Comparative slave systems: an economic analysis of sugar production in Jamaica and Louisiana

Martin J. Eisenberg
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COMPARATIVE SLAVE SYSTEMS:
AN ECONOMIC ANALYSIS OF SUGAR PRODUCTION
IN JAMAICA AND LOUISIANA

by

Martin J. Eisenberg

Submitted in Partial Fulfillment of the Requirements
of the Senior Scholars Program

COLBY COLLEGE
1982
APPROVED BY:

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CHAIRMAN, DEPARTMENT OF

READER

CHAIRMAN
ABSTRACT

In order to compare slave productivity, this study analyzes institutional and demographic features underlying slavery in Jamaica and Louisiana in the early Nineteenth Century. Louisiana planters received slaves from the interregional redistribution of slaves in the United States. Migration estimates are calculated for the population moving out of Virginia and the population moving into Louisiana. These estimates and demographic data on the populations that do not migrate are used to refute the slave breeding hypothesis.

Jamaican population growth in the absence of slave imports is examined with an effort to explain why Jamaica's population was incapable of reproducing itself. This phenomenon is explained by prime age population erosion where the African population aged and the Creole population was too young to regenerate the population.

The uses of labor and capital in plantation operations are analyzed and a model, based on slave labor constraints, is advanced to explain these uses. This model is then used to explain why Jamaican planters used the steam engine and the hoe while Louisiana planters used the steam engine and the plow in the manufacturing of sugar.

The features underlying slavery are reexamined to formulate the hypothesis that slaves in Louisiana were more productive than slaves in Jamaica. This hypothesis is then empirically verified.
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INTRODUCTION

In the early Nineteenth Century, both Jamaican and Louisiana planters relied on chattel slavery to produce sugar. However, slavery developed differently in the two regions which led to different demographic and institutional features. These features affected the production process for manufacturing sugar. Planters in the two regions employed capital and labor differently. This paper will first examine the production inputs, labor and capital, and then, the productivity of slave labor.

Before the productivity of labor can be assessed, the demographic and institutional features underlying slavery need to be evaluated. First, population inflows into the two regions will be examined. On January 1, 1808, the African Slave Trade was officially closed in Jamaica and the United States. After that date it was illegal to introduce new African slaves into either region. While there was smuggling, Jamaican sugar growers did not receive new African slaves after 1808. Louisiana planters, on the other hand, were part of the United States which allowed the redistribution of slaves within its borders. Therefore, Louisiana was the recipient of slave inflows in the Nineteenth Century. Chapter 1 examines these population flows and assesses whether slaveowners on the Atlantic Seaboard were breeding slaves for sale to the southwest.
Chapter 2 will examine how Jamaican planters were effected by the closing of the African Slave Trade. Since Jamaica's slave population was incapable of reproducing itself, Jamaican planters had relied on the trade to sustain the population. After the trade was closed, the population began to decline. Chapter two assesses what the causes of this decline were.

In Chapter 3, the emphasis shifts to the other factor of production, capital. Planters in the two regions employed different combinations of capital and labor. In this chapter, a model based on labor constraints in the two regions will be advanced to explain the different factor of production decisions.

Finally, Chapter 4 addresses the question of which slave population was more productive. First, the institutional and demographic features will be evaluated to formulate a hypothetical answer to the question. Then, this hypothesis will be empirically tested.
American anti-slavery societies often repeated the charge that southern slaveowners on the eastern seaboard systematically interfered in the sexual lives of their slaves in order to increase offspring which could be sold to the southwest for profit. A typical example of this 'slave breeding' charge is quoted here from the 1837 edition of the Anti-Slavery Record:

The competition of free with slave labor, in the bread-stuffs and other productions of Maryland, Virginia, and North Carolina had greatly diminished the value of slaves, and promised to prepare the way for general emancipation at no distant day. But the rapid extension of the cotton and sugar cultivation, and the settlement of the new states at the south and west, gave to the northern slaves a value as articles of export, which they did not possess as laborers. The three states we have mentioned, denied by their climate the privilege of growing cotton and sugar of late years vigorously prosecuted the business of breeding slaves for the southern market.

The charge can also be found in the works of contemporaries who were not abolitionists. Frederick Olmsted in his book, A Journey in the Seaboard Slave States, cited the following passage from a slaveholder's letter:

In the states of Maryland, Virginia, North Carolina, Kentucky, Tennessee, and Missouri, as much attention is paid to the breeding and growth of

---

negroes as to that of horses and mules.  

Right up to the present, this charge has fascinated historians because of the issue's broader implications summed up by Richard Lowe and Randolph Campbell when they ask, "Did slaveholders actually disregard all considerations of human dignity and deliberately breed slaves as they might have bred their horses?" Answers over the years have varied with some historians answering yes and others no.

HISTORICAL SOLUTIONS TO THE PROBLEM

In order to assess the slave breeding charge, the majority of studies have examined rates of returns, the age


and sex characteristics of the population in the exporting and importing regions, and child to women ratios. Conrad and Meyer's study approached the question from a rate of return perspective. They compared male to female differentials in annual hiring rates and in purchase prices. They found that purchase price differentials were smaller than hiring rate differentials. Since they argued that hiring rates reflected the field value of a slave, the difference in the two differentials reflected the value placed on a female slave for her offspring. More importantly, they found that while Virginia and South Carolina had large differentials in hiring rates between men and women, the purchase prices were almost equal in those two regions. They explain this by arguing, "the old South recognized the market value of its function as the slave-breeding area for the cotton-raising west." The whole line of reasoning rests on the assumption that annual hiring rates reflected the field value of a slave. Male slaves who were hired out were not just fieldhands, many of them were skilled laborers, carpenters and blacksmiths. Female slaves did not possess these skills and were hired out as domestics and fieldhands. These slaves would command a higher price in the hiring market than fieldhands. As a result arguments that rely on the hiring market require further documentation and understanding of that market.

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5 Conrad and Meyer, p. 73.
Fogel and Engerman base their conclusion on the slave breeding issue on the basis of the redistribution of the slave labor force. They argued, "available evidence indicates that about 84% of the slaves engaged in the westward movement migrated with their owners." From this piece of evidence, they calculated the value of breeding slaves to slaveowners on the eastern seaboard and found that it was less than $4 per year. From this, they concluded that slaves were not a substantial product of the seacoast states. The whole argument stems from their estimate of owner accompanied migration. As Herbert Gutman and Richard Sutch argued in Reckoning With Slavery, there is no evidence to warrant this conclusion provided in Time on the Cross. In fact, Fogel and Engerman offer little explanation of how they arrived at the 84% estimate.

Richard Sutch focused on demographic patterns and migration at the state level between 1850 and 1860. He found evidence that fertility levels were higher on the Atlantic seaboard than in the southwest. Moreover, he argued that these fertility levels were biologically high, indicating that owners interfered in the sex lives of their slaves. His work has subsequently been challenged by Lowe

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and Campbell who argued that the differentials did not exist. However, Lowe and Campbell suggested, "the nature of these state-level data conceals evidence of regional specialization."8 They then proceeded to investigate this possibility by studying the demographic patterns on Texas plantations owning more than fifty slaves. In the process of solving the problem, Lowe and Campbell lost evidence of the behavior of smaller planters. The large planters they studied owned only a small percentage of the slaves. Kenneth Stampp found that in 1860 88% of the slaveowners owned less than twenty slaves.9 As an alternative to the Lowe and Campbell examination of large slaveholders, this study will examine the issue by focusing on the county or parish level, which was smaller than the state level but larger than the plantation level.

THE DATA

A study focused on the county or parish level includes both the small and large slaveholders. Another advantage of using counties to study the problem is that all the necessary data is contained in the 1850 and 1860 censuses. In order to prevent the unique behavior of any one county from biasing the data, two samples of counties will be used. A representative sample of exporting counties will be taken.

8 Lowe and Campbell. p. 407.
9 Stampp, p. 31.
from Virginia. These counties appear in Table 1-1 along with their total populations for the years 1840, 1850, and 1860. All of them exhibited a population decline between 1840 and 1850 which ensures that population was leaving the area. The importing sample is comprised of the Louisiana parishes that appear in the lower half of Table 1-1. These parishes first appeared in the Census of 1850. This does not mean that they were unpopulated in 1840, but that they were rapidly growing and by 1850 had a population large enough to warrant calling them independent parishes. These two samples will be used to examine the age and sex characteristics of the two regions' populations in 1850 and 1860, and to examine child to women ratios for the two regions.

THE AGE AND SEX CHARACTERISTICS OF THE MIGRANT POPULATION

The first step in analyzing the slave breeding hypothesis is to examine the domestic slave trade. Since records of slave sales are incomplete, they cannot be used to measure the magnitude or the demographic composition of the domestic slave trade. Instead, migration estimates will be used as a proxy for the magnitude of the slave trade. These estimates by themselves do not prove the

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10 Calderhead attempted to estimate the magnitude of the trade for Maryland from sales records, but as discussed in Chapter Three of Reckoning With Slavery, [David, pp. 94-133.] Calderhead did not take into account the trading that took place in Baltimore and Washington, D.C. which distorted his findings.


