output that placed it fourth to New York, Pennsylvania, and Massachusetts. However, Virginia's manufacturing per capita was not among the leaders. Even in cotton manufacturing, the South produced 10% of total output by 1850. Furthermore, southern manufacturing growth between 1850 and 1860 was strong enough to keep the region's percentage of overall manufacturing output steady at about 10-11% of total U.S. manufacturing output. In 1860, the total manufacturing output of the South was less than that for New York, Pennsylvania, and Massachusetts alone (Bateman, Foust, and Weiss, 1975). The South lagged far behind the northern and middle states, but so did the western states and the rest of the world other than England.\(^{15}\) By fraction of total output, the most important manufacturing products of the South were flour and corn meal, cotton goods, and machinery.

Rather than endeavoring to explain southern backwardness in manufacturing, we will focus our attention on rates of return for southern firms. From a sample of firms collected from U.S. Census data for 1850 and 1860, Bateman, Foust, and Weiss (1975) estimate rates of return for southern manufacturing concerns far in excess of those realized by northern firms. They state that the average rate of return for firms included in

\(^{15}\) From the Census of 1870, the middle states accounted for 43% of U.S. manufacturing output in 1860 compared to 25%, 18%, 10%, and 4% for New England, the West, the South, and the Pacific states, respectively.
their samples was 25% in 1850 and 28% in 1860. These rates are over five percent higher than comparable rates for northern manufacturing concerns during the same years.

Bateman, Foust, and Weiss state that they have not included the owners' implicit wages in their calculation and admit that this causes upward bias in their reported rates. They go on to state that these costs were unavailable in the 1860 Census and would need to be estimated. Such as estimation, they assert, would rest on questionable grounds. They counter the suggestion that these implicit costs should be included by stating that many of these owners did not realize the majority of their income from manufacturing. Since these investors were primarily farmers, Bateman, Foust, and Weiss assert that the error arising from not including their implicit wages is minor. With returns from manufacturing outstripping those realized from agriculture, this begs a fundamental question. Why would these investors, who would be inarguably well-informed about the relative rates of return they were receiving from their various investments, fail to expand their more remunerative manufacturing enterprises? The implications of their argument are clear: even when presented clear evidence of the superiority of investing in manufacturing concerns, southern investors behaved irrationally to prop up the institution of slavery. This unintuitive explanation motivated researchers to investigate both their methodology and conclusions.

Vedder and Gallaway (1980) criticized Bateman, Foust, and Weiss's findings on two major grounds. First, Bateman, Foust, and Weiss used unweighted averages to arrive at both the industry and overall means. The use of unweighted averages severely biased the results since small firms dominated southern manufacturing and were treated equally for the purposes of calculating the average return. Smaller firms, as is expected
considering risk, realized much higher average rates of return than their larger competitors. When weighted averages are used, Bateman, Foust, and Weiss's average return for 1850 declines by three percentage points even within the sub-sample of large firms. In addition, Bateman, Foust, and Weiss failed to weight the averages from different geographic areas. Accounting for this, the rate of return for large firms in Bateman, Foust, and Weiss's sample falls another three percent. Vedder and Gallaway also fault Bateman, Foust, and Weiss for investigating a relatively small sample of firms included in the Census. Bateman, Foust, and Weiss included less than five percent of the nation's Census-reporting firms in their sample. Using the entire Census-reporting population, Vedder and Gallaway arrive at an overall U.S. average of 11.5% compared to the 25% reported by Bateman, Foust, and Weiss. Including miscellaneous costs thought to be underreported in Census data, Vedder and Gallaway find the overall U.S. average to be 10.04%. Vedder and Gallaway do not investigate the impact on the same rates of return for southern firms, but it stands to reason that the impact on those rates would be similar.

Niemi (1989) built on the criticisms of Vedder and Gallaway but takes the analysis the next logical step by comparing the modified returns from the South to those of northern manufacturers. He begins by citing Bateman, Foust, and Weiss's startling returns and observing that the clear implication drawn is that market forces were being ignored to maintain the plantation culture. He notes that the vast literature on the southern economy otherwise indicated that market forces in the South were quite strong. He then identifies the perpetuation of slavery as a perfect example of the dominant influence of market forces despite competing ethical and humanitarian concerns.
Niemi then outlines the methodology he used to revise Bateman, Foust, and Weiss's estimated rates of return. Like Vedder and Gallaway, he chooses to include all Census-reporting firms in his sample. Niemi takes the criticism a step further by arguing that Bateman, Foust, and Weiss's sample is unrepresentative of the population. While 60% of the firms in the 1860 southern sample were operating in four industries, the same industries made up only four percent of Bateman, Foust, and Weiss's sample. Like Vedder and Gallaway, Niemi uses the entire population of census-reporting firms. He notes that, unlike Bateman, Foust, and Weiss, he includes firms operating in Georgia and Louisiana.

Niemi's analysis follows the same framework set up by Bateman, Foust, and Weiss, with a few notable differences. The formula used for calculating rate of return is

\[ r = \frac{Q - (R + W + M + X + D)}{K_f + K_w} \]

where
- \( Q \) = gross value of output
- \( R \) = cost of raw materials
- \( W \) = wages
- \( M \) = managerial costs
- \( X \) = miscellaneous costs
- \( D \) = depreciation
- \( K_f \) = fixed capital
- \( K_w \) = working capital

These quantities are taken directly from 1850 and 1860 census records except for managerial costs, miscellaneous costs, depreciation, and working capital. The reader will
recall that Bateman, Foust, and Weiss did not include managerial costs. Niemi estimated managerial costs for both 1850 and 1860 by assuming the ratio of managerial costs to wages remained constant between 1850 and 1890. For example, 

\[
\frac{M_{1890}}{W_{1890}} \cdot (W_{1850}) = M_{1860}
\]

where \(M\) equals managerial costs and \(W\) represents wages. Similar assumptions and formulas are used for estimating miscellaneous costs and working capital. He used Bateman, Foust, and Weiss's formula for determining depreciation. Two different formulas for estimating working capital are used, which leads to two estimates of rate of return.\(^{16}\) He notes that Bateman, Foust, and Weiss use the same method of estimation but use the ratio of working capital to the gross value of output. It is unclear which approach is more reasonable, but this difference does not appear to play an important role in the results.\(^{17}\)

Niemi estimates rates of return for twenty-two industries for the entire United States and the South using each of his two formulas for working capital. Both procedures result in very similar rates of return for the U.S. and the South. His more conservative algorithm resulted in a difference between the entire U.S. and the South of 0.3% in 1850 and 0.7% in 1860. Meanwhile, the other formula found a difference of 0.4% and 0.1% for 1850 and 1860, respectively. As can be gleaned from these small differences in rate of return, the North and South were quite comparable in profitability if not in absolute scale. Niemi's results are summarized in Tables 1.2 and 1.3.

\(^{16}\) For the first estimation of working capital, Niemi assumes the ratios of working capital to fixed capital are identical in 1850, 1860, and 1890. For the second, and more conservative, estimate, he uses the ratio of working capital to value added.

\(^{17}\) The maximum contribution of the difference in working capital on the estimated rates of return is 1.9%, and this assumes zero effect from Bateman, Foust, and Weiss's failure to weight by geographical region.
Table 1.2. Rates of Return by Region - Method 1

<table>
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<th>1850</th>
<th>1860</th>
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</thead>
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<td>U.S.</td>
<td>6.9</td>
<td>10.7</td>
</tr>
<tr>
<td>South</td>
<td>7.2</td>
<td>10.0</td>
</tr>
</tbody>
</table>

Table 1.3. Rates of Return by Region - Method 2

<table>
<thead>
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<th></th>
<th>1850</th>
<th>1860</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S.</td>
<td>8.9</td>
<td>13.9</td>
</tr>
<tr>
<td>South</td>
<td>9.3</td>
<td>14.0</td>
</tr>
</tbody>
</table>

Bateman, Foust, and Weiss's estimated overall rate of return for southern manufacturing concerns exceeded Niemi's by 16%. The greatest contribution to the difference is the discrepancy in the weighting schemes used in the two papers. Bateman, Foust, and Weiss's failure to include managerial costs and their method of estimating working capital each accounted for about four percent of the discrepancy. It is difficult to render an informed opinion of whose estimate of working capital is more reliable, but on the other issues Niemi has the more convincing rationale for his methods.

An entirely different view of southern decision making has emerged from this analysis. To more completely square southern decisions regarding manufacturing investment with our economic intuition, southern patterns of investment should be broken down by industry. Niemi accomplishes this by comparing industry rates of employment growth between 1850 and 1860 according to whether the industry could be considered a low- or high-profit industry. Industries with 1850 rates of return below eight percent are
classified as low growth and those above this threshold are deemed high-profit industries. If southerners were properly responding to market signals, one would expect higher employment growth in the industries with better returns. This is exactly what Niemi found; employment dropped by 2.2% (846 jobs) in low-earning industries and jumped 51.9% in the more profitable industries. This difference in growth rates is even more profound than the discrepancy for the entire U.S. (24.8% and 37.0%, respectively). Similar results are obtained if Bateman, Foust, and Weiss’s sample is separated into low- and high-earning industries. Overall employment growth for the 22 industries was about four percent lower in the South than for the entire U.S.\textsuperscript{18} 

Niemi’s results indicate that southern manufacturing rates of return were comparable to those realized in the North. In addition, through separating the industries by growth rates, he has demonstrated that southern manufacturing investment decisions were eminently sensible. Finally, the rates of return he estimated for the southern and northern textile industries indicate returns were representative of overall manufacturing returns. Indeed, rates of return for textile firms exceeded the weighted average for the entire U.S. in 1850 and were 0.5% lower than the overall weighted average in 1860.\textsuperscript{19} Since census data was only available in ten-year increments, we require more frequent data for an informative comparison to the returns on owning slaves. For this, we will need annual data, so we turn now to a discussion of the only manufacturing industry for which satisfactory data exists: New England textiles.

\textsuperscript{18} Furthermore, the difference between the regions can likely be explained by noting vastly different rates of immigration in the two regions during the antebellum period. 
\textsuperscript{19} Rates of return for southern textile firms were lower than the overall weighted average for the South, but since our comparison set includes only northern firms, this is not a major concern.
1.8. New England Textile Manufacturing

McGouldrick (1968) conducted a thorough study of the New England textile industry between 1836 and 1860. He selected companies thought to be representative of the industry and divided the resulting firms into two samples. The data for the 'Baker' sample was taken from accounting and other business records housed in the business manuscripts section of the Baker Memorial Library, Harvard School of Business Administration. It is a rolling sample of 7 to 11 companies that entered and left the sample. Appendix Table A.3. lists the companies that were included in the sample. The 'Martin' sample is used exclusively for the purpose of verification and consists of up to 35 companies and includes the entire Baker sample. The author then discusses his criteria in choosing his samples. First, new companies should be included to minimize aging effects on profits and capital spending. Second, only firms primarily involved in cotton textile manufacturing were chosen in order to ensure homogeneity. Third, the company must have manuscript records for at least 20 years. Finally, companies with regularly occurring large windfall gains or losses were avoided. Since the primary criterion of the current study is representativeness, McGouldrick's criteria appear to be entirely consistent with our goals.\(^\text{20}\) All 11 firms in the Baker sample possessed widely held shares.

In order to place the records in the proper context, we discuss the textile manufacturing industry environment during this period. Prior to the 1830s, the New England textile industry was in a developmental stage in which technological

\(^{20}\) It should be noted that McGouldrick chose to delineate results by fiscal year instead of calendar year. His fiscal years began in June and ended in May. It is unclear whether the same approach is taken when the author reports the firms' market values, but any inconsistencies in accounting period between the textile firms and the other investments in the comparison set are likely to result in smaller distortions than those resulting from extrapolating between years. Therefore, we have chosen to take the author's results as reported.
obsolescence was rapid and managerial innovation was commonplace. During the latter half of the 1830s, the industry entered the mature phase in which innovation slowed markedly. As evidenced by the relatively small size and low returns for the southern textile industry, the South was not yet a credible competitor in the industry, and southern firms did not compete effectively until the 1880s. Therefore, the time frame chosen by McGouldrick is a particularly non-chaotic phase of the New England textile industry's development.

The author asserts that the results, properly shaded for the quirks of the sample, can be taken as representative of the northern U.S. textile industry. Coupled with Niemi's results comparing southern and northern manufacturing returns, this conclusion allows us to take the results from the Baker sample to be representative of manufacturing returns during the antebellum period. McGouldrick warns against making inferences concerning the southern textile industry, but since the southern textile industry is not of primary importance to the current analysis, his concern need not deter us from a more in-depth investigation of his work.

A careful examination of the McGouldrick's sample and the New England textile industry will allow us to evaluate his claim of the representativeness of his returns and provide confirmation of Niemi's findings regarding U.S. textile firms. We first discuss the general characteristics of the industry and sample to set the stage for the more technical discussion of competitive conditions to follow. As previously noted, there was a burst of innovation in the New England textile industry during the 1820s, but technological change over the rest of the century was comparatively slow, but progress was not nonexistent. The firms in the sample were financed almost entirely through
equity, reflecting the strong aversion to debt accumulation characteristic of the period. Management gave every indication that it was responsive to the shareholders’ desire for high returns by distributing almost all of their earnings through the payment of dividends.

The corporate incorporation laws of Massachusetts provided strong incentive for shareholders to hold firms accountable. Although shareholders were no longer participating in any meaningful way in day-to-day corporate governance by the 1830s, they could be held liable for corporate debts beyond the amount they invested in the firm. In fact, until the 1850s, individual investors were jointly liable for corporate debts in Massachusetts. Unlike today, there was a full range of stockholder participation instead of a sharp contrast between large investors and individuals.

The managerial practices within textile firms were not without critics. Some of the more vocal critics accused firms of failing to retain enough earnings to foster growth, falsifying financial documents, and engaging in transactions for managerial benefit (Ayer, 1863). The criticism that retaining earnings was insufficient does not resonate because dividends were not taxed, so it would have to be shown that foregone future profits would clearly outstrip dividends paid in present value to justify retaining income. This argument has not been persuasively made by critics. Some falsifications of financial records have been verified, but evidence does not exist to establish that this practice was more prevalent in textile manufacturing than in other industries. The same rebuttal applies for self-serving decisions by management. Ayer’s criticisms fall short of establishing reason to believe the firms included in the Baker sample were unrepresentative of the textile or any other antebellum industry.
We now turn our attention to the degree of competition faced by New England textile firms in the production and factor markets. The returns of textile firms would be inappropriate to include in the comparison set if they were subject to unrepresentative levels of competition in either market. First, we investigate the production market. McGourkin states that textile producers between 1830 and 1890 "had to throw output onto the market for what they could get." Most historians agree with this assessment with the notable exceptions of Josephson (1949) and Bagnall (1893). Josephson claimed that the textile firms engaged in price fixing without citing evidence. While communications involving wage setting occurred several times in the manuscripts, only one example of an attempt to fix prices is evident, and the attempt was unsuccessful. Prices fell by 16% during the proposed period of output restriction. Bagnall asserted that there was sufficient product differentiation to allow only limited substitutability. This argument may well have held some merit before 1830, but by the mid-1830s, the number of firms was too large to permit significant differentiation. As McGouldrick reveals, even mills starting operations during this period produced cloth virtually indistinguishable from those of other firms. Before the 1830s, U.S. producers were able to produce a more durable fabric than their British competitors due to the low cost of water, but the British then switched to power looms and were able to produce cloth of the same quality. In addition, variability in prices was uniform across all levels of quality. Although detailed pricing information is not available for a thorough study of the issue, the accusations leveled by critics do not give reason to disbelieve McGouldrick's assertion that the product market was competitive.
The degree of competition in the labor market is more difficult to assess. The firms in the Baker sample were located in a relatively small geographic area, and their labor supplies were of the same nature. Each firm had access to a large supply of unmarried female workers. Indeed, McGouldrick reveals that about 90% of their aggregate labor force was female. Furthermore, communications involving coordination in setting wage rates were mentioned in the manuscripts. Wages grew less rapidly than for those of other occupations. McGouldrick cites numerous reasons why these facts do not settle the argument. First, wages for these textile workers rose as rapidly as those for common labor. Since textile work generally demanded only semi-skilled labor, this is a fair comparison. Second, the female workers, for the most part, still lived at home and could be assumed to have the ability to quit if they felt they were being exploited. More convincingly, since some mills were in close proximity to one another, workers had mobility among mills. Complaints about worker poaching by competitors are documented in the manuscripts. Since workers were compensated by piece rates, the most powerful argument against wage fixing is that the endeavor would have been quite elaborate since literally hundreds of piece rates would have had to be set by the firms. Rapid productivity increases and industry growth would have made the practice even more problematic. McGouldrick hypothesizes that wage rates were probably too high and were set to pull them back in line, though he does not construct a technical argument to fortify this assertion. Based on the information available, the most appropriate conclusion to draw is that wage rates were competitive during the majority of the period, but with periods of less competitive wages after collusion. In this paper, we are not as concerned with higher than average profits in the comparison set as we are by lower than
average profits, so this assessment is not catastrophic to our analysis. Due to the scarcity of data on industrial enterprises of the period, a perfect comparison set is not to be expected.

McGouldrick offers a wealth of options for rates of return. Return on equity is the immediately intuitive choice, since it represents the rate of return realized by the owners of the firm. Rates of return on equity for the Baker companies averaged 8.4% between 1836 and 1886 with no discernible trend. This rate is consistent with Niemi's (1989) more conservative results for the entire U.S., and the yearly rates are comparable to the returns of other firms in the regional industry. However, cycles were pronounced with peaks in the mid-1830s, 1845, and 1853 and troughs in 1842 and 1857. The rates of return to capital and real net worth reported by McGouldrick are consistent with the results for equity. If these rates of return to equity are credible, they would be strong candidates for selection as our comparison set for manufacturing returns. Unfortunately, these rates of return are potentially compromised due to the lack of accounting standards during the antebellum period. Inventories were valued differently by the various firms. In addition, arbitrary write-offs were the norm due to the nonexistence of corporate and dividend taxation. Although consistent with our ultimate choice, these concerns merit the elimination of return on equity as our metric of choice.

As mentioned previously, the Baker firms were funded almost exclusively through common equity. The return on investment realized from purchasing stock in Baker companies is a particularly attractive choice for inclusion in our comparison set.

---

21 The Panic of 1837 does not appear to have affected the New England textile industry as much as one might expect.
22 Returns on equity were tried as the metric of profitability as a sensitivity check, and similar results to those reported later were obtained.
Since the other three members of our comparison set are financial instruments, this choice allows for analogous cash flow streams. While return on investment will present its own difficulties, this metric is not subject to quirky accounting systems or arbitrary write-offs. Actual dividend payments are reliable and readily available for all Baker firms. The formula for measuring rate of return is simply

\[ ROR = \frac{\text{change in stock price} + \text{dividends}}{\text{Stock price at beginning of year}} \]

This return represents the return on present value of capital to the shareholders. McGouldrick states that rates of return for the Baker companies are comparable with rates of return realized by shareholders of the other textile firms of the region and period, although records are more irregular for most other companies. Another advantage of using this metric is that the inflation indexing embedded in the other measures of profitability no longer concerns us. The most serious concern about using this as a measure of profitability is that the stocks were sold irregularly so the changes in price may be somewhat speculative. McGouldrick states that less than half of the stock quotes are represented in a special manuscript table of transactions. However, it is unclear whether the writer reported or, more importantly, had access to all the stock transactions for the period. Even if some of the quotes are imputations, a broker in these commodities was making the judgment as to the amount he would accept for the stock. This is far from ideal, but there is no reason to believe such estimates would be unreasonable. Return on investment is the most intuitively reasonable measure of profitability considering the rest of the investments in the sample, and it is consistent with the other possible choices. We find sufficient support to choose this as our summary measure of profitability for New England textile manufacturers.
1.9. Evaluation of Investments Using the Sharpe Index and Discussion of Results

As discussed in section 1.3, Sharpe’s ratio is the only well-known measure of RAROR that is applicable when an appropriate benchmark portfolio cannot be constructed. Therefore, we will calculate Sharpe ratios for the investments under study as a preliminary measure of performance. The Sharpe ratio, in this case, will be

\[
Sharpe\ ratio = \frac{\bar{r}_i - r_f}{\sigma_i} = \frac{average\ excess\ return\ of\ asset}{std.\ deviation\ of\ asset's\ excess\ return}
\]

with the risk-free rate, \( r_f \), representing the constant maturity yield on 10-year treasury bonds available during the period.

Table 1.4. Sharpe ratio for Antebellum Investments - Three-year windows

<table>
<thead>
<tr>
<th>PERIOD</th>
<th>SLAVES</th>
<th>N.Y. BILLS</th>
<th>BOSTON PAPER</th>
<th>TEXTILES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1836-1838</td>
<td>0.2213</td>
<td>1.872</td>
<td>1.672</td>
<td>2.245</td>
</tr>
<tr>
<td>1839-1841</td>
<td>-0.892</td>
<td>1.276</td>
<td>1.144</td>
<td>0.125</td>
</tr>
<tr>
<td>1842-1844</td>
<td>-0.560</td>
<td>0.385</td>
<td>0.359</td>
<td>2.362</td>
</tr>
<tr>
<td>1845-1847</td>
<td>1.718</td>
<td>1.639</td>
<td>1.541</td>
<td>2.189</td>
</tr>
<tr>
<td>1848-1850</td>
<td>3.186</td>
<td>1.886</td>
<td>1.859</td>
<td>0.649</td>
</tr>
<tr>
<td>1851-1853</td>
<td>4.785</td>
<td>2.190</td>
<td>1.857</td>
<td>4.117</td>
</tr>
<tr>
<td>1854-1856</td>
<td>6.002</td>
<td>5.347</td>
<td>4.627</td>
<td>4.409</td>
</tr>
<tr>
<td>1857-1860</td>
<td>3.150</td>
<td>0.877</td>
<td>0.960</td>
<td>0.307</td>
</tr>
</tbody>
</table>
Table 1.5. Sharpe ratio for Antebellum Investments - Five-year windows

<table>
<thead>
<tr>
<th>PERIOD</th>
<th>SLAVES</th>
<th>N.Y. BILLS</th>
<th>BOSTON PAPER</th>
<th>TEXTILES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1830-1835</td>
<td>4.615</td>
<td>1.067</td>
<td>0.883</td>
<td></td>
</tr>
<tr>
<td>1836-1840</td>
<td>-0.333</td>
<td>1.7425</td>
<td>1.545</td>
<td>1.126</td>
</tr>
<tr>
<td>1841-1845</td>
<td>-1.112</td>
<td>0.765</td>
<td>0.730</td>
<td>1.022</td>
</tr>
<tr>
<td>1846-1850</td>
<td>4.346</td>
<td>1.839</td>
<td>1.841</td>
<td>0.785</td>
</tr>
<tr>
<td>1851-1855</td>
<td>6.709</td>
<td>2.986</td>
<td>2.475</td>
<td>2.445</td>
</tr>
<tr>
<td>1856-1860</td>
<td>5.542</td>
<td>1.086</td>
<td>1.188</td>
<td>0.441</td>
</tr>
</tbody>
</table>

As discussed in section 1.3, using the treasury bond rate is not ideal for at least two reasons. First, the ten-year period exposed an investor to significant interest-rate risk. Second, data is not available for when the government issued no debt (1835-1842), so a proxy rate, the return on high-grade Boston municipal bonds, was used for this time period. Periods of three and five years will be utilized to determine the average excess return, and the standard deviation will be calculated based on the same period. The results of these calculations are presented in Tables 1.4 and 1.5, respectively. The results for the years between 1846 and 1860 are particularly striking for the five-year window because of the large differences between the Sharpe ratios for investment in slaves compared to other securities. We do not see the same domination in the three-year window data because variation because slave prices rose much more quickly between 1857 and 1860 than between 1854 and 1856, and the variation in rates of return for the loans experienced little variation. Using either window, we get mixed results because investment in slaves underperformed during the period 1836-1845. It is clear that
investment in slaves was a substantially riskier enterprise than putting money in New York state bonds or in Boston commercial paper. We cannot choose the best investment based on these results, and the Sharpe ratio is not a flexible measure of risk because the possibility of diversification is not taken into account. It is for this reason that we will develop and apply the directional distance function to the same data.

1.10. Directional Distance Function-Risk-Adjusted Rate of Return (DDF-RAROR) and Comparison of Investments

As mentioned in section 1.3, none of the standard RAROR metrics (other than the Sharpe ratio) are applicable to ranking investments of the antebellum period. The directional distance function (DDF) developed by Chung, Fare, and Grosskopf (1997) will provide a useful metric for our purposes. Based on rate of return data of the various investments, we will first construct the investment opportunity set with its associated efficient frontier. Since estimation of an efficient frontier is done nonparametrically, we avoid the usual assumption of normality. In addition, the mean-variance theory of Markowitz (1959) assures us that the investment opportunity set will be convex as long as we assume a weighted average of portfolios along the efficient frontier is also a feasible portfolio.

Directional distance functions were developed as a method of assessing the productivity of a firm, comparing the productivity of several firms, or evaluating productivity changes over time. In our framework, risk replaces input and returns take the place of outputs. We are left with the simplest of production situations in which there is both a single input and output. The production frontier is the maximum output (rate of return) that can be realized at a given level of input (risk). A firm on the production
frontier is realizing the maximum rate of return with a given level of risk and is referred to as technically efficient. This is the appropriate measure of performance for the purposes of this study. It should be noted that technical efficiency does not imply allocative or economic efficiency. Allocative efficiency reflects the ability of the firm to use inputs in optimal proportion. This concept is inapplicable in our case since the level of risk inherent in an investment is not adjustable to the investor. This also renders economic efficiency irrelevant since it is defined as the combination of technical and allocative efficiency. The upshot of this discussion is that our results should not be taken to imply that any of the investments in the comparison set were 'optimal' with respect to a particular or representative investor of the period. Indeed, it would be impossible to make such judgments. We can only conclude that, given the efficient frontier, the investment yielded the maximum return with the given level of risk.

We should consider alternative methods of comparing these investments. Total factor productivity (TFP) indices are the immediately intuitive choice, but these indices assume efficiency, so they are inappropriate for our purposes. In fact, the entire purpose of this research is to establish the inefficiency of various investments. In the presence of inefficiency, data envelopment analysis (DEA) and stochastic frontier models are frequently used. The most fundamental difference is that data envelopment analysis involves solving a deterministic linear programming problem, while stochastic frontier models rely on econometric estimation. Stochastic frontier models are parametric models which necessitate specifying a relationship between the independent (risk) and dependent (return) variables. As noted earlier in our discussion of the CAPM, specifying a functional relationship between risk and return for investments during the antebellum
period is especially problematic. Even though such relationships exist for modern investments, the primitive investment environment and incomplete information on alternative investments make the use of such models inappropriate for the period before the Civil War. For this reason, data envelopment analysis (DEA) is preferred. In addition, DEA can be improved through the use of bootstrapping, which allows us to conduct statistical inference even though the underlying model is deterministic.