<table>
<thead>
<tr>
<th>County/Parish</th>
<th>Population 1840</th>
<th>Population 1850</th>
<th>Population 1860</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Virginia Sample:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brunswick</td>
<td>14,346</td>
<td>13,894</td>
<td>14,800</td>
</tr>
<tr>
<td>Buckingham</td>
<td>18,786</td>
<td>13,837</td>
<td>15,212</td>
</tr>
<tr>
<td>Charlotte</td>
<td>14,595</td>
<td>13,995</td>
<td>14,471</td>
</tr>
<tr>
<td>Cumberland</td>
<td>10,399</td>
<td>9751</td>
<td>9961</td>
</tr>
<tr>
<td>New Kent</td>
<td>6230</td>
<td>6064</td>
<td>5884</td>
</tr>
<tr>
<td>Northampton</td>
<td>7715</td>
<td>7496</td>
<td>7830</td>
</tr>
<tr>
<td>Northumberland</td>
<td>7924</td>
<td>7346</td>
<td>7531</td>
</tr>
<tr>
<td>Nottoway</td>
<td>9719</td>
<td>8437</td>
<td>8836</td>
</tr>
<tr>
<td>Prince Edward</td>
<td>14,069</td>
<td>11,857</td>
<td>11,844</td>
</tr>
<tr>
<td>Stafford</td>
<td>8044</td>
<td>8454</td>
<td>8555</td>
</tr>
<tr>
<td>Surry</td>
<td>6480</td>
<td>5679</td>
<td>6133</td>
</tr>
<tr>
<td>Sussex</td>
<td>11,229</td>
<td>9820</td>
<td>10,175</td>
</tr>
<tr>
<td>York</td>
<td>4720</td>
<td>4460</td>
<td>4949</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>134,249</td>
<td>121,092</td>
<td>126,183</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Louisiana Sample:</strong></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bossier</td>
<td>-</td>
<td>6962</td>
<td>11,348</td>
</tr>
<tr>
<td>De Soto</td>
<td>-</td>
<td>8023</td>
<td>13,298</td>
</tr>
<tr>
<td>Franklin</td>
<td>-</td>
<td>3251</td>
<td>6162</td>
</tr>
<tr>
<td>Jackson</td>
<td>-</td>
<td>5566</td>
<td>9465</td>
</tr>
<tr>
<td>Morehouse</td>
<td>-</td>
<td>3913</td>
<td>10,357</td>
</tr>
<tr>
<td>Ouachita</td>
<td>-</td>
<td>5008</td>
<td>4727</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>-</td>
<td>32,723</td>
<td>55,357</td>
</tr>
</tbody>
</table>


existence of such a trade. However, if a slave trade existed, the demographic composition of that trade would be reflected in the migration estimates.

If there had been a slave trade populated by slave
breeding, one would expect to find a large proportion of prime age males migrating. One would expect masters to keep male children on their plantations until they were old enough so that the risks of transport were minimal, and one would expect them to keep female children as potential breeders. Most definitely, one would not expect to find a large proportion of women in child bearing ages migrating.

There is some impressionistic evidence to the contrary collected by Frederic Bancroft and Winfield Collins from advertisements of slave traders looking to purchase slaves. These ads call for both prime age males and females. However, these may be isolated examples and not typical behavior.

The method of estimating migration patterns for the two samples under discussion is relatively simple. Using a survival ratio, a hypothetical population can be calculated

11 Examples of these ads are reprinted here first from Bancroft then from Collins:

John Bull buying on Maryland and Virginia peninsula of Eastern Shore offered cash for slaves to go to Louisiana. For first-rate young men from 18 to 24 years of age, from $400 to $450; for women of the same age, $250 to $275, or $280 for first rate. Bancroft, p. 30.

Cash for Negroes:-- We will give cash for 200 Negroes between the ages of 15 and 25 years old of both sexes. Collins, p. 51.

12 While the fundamentals of the method are sketched out in the text a more detailed description can be found in the appendix.
for 1860 assuming no migration had taken place. This hypothetical population is then subtracted from the actual population which is known in order to obtain the migration estimate. The survival ratios are obtained from the age and sex data of the total United States slave population in 1850 and 1860. This method makes a few important assumptions which affect the estimates. It is assumed that mortality patterns throughout the country are the same. In this case it is assumed that Louisiana and Virginia have the same mortality patterns. If mortality in one region is overstated, then for the older age cohorts the hypothetical population estimate is too small, leading to an upward bias in the migration estimate.\(^{13}\) Conversely, if mortality is understated, the hypothetical population estimate is too large, leading to a downward bias in the migration estimate. The direction of this bias cannot be determined. Since it is improbable that mortality patterns were the same in the two regions, the migration estimates for the older age population cohorts must be viewed with some skepticism.

The migration estimates for the slave populations of the two samples appear in the first and third columns of Table 1-2 by age and sex cohorts. In the table a (-) sign implies an outward migration while a (+) sign implies an inward migration. The second and fourth columns of the

\(^{13}\) One would reasonably expect there to be differences in mortality patterns because of the different crops grown in the two regions.
table translate these estimates into migration rates per 1000 slaves. From these rates and estimates, it is apparent that relatively few children and elderly migrated. As was expected, there was an outflow of population from the Virginia counties and inflow of population into the Louisiana parishes. The table also shows that the majority of migrants were between the age of 15 and 29, as Collins and Bancroft suggested. However, as Table 1-2 shows there was not an imbalance of men in the migration: as many women migrated including women aged 15 to 39 who were in their child bearing years. Thus, it is difficult to reconcile the demographic composition of these migration estimates with the slave breeding hypothesis. Why would planters, if they wanted to breed slaves, sell or send south women in their reproductive years?

This dilemma can best be resolved by determining whether this migration was the result of the domestic slave

14 These ratios were calculated as the percentage leaving the area based on the region's population in 1855 which was estimated as the average of the 1850 and 1860 populations.

15 While it may seem that a large number of slaves over the age of 80 in Virginia migrated, these figures are biased upward because of the mortality assumptions. In all likelihood Virginia had a lower mortality rate than the national average. Moreover, the fact that migration rates in Louisiana exceeded 1000 per 1000 slaves means that these estimates are implausible.

16 The positive sign in the estimate of female Virginian migrants aged 70 to 79 is once again the result of the uniform mortality assumption and age heaping.
TABLE 1-2
MIGRATION AND MIGRATION RATES PER 1000 SLAVES, 1850-1860

<table>
<thead>
<tr>
<th>Age of Cohort in 1860</th>
<th>Virginia Sample:</th>
<th></th>
<th>Louisiana Sample:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Males Rate Per 1000 Slaves</td>
<td>Females Migration</td>
<td>Males Rate Per 1000 Slaves</td>
</tr>
<tr>
<td>0-4</td>
<td>-316 55</td>
<td>-331 55</td>
<td>+272 95</td>
</tr>
<tr>
<td>5-9</td>
<td>-697 134</td>
<td>-705 134</td>
<td>+617 261</td>
</tr>
<tr>
<td>10-14</td>
<td>-732 133</td>
<td>-841 158</td>
<td>+754 415</td>
</tr>
<tr>
<td>15-19</td>
<td>-953 208</td>
<td>-963 214</td>
<td>+572 363</td>
</tr>
<tr>
<td>20-29</td>
<td>-1745 236</td>
<td>-1674 241</td>
<td>+1728 615</td>
</tr>
<tr>
<td>30-39</td>
<td>-323 66</td>
<td>-473 103</td>
<td>+363 335</td>
</tr>
<tr>
<td>40-49</td>
<td>-139 43</td>
<td>-209 66</td>
<td>+200 350</td>
</tr>
<tr>
<td>50-59</td>
<td>-302 128</td>
<td>-193 94</td>
<td>+582 326</td>
</tr>
<tr>
<td>60-69</td>
<td>-76 47</td>
<td>-88 66</td>
<td>+363 350</td>
</tr>
<tr>
<td>70-79</td>
<td>-11 13</td>
<td>+50 63</td>
<td>+200 350</td>
</tr>
<tr>
<td>80+</td>
<td>-139 304</td>
<td>-72 140</td>
<td>+59 1710</td>
</tr>
</tbody>
</table>

trade or the result of owners migrating with their plantations to the southwest. Since there was an expense in moving slaves, owners would have logically been reluctant to transport older less productive slaves whose labor in the new region would not have paid off the transportation costs in a reasonable period of time. They would have also avoided taking young children with them since transporting young children was difficult especially for owners who walked their slaves west. They would have taken their
prime-age women with them since these women had value as laborers as well as in their offspring. While the owner migrating with his plantation hypothesis explanation seems to fit the evidence better than the slave trade migration hypothesis, there is also the possibility that there was a slave trade without systematic slave breeding. These owners, while encouraging fertility, were willing to sell off excess slaves who would generate a profit. This included prime-age women as well as men because of their breeding characteristics.

Richard Sutch in his analysis of what caused this migration argued that the migration was the result of a slave trade. His major piece of evidence is the decennial growth rate of slaveowners. He showed that the number of slaveowners grew larger in all but Maryland, Delaware, Virginia, and the District of Columbia. Even though these regions were considered major sources of slaves for the southwest, Sutch's argument is not conclusive. Implicit in his argument is the assumption that slaveholding patterns did not change between 1850 and 1860. In other words, he assumed that there was no increase in small slaveholdings. On the eastern seaboard where tobacco was the major crop it was possible for a farmer to operate with one or two slaves

17 Systematic breeding here means a system where owners did more than encourage fertility by offering awards, but kept a disproportionate number of women on their plantations and forced mating.
which would classify him as a slaveowner in the census. If these small slaveowners purchased the plantations of large slaveholders who had migrated to the southwest with their slaves, the number of slaveholders would increase but the migration would not be the result of the slave trade. Thus, a positive decennial growth rate is an insufficient condition for arguing that migration was the result of the slave trade. One must take into account average slaveholdings as well. Unfortunately, the two censuses do not provide comparable average slaveholding data. As a result, whether slave migration was the result of owners moving their plantations or the result of owners selling their slaves to the southwest remains ambiguous. The only way a positive conclusion can be reached is if there is evidence of slave breeding. If there had been slave breeding, then there would have had to have been a slave trade. Therefore, the next step is to examine the population data to see if there is evidence of slave breeding.

18 For example, say in region A in 1850 there were 10 slaveowners each owning 10 slaves. Between 1850 and 1860 there were no new slaves introduced into the area, no slave deaths and no slave births for simplicity's sake. In this period, five owners took their slaves to the southwest with them leaving only fifty slaves in the area in 1860. Furthermore, each of the remaining owners sold off two slaves to two different owners who began to farm the areas vacated by the migrating slaveowners. Thus, in 1860 there were 15 slaveowners showing an increase of 50% but the migration was the result of owners taking slaves with them. Such from this data would argue that this was the result of the slave trade. He would have forgotten to take into account that average slaveholdings have decreased from 10 to 3.34.
THE AGE AND SEX CHARACTERISTICS OF THE POPULATIONS IN 1850 AND 1860

If one assumes for a moment that there was slave breeding and a domestic slave trade, then this should be reflected in the age and sex characteristics of the populations. First, there should have been imbalanced sex ratios in the two regions. One would expect the selling or exporting regions, in this case the Virginia counties, to have had a disproportionate number of females. While in the importing regions, in this case the Louisiana parishes, one would expect to have had a disproportionate number of males. Second, there should have been a larger proportion of children in the Virginia sample than in the Louisiana sample. Third, there should have been a larger proportion of women in child bearing ages in the Virginia counties. All three of these hypotheses can be tested with census data.