In this section, we will present the DDF-RAROR as an alternative ranking for investments during the antebellum period. To arrive at these rankings, we follow the methodology of Jin (2004). First, we group the investments for which we have data in a comparison universe. We then calculate the directional distance associated with each investment. These distances are ordered, and then we perform a statistical test using these sorted rankings.

Each investment can be characterized by a risk-return pair \((\sigma, r)\) such that \(r \in R^1_+\) and \(\sigma \in R^1_+\). Now the investment opportunity set can be characterized as the set of financially feasible combinations of \((\sigma, r)\) defined as

\[ F = \{(\sigma, r) | (\sigma, r) \in P\} \]

where \(P = \{(\sigma, r) \in R^2_+\}\). It is necessary to impose some restrictions on the investment opportunity set. First, free disposability of risk and return is assumed as represented by

\[ (\sigma, r) \in F \quad \text{and} \quad \sigma' \geq \sigma, r' \leq r \Rightarrow (\sigma', r') \in F. \]

Simply stated, when an investment is feasible, other investments with higher risk and lower return are also feasible. Another assumption is that reduction of risk is costly in terms of reduced return or

\[ (\sigma, r) \in F \quad \text{and} \quad 0 \leq k \leq 1 \Rightarrow (k\sigma, kr) \in F \]
As discussed earlier, convexity of the investment opportunity set is also assumed.

Finally, we assume that rates of return beyond the risk-free rate are not possible without undertaking risk, that is,

\[(\sigma, r) \in F \quad \text{and} \quad \sigma = 0 \Rightarrow r = r_f.\]

The distance we seek to measure is the distance between the security’s risk-return pair and the efficient frontier, which is the boundary of the investment opportunity set, \(F\).

The directional distance function developed by Chung, Grosskopf, and Fare (1997) will be calculated as:

\[\tilde{d} = \sup \{d \mid (\sigma + dg, r + dr) \in F\}\]

where \(g_\sigma\) and \(g_r\) are, respectively, the elements for risk and return of the direction vector \(g\). When \((\sigma, r)\) is not on the efficient frontier, \(\tilde{d} \leq 1\) indicates the proportionate reduction of risk and enhancement of return necessary for the investment to reach the efficient frontier.

It is possible that the directional distance will vary according to the direction along which performance is evaluated. In the risk-minimizing direction, \(g = (-\sigma, 0)\), the directional distance will be

\[\tilde{d} = \inf \{d \mid (d\sigma, r) \in F\}\]

where \(\tilde{d} \leq 1\) represents the proportionate reduction of risk for a security at \((\sigma, r)\) to reach the efficient frontier. In words, this is the maximum contraction of risk possible without going beyond the efficient frontier. Alternatively, in the return-maximizing direction, \(g = (0, r)\), the directional distance will be

\[\tilde{d} = \sup \{d \mid (\sigma, dr) \in F\}\]
where $\tilde{d} \geq 1$ represents the proportionate enhancement of return that a security would need to reach the efficient frontier. This represents the minimum increase in return necessary to place the instrument on the efficient frontier. The directional distance function can be visualized by Figure 1.1.

For the purpose of defining a RAROR, we invert the directional distance to obtain the DDF-RAROR defined as:

$$\tau = 1/(1 + \tilde{d})$$

![Figure 1.1. Directional Distance](image)

The intuition of DDF-RAROR is especially simple: there exists a tradeoff between risk and return, and the closer an investment is to the efficient frontier, the more desirable the investment. In order for a security to reach the efficient frontier, risk should be reduced with a simultaneous enrichment of return.

The investment opportunity set, $F$, and efficient frontier are unknown, so the DDF-RAROR will be estimated from a random sample of risk-return pairs represented by
\( Y_n = \{(\sigma_i, r_i) \mid i = 1, \ldots, n\} \). From the work of Deprins, Simar, and Tulkens (1984), the Free Disposal Hull (FDH) of the set of observations

\[
\hat{F}_{FDH} = \left\{ (\sigma, r) \in \mathbb{R}^2 \mid \sigma \geq \sigma_i, r \leq r_i, \quad i = 1, \ldots, n \right\}
\]

is used to estimate \( F \). Using the convex hull of \( \hat{F}_{FDH} \), we arrive at the DEA estimator of \( F \) proposed by Charnes, Cooper, and Rhodes (1978)

\[
\hat{F}_{DEA} = \left\{ (\sigma, r) \in \mathbb{R}^2 \mid \sigma = \sum_{i=1}^{n} w_i \sigma_i, r \leq \sum_{i=1}^{n} w_i r_i, \quad \text{s.t.} \quad \sum_{i=1}^{n} w_i = 1, w_i \geq 0, i = 1, \ldots, n \right\}.
\]

Now that the investment opportunity set has been estimated, all that remains is to calculate the directional distance \( \hat{d}_i \) and its associated DDF-RAROR, \( \hat{t}_i \). We accomplish this through standard linear programming:

\[
\hat{d}_i = \max \beta \\
\text{s.t.} \quad (1 + \beta)r_i \leq w'r \\
(1 - \beta)\sigma_i = w'\Sigma w \\
w'c = 1
\]

The objective function provides the directional distance. The first constraint ensures that the return on the security augmented by the directional distance lies on the efficient frontier. The second constraint accomplishes the same goal with the covariance matrix. The final constraint verifies that the portfolio weights sum to one and prohibits the taking of short positions.\(^{23}\) If diversification is considered implausible, we can restate the linear programming problem as

\[
\hat{d}_i = \max \beta \\
\text{s.t.} \quad (1 + \beta)r_i \leq w'r \\
(1 - \beta)\sigma_i = w'\sigma \\
w'c = 1
\]

\(^{23}\) The taking of short positions was clearly impossible for these investments during the antebellum period.
In this case, the optimization problem becomes the usual linear programming model utilized in conventional productivity analysis. Now the DDF-RAROR is determined from the distance between the Capital Allocation Line (CAL) and the security rather than based on the distance between the investment and the concave efficient frontier. To allow for diversification, which undoubtedly occurred during the ante bellum period, we will focus our efforts on the first of the two programs. We can now turn our attention to ranking the investments.

Numerous ranking algorithms have been developed within the data envelopment analysis framework. The cross efficiency ranking method was developed by Sexton (1996). Sexton's method uses the same set of weights for each firm to ensure comparability. The weight used for a particular firm is determined by performing the analysis on the other firms in the comparison set, and the results are averaged over all the evaluations to arrive at an overall score. Sinuany-Stern and Friedman (1998) specified an algorithm using the principles of discriminant analysis. They maximize the ratio of between group variance and within group variance of the ratio between composite output and composite input. The advantage of this algorithm is that all firms are rank scaled with a common set of weights. However, there is no guarantee that the resulting solution is globally optimal (Hadad et. al., 2003). Andersen and Petersen (1993) devised an algorithm that allows for ranking firms on the efficient frontier. We find this approach to be most appropriate for the present study, since the additional information gleaned from super efficiency scores will be especially beneficial. The data were also analyzed using the cross efficiency algorithm, and the only differences with the current analysis involved investments that were not ranked first or second.

24 For a more complete treatment, see Adler, Friedman, and Sinuany-Stern (2002).
In order to include all years going back to 1830, the risk-adjusted rate of return of owning slaves was conducted with two separate comparison universes. In the first comparison, returns from owning slaves were compared to those on New York state bonds, Boston commercial paper offerings, and U.S. Treasury bonds. In the second comparison, rates of return from New England textile manufacturing were included as part of the comparison set. As mentioned previously, rates of return for these firms are only available between 1836 and 1860, so we limit the other investments to this period in this comparison. Since U.S. Treasury bonds were not offered between 1835 and 1842 due to the retirement of all existing government debt, we again substituted returns on Boston municipal bonds during this period. The returns from these bonds are comparable to those one would expect if Treasury bonds would have been offered. It should be noted that the Treasury bonds were redeemable at the discretion of the government (Homer and Sylla, 1996), while the Boston bonds did not share this provision.

As mentioned previously, the calculations of Evans (1962) were modified and utilized to arrive at estimates for the rate of return one realized from owning slaves. We based our demographics on the population of slaves as a whole so that we are left with a credible estimate of the return on a representative plantation. We use both Phillips's (1929) and Fogel and Engerman's (1974) mean price change in slaves between years. The reader will recall that Phillips's averages can be thought of as a 'smoothed' version of Fogel and Engerman's series and tend to produce more optimistic results for slave returns due to the reduction in variance and slight increase in mean. Conrad and Meyer (1962) were consulted for rates on New York bonds and Boston commercial paper, while U.S.
Treasury bond returns were gleaned from Homer and Sylla (1996). Appendix Table A.4. lists yields for various investments not included in the comparison set.

Our testing methodology was straightforward. For each comparison universe, we calculated directional distances for each investment for each five-year period during the years 1831-1860. Next, we ordered these distances and assigned each of them a rank. At this point, the Wilcoxon rank-sum test was performed. We can state the null and alternative hypotheses as follows:

H₀ : The ranking distribution is the same for the investments in the comparison universe.

H₁ : The ranking distribution is smaller for the investment in slaves.

For the period 1830-1860, we fail to reject the null hypothesis that slave returns were equal to those available on the purely financial instruments. If we choose smaller time frames by pulling three-year periods out of the data starting from 1830, we obtain a statistically significant test statistic from 1845-1860 using Phillips's means and 1848-1860 using Fogel and Engerman's data. Using five-year windows, we find that both choices for the mean result in a significant result starting in the period 1841-1860.

Despite the fact that the institution of slavery performs so poorly in the first period, slavery returns such dominant results in the other periods that the Wilcoxon rank-sum test is still significant. We reach mixed conclusions, but we clearly see that the risk-return performance of slavery was dominant during the years 1845-1860. Slavery was most certainly not a moribund institution. Since our comparison set is so limited, our results are somewhat compromised by having more than one investment on the risk-return frontier. This problem will only be amplified when we observe the bootstrapping results presented in the next section.
1.11. Bootstrapping Methodology and Results

The directional distances in the previous section were calculated utilizing the technique of linear programming. Results from linear programming are deterministic, but in the current analysis such a viewpoint is misleading. In the case of the antebellum period, our rates of return cannot be considered deterministic. Especially in the case of slaves, there is every reason to believe that there was substantial variation in earnings by plantation. Since there is significant variation in the returns themselves, the efficient frontier cannot be considered deterministic either. One way to model this variability is to attempt to replicate the data generating process through bootstrapping. Using the methodology presented in Simar and Wilson (1998), we can form confidence intervals around our point estimates of directional distance and reaffirm the statistical significance of our results.

The assumptions necessary to characterize the data generating process can be stated as follows.

(Assumption 1) \( \{ (r_i, \sigma_i), i = 1, \ldots, n \} \) are i.i.d. random variables on the convex investment opportunity set, \( F = R^2_+ \) and both are freely disposable.

(Assumption 2) The actual returns and standard deviations of the investments in the comparison set are realizations of random variables possessing probability density functions whose bounded support in \( R_+ \) is compact.

(Assumption 3) Probability mass exists in a neighborhood of the true frontier.

(Assumption 4) The distance function \( d \) is differentiable in its arguments.

Under these assumptions, Kneip, Park, and Simar (1998) established that

\[
\hat{d} - d = O_P\left( n^{-1/2} \right)
\]
where \( \hat{d} \) is a consistent estimator of \( d \). For the purposes of our analysis, the rate of convergence is equal to 1/2.

In order to implement bootstrapping methods, we first assume that a random sample \( Z = \{(r_i, \sigma_i), i = 1,...,n\} \) is drawn from a data generating process (DGP) under the stated assumptions. The goal of the bootstrap is to replicate the DGP utilizing a large number of pseudo samples. We will represent the set of pseudo samples as

\[ Z^b = \{(r_i^b, \sigma_i^b), i = 1,...,n\} \] where \( b = 1,...,B \). Once each pseudo sample is generated, estimation of the directional distance is performed exactly as in the previous section:

\[
d_i^b = \max \beta \\
s.t. \quad (1 + \beta)r_i \leq w'r_i^b \\
(1 - \beta)w'\sigma_i = w'\sigma_i^b \\
w'c = 1
\]

We will implement this procedure under both comparison universes, which will yield bootstrap directional-distance estimates of \( \hat{d}^b \) and \( \hat{d}_{TB}^b \) where the TB subscript indicates the sample includes information concerning treasury bond returns.

As presented in Simar and Wilson (2000), we follow the 11-step bootstrapping algorithm.

(Step 1) Estimate \( \{\hat{d}, \hat{d}_{TB}\} \) for all investments using the original data.

\[ Z = \{(r_i, \sigma_i), i = 1,...,n\}. \]

(Step 2) As revealed in Simar and Wilson (2000), the naïve bootstrap is inconsistent in frontier estimation. In order to ensure consistency, we implement the reflection method proposed by Silverman (1986). From the \((n \times 1)\) vectors \( P_1 = [\hat{d}_1, ..., \hat{d}_n]' \) and \( P_2 = [\hat{d}_{TB,1}, ..., \hat{d}_{TB,n}]' \) where \( n \) is the number of investments, form the \((4n \times 2)\) augmented matrix
\[
A = \begin{bmatrix}
P_1 & P_2 \\
-P_1 & P_2 \\
P_1 & -P_2 \\
-P_1 & -P_2
\end{bmatrix}
\]

As can be easily seen, constructing the augmented matrix in this way eliminates
the concern that the distances are bounded below by zero.

(Step 3) Calculate the estimated covariance matrix \( \hat{\Sigma}_1 \) using the original data \([P_1 \ P_2] \)
and \( \hat{\Sigma}_2 \) from \([P_1 \ -P_2] \).

\[
\hat{\Sigma}_1 = \text{Cov}(P_1, P_2) = \text{Cov}(-P_1, -P_2)
\]

\[
\hat{\Sigma}_2 = \text{Cov}(P_1, -P_2) = \text{Cov}(-P_1, P_2)
\]

Using the Cholesky decomposition, compute the lower triangular matrices \( L_1 \) and \( L_2 \)
such that \( \hat{\Sigma}_1 = L_1L_1' \) and \( \hat{\Sigma}_2 = L_2L_2' \).

(Step 4) Draw \( n \) rows randomly with replacement from the augmented matrix and
denote the result by the \((n \times 2)\) matrix \( A^b \). Obtain \( \overline{A}^b \), which is the \((1 \times 2)\) row vector
made up of the column means of \( A^b \).

(Step 5) Randomly generate the \((n \times 2)\) i.i.d. matrix \( \varepsilon \) and then construct the bootstrap
version \( \varepsilon^b \) with

\[
\varepsilon^b_i = \varepsilon_iL_j' \quad j = 1, 2
\]

where \( \varepsilon^b_i \sim N(0, \hat{\Sigma}_1) \) or \( N(0, \hat{\Sigma}_2) \). If \( i \in \{1, \ldots, n, 3n + 1, \ldots, 4n\} \) then the covariance matrix
is \( \hat{\Sigma}_1 \), whereas \( i \in \{n + 1, \ldots, 2n, 2n + 1, \ldots, 3n\} \) then the covariance matrix is \( \hat{\Sigma}_2 \).

(Step 6) Calculate the \((n \times 2)\) random deviates for the bootstrap by using the \( \Delta \) function.

This process is described in Silverman (1986).
\[ \Delta = (1 + h_2)^{-0.5} \left( M \cdot \Delta^b + h e^b \right) + c_a \otimes \Delta^b \]

where \( M = I_n - c_n c_n' / n \), \( I_n \) is a \((n \times n)\) identity matrix, and \( c_n \) is a \((n \times 1)\) unit vector.

(Step 7) Set \( h = (4/5n)^{1/6} \), as the bandwidth \( h \) of the bivariate kernel density estimator used in step six.

(Step 8) Label the newly constructed \((n \times 2)\) matrix of bootstrap pseudo data \( D^b \)

\[ d^b = |\delta_y| \quad \text{where} \quad \Delta = (\delta_y) \]

(Step 9) Used this pseudo data to construct the pseudo sample \( Y^b = \{(r^b, \sigma^b), i = 1, \ldots, n \} \) by setting:

\[ r^b = r_i (1 + \hat{d}^b_i) / (1 + \hat{d}^b) \quad \text{and} \quad \sigma^b = \sigma_i (1 - \hat{d}^b_i) / (1 - \hat{d}^b) \]

(Step 10) Calculate both \( \hat{d}^b, \hat{d}^b_{tb} \). These estimates can be obtained by solving the programming problem under the pseudo investment opportunity set consisting of the pseudo sample \( Z^b \) (and \( Z^b_{tb} \)).

(Step 11) Repeat steps (5)-(10) \( B \) times to yield the bootstrap estimates \( \{\hat{d}^b, \hat{d}^b_{tb} | b = 1, \ldots, B \} \). Confidence intervals for these directional distances can now be derived.

The procedure for calculating confidence intervals is straightforward. The bootstrap estimates \( \{\hat{d}^b, \hat{d}^b_{tb} | b = 1, \ldots, B \} \) are calculated and ordered, and then the extreme \((\alpha/2)\) percentages are deleted from both ends of the distribution. The remaining endpoints form the confidence intervals for each investment.

---

25 For observations where this results in infeasible solutions, repeat steps 5-10.
If the entire thirty-one year period is examined, all of the resulting confidence intervals overlap. This is not surprising considering the results from the Wilcoxon-rank sum test and the Sharpe ratios. Confidence intervals that discriminate between the investments do not exist until we limit the time frame to 1845-1860. Confidence intervals for this period are reported in Table 1.6. Figures were rounded at the second decimal place. The confidence level is 95%.

Table 1.6. Directional Distance Confidence Intervals 1845-60 - Three-Year Windows

<table>
<thead>
<tr>
<th>INVESTMENT</th>
<th>LOWER BOUND</th>
<th>UPPER BOUND</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slaves</td>
<td>0</td>
<td>0.125</td>
</tr>
<tr>
<td>Textiles</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Boston Commercial Paper</td>
<td>0.17</td>
<td>1</td>
</tr>
<tr>
<td>N.Y. Bills</td>
<td>0</td>
<td>0.78</td>
</tr>
</tbody>
</table>

Although these intervals cast the institution in a favorable light from a profitability standpoint, we are clearly unable to conclude that slavery was unambiguously more profitable than the other investments. Confidence intervals for three-year periods starting in 1851 show more discrimination between the investments.26 These intervals are listed in Table 1.7.

---

26 If the relationship between risk and rate of return is assumed to exhibit constant returns to scale, the institution of slavery is judged to significantly outperform the other investments between 1845 and 1860 for five-year intervals and between 1848 and 1860 for three-year intervals.
Table 1.7. Directional Distance Confidence Intervals 1851-60 – Three-Year Windows

<table>
<thead>
<tr>
<th>INVESTMENT</th>
<th>LOWER BOUND</th>
<th>UPPER BOUND</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slaves</td>
<td>0</td>
<td>0.06</td>
</tr>
<tr>
<td>Textiles</td>
<td>0.11</td>
<td>1</td>
</tr>
<tr>
<td>Boston Commercial Paper</td>
<td>0.24</td>
<td>0.58</td>
</tr>
<tr>
<td>N.Y. Bills</td>
<td>0.21</td>
<td>0.72</td>
</tr>
</tbody>
</table>

The institution of slavery dominates the other investments during this period. Interestingly, the differences between the other investments are not statistically significant. For the period 1851-1860, we conclude that the institution of slavery was unambiguously superior to the investments in the comparison set. Taking Niemi’s (1989) findings into account, owning slaves was one of the better performing investments in the entire United States.

1.12. Super Efficiency and Other Methods

We have been unable to arrive at an unambiguous ranking of investments for some periods because more than one investment has resided on the efficient frontier of risk and return. More technically, we would like to be able to order the efficient investments but have been unsuccessful because their directional distances are equal.

Andersen and Petersen proposed that each efficient investment be excluded in turn from the comparison set. Figure 1.2 can be used to illustrate the concept.
When the linear program is run on the original comparison set, firms A, B, and C are found to be producing on the efficient frontier. Each of these firms is then removed individually from the linear program to form new efficient frontiers. Taking firm B as our example, the firm is removed from the linear program and the new efficient frontier calculated with firms, D, and E consists only of firms A and C. We see that firm B now lies beyond the efficient frontier. Firm B could move to point B' and remain efficient, so both its output can be increased and its input decreased while remaining of the efficient frontier. Therefore, firm B's efficiency score will be greater than that for the other investments while it is excluded from the constraints. The resulting score is called its
super-efficiency score. The higher the super-efficiency score, the further beyond the modified efficient frontier the firm resides.\textsuperscript{27} Therefore, we consider higher super-efficiency scores to represent better performing firms.

We now return to our stylized model. Mathematically, Andersen and Petersen's super-efficiency algorithm can be represented by

\[
\tilde{d}_i = \max \beta \\
\text{s.t.} \quad (1 + \beta)r_i' \leq w'r \quad i = 1, \ldots, n \quad i \neq k \\
(1 - \beta)\sigma_i = w'\Sigma w \quad i = 1, \ldots, n \quad i \neq k \\
w'c = 1
\]

where \( k \) represents the super-efficient firm. In words, we have removed the bounds on the score of investment \( k \). We then run the linear program for each of the efficient investments and obtain super-efficiency scores for each of them.

We conducted this procedure for each of the periods in which multiple investments made up the efficient frontier. We then arrive at an unambiguous ranking for each three- or five-year period using both Fogel and Engerman's and Phillips's mean slave price series. The results for both the three- and five-year period analyses are reported for Fogel and Engerman's series since the results are identical to those for Phillips.

\textsuperscript{27} Under this notation, the highest score in absolute value is technically correct since the distance \( \beta \) will often be negative.
Table 1.8  Rankings of Investments - Three-Year Periods

<table>
<thead>
<tr>
<th>PERIOD</th>
<th>BEST</th>
<th>SECOND</th>
<th>WORST</th>
</tr>
</thead>
<tbody>
<tr>
<td>1830-1832</td>
<td>Slavery</td>
<td>N.Y. Bills</td>
<td>Boston Paper</td>
</tr>
<tr>
<td>1833-1835</td>
<td>Slavery</td>
<td>N.Y. Bills</td>
<td>Boston Paper</td>
</tr>
<tr>
<td>1836-1838</td>
<td>Textiles</td>
<td>N.Y. Bills</td>
<td>Slavery</td>
</tr>
<tr>
<td>1839-1841</td>
<td>N.Y. Bills</td>
<td>Boston Paper</td>
<td>Slavery</td>
</tr>
<tr>
<td>1842-1844</td>
<td>Textiles</td>
<td>Boston Paper</td>
<td>Slavery</td>
</tr>
<tr>
<td>1845-1847</td>
<td>Textiles</td>
<td>Slavery</td>
<td>Boston Paper</td>
</tr>
<tr>
<td>1848-1850</td>
<td>Slavery</td>
<td>N.Y. Bills</td>
<td>Textiles</td>
</tr>
<tr>
<td>1851-1853</td>
<td>Slavery</td>
<td>Textiles</td>
<td>Boston Paper</td>
</tr>
<tr>
<td>1854-1856</td>
<td>Slavery</td>
<td>N.Y. Bills</td>
<td>Textiles</td>
</tr>
<tr>
<td>1857-1860</td>
<td>Slavery</td>
<td>Boston Paper</td>
<td>N.Y. Bills</td>
</tr>
</tbody>
</table>

Table 1.9.  Rankings of Investments - Five-Year Periods

<table>
<thead>
<tr>
<th>PERIOD</th>
<th>BEST</th>
<th>SECOND</th>
<th>WORST</th>
</tr>
</thead>
<tbody>
<tr>
<td>1831-1835</td>
<td>Slavery</td>
<td>N.Y. Bills</td>
<td>Boston Paper</td>
</tr>
<tr>
<td>1836-1840</td>
<td>N.Y. Bills</td>
<td>Boston Paper</td>
<td>Slavery</td>
</tr>
<tr>
<td>1841-1845</td>
<td>Textiles</td>
<td>N.Y. Bills</td>
<td>Slavery</td>
</tr>
<tr>
<td>1846-1850</td>
<td>Slavery</td>
<td>N.Y. Bills</td>
<td>Textiles</td>
</tr>
<tr>
<td>1851-1855</td>
<td>Slavery</td>
<td>N.Y. Bills</td>
<td>Textiles</td>
</tr>
<tr>
<td>1856-1860</td>
<td>Slavery</td>
<td>Boston Paper</td>
<td>Textiles</td>
</tr>
</tbody>
</table>
We observe that the institution of slavery is the best-performing investment for six of the ten three-year periods and for four of the six five-year periods. We conclude that the owning of slaves was a comparatively remunerative proposition. Meanwhile, the institution of slavery was the worst-performing investment in all of the other five-year periods and for three out of four three-year periods. The periods 1830-1835 and 1848-1860 were generally regarded as prosperous periods in United States' history, and the period 1837-1845 was considered to be a significant recession. These observations and our Sharpe's ratio calculations allow us to draw additional inferences from our results. First, the institution of slavery generally outperformed other investments in prosperous times. While such a conclusion is not warranted for a comparison set of all possible antebellum investments, owning slaves clearly outperformed all purely financial instruments for which we have data.

The economic climate of the antebellum period is an important factor for placing these results in the proper context. The best available estimates of manufacturing returns from the antebellum period indicate that textile manufacturing was, at worst, an average industry in terms of profit. Therefore, the evidence indicates that the institution of slavery provided above-average rates of return across all major investment categories during times of economic growth. The institution of slavery was more affected by significant financial downturns than were other antebellum investments. The Panic of 1837 has been compared to the Great Depression (Homer and Sylla, 1996), so this conclusion can only be drawn for major economic disturbances. We consider further explanations for slavery's poor performance in the following paragraph. The U.S. economy slowed during the years of 1857-1860, so this period can be considered normal
growth from an economic perspective. The institution of slavery continued to outperform the alternative investments during this period. Based on these results, slaveowners had every reason to be economically sanguine before the Civil War, but their worst fears would soon be realized politically with the start of the Civil War.