Table 1-3 contains female to male ratios for white and slave populations in the Louisiana and Virginia samples in 1850 and 1860. The table indicates that there were more female slaves for every male slave in the Louisiana sample than in the Virginian sample. However, all of these ratios with the exception of the Louisiana white population ratio indicate that men and women were evenly distributed throughout the two regions. There does not appear to be an abundance of women in Virginia, the supposed slave breeding area. It is difficult to reconcile this observation with
the slave breeding hypothesis. However, the result corresponds with the demographic composition of the migration patterns. The ratio of female to male slaves leaving the Virginia sample was 0.93 while the ratio entering the Louisiana sample was 0.99. For the Virginia sample, this implies that slightly more men than women were migrating which explains the slight increase in the female to male ratio between 1850 and 1860. The impact of more males entering Louisiana than females can be seen in the very slight decline in the female to male ratio. More importantly, the ratios do not change dramatically because the sex composition of the migrating populations were also approximately one to one.

**TABLE 1-3**

<table>
<thead>
<tr>
<th>Sample</th>
<th>1850</th>
<th>1860</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virginia:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whites</td>
<td>1.08</td>
<td>1.00</td>
</tr>
<tr>
<td>Slaves</td>
<td>0.95</td>
<td>0.96</td>
</tr>
<tr>
<td>Louisiana:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whites</td>
<td>0.83</td>
<td>0.82</td>
</tr>
<tr>
<td>Slaves</td>
<td>1.02</td>
<td>0.98</td>
</tr>
</tbody>
</table>

For each sample, Table 1-4 provides data on the percentage of children in the total population. If Virginia was breeding slaves, then one would expect to find more children in Virginia than in Louisiana. A child in this table is defined as anyone under the age of 15. Since the slave migration estimates already discussed showed that a large proportion of migrants were aged 10 to 14, Table 1-5 gives
the percentage of children in the total population where a child is defined as anyone under the age of 10. Whichever table is used, the conclusion remains the same: children did not make up a larger percentage of the population in the Virginia sample. Once again, this piece of evidence is hard to reconcile with the slave breeding hypothesis.

<table>
<thead>
<tr>
<th>TABLE 1-4</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHILDREN UNDER 15 AS A PERCENTAGE OF THE POPULATION</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sample</th>
<th>1850</th>
<th>1860</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virginia</td>
<td>45.0</td>
<td>44.9</td>
</tr>
<tr>
<td>Louisiana</td>
<td>44.4</td>
<td>44.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TABLE 1-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHILDREN UNDER 10 AS A PERCENTAGE OF THE POPULATION</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sample</th>
<th>1850</th>
<th>1860</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virginia</td>
<td>31.2</td>
<td>30.8</td>
</tr>
<tr>
<td>Louisiana</td>
<td>30.7</td>
<td>31.4</td>
</tr>
</tbody>
</table>

AN EXAMINATION OF FERTILITY IN THE TWO REGIONS

Since the number of children in a society is affected by fertility, the fertility patterns of the two regions also need to be compared. The first step in analyzing fertility patterns is to examine the percentage of women in child bearing years which will be defined as 15 to 39. From the data provided in Table 1-6, one can conclude that women in child bearing years in Louisiana made up a larger segment of the population, but the demographic composition of the slave
trade biases the data. Louisiana was the recipient of a prime age female migration which increased the percentage of child bearing women in the region. Moreover, there is an opposite effect biasing the Virginia data since there was an exodus of prime age females, leaving more old and young women in the region. Thus, Table 1-6 offers little in the way of concrete evidence. More importantly, even if the table were unbiased, the possibility of slave breeding occurring would not be ruled out. Women in the southwest could have been working in the fields doing more rigorous labor than women on the seaboard. The effect of this labor might have been to reduce fertility, meaning that there were fewer births with more women in child bearing years. Therefore, a measure of fertility is needed.

### TABLE 1-6
WOMEN IN REPRODUCTIVE YEARS (15-39) AS A PERCENTAGE OF THE FEMALE POPULATION

<table>
<thead>
<tr>
<th>Sample</th>
<th>1850</th>
<th>1860</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virginia</td>
<td>40.0</td>
<td>37.5</td>
</tr>
<tr>
<td>Louisiana</td>
<td>44.3</td>
<td>44.2</td>
</tr>
</tbody>
</table>

Since records of births on a large scale basis are unavailable, a direct measure of fertility cannot be calculated, but child to women ratios (CWR) can be used as a proxy. There are however some problems with such measures that must be kept in mind. Census takers only recorded children living at the time of the census, so if child mortality were higher in one region than another the CWR in
that region would be biased downward. There was also an under-counting problem as well. The preface to the 1850 census stated:

In many counties the assistant marshals have adopted one year as the lowest designation of age, and therefore the [children under one year of age] as published in those counties show proportionately small. This was often the case with slaves.  

Since this undercounting was not uniform across the south, the error may be in one sample but not in the other. Therefore, the CWR may be biased downward. Richard Sutch suggested standardizing the slave CWR to the white population's CWR, thereby coming up with a measure of slave births to white births. This solves the problem because it is safe to assume that the census taker treated slave and white infants in the same manner. Both the standardized and the crude CWR appear in Table 1-7. While unstandardized CWR show tremendous fertility growth in Virginia between 1850 and 1860, this growth disappears in the standardized ratios. In spite of this phenomenon, it is apparent that fertility as reflected in CWR's was higher in Virginia than in Louisiana, but the standardized figures are not comparable figures since they reflect white fertility. They should be interpreted to mean that in Virginia in 1850 there were 1.27 slave children for every one white child, while in the same

---

year in Louisiana there were only 0.57 slave children for every white child. The figures could only be compared if the white CWR were equal, but Table 1-8 shows that they were not. In fact white CWR were significantly higher in Louisiana. Thus, while standardized CWR correct the undercount problem, they do not allow a comparison of CWR's across regions.

TABLE 1-7
CRUDE AND STANDARDIZED CWR'S

<table>
<thead>
<tr>
<th></th>
<th>1850</th>
<th>1860</th>
<th>Standardized</th>
<th>1850</th>
<th>1860</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virginia</td>
<td>0.136</td>
<td>0.184</td>
<td>1.27</td>
<td>1.30</td>
<td></td>
</tr>
<tr>
<td>Louisiana</td>
<td>0.114</td>
<td>0.171</td>
<td>0.57</td>
<td>0.86</td>
<td></td>
</tr>
</tbody>
</table>

TABLE 1-8
WHITE CRUDE CWR'S

<table>
<thead>
<tr>
<th>Sample</th>
<th>1850</th>
<th>1860</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virginia</td>
<td>0.107</td>
<td>0.142</td>
</tr>
<tr>
<td>Louisiana</td>
<td>0.199</td>
<td>0.199</td>
</tr>
</tbody>
</table>

Since the Sutch method is inappropriate, another method to remove the undercount must be devised. If one wants to be able to compare CWR's. One way to do this is to redefine the child in the CWR. In Table 1-7, CWR were calculated by taking the ratio of children less than one to the number of women in child bearing years which made the entire numerator of the ratio subject to undercount errors. These errors can be minimized by including more children into the numerator, whose probability of being accurately counted was higher.
The drawback to this solution is that more children aged 0 to 5 migrated, which affects the CWR's, but since the demographic composition of the migration is known, the effect of this migration on these CWR can be analyzed. These CWR\textsubscript{0-5} where the 0-5 denotes the definition of a child appear in Table 1-9. In order to assess the effects of migration on these ratios, the CWR\textsubscript{0-5} of the migrating population appear in the third and fourth rows of Table 1-9. The small CWR\textsubscript{0-5} for the migrating populations reflects the fact that there were more women in the reproductive years migrating than children. In Virginia where there was an exodus of women in these years, the CWR is biased upward since the denominator of the ratio decreased. In Louisiana, the opposite is true since women in the reproductive years migrated into the region without children. As a result, the denominator increased, thereby yielding a downward bias in the CWR\textsubscript{0-5}. One way to correct for these effects is to hypothesize that there was no slave migration at all. If this were the case and there was slave breeding, then there would still be higher fertility in the Virginia sample reflected by larger CWR\textsubscript{0-5}. These CWR\textsubscript{0-5} can be calculated from the hypothetiological populations that were used to estimate migration. Therefore, these CWR's are affected by all the assumptions that underly the migration estimates. In essence, the outward migration is being added back into the Virginia population, while the inward migration is being subtracted from the Louisiana population. The CWR\textsubscript{0-5} for the two samples
assuming no migration had occurred appear in Table 1-10. The \( CWR_{0-5} \) can only be calculated for 1860 since the migration patterns between 1840 and 1850 are unknown. The conclusion from these \( CWR \)'s becomes obvious. On the basis of \( CWR \)'s, one cannot conclude that in 1860 fertility was higher in Virginia. While the Virginia \( CWR \) from Table 1-9 appeared to be significantly higher than the Louisiana ratio, this was only because of the composition of the migration. Women were shipped without their children, but these women were no less fertile than the women who did not migrate. Moreover, from the growth of the Louisiana \( CWR \) in Table 1-7, it is apparent that migrating women were just as fertile but took a few years to have children in their new homes. Thus, \( CWR \)'s when migration patterns are taken into account do not support the slave breeding hypothesis.

**TABLE 1-9**

<table>
<thead>
<tr>
<th>Sample</th>
<th>1850</th>
<th>1860</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virginia</td>
<td>1063</td>
<td>1044</td>
</tr>
<tr>
<td>Virginia Migrants</td>
<td>809</td>
<td>265</td>
</tr>
<tr>
<td>Louisiana</td>
<td>217</td>
<td>921</td>
</tr>
</tbody>
</table>

**TABLE 1-10**

<table>
<thead>
<tr>
<th>Sample</th>
<th>1860</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virginia</td>
<td>906</td>
</tr>
<tr>
<td>Louisiana</td>
<td>1397</td>
</tr>
</tbody>
</table>
CONCLUSIONS

From examining slave migration patterns, the age and sex characteristics of the two populations in 1850 and 1860, and the CWR's, the evidence strongly suggests that there was not systematic slave breeding in the south. This in turn rules out the only piece of evidence that could prove whether the migration was the result of a slave trade or owners moving with their plantations. This issue cannot be resolved from census data. Instead, as Olmsted's planter suggested and Stampp argued, slave breeding took place in both the Virginia and Louisiana sample in the sense that owners encouraged high fertility. Just how they encouraged this fertility—whether it was through monetary awards, or other means—cannot be determined from the census, but it is apparent that southern slaveowners did not breed slaves as

21 Stampp concluding his analysis of slave breeding wrote:

Many masters counted the fecundity of Negro women as an economic asset and encouraged them to bear children as rapidly as possible. In the exporting states these masters knew that the resulting surpluses would be placed on the market. Though few held slaves merely to harvest the increase or overtly interfered with their normal sexual activity, it nevertheless seems proper to say that they were engaged in slave breeding. Stampp, p. 246.