The poor performance of the institution of the institution of slavery during and after the Panic of 1837 warrants consideration of possible explanations. Bondsmen purchased on the open market were likely to be used to expand existing plantation operations. During an economic contraction as severe as the Panic and its aftermath, slaveowners would be especially unlikely to choose to expand their operations. The purchase of a bondsman was a major investment, and it is well-established that sales of durable goods are heavily impacted by economic conditions. It is also possible that slaveowners were cash-constrained during these difficult economic times, and they might not have possessed sufficient liquid capital to make such a major purchase. An analysis focusing on production would almost certainly find higher rates of return during this period. It is likely that using our approach overstates the risk borne by slaveowners because ours is a marginal analysis.

1.13. Concluding Remarks for Chapter 1

We have undertaken the first modern study of the risk, as well as the return, involved in owning slaves during the antebellum period. We have found that the owning of slaves outperforms other investments available during the period using distance from the efficient frontier as the ranking criterion. Although the bootstrap confidence intervals provide mixed results, the institution of slavery dominates the other investments in the last half the period. One can conclude that the owning of slaves was a very profitable
enterprise, and that the economic climate was not likely to change so dramatically that this would no longer be the case. Indeed, the rates of return close to the end of the period are the most impressive of the study, with the variation in returns steadily decreasing at the same time. However, this begs the question what was driving these high rates of return. It could be that westward expansion explained the high rates of return, and it could be argued that these rates of return were unsustainable. Chapter 2 seeks to provide evidence in this regard using methods from the empirical analysis of auctions.
Chapter 2

Estimating the Number of Bidders in New Orleans Slave Auctions

2.1. The History of the Profitability Debate

For many years, it was believed that slavery was unprofitable in its later years, and thus the Civil War could have easily been avoided without undue economic hardship for the southern states. This paradigm was dubbed "the Phillips school" by Fogel and Engerman (1974) after U.B. Phillips, the most influential historian of the ante bellum south. Several of these early scholars, such as Charles Ramsdell (1929) and Eugene Genovese (1965) argued that slavery would not have continued to exist without the territorial expansion of slavery. In particular, the rapid deterioration of the soil in the Southeastern U.S. was making expansion into states with more fertile soil necessary for the U.S. to continue to lead the world in cotton production. Indeed, Genovese argues that, even on the frontier, land could not be reclaimed once it had been utilized for cotton, and crop rotation was rendered impossible. The natural conclusion is that the interregional trade of slaves was propping up slavery in the 'Old South' (this term will generally refer to Maryland, Virginia, the Carolinas, Georgia, and Alabama. Meanwhile, Tennessee, Arkansas, Louisiana, and Texas will be termed the 'New South'.)

As detailed in chapter 1, Conrad and Meyer (1958) did much to counter the Phillips school. Conrad and Meyer made the case that slave labor was quite profitable in the New South. However, considering the lower level of production in states such as South Carolina and Alabama, the rates of return seen in the Old South do not appear to reach
the level of railroad or municipal bonds until possible profits from the slave trade are factored into the analysis. Conrad and Meyer are unambiguous on this point, offering “Slavery in the immediate antebellum years was, therefore, an economically viable institution in virtually all areas of the South as long as slaves could be expeditiously and economically transferred from one sector to another (emphasis added).” The interference to be drawn from this is clear: the Old South was profitable only as it could produce labor for the New South. They cite differing demographics and higher fertility in the Old South to justify the claim that this is exactly what was occurring. They also point out that unusually fertile females were treated as plantation heroes through improved living quarters and reduced duties. Fogel and Engerman (1974) rebut this by stating that only approximately one percent of a typical slaveowner’s income came from inter-regional sales. They go on to state that intervention would likely lower morale and hurt productivity. In addition, there are no examples in the manuscripts of owners or their overseers attempting to intervene in slave reproduction.

In *Time on the Cross* (1974), Fogel and Engerman reviewed Conrad and Meyer’s work and concluded that Conrad and Meyer’s rates of return were too low because the authors underestimated slave productivity. Fogel and Engerman pointed out that Conrad and Meyer utilized rates of productivity growth that were not current. Utilizing their estimates instead of Conrad and Meyer’s productivity estimates, Fogel and Engerman concluded that the average rate of return on a slave was approximately ten percent and was consistent across geographic regions.

Fogel and Engerman’s primary basis for positing that slavery was universally profitable in southern America was the work of Evans (1962). As discussed in chapter 1,
Evans utilizes the rates of hire for slaves as the gold standard for the revenue of slave holders. Indeed, the practice of hiring slaves out for other activities was quite common. In fact, the proportion of slaves under hire in Richmond during 1860 was over fifty percent (Fogel and Engerman, 1974). Evans asserts that rates of return ranged between 9.5 and 18.5 percent between 1830 and 1860. The results from chapter 1 indicate that the risk-adjusted returns from the institution of slavery were higher than those that could be expected from financial instruments and textile manufacturing for much of the antebellum period. The structure of this paper is as follows. In section 2.2, we state the natural limits hypothesis and discuss its implications and treatment in the literature. Section 2.3 deals with the westward expansion of slavery. In section 2.4, we describe how the data was collected and summarize the data to compare it with results from previous studies. In section 2.5 we provide a brief introduction to auction theory. In section 2.6 we develop the econometric model and present the results. Section 2.7 concludes the chapter and the dissertation.

2.2. The Natural Limits Hypothesis and the Future of Slavery

Ramsdell (1929) propagated the ‘natural limits’ thesis, which essentially holds that climate and soil effectively set a geographical limit to the extension of slavery. In fact, Ramsdell posited that this natural limit had been reached by 1860. As noted earlier, Genovese (1965) and Conrad and Meyer (1958) subscribe to the related view that slavery in the Old South could not survive (at least profitably) without westward expansion and profits from the slave trade. The continued degradation of the soil in the more established slave states as well as the perverse lowering of the price of cotton due to interregional migration/trading make this argument intuitively appealing. The powerful
sentiment of southerners concerning the westward expansion of slavery further fortifies this conclusion. The argument could be made that concern over the complete banning of slavery due to loss of political power (fewer slave states relative to free states) was the true worry of southerners. However, this hypothesis is undermined by the fact that secession would have been an absolute certainty in that case. The complete outlawing of slavery was not politically tenable (the Dred Scott decision in 1857 made the banning of slavery impossible without a constitutional amendment), and southerners were completely aware of it. Evans (1962) stated that the majority of westward expansion took place between 1830 and 1840 and was virtually complete by 1850. This statement is supported by our results, but it is unclear how he came to this conclusion. We will take an agnostic view of when the expansion occurred to determine its effect.

Fogel and Engerman (1974) combat the natural limits hypothesis and the ultimate viability of slavery through other means. They begin by constructing a practical and testable interpretation of the natural limits hypothesis. That is, a rise in the ratio of slave labor would have eventually doomed the institution. This hypothesis rests on the assertion that slave labor could not have been used for anything other than cotton production. The slave hiring results from Chapter 1 of this dissertation provides ample evidence that this assertion is unfounded. Fogel and Engerman reach the same conclusion by estimating that slave prices would have increased in the absence of the Civil War. Slave prices increase because cotton demand remained strong after the war and land devoted to cotton production increased.

Fogel and Engerman continue to combat the assertion that slavery was doomed through examining urban slavery during the antebellum period. They point out that urban
slavery was not in a steep decline before the war despite the drop in urban slave population. They argue that the primary phenomenon was a move to lower South cities from the urban areas of the Upper South. Fogel and Engerman also observe that the urban population of slaves had an inverse relationship with the price of cotton. This indicates that slave labor could compete effectively with free labor when the rate of return to cotton production did not allow for higher returns. In other words, rental rates were more attractive when cotton prices were relatively low. The cities with the largest drop in slave population also had the largest influx of immigrant labor. Slaves were simply moved to urban areas in which the labor supply was relatively scarce. One cannot conclude from the available evidence that slave labor was unable to effectively compete with free labor in urban rental markets.

Fogel and Engerman's final argument is that slaveowners were optimistic. They construct a sanguinity index defined by the ratio of the average sales price of slaves over the average rental rate. Since the purchase of a slave would generally be a decision based on expectations over a much longer time period than that of renting a slave, this ratio serves as a useful gauge of the optimism of slaveowners. Fogel and Engerman find that the ratio increased in the New South from 1841-1860 and rose in the Old South from 1851-1860.

Evans also considers the broader question of slavery’s ultimate viability. Evans posits that, if slavery were actually moribund, that (1) the demand for slaves would have decreased, (2) the slave birth rate would have slowed, (3) and there would have been less demand for female slaves. We would like to add that cotton farmers would have likely started shifting out of the industry if it were indeed moribund. This did not occur. Slave
prices increased substantially during the period, as Evans presents in his paper based on the estimates of Phillips. Fogel and Engerman’s (1974) large sample collected from the New Orleans notarial archive traces a similar pattern (see Figure 2.1 on page 70). Factor (2) is irrelevant since evidence for intervention in slave reproduction during the antebellum period is skimpy. Otherwise, this rate is beyond the control of the slaveowner. In any event, the best available data indicates that birth rates were relatively stable over the entire period (Evans, 1962). Evans also shows that the ratio of female/male prices generally rose slowly over between the years of 1842 and 1860. The only argument Evans provides in favor of a declining industry is that agitation over whether a state would be admitted as slave or free tends to support Ramsdell’s hypothesis that slavery was reaching its natural limits. A more benign explanation of this phenomenon is that more southerners wanted to enter cotton production industry.

The literature is mixed on the future of slavery. Conrad and Meyer (1958) conclude that the transfer of slaves to the New South was propping up the institution in the Old South. This argument supports the proposition that slavery was ultimately doomed, though the time frame of extinction could be debated. Fogel and Engerman (1974) and Evans (1962) find that slavery was on a firm footing throughout the South. A more technical evaluation of the effect of westward expansion on slave prices will help inform us, since a strong effect would indicate that the price increase was unsustainable.

2.3. Westward Expansion and its Effect on the Price of Slaves

The most obvious route to take in analyzing the effect of westward expansion on slave prices, and thus on profitability in the Old South, would be to examine the historical data on westward expansion. The best available estimates are that approximately
835,000 slaves were moved from the Old South to New South states between 1790 and 1860 (Goldin, 1972 and Calderhead, 1972). Fogel and Engerman (1974) claim that the low percentage of inter-regional sales indicates that intervention in slave reproduction was not occurring in the Old South. This inference neglects the possibility that prospective migrants procured slaves before they actually moved. Procurement before relocation would be eminently sensible because of the presumably large transaction costs associated with returning to acquire slaves. It is difficult to imagine that migrants would sit idle at their new home and then suddenly realize slaves would be needed. Indeed, Pritchett (1998) and Tadman (1989) estimate that the percentage of migrating slaves originating out of the slave trade was fifty and sixty percent, respectively.

Another way to approach this problem is to construct an equilibrium model and attempt to draw conclusions concerning the effect of westward expansion on the price of slaves. Obviously, westward expansion would tend to inflate slave prices due to increased demand, but the resulting decrease in the price of cotton would tend to decrease the value of the labor producing that cotton. Passell and Wright (1972) and Kotlikoff and Pinera (1977) conclude that the suppression of cotton prices involved with the selling of slaves to those in the west overwhelmed the increase in demand for slaves, so westward expansion had a net negative effect on the prices of slaves. As Schmitz and Schaefer (1981) note, the negative results of both papers depend crucially on the price elasticities of both cotton and land. Schmitz and Schaefer contend that Passell and Wright and Kotlikoff and Pinera used poor estimates of these price elasticities, causing their results to be severely flawed. Schmitz and Schaeffer then utilize the arguably more reliable elasticity estimates of Wright (1971). They were then able to conclude that expansion
had a slightly positive effect on the prices of slaves. Clearly, the explicit dependence on a proper specification of these elasticities continues to be an issue.

In this paper, we drop any reliance on price elasticities. The vital assumption will be that bidders’ individual values assigned to slaves available for auction follow a certain distribution, in this case a lognormal distribution with a specified standard deviation. It could certainly be the case that this assumption is every bit as onerous as assumptions concerning elasticities, so we will find it necessary to test the sensitivity of the results to violations of this assumption in later work. Regardless, we obtain a result that is wholly independent of any others currently in the literature.

Choo and Eid (2007) also purport to estimate the number of bidders in New Orleans slave auctions. They used Fogel and Engerman’s (2000) New Orleans slave sale sample to derive their results. Fogel and Engerman never claim that their sample consists entirely of sales conducted via auction. In fact, slave sales were conducted in a wide variety of ways. Indeed, we noted many sales were explicitly completed by private sale during the data collection process at the New Orleans Notarial Archives. Fogel and Engerman’s data was collected from the same archive, and they did not report whether a sale was conducted through auction or private sale. Furthermore, Choo and Eid do not estimate the number of bidders through the auctions themselves. We examine their methodology later in this chapter and relate their findings to our own.

Our approach will be to utilize the techniques of Laffont, Ossard, and Vuong (1995) to estimate the number of bidders in an auction. Therefore, we will find it possible to separate the effects of an increase in demand (represented by an increase in the number of bidders), and the mean intrinsic value bidders assign to the slaves offered for auction in
New Orleans between 1840 and 1860. Therefore, we plan to separate the effects of westward expansion from the buyers’ perceptions of the value of slave labor. A large increase in the number of bidders would point to westward expansion as the primary catalyst for price growth, while a decrease indicates slaves were becoming more valuable. The implications for the imminent demise of slavery in the Old South are clear: an increase in the intrinsic value of slave labor was necessary for the perpetuation of intervention in slave reproduction as the basis of profit because the ‘natural limits’ theory would eventually carry the day due to an always limited amount of arable land.  

2.4. Description of the Data, Data Collection, and Comparison with the Private Sale of Slaves

Slave auction data was collected from the New Orleans Notarial Archive\(^{28}\). The observations were obtained through a manual search of individual notarial acts concerning the sale of slaves. Each notary collected his/her acts in a ledger which were not sorted by transaction type. Therefore, all the acts in a notarial ledger were skimmed to determine whether they concerned the auction of a slave. Some notarial ledgers were written in Creole French and some were written in English. When it was determined that a notarial act concerned the auction of slave(s), the relevant information was collected from the act. Data was not collected if it was not explicitly stated that the sale was facilitated by use of an auction. Since a notarial act was a legal document, the data collected in this manner is likely to be quite accurate. The acts were categorized by notary and then by year within each notary.

\(^{28}\) The New Orleans Notarial Archives is a repository of signed acts compiled by the notaries of New Orleans, Louisiana between the years of 1731 and 1970. More information can be obtained at http://www.notarialarchives.org.
For several reasons, the collected data cannot totally be considered a random sample of slave sales between 1840 and 1860. First of all, our sampling was designed to gather data from specified individual years so some years have been missed. Secondly, a subset of notaries known to specialize in estate sales was selected for searches. Therefore, other biases that could result from these notaries' clienteles could be present.

The current analysis examines data from slave auctions occurring between the years 1840 and 1860. Selecting such a relatively short window of time allows for control of such variables as political climate and number of slaves on sale in the market. Since information concerning many economic variables is not available for this time period, the effects of many potentially confounding variables cannot be adequately captured.

The dataset contains information concerning the year of the auction, age, sex, and skills of the slave, notary recording the act, the population of New Orleans, the price of cotton, and the productivity of slaves in general during the years in question. The only variables not available from the notarial archives are the population of New Orleans, the price of cotton, and the productivity of slaves. The population of New Orleans for the years 1840, 1850, and 1860 was collected from the U.S. Census for those years. In the intervening years, an exponential growth rate was assumed. The price of cotton and the productivity of slaves were taken from Conrad and Meyer (1958). Data is available for over half of the years between 1840 and 1860.

It will be useful to compare summary statistics from our data to those presented in Kotlikoff (1978) and Fogel and Engerman (1974)\(^{29}\) to get an indication whether our data

\(^{29}\) Kotlikoff uses the data from Fogel & Engerman (1977). For convenience, we will label this data as F&E.
are comparable to that used in those studies. We might first want to compare yearly means for slave prices. Figure 2.1 below summarizes these means.

Figure 2.1. Mean Slave Price by Year

Figure 2.1 compares the temporal patterns of slave prices of our data with Fogel and Engerman (1974) and Phillips (1929). The downturn in prices seen in 1857 in this data is not seen in Fogel and Engerman, but their data does indicate a downturn in prices around 1855. The upturn in prices in 1841 is also not seen in Fogel and Engerman’s data, but it is a very minor up tick in this data considering the sample size. These summary statistics are also consistent with those given by Phillips (1929). Not only do prices seem to follow a similar time pattern, but the overall mean price levels appear to be consistent.

We also want to investigate whether there is a gender premium involved, since much is made of this in the literature due to the hypothesis of intervention in slave reproduction. We find that there is a 36% premium for buying a male versus a female in this dataset. This is alarming because the literature suggests a 10-15% premium for

30 Data from Phillips (1929) estimated from Chart 1 in Kotlikoff (1977).
31 A more complete summary of the data is included in the data appendix.
males relative to females. There is a 15% premium in Fogel and Engerman's data. If anything, this provides more strength for our private values assumption because, if reproductive intervention were a major concern for these particular slaves, we would not see such a large gender premium. It appears clear that these slaves were being bought for use as field hands and not for resale. This significant discrepancy should be kept in mind when we analyze our results later on in the paper.

We can also investigate how sales price varies with age. Significant differences could arise in the price/age profile for a number of reasons, for example differing compositions of house slaves as opposed to field hands in auction sales versus regular sales.

In Figure 2.2, we present the results of a polynomial regression using age to explain price. Our data has a more pronounced slope, but the general relationship is almost identical to that found by fitting the same model to Fogel and Engerman's data\textsuperscript{32}.

\textsuperscript{32} A third-order polynomial was utilized. All of the parameter estimates were statistically significant ($p < 0.10$) at this level.
Next we estimate an exploratory reduced-form model of winning bids to compare to Kotlikoff's (1978) results for the sale of slaves for the years 1804 to 1862. Kotlikoff's dependent variable is the logarithm of the relative price, so this analysis will be consistent:

$$\ln b_n^{(2)} = \ln y_n^{(2)} = x_n'\beta + \varepsilon$$

where $b_n^{(2)}$ is the observed price, $x_n$ is the vector of explanatory variables, and $\varepsilon$ represents the error term. For now, we will assume that the errors on the bids that are observed are normally distributed. We will no longer assume this when we move beyond exploratory data analysis. Table 2.1 summarizes the results of this model.
Table 2.1. Regression Analysis Results

<table>
<thead>
<tr>
<th>Explanatory Variable</th>
<th>Coefficient</th>
<th>t-Stat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept*</td>
<td>-6.096</td>
<td>-2.76</td>
</tr>
<tr>
<td>Ln(Age)*</td>
<td>7.224</td>
<td>5.32</td>
</tr>
<tr>
<td>Ln(Age)^2</td>
<td>-1.180</td>
<td>-5.62</td>
</tr>
<tr>
<td>Gender*</td>
<td>0.2735</td>
<td>4.82</td>
</tr>
<tr>
<td>Skills</td>
<td>0.0730</td>
<td>0.829</td>
</tr>
<tr>
<td>Ln(Cotton price)*</td>
<td>0.7033</td>
<td>4.84</td>
</tr>
</tbody>
</table>

* - statistically significant at the 1% level

Although Kotlikoff splits the decades into separate regressions, we can comment on some similarities and differences in our results. Unlike Kotlikoff, we find that skills are not statistically significant. However, we agree with Kotlikoff on the signs and statistical significance of the age parameter estimates. In addition, both models find that gender is statistically significant.

In summary, although our data exhibits more variation than the data seen in earlier studies, it appears the data is, for the most part, consistent with other studies. The most important difference between our new data and others is that the gender premium is much higher than in other studies. As noted, this result actually helps solidify our private values assumption because such a large gender premium suggests the females were not being bought for intervention in slave reproduction. This is intuitively appealing because these slaves were to be working some of the most fertile crop land in the world, so short-term efficiency was important.
2.5. Brief Background on Auction Theory

Before auction data can be analyzed, several issues need to be addressed. The first concerns the format of the auction; the equilibrium strategy chosen by bidders will depend in a fundamental manner on how the auction is conducted. From the discussion in Phillips (1929), it is clear that slave auctions were conducted using a typical second-price ascending auction. That is, higher prices were barked by the auctioneer until only one bidder remained.

The second issue is whether bidders assigned a common or private value to a slave being auctioned. That is, we must decide whether bidders evaluated worth based entirely on their own valuation (pure private value auction), completely based on the valuation of others, including perhaps an expert (pure common value auction), or by some combination of the two (affiliated value auction). Fogel and Engerman (1974) and Fogel (1989) indicate that slaves were almost always purchased for private use by pointing out that the great majority of slave sales were estate sales. That is, plantation owners typically did not sell slaves unless they were bankrupt. As mentioned previously, slave sales were mandated in New Orleans when ownership of slaves was not specified in a will. Therefore, the fact that a strong secondary market existed is mitigated by the fact that secondary sales were seldom conducted under ordinary circumstances, otherwise the slaves were to be utilized by the buyer until one of their deaths. A supporting reason for a private values framework is that the slaves sold in the auctions we are investigating were to be working some of the most fertile fields in the country. It would appear counterintuitive to resell if the owner was planning to use the slave in the most
productive manner possible. We will assume that slave auctions were private-value auctions\textsuperscript{33}.

With these two key issues in mind (in addition, we will assume that bidders’ private values are drawn independently from the same distribution), we can turn our attention to developing the theoretical model. Vickrey (1962) established that a weakly dominant strategy in a second-price ascending auction is to bid one’s true value, or

\[ b_{i,l} = v_{i,l} \]

where \( l \) represents the \( l \)-th auction and \( i \) represents the \( i \)-th bidder. Therefore, the payoffs for individual bidders are

\[ \pi_i = v_i - \max_{j \neq i} b_j \]

if the bidder wins the auction (\( b_i > \max_{j \neq i} b_j \)). Clearly, the payoff is zero if the highest bid bidder does not win the auction. Finally, the expected payment for bidder \( i \) is

\[ m(v) = \Pr(Win) \times E[2nd \text{ highest bid } | v \text{ is the highest bid}] = \Pr(Win) \times E[2nd \text{ highest bid } | v \text{ is the highest value}] \]

Myerson (1981) and Riley and Samuelson (1981) established that, if values are independently and identically distributed and all bidders are risk neutral, then all standard auctions yield the same expected revenue to the seller. This implies that we may use results applying to first-price auctions when these assumptions are met. Therefore, we may utilize the general methodology of Laffont, Ossard, and Vuong (1995) to analyze the New Orleans slave auctions. As Laffont, Ossard, and Vuong mention, we will be able to obtain structural estimates of the parameters under the private-values framework.

\textsuperscript{33} In fact, we are not able to identify the parameters in our model if slaves were a pure common value good (Athey and Haile 2000).
2.6. Econometric Methods and Results

The method of simulated non-linear least squares (SNLLS) of Laffont, Ossard, and Vuong (1995), based on the work of McFadden (1995) and Pakes and Pollard (1989), is appropriate for the analysis of independent and private-value auctions with an assumed distribution of private values. Ordinarily, maximum likelihood methods would be a compelling choice, but, maximum likelihood estimation is more problematic for our primary goal, that is, for estimating the number of bidders. We can begin to appreciate the difficulties involved by specifying the model. Since slave auctions were oral-ascending auctions, specifying the cumulative distribution of the second-order statistic for bids whose logarithm is normally distributed provides a convenient starting point:

\[ F_w(w \mid N_i) = N_i (N_i - 1) \int_0^{F_{F'}(w)} u^{N_i - 2} (1 - u) du \]

\( N_i \) represents the number of bidders in the \( i \)-th auction and \( w \) represents the price-setting bid. If we carry out the integration, we obtain

\[ F_w(w \mid N_i) = N_i F_{F'}(w)^{N_i - 1} (N_i - 1) F_{F'}(w)^{N_i} \]

Taking the derivative yields the probability density

\[ f_w(w \mid N_i) = \frac{N_i (N_i - 1)}{w \sigma} \Phi \left( \frac{\log(w) - \mu}{\sigma} \right)^{N_i - 2} \left[ 1 - \Phi \left( \frac{\log(w) - \mu}{\sigma} \right) \right] \phi \left( \frac{\log(w) - \mu}{\sigma} \right) \]

From this equation, the log-likelihood is found to be
\[
\ell(\mu, \sigma; w, N) = \sum_{i=1}^{T} \log [N_i (N_i - 1)] + \sum_{i=1}^{T} (N_i - 2) \log \left[ \Phi \left( \frac{\log(w_i) - \mu}{\sigma} \right) \right] \\
+ \sum_{i=1}^{T} \log \left[ 1 - \Phi \left( \frac{\log(w_i) - \mu}{\sigma} \right) \right] + \sum_{i=1}^{T} \log \left[ \phi \left( \frac{\log(w_i) - \mu}{\sigma} \right) \right] \\
+ \sum_{i=1}^{T} \log w_i - T \log(\sigma)
\]

The difficulty arises from the second term. This is the only term in the equation in which the number of bidders interacts with the logarithm of the cumulative distribution function evaluated at the winning bid. Since the cumulative distribution function is bounded above by one, the logarithm will necessarily be negative. The term inside the cumulative distribution function can be thought of as the normalized difference between the logarithms of the actual and predicted bids. If the actual bid is lower than the predicted bid, this number will be negative, and the converse will be true for bids exceeding the predictions. For years in which our model consistently predicts a winning bid higher than the observed bid, the estimated number of bidders will be the lower bound. For years in which our model predicts lower winning bids than what is observed, the estimated number of bidders will be the upper bound. Barring some reasonable way to constrain the likelihood, simulated non-linear least squares is preferred over maximum likelihood estimation. In addition, maximum likelihood estimation is designed for estimation when the number of bidders is known. The number of bidders is not normally a parameter to be estimated. With those caveats in mind, the number of bidders estimated through maximum likelihood estimation can serve as a useful check of our simulated non-linear least squares estimates. Limits can be set on the number of bidders, and we can observe which years go to the lower and upper bounds. The results of this approach will be reported after the simulated non-linear least squares estimates.
Several non-parametric and semiparametric methodologies have been developed for the empirical analysis of auctions. Generally, auction models are non-parametrically unidentified unless the number of bidders is known (Athey and Haile, 2002). However, recent papers have identified special situations when identification is possible. Song's (2004) technique requires information be used from the third highest bid. Since we possess only the winning bid, Song’s methodology cannot be implemented. Adams (2006) was able to establish identification without use of the third-highest bid. This result depends on the existence of a variable that alters the distribution of the number of bidders but does not affect valuations. We have been unable to identify such a variable for use in this study. Finally, Bayesian techniques such as those utilized in Bajari and Hortascu (2002) require that the bidding function be linearly scalable. This assumption is violated by our structural form.