Olmsted's planter in another passage of his letter wrote:

Further South, we raise them [slaves] both for use and for market. Planters command their girls and women (married or unmarried) to have children. Olmsted, pp. 60-61.
if they were cattle. Nevertheless, as much as one can gen-
eralize the experience of these two samples of counties, slave owners throughout the south viewed slave offspring as a valuable economic asset and took measures to encourage slave births.
All methods of estimating migration based on census data are essentially similar. First, they estimate a hypothetical population for a region as if no migration had occurred. Then, the difference or residual of the hypothetical and actual populations becomes the migration estimate. One way to do this is to apply the following equation:

\[ M_{x+t} = P_{x+t}^t - P_x^0 \]  \( (1) \)

where \( M_{x+t} \) is the migration estimate for the \( x^{th} \) age and sex cohort; \( P_x^0 \) is the population at the first census; \( P_{x+t}^t \) is the population at the next census age, \( x+t \); and \( s \) is the survival rate.\(^1\)

This method does not take into account migrants who died before the second census. To correct for this problem, this study used the method that Richard Sutch outlined in his work.\(^2\) Sutch starts with a simple identity which states, "the aggregate population of a region at the beginning of the period \( (P_0) \) plus the number of births within that time period \( (B) \) less the number of deaths \( (D) \) plus the net in migration \( (M) \) must equal the aggregate population at the end of the period \( (P_1) \):

---

1 Shyrock, p. 379.
2 Sutch, Appendix.
Unfortunately, the census which is the data source does not provide information on B and D, so Sutch rewrites the identity as follows:

\[ P_0 + B - D + H = P_1. \]  

(2)

where \( M_p \) denotes the number of potential migrants who would have migrated if no one had died; \( D_m \) refers to the deaths of nonmigrants; \( D_{mb} \) is the number of migrants who died before migrating; and \( D_{ma} \) is the number of migrants who died after migrating. The net migration, \( M \), is simply the potential migrants, \( M_p \), minus those who died before migrating \((M = M_p - D_{ma})\).

From these identities Sutch assumes that the number of deaths, \( D_m \), can be calculated if one knows the appropriate mortality rate, \( d \):

\[ D_m = dP_0. \]  

(4)

By substituting equation 4 into equation 3 and by replacing \( 1 - d \) with the survival rate, \( s \), the following is obtained:

\[ sP_0 + M - D_{ma} = P_1. \]  

(5)

At this point, an estimate for \( D_{ma} \) is needed. Sutch obtains this estimate by applying the survival rate to the potential migrants, \( M_p \):

\[ (1 - s)M_p = D_{mb} + D_{ma}. \]  

(6)

\[^{3}\text{Sutch, p. 201.}\]
Having no estimate of $D_{mb}$ and $D_{ma}$, Sutch assumes that the two are equal based on the following rationale:

If the total number of potential migrants within a period were distributed uniformly throughout the census decade, one would expect more to have died after moving than before since the probability of dying generally rises with age. On the other hand, the morbidity preceding death may deter migration in a sizable number of cases. This will have an opposite effect: death will overtake more of the potential migrants before the move than after.

This allows Sutch to solve $D_{ma}$ in terms of $M$:

$$D_{ma} = \frac{(1-s)M}{(1+s)} \text{(7)}$$

Finally, substituting this expression into equation 5 yields:

$$M = \frac{(1+s)}{2}(P_1 - P_0) \text{(8)}$$

At this point, if one knows the two terminal populations and survival rates, then one can estimate migration. This equation differs from equation 1 by a factor of $(1+s)/2$. This factor takes into account those migrants who died before the terminal census was taken.\(^5\)

Getting estimates of $s$ is relatively simple since they can be based on national data as long as that population is a closed population. For slaves in America between 1850 and 1860, national census data can be used. There was minimal smuggling of slaves into the United States and there was

---

\(^4\) Ibid. p. 201.

\(^5\) For a sensitivity analysis of migration estimates to survival rates see Sutch, p. 203.
minimal out migration by slaves. The survival rates used to calculate the migration estimates can be found in Table 1-11. Theoretically, it is impossible for a survival rate to be greater than 1 but that is the case for male slaves aged 10-14 in 1860. This is probably because children aged under five were undercounted in 1850. However, this estimate of survival rate is used in the calculation because underenumeration and age heaping are uniform across the country which means that the survival rates will correct for the bias.

Of course it is impossible to calculate a survival rate for children aged 0-10 in the terminal census year. Another method to estimate migration must be used. Once again Sutch outlined a method which will be discussed here. The method relies on the use of child to women ratios, and is a nine step procedure.

First, a Regional Fertility Ratio for the \( x^{th} \) year \((RFR_x)\) is calculated by dividing the number of children aged less than one by the number of women in childbearing years, defined as one-half the women aged 15 to 19 and all the women aged 20 to 39. This ratio is also calculated for the second census which is denoted by the subscript \( x+t \).

Second, the weighted average, \( RFR_a \), of \( RFR_x \) and \( RFR_{x+t} \) is calculated by the following formula:

\[
RFR_a = \frac{N_x RFR_x + N_{x+t} RFR_{x+t}}{N_x + N_{x+t}}
\]

(9)

where \( N_x \) and \( N_{x+t} \) are the sample sizes in the first and second censuses, respectively.
<table>
<thead>
<tr>
<th>Age of Cohort</th>
<th>in Cohort 1850</th>
<th># of Males Survival Rate 1850</th>
<th>Male Survival 1850</th>
<th># of Females 1860</th>
<th>Female Survival Rate 1860</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 5</td>
<td>10-14</td>
<td>267,088</td>
<td>1.037</td>
<td>273,406</td>
<td>0.967</td>
</tr>
<tr>
<td>5-9</td>
<td>15-19</td>
<td>239,163</td>
<td>0.921</td>
<td>239,925</td>
<td>0.952</td>
</tr>
<tr>
<td>10-19</td>
<td>20-29</td>
<td>397,649</td>
<td>0.893</td>
<td>395,825</td>
<td>0.867</td>
</tr>
<tr>
<td>20-29</td>
<td>30-39</td>
<td>289,595</td>
<td>0.754</td>
<td>282,615</td>
<td>0.780</td>
</tr>
<tr>
<td>30-39</td>
<td>40-49</td>
<td>175,300</td>
<td>0.803</td>
<td>178,355</td>
<td>0.779</td>
</tr>
<tr>
<td>40-49</td>
<td>50-59</td>
<td>109,152</td>
<td>0.731</td>
<td>110,780</td>
<td>0.685</td>
</tr>
<tr>
<td>50-59</td>
<td>60-69</td>
<td>65,254</td>
<td>0.708</td>
<td>61,762</td>
<td>0.714</td>
</tr>
<tr>
<td>60-69</td>
<td>70-79</td>
<td>38,102</td>
<td>0.405</td>
<td>36,569</td>
<td>0.430</td>
</tr>
</tbody>
</table>
| 70+           | 80+            | 19,361                        | 0.342             | 20,720            | 0.384                   

TABLE 1-11
SURVIVAL RATES, 1850-1860
second census years respectively.

Third, a national fertility ratio (NFR) is calculated in the same manner as the RFR for a closed population. In this case, the United States as a whole served as the closed population. Then using equation 9, substituting NFR\textsubscript{x} and NFR\textsubscript{x+t} for RFR\textsubscript{x} and RFR\textsubscript{x+t} respectively, a weighted average, NFR\textsubscript{a} is obtained.

Fourth, a regional fertility index (RFI) is calculated by dividing RFR\textsubscript{a} by NFR\textsubscript{a}:

\[
\text{RFI} = \frac{\text{RFR}_a}{\text{NFR}_a}. \tag{10}
\]

Fifth, a census decade fertility ratio (CDFR) is calculated for the closed population by finding the ratio of children under ten to the average of women who were 15 to 39 in the first census and 20 to 29 in the second census. The CDFR can be written:

\[
\text{CDFR} = \frac{2Y}{W_x + W_{x+t}} \tag{11}
\]

where \( Y \) is the number of children less than 10; \( W_x \) is the number of women 15 to 39 in the first census conducted in year \( x \); and \( W_{x+t} \) is the number of women 20 to 29 in the terminal census conducted in \( x+t \).

Sixth, a second regional fertility ratio, denoted RFR\textsubscript{2}, is obtained by multiplying the CDFR by the RFI:

\[
\text{RFR}_2 = \text{CDFR} \times \text{RFI}. \tag{12}
\]
Seventh, using the definition in step five, the average number of childbearing women, $W_a$, can be calculated for the specific region in question.

Eighth, the expected number of children aged 0-9, $P_e$, if no migration had occurred can be calculated:

$$P_e = (CDFR x RFR^2 x W_a). \quad (13)$$

Ninth, the hypothetical population is subtracted from the actual population, $P_a$, to arrive at a migration estimate, $M$:

$$M = P_a - P_e. \quad (14)$$

While the method on paper seems complicated and cumbersome, in actuality, it all serves to accomplish what the survival rate technique did. It calculates the hypothetical number of children in a region if there had been no migration between the two census years. Then, by subtraction, a migration estimate is obtained. However, as Lowe and Campbell point out, the method does not include in the hypothetical population the children born to women who had already migrated in the second census. In order to correct for this problem, this study rejects Sutch's method for estimating the migration of children under ten. Instead, the study relies on the method described in United Nation's Manual VI.

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6 For a more detailed critique of the Sutch approach see Lowe and Campbell, p. 410.
as presented by Shyrock:

If the ratios of children aged 0-4 to women aged 15-44 and of children aged 5-9 to women aged 20-49 are denoted $\text{CWR}_0$ and $\text{CWR}_5$ respectively, then the estimates of net migration for the age group 0-4 (denoted by $\text{Net}_{5M_0,1}$ and 5-9 (denoted by $\text{Net}_{5M_5,1}$) are given by:

\[
\text{Net}_{5M_0,1} = \frac{1}{4} \text{CWR}_0 \text{Net}_{30M_{15,1}}
\]
\[
\text{Net}_{5M_5,1} = \frac{3}{4} \text{CWR}_5 \text{Net}_{30M_{20,1}}
\]

where $\text{Net}_{30M_{15,1}}$ and $\text{Net}_{30M_{20,1}}$ are the area estimates of net migration for females aged 15-44 and 20-49 respectively. If we assume that the flow of migration was even and fertility ratios constant, then one-fourth of the younger and three-fourths of the older children would have been born before their mothers migrated. These proportions are derived as follows: the children under 5 years old at the census were born on the average 2.5 years earlier; only 1/4 of their mothers' migration occurred after that date. The children 5 to 9 years old at the census were born, on the average 7.5 years earlier; 3/4 of their mothers' migration occurred after that date.  

The only minor change that was made in the method was that

\[7 \text{ Shyrock, p. 381.} \]
\( \text{CH}_{10} \) was redefined to be the ratio of children aged 0-4 to the women aged 20-39 because the census does not give enumeration figures for the age cohort 40-44. This change once again makes these estimates rough approximations. A second advantage of this method is that the undercounting of children is minimized because children are defined as 0-5. A further advantage is that this method breaks the child migration estimates into two age cohorts. Thus, this study used the UN Manual method for estimating migration of those children under ten in 1860 and used the Sutch method for estimating the remainder of the population's migration patterns.
TWO: CAUSES OF JAMAICAN POPULATION DECLINE IN THE EARLY NINETEENTH CENTURY

One feature of any population that is essential to its survival is its ability to reproduce itself. Historical experience has shown that this was a rare phenomenon among slave societies. In the Western Hemisphere, while there were many slave societies, only in the United States did that population regenerate itself. In the period 1500 to 1870, the United States received 6% of the slave imports to the New World, but by 1825, 36% of the slaves in the western Hemisphere were living in the United States. Why were these other societies unable to reproduce themselves? In particular, this paper will examine why Jamaica was unable to regenerate its population in the early nineteenth century. The mode of analysis will be a demographic comparison of Jamaica and the United States. Section one assesses whether crop differences answer the question by examining whether the Louisiana sugar growing region had a regenerating population. Section two examines and documents the declining Jamaican population. Sections three and four compare mortality and fertility patterns in the two regions in order to explain the differences observed in population growth.

1 Fogel and Engerman, pp. 14, 28.
HAS THE LOUISIANA SUGAR GROWING REGION'S POPULATION ABLE TO REPRODUCE ITSELF?

As table 2-1 shows, the number of slaves in the United States increased rapidly from 1820 to 1860. There were minimal slave imports to account for the increase since the slave trade had already been closed. Thus, the growth can be attributed to natural increase. The crude birth and death rates calculated by Fogel and Engerman for the United States in 1830 substantiate this view. They estimated a crude birth rate of 55 per 1000 slaves and a crude death rate of 30 per 1000 slaves. Such figures indicate that there was an excess of births over deaths meaning the population was reproducing itself and growing.

<table>
<thead>
<tr>
<th>Year</th>
<th>Population</th>
<th>Percent Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>1820</td>
<td>1,538,038</td>
<td></td>
</tr>
<tr>
<td>1830</td>
<td>2,009,043</td>
<td>31</td>
</tr>
<tr>
<td>1840</td>
<td>2,487,455</td>
<td>24</td>
</tr>
<tr>
<td>1850</td>
<td>3,204,313</td>
<td>29</td>
</tr>
<tr>
<td>1860</td>
<td>3,953,760</td>
<td>23</td>
</tr>
</tbody>
</table>


However, the fact that the United States as a whole had

a regenerating population does not mean that the sugar region of Louisiana had a regenerating population. Slaves working on cotton or tobacco plantations could have experienced different fertility and mortality patterns than slaves working on sugar plantations. The sugar regions could have relied on continual purchases of slaves in the domestic slave market to sustain their populations. Winfield Collins in his 1904 study of the slave trade expressed this view:

In 1829, the statement was made in a report of the Agricultural Society of Baton Rouge, Louisiana, that the annual loss of life on well conducted sugar plantations was 2 1/2% more than the annual increase.\(^3\)

More recently, Conrad and Meyer while discussing the ability of the slave labor force to reproduce itself commented, "all but the Louisiana sugar area, more than reproduced itself."\(^4\) J. Carlyle Sitterson, on the other hand, in his study of the sugar region found, "most plantations of which records have been examined by the writer [Sitterson] the slave population more than reproduced itself, although there are instances in which such was not the case."\(^5\) The best way of resolving these conflicting viewpoints is to examine mortality and fertility patterns of Louisiana in respect to the larger population which was clearly reproducing itself.

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\(^3\) Winfield Collins, p. 30.

\(^4\) Conrad and Meyer, p. 68.

There have been few studies that have examined mortality and fertility on a regional or cash crop basis. However, Richard Steckel has studied child mortality and fertility by examining individual plantation records on a widespread basis which has allowed him to assess the effect of different cash crops. In terms of mortality, Steckel concluded:

sugar does not register as a crop associated with a high probability of death. Among children aged 1-4 the probability of death was lowest on sugar plantations.6

In his study of fertility, Steckel found that the production of sugar had little effect on fertility. Instead, Steckel found that fertility was inversely related to plantation size.7 Since sugar growers also had to refine the raw sugar cane into sugar, their plantations tended to be large. This meant that fertility levels were probably slightly lower on sugar plantations because of their size. At the same time, mortality levels according to Steckel were also lower. Thus, on the basis of Steckel's research it is safe to conclude that the sugar growing population of Louisiana regener-erated itself. Hence, the production of sugar did not prevent a population from sustaining itself.


DID THE SUGAR ISLAND OF JAMAICA HAVE A REGENERATING POPULATION?

While it was possible to document the natural increase of the United States population from the decennial population censuses, the first Jamaican census was not tabulated until 1842 after emancipation. Nevertheless, there is demographic data contained in the National Registry. This registry was not a census, but an attempt to ensure that no new African slaves were imported into the British West Indies after the African Slave Trade was abolished in 1808. The laws of the registry required that owners register their slaves triennially. They also were required to report the number of births and deaths that occurred in the three year interval. From these registration lists, it is possible to examine whether Jamaica's population was regenerating itself.

Henry Charles Carey, in his 1856 study of the slave trade, tabulated the number of births and deaths recorded in the registry. His results are presented in Table 2-2. In each period, the number of deaths exceeded the number of births by a greater amount. Individual plantation studies such as Michael Craton's analysis of Worthy Park yield similar results. Craton found that between 1817 and 1829, the

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plantation's labor force without sales or manumissions decreased from 527 to 431.9

### TABLE 2-2
**JAMAICAN BIRTHS AND DEATHS, 1817 TO 1829**

<table>
<thead>
<tr>
<th>Registration Period</th>
<th>Births</th>
<th>Deaths</th>
<th>Births-Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>1817-1820</td>
<td>24,348</td>
<td>25,104</td>
<td>-756</td>
</tr>
<tr>
<td>1823-1826</td>
<td>23,026</td>
<td>25,171</td>
<td>-2145</td>
</tr>
<tr>
<td>1826-1829</td>
<td>21,728</td>
<td>25,137</td>
<td>-3409</td>
</tr>
</tbody>
</table>


While the experience of one individual plantation may not be typical, a 12 plantation sample also leads to the same conclusions. This sample was compiled in 1830 by the Select Commission on Slavery in the British Parliament.10 Included in their final report were the registry returns of 12 individual plantations distributed across the entire island. This data has the additional advantage that it breaks the population down into Creoles and Africans by age and sex cohorts. Moreover, it also included information on the number of births and deaths for four three year periods.

The aggregate population on these 12 plantations

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decreased from 5089 on June 28, 1817 to 4739 on June 28, 1829. This decrease of 350 occurred in spite of purchases of 23 slaves. Not all of the decrease can be attributed to deaths exceeding births either since 39 slaves were manumitted, 28 were transported to other estates or ran away and 29 were sold. Hence, a decrease of 277 can be attributed to the fact that deaths exceeded births.

In understanding why these plantations were unable to sustain their populations, a breakdown of the birth and death data into the population's ethnic components is insightful. Table 2-3 shows the number of births attributed to African women, African deaths, the number of births attributed to Creole women, and Creole deaths. From this table, it is apparent that the Creole segment of the population was reproducing itself while the African population was not. The increasing number of African deaths can be attributed to the cessation of the African Slave Trade in 1808. Since that date Africans had not been introduced into Jamaica which meant that twenty years later this component of the population was aging. This manifested itself in two ways: one, as the African population aged it began to die off and two, the women who had been imported twenty years earlier had outlived their childbearing years which explains the low fertility levels of African women.

**DID MORTALITY PATTERNS EXPLAIN JAMAICA'S INABILITY TO REGENERATE ITS POPULATION?**
### TABLE 2-3

BIRTHS AND DEATHS BROKEN INTO CREOLE AND AFRICAN SLAVES ON 12 JAMAICAN PLANTATIONS

<table>
<thead>
<tr>
<th>Period</th>
<th>Total Births</th>
<th>Total Deaths</th>
<th>(1)-(2)</th>
<th>African Births</th>
<th>African Deaths</th>
<th>(4)-(5)</th>
<th>Creole Births</th>
<th>Creole Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>1817-1820</td>
<td>421</td>
<td>417</td>
<td>+4</td>
<td>111</td>
<td>173</td>
<td>-62</td>
<td>307</td>
<td>244</td>
</tr>
<tr>
<td>1820-1823</td>
<td>390</td>
<td>440</td>
<td>-50</td>
<td>77</td>
<td>158</td>
<td>-81</td>
<td>305</td>
<td>282</td>
</tr>
<tr>
<td>1823-1826</td>
<td>417</td>
<td>504</td>
<td>-87</td>
<td>47</td>
<td>198</td>
<td>-151</td>
<td>363</td>
<td>306</td>
</tr>
<tr>
<td>1826-1829</td>
<td>350</td>
<td>494</td>
<td>-144</td>
<td>30</td>
<td>208</td>
<td>-178</td>
<td>316</td>
<td>286</td>
</tr>
<tr>
<td>Totals</td>
<td>1578</td>
<td>1855</td>
<td>-277</td>
<td>265</td>
<td>737</td>
<td>-472</td>
<td>1291</td>
<td>1118</td>
</tr>
</tbody>
</table>

One possible explanation for the declining Jamaican population was that mortality rates were high. In particular, slaves who entered the Caribbean from Africa experienced high mortality levels. These 'seasoning' losses can be attributed to the crossing of an epidemiological border, climate differences, overwork, and nutritional changes. Horace Patterson, after examining the records of individual plantations, estimated that one-quarter to one-third of the Africans imported died in their first three years in Jamaica.\footnote{Horace Patterson, \textit{The Sociology of Slavery} (Teaneck, New Jersey: Fairleigh Dickinson University Press, 1967), p. 98.} H. C. Carey, studying the period 1792 to 1799, estimated these losses even higher at one-half.\footnote{Carey, p. 10.} While seasoning losses inflate crude death rates, by 1829 the impact of seasoning losses should have been minimal. Africans alive in 1829 had already been in Jamaica well over three years. These slaves would already have endured the crossing of the epidemiological border and climate changes. However, this does not rule out overwork as an explanation. In assessing this possibility, one must recall that slaveowners had a tremendous investment in their slaves: to mistreat a slave to the point of excess which resulted in that slave's death resulted in the loss of a sizable capital investment. Therefore, it is unlikely that slaves on a widespread basis were mistreated but this does not mean that individual...
slaveowners did not mistreat their slaves to the point of excess.