Laffont, Ossard, and Vuong’s methodology allows straightforward estimation of the number of bidders. In addition, Laffont, Ossard, and Vuong’s estimator is consistent and asymptotically normal. Under our assumptions and considering our objectives, the SNLLS estimator is a compelling choice.

In the method of SNLLS, the distance between the observed winning bid and simulated winning bids is minimized. That is, the most intuitively appealing objective function is

\[ Q_{s,t}(\theta) = \frac{1}{L} \sum_{l=1}^{L} (b_i^w - \overline{X}_l(\theta))^2 \]

where \(L\) = number of auctions

\(s\) = number of simulations per auction

\(b_i^w\) = winning bid for \(i\)-th auction

\(\overline{X}_l(\theta)\) = simulated winning bid for \(l\)-th auction
As shown in Laffont, Ossard, and Vuong, the estimator of $\theta$ that would result from such a minimization would be inconsistent. We introduce a bias correction term

$$\Delta_{S,L} = \frac{1}{L} \sum_{l=1}^{L} \frac{1}{S(S-1)} \sum_{s=1}^{S} (X_{l,s}(\theta) - \bar{X}_{l}(\theta))^2$$

so that

$$Q_{S,L}(\theta) = \frac{1}{L} \sum_{l=1}^{L} \left[ ((b_{l}^{w} - \bar{X}_{l}(\theta))^2 - \frac{1}{S(S-1)} \sum_{s=1}^{S} (X_{l,s}(\theta) - \bar{X}_{l}(\theta))^2 \right]$$

is our objective function, and our estimator will be the $\hat{\theta}$ resulting from minimizing this function. We can then use the results from Pakes and Pollard (1989) to establish that the given estimator will be consistent and asymptotically normal. We will utilize the fact that

$$Eb_{l}^{w} = E[\max(v_{l,t-1}, p_{l}^{0})]$$

where $p_{l}^{0} =$ reservation price (assumed zero here because these were estate sales) to stimulate the first moment of $b_{l}^{w}$. As in Laffont, Ossard, and Vuong, estimation of the number of bidders will proceed utilizing a grid search methodology. The simulated bids will then be generated using the model

$$E \ln b_{n}^{w} = E \ln b_{l}^{(2)} = E \ln v_{l}^{(2)} = x_{l}^{'} \beta + \ln \rho_{n}^{(2)}$$

The distributional assumption comes into play here in that the error term $\rho_{n}^{(2)}$ is an order statistic of the simulated lognormal error terms. Estimates of the parameters $\beta$ are then determined utilizing standard minimization routines. The covariance matrix was generated using the asymptotic approximation

$$\hat{\Sigma}_{S,L} = \hat{A}_{S,L}^{-1} \hat{B}_{S,L} \hat{A}_{S,L}^{-1}$$

with
\[ \hat{A}_{S,L} = \frac{1}{L} \sum_{j=1}^{L} [\frac{\hat{Y}_j(\hat{\theta}) \bar{Y}_j(\hat{\theta})}{\bar{Y}_j(\hat{\theta})} - \frac{1}{S(S-1)} \sum_{s=1}^{S} (Y_{s,j}(\hat{\theta}) - \bar{Y}_j(\hat{\theta}))(Y_{s,j}(\hat{\theta}) - \bar{Y}_j(\hat{\theta}))'] \]

\[ \hat{B}_{S,L} = \frac{1}{L} \sum_{j=1}^{L} d_{S,j}(\hat{\theta})d_{S,j}(\hat{\theta})' \]

\[ d_{S,j}(\hat{\theta}) = (b_i^* - \bar{X}_j(\hat{\theta}))\bar{Y}_j(\hat{\theta}) + \frac{1}{S(S-1)} \sum_{s=1}^{S} (X_{s,j}(\hat{\theta}) - \bar{X}_j(\hat{\theta}))Y_{s,j}(\hat{\theta}). \]

This estimator was proven consistent by Laffont, Ossard, and Vuong.

The right-hand side variables included the age of the slave, age squared, gender, a dummy to indicate whether the slave was skilled, the price of cotton, and the productivity of slaves using results from Conrad and Meyer (1958). The parameter estimates and their associated p-value range are listed in Table 2.2. It should be noted that the overall standard deviation was chosen to be consistent with the data presented in Phillips (1929).

### Table 2.2. Results for Model 1

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient Estimate</th>
<th>P-value range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>6.6391</td>
<td>p &lt; 0.05</td>
</tr>
<tr>
<td>Gender</td>
<td>0.4016</td>
<td>p &lt; 0.05</td>
</tr>
<tr>
<td>Ln(Age)</td>
<td>-0.7657</td>
<td>p &lt; 0.05</td>
</tr>
<tr>
<td>[Ln(Age)]²</td>
<td>0.0908</td>
<td>p &lt; 0.05</td>
</tr>
<tr>
<td>Skill dummy</td>
<td>0.3471</td>
<td>p &gt; 0.10</td>
</tr>
<tr>
<td>Ln(Price of cotton)</td>
<td>0.6931</td>
<td>p &gt; 0.10</td>
</tr>
<tr>
<td>Ln(Productivity)</td>
<td>0.9814</td>
<td>p &lt; 0.05</td>
</tr>
</tbody>
</table>

The signs on the parameter estimates agree with our intuition. Since the relationship between price and age is clearly more complicated (see graph by age) than a
simple linear relationship, the squared term was added and found statistically significant. In addition, some of our results confirm the points noted in our descriptive statistics. The gender premium in our data was much larger than in previous studies, and so we are not surprised that the dichotomous variable gender is statistically significant in our structural modeling results. It is not possible to conclude much from relative sales price by gender because females were almost as productive as males when not pregnant or raising children, and, if intervention in slave reproduction was the goal of the purchase, we would expect a premium price despite the loss of productivity. It is therefore impossible to separate these effects without being able to track each slave after purchase. In addition, there are more statistical outliers for the females in this population, as a very disproportionate share of the females had a sales price of below $500. Since the private value assigned to a slave appears (with strong intuitive appeal) to have been low at very advanced ages, the negative coefficient for ln(age) is in line with what common sense would tell us. It is not surprising that the estimates for the price of cotton and slave productivity are positive. As indicated in Conrad and Meyer (1958), the price of cotton was certainly not monotonic during this period of time, so this variable was included to explain the possible effects of speculation on price. It is interesting to note, however, that the price of cotton is not statistically significant in explaining price. The results for estimating the number of bidders by year are listed in Table 2.3. In some cases, multiple years were aggregated in order to increase that cell's sample size.\footnote{For auctions within a single year, this assumption is not as strong as it seems, since auctions were often conducted on the same day. Across years this grouping becomes more problematic. In order to minimize the effects of this grouping, we chose natural clusters of years so that there was always a gap of at least one year between groupings.}
Table 2.3. Estimating the Number of Bidders – Model 1

<table>
<thead>
<tr>
<th>Year(s)</th>
<th>Estimated Number of Bidders</th>
</tr>
</thead>
<tbody>
<tr>
<td>1840</td>
<td>2</td>
</tr>
<tr>
<td>1841-1842</td>
<td>16</td>
</tr>
<tr>
<td>1845-1848</td>
<td>7</td>
</tr>
<tr>
<td>1850</td>
<td>4</td>
</tr>
<tr>
<td>1853-1854</td>
<td>10</td>
</tr>
<tr>
<td>1856-1858</td>
<td>5</td>
</tr>
<tr>
<td>1860</td>
<td>4</td>
</tr>
</tbody>
</table>

These results certainly seem counterintuitive. One would expect the number of bidders to increase, if for nothing else, because the population of New Orleans increased by a large amount during this period. We see that, if anything, the number of bidders decreased between 1840 and 1860. As remarkable as this result appears, Choo and Eid (2007) reached a similar result using a different method of estimation. As discussed previously, Choo and Eid’s study does not examine auctions exclusively, but their estimation of the number of bidders in the auctions is independent of their other econometric results. They estimate the number of bidders through the equation

\[ n_y = \frac{1}{30} \left( \frac{m_y}{\sum_{i=1}^{12} m_i} h_y + m_y \right) \]

where \( m_y \) = the weighted number of sales in month \( i \) in year \( y \)
and \( h_y \) = the number of hiring transactions in year \( y \)
In their words, "our estimate of the number of bidders is equal to the sum of the number of sales transactions and the number of hiring transactions weighted by the relative proportion of sales transactions for that month, divided by thirty days." Including the number of hiring transactions helps frame demand for the services of slaves since such transactions were not mandated by law. Even though, as explained in the previous chapter, a fair number of the slave sales were mandated by law, the total number of sales should also correlate positively with the number of relative number of bidders. While there are problems with this method of estimation, the resulting estimates are credible on a relative basis. The trend in Choo and Eid's estimated number of bidders is consistent with the decreasing trend found in this study and serves as a completely independent estimation methodology finding similar results.

Before attempting to explain this result, we will verify that the result is not sensitive to slightly different specifications of the model. Removing the skill dummy from the analysis, we get the results presented in Tables 2.4 and 2.5.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient Estimate</th>
<th>P-value range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>6.5814</td>
<td>p &lt; 0.05</td>
</tr>
<tr>
<td>Gender</td>
<td>0.3903</td>
<td>p &lt; 0.05</td>
</tr>
<tr>
<td>Ln(Age)</td>
<td>-0.6189</td>
<td>p &lt; 0.05</td>
</tr>
<tr>
<td>[Ln(Age)]^2</td>
<td>0.0713</td>
<td>p &lt; 0.05</td>
</tr>
<tr>
<td>Ln(Price of cotton)</td>
<td>0.6341</td>
<td>0.10 &lt; p &lt; 0.15</td>
</tr>
<tr>
<td>Ln(Productivity)</td>
<td>0.9516</td>
<td>p &lt; 0.05</td>
</tr>
</tbody>
</table>
We see that the results are largely unaffected by this change. The price of cotton is now borderline significant (at the 0.10 level). Both age terms retain both their signs and statistical significance. Table 2.5 confirms this model’s robustness to this minor change. The number of bidders has remained constant for each grouping. Our overall conclusions still hold.

Table 2.5. Estimating the Number of Bidders – Model 2

<table>
<thead>
<tr>
<th>Year(s)</th>
<th>Estimated Number of Bidders</th>
</tr>
</thead>
<tbody>
<tr>
<td>1840</td>
<td>2</td>
</tr>
<tr>
<td>1841-1842</td>
<td>16</td>
</tr>
<tr>
<td>1845-1848</td>
<td>7</td>
</tr>
<tr>
<td>1850</td>
<td>4</td>
</tr>
<tr>
<td>1853-1854</td>
<td>10</td>
</tr>
<tr>
<td>1856-1858</td>
<td>5</td>
</tr>
<tr>
<td>1860</td>
<td>4</td>
</tr>
</tbody>
</table>

In order to control for possible spurious results due to multiple slaves being sold at the same time (typically, a mother and child), we include an indicator variable for this. The number of bidders is not affected. We see that neither the parameter estimates nor the estimates of the number of bidders are affected much by alternative specifications of the model.
Table 2.6. Results for Model 3

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient Estimate</th>
<th>P-value range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>6.8642</td>
<td>( p &lt; 0.05 )</td>
</tr>
<tr>
<td>Gender</td>
<td>0.3098</td>
<td>( p &lt; 0.05 )</td>
</tr>
<tr>
<td>Ln(Age)</td>
<td>-0.7912</td>
<td>( p &lt; 0.05 )</td>
</tr>
<tr>
<td>([\text{Ln}(\text{Age})]^2)</td>
<td>0.0898</td>
<td>( p &lt; 0.05 )</td>
</tr>
<tr>
<td>Multiple</td>
<td>0.3430</td>
<td>( p &gt; 0.10 )</td>
</tr>
<tr>
<td>Ln(Price of cotton)</td>
<td>0.6685</td>
<td>( p &lt; 0.05 )</td>
</tr>
<tr>
<td>Ln(Productivity)</td>
<td>0.9460</td>
<td>( p &lt; 0.05 )</td>
</tr>
</tbody>
</table>

As mentioned previously, maximum likelihood estimation can provide useful verification of the estimated number of bidders. Due to the limitations of maximum likelihood estimation in this regard, the number of bidders for each period was bounded below by three and above by twenty. The results are listed in Table 2.7. If the model returned three as the estimated number of bidders, lower bound (represented by \( L \)) is reported in the table, while upper bound (represented by \( H \)) is listed when the estimated number of bidders is twenty.

The overall pattern in Table 2.7 is consistent with that of our SNLLS results. The number of bidders did not display an increasing trend, though it is unclear whether the number of bidders was decreasing using this methodology. The sign of the parameter estimates were consistent with those obtained through SNLLS.
Table 2.7. Maximum Likelihood Estimation - Number of Bidders

<table>
<thead>
<tr>
<th>Year(s)</th>
<th>High or Low Limit for Number of Bidders</th>
</tr>
</thead>
<tbody>
<tr>
<td>1840</td>
<td>L</td>
</tr>
<tr>
<td>1841-1842</td>
<td>H</td>
</tr>
<tr>
<td>1845-1848</td>
<td>H</td>
</tr>
<tr>
<td>1850</td>
<td>L</td>
</tr>
<tr>
<td>1853-1854</td>
<td>H</td>
</tr>
<tr>
<td>1856-1858</td>
<td>L</td>
</tr>
<tr>
<td>1860</td>
<td>L</td>
</tr>
</tbody>
</table>

It should also be noted that this non-increasing trend in the number of bidders is robust to various distributional assumptions and model specifications. Numerous models were fit using both the gamma and logistic distributions, and none of the models detected an increasing trend. In fact, the estimated number of bidders is the most stable quantity in the estimations other than the effect of productivity on sales price. The population of New Orleans was omitted from the models presented here due to concerns its presence would obfuscate any trends in the number of bidders. Including the population of New Orleans in the analysis slightly decreased the estimated number of bidders for most of periods, but the number of bidders did not show an increasing trend. Although one would always like to possess more data, the robustness of this result to various assumptions and the anecdotal evidence that westward expansion was winding down during the last half of the period provide us with a measure of confidence in our conclusions.
2.7 Overall conclusions

From an economic perspective, the institution of slavery was thriving before the Civil War. Furthermore, the evidence presented in this dissertation indicates that it was growing more lucrative, and slaveowners had every right to be optimistic. Not only were profits strong, but there was a healthy and growing demand for slave labor. In the last half of the period 1830-1860, slavery outperformed a typical New England manufacturing industry and also dominated the best-performing financial instruments of the era. Through the ranking of antebellum investments using modern quantitative methods, the institution of slavery has been shown to be a superior performer.

The institution of slavery was more susceptible to severe downturns than were alternative investments, realizing low rates of return compared with the other investments during the Panic of 1837 and its aftermath. Since this was a particularly severe downturn and did not significantly discourage participation in the institution, it is highly unlikely that any downturn short of the magnitude of the Great Depression would have deterred continued exploitation of slave labor.

Demand for slave labor was strong and growing toward the end of the antebellum period. Westward expansion, though clearly a factor, can not completely explain the rapid increase in the average prices of slaves between 1850 and 1860 because the evidence presented here indicates the majority of slave procurement for westward expansion occurred primarily before the decade of the 1850s.

Since the profitability estimates in this research effort were based on rental rates, the demand for slave labor to be used in non-agricultural work was robust. When this result is coupled with relatively high prices for slaves on the auction market, it becomes
clear that this was an institution with a bright financial outlook. Despite the fact that westward expansion was slowing and often frustrated by political events, the institution of slavery was in its economic heyday.

The research performed here suggests several avenues for future research. First, a careful synthesis of the literature and historical data may allow for modernizing the existing estimates for the profitability of slavery based on production technology. The results from such a study could be compared to those reported here. Second, additional data from slave auctions, preferably from multiple data sources and cities, could allow the use of non-parametric estimation. This would be contingent on finding appropriate means of identification, but much progress is being made here, and additional data could provide identification using current theory. Finally, new measures of risk and algorithms for ranking investments can be adapted to evaluate the performance of the institution of slavery during the antebellum period.
Appendix A

Table A.1. Comparison of Rates of Return

<table>
<thead>
<tr>
<th>PERIOD</th>
<th>EVANS</th>
<th>REVISED EVANS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1830-1835</td>
<td>11.25</td>
<td>11.32</td>
</tr>
<tr>
<td>1836-1840</td>
<td>9.5</td>
<td>0.8</td>
</tr>
<tr>
<td>1841-1845</td>
<td>16.4</td>
<td>0.8</td>
</tr>
<tr>
<td>1846-1850</td>
<td>14.8</td>
<td>16.7</td>
</tr>
<tr>
<td>1851-1855</td>
<td>12.9</td>
<td>11.0</td>
</tr>
<tr>
<td>1856-1860</td>
<td>10.8</td>
<td>10.6</td>
</tr>
</tbody>
</table>
Table A.2. Economic Conditions and Important Economic Events: 1830-1860

<table>
<thead>
<tr>
<th>PERIOD</th>
<th>DESCRIPTION AND IMPACT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1830-1836</td>
<td>Rapid growth in spending on improvement projects. Generally prosperous period.</td>
</tr>
<tr>
<td>1835-1841</td>
<td>Retirement of the U.S. government's debt. No long-term debt issued during this period.</td>
</tr>
<tr>
<td>1837-1842</td>
<td>The Panic of 1837 caused a severe economic downturn. A general business recovery did not begin until 1842.</td>
</tr>
<tr>
<td>1857-1860</td>
<td>Relatively mild panic largely brought about by events in Europe.</td>
</tr>
</tbody>
</table>
Table A.3. Baker Companies and Their Years in the Sample

<table>
<thead>
<tr>
<th>COMPANY</th>
<th>ENTRY</th>
<th>EXIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boston</td>
<td>1836</td>
<td>1862</td>
</tr>
<tr>
<td>Merrimack</td>
<td>1836</td>
<td>1887</td>
</tr>
<tr>
<td>Hamilton</td>
<td>1836</td>
<td>1887</td>
</tr>
<tr>
<td>Nashua</td>
<td>1836</td>
<td>1887</td>
</tr>
<tr>
<td>Tremont</td>
<td>1836</td>
<td>1866</td>
</tr>
<tr>
<td>Suffolk</td>
<td>1836</td>
<td>1866</td>
</tr>
<tr>
<td>Lawrence</td>
<td>1836</td>
<td>1862</td>
</tr>
<tr>
<td>Dwight</td>
<td>1843</td>
<td>1887</td>
</tr>
<tr>
<td>Naumkeag</td>
<td>1851</td>
<td>1887</td>
</tr>
<tr>
<td>Pepperell</td>
<td>1853</td>
<td>1887</td>
</tr>
<tr>
<td>Lyman</td>
<td>1855</td>
<td>1887</td>
</tr>
<tr>
<td>YEAR</td>
<td>BOSTON CITY BONDS(^{35})</td>
<td>MASS. BONDS(^{35})</td>
</tr>
<tr>
<td>------</td>
<td>-----------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>1830</td>
<td>4.9</td>
<td></td>
</tr>
<tr>
<td>1831</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1832</td>
<td>5.00</td>
<td></td>
</tr>
<tr>
<td>1833</td>
<td>4.87</td>
<td></td>
</tr>
<tr>
<td>1834</td>
<td>4.87</td>
<td></td>
</tr>
<tr>
<td>1835</td>
<td>4.83</td>
<td></td>
</tr>
<tr>
<td>1836</td>
<td>4.96</td>
<td></td>
</tr>
<tr>
<td>1837</td>
<td>4.95</td>
<td>5.07</td>
</tr>
<tr>
<td>1838</td>
<td>5.01</td>
<td>4.92</td>
</tr>
<tr>
<td>1839</td>
<td>5.21</td>
<td>5.06</td>
</tr>
<tr>
<td>1840</td>
<td>5.07</td>
<td>5.08</td>
</tr>
<tr>
<td>1841</td>
<td>4.99</td>
<td>5.41</td>
</tr>
<tr>
<td>1842</td>
<td>4.95</td>
<td>5.65</td>
</tr>
<tr>
<td>1843</td>
<td>4.88</td>
<td>5.25</td>
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<tr>
<td>1844</td>
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<td>4.87</td>
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<tr>
<td>1845</td>
<td>4.86</td>
<td>4.84</td>
</tr>
<tr>
<td>1846</td>
<td>4.92</td>
<td>5.00</td>
</tr>
<tr>
<td>1847</td>
<td>5.14</td>
<td>5.34</td>
</tr>
<tr>
<td>1848</td>
<td>5.31</td>
<td>5.52</td>
</tr>
<tr>
<td>1849</td>
<td>5.31</td>
<td>5.36</td>
</tr>
<tr>
<td>1850</td>
<td>5.13</td>
<td>5.13</td>
</tr>
<tr>
<td>1851</td>
<td>5.08</td>
<td>5.07</td>
</tr>
<tr>
<td>1852</td>
<td>4.98</td>
<td>5.04</td>
</tr>
<tr>
<td>1853</td>
<td>4.99</td>
<td>5.00</td>
</tr>
<tr>
<td>1854</td>
<td>5.13</td>
<td>5.12</td>
</tr>
<tr>
<td>1855</td>
<td>5.16</td>
<td>5.16</td>
</tr>
<tr>
<td>1856</td>
<td>5.10</td>
<td>5.16</td>
</tr>
<tr>
<td>1857</td>
<td>5.24</td>
<td>5.24</td>
</tr>
<tr>
<td>1858</td>
<td>5.09</td>
<td>5.08</td>
</tr>
<tr>
<td>1859</td>
<td>4.95</td>
<td>4.97</td>
</tr>
<tr>
<td>1860</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^{35}\) Taken from Homer and Sylla (1996)

\(^{36}\) Taken from Evans (1962)
Appendix B. Data Collection and Descriptive Statistics

The data was collected onsite at the New Orleans Notarial Archive in New Orleans, Louisiana. Notarial acts are contained in ledgers for individual notaries. Generally, notaries filled one ledger per year but occasionally notaries would fill more than one volume per year. Estate sales could very easily necessitate more than one act, as land and housing sales would appear under a separate act. The sale of slave(s) was always a separate act so the identification of such an act was straight-forward. It was then determined whether the slave was sold through auction. The sale was included only if the notarial act specifically mentioned that the sale was conducted using an auction.

We now include summary statistics and compare the results to those of Fogel and Engerman when possible:

Table B.1. Mean slave prices in New Orleans auctions for selected years

<table>
<thead>
<tr>
<th>Year</th>
<th>Our Data</th>
<th>Fogel &amp; Engerman</th>
<th>Our Sample Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1840</td>
<td>$735</td>
<td>605</td>
<td>23</td>
</tr>
<tr>
<td>1841</td>
<td>828</td>
<td>626</td>
<td>5</td>
</tr>
<tr>
<td>1842</td>
<td>421.25</td>
<td>540</td>
<td>16</td>
</tr>
<tr>
<td>1845</td>
<td>412.5</td>
<td>490</td>
<td>8</td>
</tr>
<tr>
<td>1848</td>
<td>422</td>
<td>605</td>
<td>14</td>
</tr>
<tr>
<td>1850</td>
<td>520</td>
<td>547</td>
<td>27</td>
</tr>
<tr>
<td>1853</td>
<td>643.33</td>
<td>780</td>
<td>3</td>
</tr>
<tr>
<td>1854</td>
<td>1194</td>
<td>814</td>
<td>13</td>
</tr>
<tr>
<td>1856</td>
<td>983</td>
<td>900</td>
<td>21</td>
</tr>
<tr>
<td>1857</td>
<td>553</td>
<td>998</td>
<td>3</td>
</tr>
<tr>
<td>1860</td>
<td>1169</td>
<td>1157</td>
<td>35</td>
</tr>
</tbody>
</table>
Table B.2. Mean Price by Gender

<table>
<thead>
<tr>
<th>Gender</th>
<th>Our Data</th>
<th>Fogel &amp; Engerman</th>
<th>Our Sample Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>$876</td>
<td>739</td>
<td>101</td>
</tr>
<tr>
<td>Female</td>
<td>646</td>
<td>645</td>
<td>67</td>
</tr>
</tbody>
</table>

Table B.3. Mean Price by Age

<table>
<thead>
<tr>
<th>Age Range</th>
<th>Our Data</th>
<th>Fogel and Engerman</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 - 14</td>
<td>730</td>
<td>545</td>
</tr>
<tr>
<td>15 - 19</td>
<td>858</td>
<td>731</td>
</tr>
<tr>
<td>20 - 24</td>
<td>1034</td>
<td>837</td>
</tr>
<tr>
<td>25 - 29</td>
<td>791</td>
<td>794</td>
</tr>
<tr>
<td>30 - 34</td>
<td>844</td>
<td>737</td>
</tr>
<tr>
<td>35 - 39</td>
<td>565</td>
<td>588</td>
</tr>
<tr>
<td>40 - 44</td>
<td>310</td>
<td>476</td>
</tr>
<tr>
<td>45 - 49</td>
<td>457</td>
<td>411</td>
</tr>
<tr>
<td>50+</td>
<td>238</td>
<td>294</td>
</tr>
</tbody>
</table>

Table B.4. Correlation Matrix for Selected Variables

<table>
<thead>
<tr>
<th></th>
<th>Year</th>
<th>Productivity</th>
<th>Cotton Price</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Productivity</td>
<td>0.834</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cotton Price</td>
<td>0.612</td>
<td>0.515</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Population</td>
<td>0.970</td>
<td>0.913</td>
<td>0.587</td>
<td>1</td>
</tr>
</tbody>
</table>
The gender premium for the data used in this paper was 35%. That is, the average winning bid on an average male slave was 35% than that observed for the average female. The literature suggests a 10-15% gender premium. In explaining the discrepancy, we note that our sample of females was skewed toward the higher ages (as shown in Figure B.1.) and the sample of males contained two influential outliers with very high winning bids (as shown in Figure B.2.). However, even if the outliers are removed from the male sample and the females that were older than any male in the study (older than 51 years old) are excluded, a 25% gender premium remains. Since our mean price for females is almost identical to Fogel & Engerman’s results for females, a natural conclusion is that our sample contains males that were more likely to be prime field hands than other New Orleans slaves sold during this time period.

Figure B.1. Boxplot of Age by Gender
Figure B.2. Boxplot of Price by Gender
References


Martin, J. (1898), *One Hundred Years' History of the Boston Stock and Money Markets.* Boston, MA.


Officer, L. (2005), "What was the Interest Rate Then? A Data Study," University of Illinois-Chicago. Working paper.