By examining age specific mortality rates, the mistreatment hypothesis can be evaluated. Normally in a nineteenth century population, one would expect high levels of infant mortality which would subsequently fall off as the cohort aged. Then, they would slowly rise steadily until the age of 42 when they would begin to rise rapidly. Table 2-4 contains age specific crude death rates for the 12 Jamaican plantations. Since the period of registration was three years, the crude death rates were calculated for the three year interval. This three year rate was subsequently divided by three to obtain the annual rate. The sample's aggregate crude death rate closely corresponds to the crude death rate of 25-6 per 1000 slaves estimated for Jamaica in 1829 by Barry Higman and revised upward to 30 per 1000 by Fogel and Engerman. 13

In terms of age-specific mortality rates, Table 2-4 shows that after six years of life, mortality levels fell dramatically. They subsequently rose steadily with a peak between the ages of 24 and 30. After this slight rise, they fell again and then rose steadily until 42 at which point crude death rates were high. While mistreatment may explain

the peaking of death rates between the ages of 24 and 30, the death rate in this cohort does not explain high levels of Jamaican mortality. The rate in this cohort was 24 per 1000 slaves which was well below the aggregate rate of 34 per 1000. Moreover, if the whole population had experienced a crude death rate of 24 per 1000, the population would have sustained itself because the crude birth rate in this period was 24 per 1000. Hence, mistreatment of slaves does not explain why Jamaica did not regenerate its population.

### TABLE 2-4

<table>
<thead>
<tr>
<th>Cohort</th>
<th>Total Population Per 1000 Slaves</th>
<th>Creole Population Per 1000 Slaves</th>
<th>African Population Per 1000 Slaves</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-6</td>
<td>48</td>
<td>48</td>
<td>-</td>
</tr>
<tr>
<td>6-12</td>
<td>12</td>
<td>12</td>
<td>-</td>
</tr>
<tr>
<td>12-18</td>
<td>15</td>
<td>15</td>
<td>-</td>
</tr>
<tr>
<td>18-24</td>
<td>16</td>
<td>16</td>
<td>-</td>
</tr>
<tr>
<td>24-30</td>
<td>24</td>
<td>24</td>
<td>-</td>
</tr>
<tr>
<td>30-36</td>
<td>19</td>
<td>16</td>
<td>23</td>
</tr>
<tr>
<td>36-42</td>
<td>29</td>
<td>17</td>
<td>42</td>
</tr>
<tr>
<td>42-48</td>
<td>28</td>
<td>16</td>
<td>34</td>
</tr>
<tr>
<td>48-54</td>
<td>52</td>
<td>33</td>
<td>65</td>
</tr>
<tr>
<td>54+</td>
<td>86</td>
<td>69</td>
<td>97</td>
</tr>
<tr>
<td>Total</td>
<td>34</td>
<td>26</td>
<td>56</td>
</tr>
</tbody>
</table>

Since seasoning losses and mistreatment of slaves do not answer the question, it seems appropriate to ask whether mortality levels in Jamaica were excessively high to prevent the population from regenerating. This can best be answered by comparing Jamaican and American crude death rate estimates. According to the research of Fogel and Engerman, the United States slave population was able to reproduce itself
with a crude death rate of 30 per 1000 in 1830. They also estimated a crude death rate of 36 per 1000 for Jamaica in 1830. Thus, there was not enough of a difference in crude death rates to support the hypothesis that high mortality levels prevented Jamaica from regenerating its population.

**DID FERTILITY EXPLAIN JAMAICA'S INABILITY TO REGENERATE ITS POPULATION?**

Since differing mortality patterns did not explain why Jamaica was unable to regenerate its population, the next logical step is to examine fertility patterns. Fogel and Engerman estimated crude birth rates for both regions in 1830. They found that the United States had a crude birth rate of 55 per 1000 slaves while Jamaica's rate was only 30 per 1000. This apparently explains why Jamaica could not sustain its population since its crude death rate exceeded its crude birth rate. However, crude birth rates do not explain why Jamaican fertility was so low. Horace Patterson, Richard Dunn, and Klein and Engerman have all tried to explain this phenomenon.

Patterson argued that there was an imbalance of men and

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14 Fogel and Engerman, "Recent Findings," p. 568.
15 Ibid. p. 568.
women in the society. He concluded that this imbalance led to promiscuity among women because of the intense demand for their bodies by both white masters and slaves. While promiscuity per se has little to do with fertility, Patterson continued his argument:

Promiscuity itself, does not necessarily impair fertility as so many of the planters thought; but there is reason to believe that venereal diseases were common among the women and this no doubt reduced fecundity. Even more important, however, was the fact that abortion was widely practiced.  

By 1830, this line of reasoning does not hold since it is based on an excess of men over women. From the 12 plantation sample, the number of males per 1000 females were calculated and appear in the first column of Table 2-5. These rates show that there was not an excess of men, but an excess of women. Nevertheless, since these figures are calculated for the total population it is possible that the portion of the population in the reproductive years had an imbalance of males and females. To investigate this possibility, male to female ratios were calculated for the portion of the population over the age of 18. These ratios appear in the second column of Table 2-5. In every three year interval, there were more females than males. In fact there was a growing surplus of women in the population. Therefore, Patterson's argument cannot be used to explain the low levels of Jamaican fertility. More importantly, the

16 Patterson, p. 108.
low fertility levels cannot be explained by an imbalance of men and women in the population.

TABLE 2-5
MALE TO FEMALE RATIOS FOR 12 JAMAICAN PLANTATIONAS

<table>
<thead>
<tr>
<th>Year</th>
<th>Males Per Females</th>
<th>Males Per 1000 Females Over 18</th>
</tr>
</thead>
<tbody>
<tr>
<td>1817</td>
<td>968</td>
<td>953</td>
</tr>
<tr>
<td>1820</td>
<td>961</td>
<td>953</td>
</tr>
<tr>
<td>1823</td>
<td>960</td>
<td>948</td>
</tr>
<tr>
<td>1826</td>
<td>947</td>
<td>938</td>
</tr>
<tr>
<td>1829</td>
<td>921</td>
<td>897</td>
</tr>
</tbody>
</table>

Patterson also argued that women doing intensive labor had gynecological problems which affected fertility. For supportive evidence, Patterson cited the frequency which slaveowners commented that their slave women complained about menstrual problems. He offered two explanations why slave women would experience these problems: improper nutrition or severe beatings which damaged the ovaries. The problem with this line of reasoning is that it does not explain why Jamaica had a lower crude birth rate than the United States. There were slave beatings in the United States and women in the Louisiana sugar region were subjected to intensive labor yet these women were more fertile than their Jamaican counterparts.

While Patterson's approach does not provide a sufficient explanation, Richard Dunn approached the problem by a

17 Ibid., p. 109.
direct comparison of two plantations, Mount Airy in Virginia and Mesoptamia in Jamaica. While generalizations from these plantations may not hold for the American South or Jamaica, Dunn pointed to a number of factors that effected fertility. He noted that average family size was smaller at Mesoptamia. He found, "only 37% of the Mesoptamia mothers had 4 or more children, whereas 86% of the Mount Airy mothers had families this large." Dunn explained this phenomenon by noting that Mesoptamia mothers on average had their first child a year later than Mount Airy mothers and Mesoptamia mothers had their last child three years earlier. One possible explanation for this observation is that Mount Airy women had a longer lifespan than those at Mesoptamia. Dunn found that while only 10% of the mothers in childbearing ages died at Mount Airy, 33% of the women in this age cohort died at Mesoptamia. However, Dunn wrote, "longevity is certainly not the only factor in our equation, nor probably the most important one." Instead, Dunn argued that fertility differences were best explained by poor nutrition which impaired reproductive development which resulted in late menarche and early menopause for Mesoptamia women.

When larger regions were examined, Klein and Engerman

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19 Ibid. p. 62.
20 Ibid. p. 62.
rejected Dunn's findings on the age of mothers at first child and last child as an explanation for low Jamaican fertility levels. They also rejected the sex imbalance explanation of Patterson. Instead, they attributed the differences in fertility to differences in child spacing patterns. They found that custom prevented a woman from having sexual relations with a male while she was breast feeding a child. In other words, they argued that breast feeding or lactation practices became an effective means of contraception. Basing their conclusions on traveler's reports, plantation records, and other contemporary sources, Klein and Engerman concluded that it was custom to breast feed a child in Jamaica for at least two years while in the United States it was customary to breast feed a child for only one year. As a result, children were spaced further apart in Jamaica than in the United States according to Klein and Engerman. The effect of this was that in the same number of childbearing years, Jamaican women would have had fewer children. Dunn in his study, rejected this explanation on the basis of the experiences of women at Mount Airy and Mesoptamia. He found that there were identical child spacing patterns among mothers who had more than seven children.

In order to reconcile these conflicting explanations.

22 Dunn, p. 61.
it is insightful to return to the concept of a crude birth rate. A crude birth rate is calculated by taking the total number of births and dividing that figure by the total population. Crude birth rates do not take into account the age structure of the population. Hence, when one is comparing crude birth rates, one is implicitly assuming that the two populations have similar age and sex composition. While other measures of fertility take into account these demographic features of the population, the majority of them require that the age of the mother be identified with her offspring. In this case, the national registry returns for the 12 Jamaican plantations only provide the number of births and tell nothing about the women associated with those births. However, the data does allow the computation of child to women ratios, the ratio of the number of children under the age of 5 to the number of women in childbearing years, 15 to 35.

These child to women ratios are an imperfect measure of fertility. They are based only on the number of children and women who survive until the period of registration or enumeration. While some women and children will die before this point, more women will survive because mortality levels associated with infants are significantly higher than the levels associated with women in childbearing years. There is also the problem of underregistration. Young children were often not enumerated which means that the number of children will be further understated. Hence child to women
ratios are understatements of the true fertility level but they do account for the population's age structure since they take into account the number of potential childbearing women.²³

Child to women ratios for the United States in 1830 and the 12 Jamaican plantations appear in Table 2-6. The United State's Census did not utilize a cohort of women aged 18 to 35 but included these ages in cohorts aged 10 to 23 and 24 to 35. The number of women 18 to 23 was obtained from the first of these cohorts by interpolation assuming that the population of the cohort was evenly distributed within that cohort. The number of children for the United States under the age of 5 was also obtained by interpolation of the cohort aged less than 10. Since mortality levels were higher in the cohort aged under 5 than in the cohort aged 6 to 9, the number of children aged under 5 has probably been overstated. This means that the child to women ratio for the United States is probably overstated. Fortunately, the calculation of the Jamaican child to women ratio involved no interpolation.

From these child to women ratios, it appears that women in Jamaica were not less fertile than women in America. In fact, even though the United States' ratio was overstated, there were significantly more children for every 1000 women

Table 2-6

Child to Women Ratios for 12 Jamaican Plantations and the United States in 1830

<table>
<thead>
<tr>
<th>Region</th>
<th>Women 18-35</th>
<th>Children under 5</th>
<th>CWR per 1000 women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jamaica</td>
<td>727</td>
<td>658</td>
<td>905</td>
</tr>
<tr>
<td>United States</td>
<td>490,615</td>
<td>420,697</td>
<td>857</td>
</tr>
</tbody>
</table>

Of childbearing age in Jamaica. If one takes into account the number of women in childbearing ages as a percentage of the total population this conclusion is not surprising. From these percentages, which appear in Table 2-7 it is apparent that in Jamaica there were fewer women in childbearing years as a portion of the population.

Table 2-7

The Percent of Women in Childbearing Years
On 12 Jamaican Plantations and in the United States in 1830

<table>
<thead>
<tr>
<th>Region</th>
<th>% Child Bearing Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jamaica</td>
<td>15.34</td>
</tr>
<tr>
<td>Creole</td>
<td>19.00</td>
</tr>
<tr>
<td>African</td>
<td>1.96</td>
</tr>
<tr>
<td>United States</td>
<td>24.42</td>
</tr>
</tbody>
</table>

Sources: U.S. Dept. of Interior, Census Office
Fifth Census;
Irish University Press Series of British Parliamentary Papers, appendix.
At this point it is now possible to understand the low levels of Jamaican fertility which prevented the population from reproducing itself. While there were equal numbers of men and women by 1820, there were relatively few women in childbearing ages. These women were no less fertile than their Louisiana counterparts. In fact, they had more children, but there were not enough women in childbearing years in the aggregate to sustain population growth.

The absence of women in the reproductive ages in Jamaica has been explained by Barry Higman. Higman pointed out that this was the effect of the cessation of the African Slave Trade and a growing Creole population. While the population as a whole was declining, the Creole population was growing and regenerating. The African population which was declining was an aging population and by 1829 the bulk of it had outgrown the reproductive age cohort. At the same time, the Creole population which was reproducing did not have sufficient numbers of offspring reaching the reproductive ages. Hence, there was erosion of the prime age population cohort. This can be seen by looking at Table 2-8 which contains the aggregate population of the 12 plantations broken down into African, Creole, and age cohorts over the period 1817 to 1820. As can be seen from this table the prime age population as a percentage declined from 1817 to 1829. Thus, there were fewer women to have children.

24 Higman, pp. 45-98.
<table>
<thead>
<tr>
<th>Year</th>
<th>Total</th>
<th>Less than 18</th>
<th>18-42</th>
<th>Over 42</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Africans</td>
<td>Creoles</td>
<td>Africans</td>
<td>Creoles</td>
</tr>
<tr>
<td>1817</td>
<td>33.3</td>
<td>20.4</td>
<td>23.9</td>
<td>14.2</td>
<td>8.0</td>
</tr>
<tr>
<td>1829</td>
<td>35.4</td>
<td>5.1</td>
<td>30.4</td>
<td>16.5</td>
<td>12.6</td>
</tr>
</tbody>
</table>

*TABLE 2-8*

THE AGE STRUCTURE IN PERCENTAGE TERMS
OF 12 JAMAICAN PLANTATIONS
CONCLUSIONS

It has been shown that Jamaica's inability to regenerate its population was not the result of fertility deficiencies or high mortality levels. Jamaica had a mortality structure similar to that of the United States, a regenerating region. Moreover, Jamaican fertility was on par with if not exceeding a regenerating region's fertility rate. When the age structures of the populations were considered, instead, Jamaica was unable to sustain its population in 1829 because of the transition of the population from being predominantly African to predominantly Creole. In 1829, Africans had not been imported for approximately twenty years which meant that the African population was just entering the reproductive years but not in sufficient numbers to maintain aggregate population growth of Africans and Creoles. The effect of these two trends was that there was a decrease in the prime age component of the population. This in turn led to a shortage of women in childbearing years which in turn led to low crude birth rates for the total population.
Sugar plantation operations can be broken down into two components: the growing of the raw product, sugar cane, and the refining of the cane into sugar. The first of these processes was agricultural and the second manufacturing. One could not be done without the other since raw sugar cane after it had been harvested deteriorated rapidly and became useless unless it was refined. Both operations involved different combinations of capital and labor. While Jamaican and Louisiana planters tended to make the same factor choices when it came to refining the cane, they did not make the same choices when it came to growing the sugar cane.

The purpose of this paper is to advance a model based on plantation labor constraints to explain this behavior. Section one examines the factors of production decisions in the agricultural process. A model to explain these decisions is presented in section two. Finally, in section three, the technology of the refining operation is examined and related to the model presented in section two.

**FACTOR OF PRODUCTION SELECTION IN THE GROWING OF SUGAR CANE: THE CASE OF THE PLOW**

The optimal climate for growing sugar cane has an
average temperature of 75 degrees F., considerable sunshine, no frosts, a well distributed annual rainfall of 60 inches or equivalent by irrigation, and a fertile soil that drains rapidly and thoroughly.\(^1\) In the early nineteenth century, neither Jamaica nor Louisiana met all of these conditions. By 1800, sugar cane had been grown in Jamaica for well over 100 years, which meant that the land had been used continuously. However, Jamaica is a large island and in 1800 there were still large tracts of virgin land. Louisiana growers benefitted from good soil conditions. The alluvial soil of the Mississippi was composed of mixed clay, sand and vegetable mold. These alluvial deposits also sloped gently down from the river providing excellent drainage. Nevertheless, Louisiana growers worked with a climatal disadvantage. Their lands were not free from frosts which could destroy the entire harvest. As a result, they were forced to plan their operation to minimize the risk of frost by harvesting the crop before December. Jamaican planters free from the threat of frost could spread their operation out over more of the year. The Mississippi, while providing excellent land and navigational routes, also provided additional burdens to Louisiana planters. While overflowing of the river acted as fertilizer by depositing silt, this overflow also washed away the crop. Therefore, planters were forced to construct a system of levees to control the river. The

\(^1\) Sitterson, p. 13.
maintenance of these systems required additional labor. Therefore, Jamaican planters had an environmental advantage over Louisiana planters.

While the timing of plantation operations were not identical in the two regions, planters had to carry out the same tasks to produce sugar. Fields that were slated to be replanted had to be furrowed and have seed holes drilled. Into these holes were placed the seed cane which was then covered and allowed to grow. The fields that were left in rattoons also had to be cleared of debris from the previous crop. The sugar cane in these fields grew out of offshoots from the previous year's planting. In Jamaica climatal conditions allowed a field to be left in rattoon for a number of years while in Louisiana rattooning for more than one year was uncommon. To ensure proper cane growth, fields had to be weeded after the shoots appeared which was usually done twice over the season. By July, the cane was high enough to prevent the weeds from crowding out the cane.

In the interim, most plantations grew other crops such as corn or peas. Drainage ditches had to be cleared, buildings had to be repaired, and in Louisiana the levees had to be repaired. In the summer, growers began preparing for the grinding season. The refining process required large quantities of fuel which had to be gathered before grinding could begin. Casks to hold the manufactured sugar and molasses also had to be constructed.
By September, the preparations for the harvest were completed and planters began to harvest the sugar cane. This process was labor intensive since mechanization of harvesting techniques did not occur until the twentieth century. First, the cane was cut by hand, then it was bundled and placed on carts. Finally it was hauled to the sugar mill to be refined into sugar. The whole operation had to be done quickly because mature sugar cane ferments quickly and the final product could be lost. To prevent this, the boiling operation went on around the clock with slaves working long hours, often two eight hour shifts a day. They also worked on Sundays which throughout the remainder of the year they customarily had off. The harvest and grinding season was the plantation's period of peak labor demand.

In this scheme of necessary tasks, Louisiana and Jamaican planters used different combinations of labor and capital. In Jamaica all the planting and weeding was done by hand with the hoe: draft animals and the plow were omitted from the production process. In Louisiana, the plow was used extensively to furrow the land for the sugar cane. Moreover, the first weeding was often done with the aid of the plow because it meant that less labor was needed. J. Carlyle Sitterson wrote that the plow was used to save expensive labor. Essentially, Louisiana planters opted for

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capital intensive means of production while Jamaican planters opted for labor intensive means.

A MODEL TO EXPLAIN FACTOR OF PRODUCTION DECISIONS

J. Carlyle Sitterson and Richard Sheridan both offered explanations for the factor of production combinations employed in Louisiana and Jamaica. Sitterson attributed the use of the plow in Louisiana to the physical properties of the land. In order for planters to ensure proper drainage of their fields, he argued that deep plowing was necessary. In Louisiana, planters used mules, oxen or horses as draft animals. However, the difference in draft animals does not explain the factor of production decisions. Louisiana planters imported their animals from Kentucky and Missouri. Why did Jamaica planters not choose to import draft animals that were capable of pulling the plow through heavy soil or hilly fields?

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4 Ibid., p. 115.
5 Sitterson, p. 115.
6 Sitterson, p. 51.
5 Sheridan, p. 111.
Moreover, why did Jamaican planters not use the plow where cattle were capable of pulling it through the soil? Thus, the draft animal explanation does not explain factor of production decisions.

Sheridan in his work offered another possible explanation. He argued if the plow used less labor for hoeing and planting, there would not be enough labor at harvest time. Essentially, what Sheridan argued was that Jamaican planters worked under a labor constraint which influenced their factor selections. Their labor demand varied throughout the year as different tasks had to be carried out in order to produce a given quantity of sugar. The peak period of demand came at the grinding season when the plantation was both an agricultural and manufacturing entity. Labor needs were not as high in the planting season and probably fell off even more after the crop was planted. In order to depict this graphically as is done in Figure 3-1, it is assumed that planters experienced only two levels of demand for labor throughout the year, $D_h$ and $D_m$. $D_h$ is inelastic because the technology of the period made sugar cane harvesting a labor intensive operation. The supply curve, $S$, is elastic reflecting a well functioning competitive market for slaves. To produce a given amount of sugar which the planter has previously chosen, he must have $OQ_h$ labor at harvest time. $OQ_m$ represents the minimal amount of labor.

7 Sheridan, p. 111.
needed for a portion of the year.

Since, the discussion here involves slave labor, one must remember that a planter who purchased a slave's labor did so for a lifetime or until he resold that slave. Therefore, in this discussion which involves differing levels of demand over the year, the only labor unit available to the planter is a year's worth of labor. While it is conceivable that a slave could be purchased and resold within the year, transaction costs prevented this from being a common occurrence. The planter did not have any means to meet his peak labor demand, \( Q_h \), but to purchase \( Q_h \) labor. Having determined the size of his labor force, this will influence the planter's factor selection for other times of the year when he is not facing \( D_h \). This can be seen by examining his position on an isoquant curve in Figure 3-2 underlying his minimal labor demand. There is only one isoquant curve because a set level of production must be carried out in order to produce the predetermined quantity of sugar for the year. It should also be noted that slave labor was actually a capital investment so this isoquant curve shows different combinations of capital that can be used to produce a set level of production. If the planter were unconstrained, he would determine the optimal combination of capital by finding the point where his isocost curve, denoted \( I-I' \), was tangent to his isoquant curve. This line's slope is determined by the relative prices of capital and slave labor. Under these circumstances, it can be seen that the planter
Figure 3-1
would choose $OQ_m$ slaves and $OK_m$ capital. However, the planter already owns $OQ_n$ labor, which means the same task can be done with $OK_n$ capital. Therefore, he will purchase less capital and employ the labor he already possesses more intensively.

While Jamaican planters operated with this labor constraint, Louisiana planters were able to purchase smaller units of labor at harvest time. This was because Louisiana had a more extensive hiring market than Jamaica. Louisiana sugar growers were part of a larger region which grew more than just sugar. Planters were in close proximity to cotton plantations who had different levels of demand throughout the year. Jamaica, on the other hand, was predominantly a sugar growing region whose labor needs moved together. When one planter faced his peak labor demand during the grinding season, all planters were harvesting their sugar crop. Thus, there was no one to hire slaves from in order to meet peak labor needs. In Louisiana, there were slaves and free labor to hire in order to meet peak labor demand in the sugar industry. Kenneth Stampp found that "during the grinding season sugar growers hired hands from Creole farmers or from cotton planters after their crops were picked." Joe Gray Taylor found that planters often hired slaves for the grinding season from as far away as Northern Mississippi. Alton Moody in his study, further documents the view

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8 Stampp, p. 71.
Figure 3-2
that there was a hiring market by noting that Acadian farmers were hired during the grinding season.\textsuperscript{10} Hence, it seems evident that a substantial hiring market existed in Louisiana because of its agricultural diversity while in Jamaica monocrop agriculture prevented such a market from developing.\textsuperscript{11}

Since Jamaican and Louisiana planters faced different labor markets at times of the year, they faced differed marginal cost curves. For simplicity, it will be assumed that at one-half of the year, planters faced $D_m$ and at the other half of the year faced $D_h$. Since slaves for hire were only available in harvesting season, planters in both regions faced the same marginal cost curve during that portion of the year when they faced $D_m$. These were the costs of maintaining a slaves, the opportunity cost of the capital investment, depreciation, plus the opportunity cost of using a slave in the next best alternative. These costs do not increase as the labor force increased so the marginal cost curve, $MC_f$, in figure 3-3 is perfectly elastic. In the


\textsuperscript{11} Here slaves for hire refers to slaves that were hired for a period of time shorter than one year. Slaves hired for the duration of the year, in terms of this analysis which is concerned with one year of operation is the equivalent of owning that slave. Owners were responsible for maintaining hired slaves as well as paying the hiring fee.
Figure 3-3
other half of the year, the marginal cost curve did not change for Jamaican planters so they faced $MC_f$ throughout the year. Louisiana planters during this portion of the year were able to hire slaves to meet their peak labor demand. These slaves were available at a lower cost than the cost of owning a slave. This was because the labor was being provided by cotton planters who had surplus labor at this time of the year. These cotton planters were forced to maintain these slaves at certain costs, but these slaves were not generating revenue for the estate at this point in the harvest cycle. Therefore, a cotton planter would defray some of his fixed costs if he hired out his labor force for any price. As a result, cotton planters were willing to provide slaves for hire at a price less than $P$. Since Louisiana sugar planters were large demanders of slaves for hire, they faced an upward supply curve. As they demanded more and more slaves, the rates they paid increased. In particular, they were responsible for paying transportation costs which increased as they had to hire slaves from further and further away. Therefore, they faced a marginal cost curve, $MC_h$, that was horizontal to $A$ then dropped off rapidly as planters employed hired labor and then rised as they demanded more and more labor to meet peak demand.

With an understanding of the marginal cost curves that the planters faced, it is now possible to calculate their total costs. The Jamaican planter in the first half of the year operated with labor force $Q_h$ which meant that his costs...
Figure 3-4
for this portion of the year were equal to the area of rectangle OPBQₜ in Figure 3-3. In the other half of the year when he faced Dₜ, he operated with the same costs. Therefore, his total costs for the year were twice the area of rectangle OPBQₜ. The Louisiana planter in the first half of the year operated with Qₘ labor which meant that the area of rectangle OPAQₘ determined his costs for this portion of the year. In the rest of the year when he faced Dₜ, the Louisiana planter hired to meet his peak labor demand. Therefore, his costs were the costs of the hands he owned, Qₘ, plus the costs of the hands he hired, QₘQₜ. The costs of the hands he owned were determined by the area of rectangle OPAQₘ. If the planter were able to discriminate and pay the marginal cost of each unit he hired, the costs of the hired labor would be equal to the area of the quadrilateral QₘCDQₜ. If, on the other hand, the planter were forced to pay the marginal cost of the last slave hired for every slave hired, then the costs of the hired labor would be equal to the area of rectangle QₘEDQₜ. For comparison purposes, the more expensive situation was used to calculate the Louisiana planter's total costs for the year which were the areas of rectangles OPAQₘ and QₘEDQₜ. With a knowledge of total plantation labor force costs over the year, the advantage of hiring to meet peak labor demand can be seen. The area of the rectangle EABD plus the area of the rectangle QₘABQₜ in Figure 3-3 was the costs that the Louisiana planter saved by being able to hire labor to meet peak demand. These savings are depen-
dent on the elasticity of the hiring market's marginal cost curve. If the curve is more inelastic, there are less savings from hiring. It is also possible that the hiring marginal cost curve, \( MC_h \), intersected the fixed labor constraint marginal cost curve, \( MC_f \), to the left of \( Q_h \). This possibility has been drawn in Figure 3-4. In this case if the planter is forced to pay the marginal cost of the last unit hired to all units hired, the planter still benefits from hiring. In the first half of the year, he saves the area of rectangle \( Q_m ABQ_h \). When he faced \( D_h \), he paid the area of the rectangle \( AEBD \) more than Jamaican planter which was the cost of hiring this labor as opposed to owning it. However, he saves the difference of rectangle \( Q_m ABQ_h \) minus rectangle \( AEBD \) which has a positive value. Therefore, the analysis is not dependent on the \( MC_h \) intersecting \( MC_f \) to the right of peak labor quantity demanded.

At this point, a model to explain the advantages of a hiring market had been advanced, but why a planter would introduce the plow, a labor saving device, has not been explicated. If a planter adopts the plow, this model allows the cost savings to be shown. The effect of the plow was to shift the \( Q_m \) curve to the right since it was in this portion of the year that it saved labor. In this portion of the harvesting cycle, the costs of the Jamaican planter who operated with a fixed labor constraint, were not determined by the location of \( D_m \) but by \( D_h \). Hence, the Jamaican planter did not benefit from introducing the plow. The
Figure 3.5
costs of the Louisiana planter who operated with a flexible labor market, were determined by the location of $D_m$. As a result, the plow offered him potential labor savings. However, since he reduced his labor needs in this portion of the year, he was forced to hire more labor to meet his peak demand which shifted the marginal cost of hiring labor from $MC_h$ to $MC_h'$. This parallel shift indicates that the planter faced the same hiring market but entered further into that market. The net effect of these two actions can be determined from figure 3-5 assuming that the planter was forced to pay the marginal cost of the last unit hired for all units hired. The effect of the introduction of the plow was to shift $D_m$ to $D_m'$. In the first half of the year, this led to a cost saving equal to the area $Q_m'A'AQ_m$. However, the planter must hire $Q_m'Q_m$ additional laborers in the second half of the year. This increased his cost in this portion of the year by the areas of quadrilaterals $Q_m'S'GQ_m$ and $GSD'D$. If the savings in the first half of the year are greater than the costs of the additional labor costs, then the planter will introduce the plow.

If one now allows the planter to discriminate and pay the marginal cost of each unit hired, this can be depicted in Figure 3-6. Once again, the plow represents a shift in $D_m$ to $D_m'$ and in $MC_h$ to $MC_h'$. In the first half of the year, the planter reduces his costs by $A'AQ_mQ_m'$. In the rest of the year, the planter's costs increase by the areas of quadrilaterals $Q_m'S'GQ_m$ and $GSD'D$ which are the costs of
Figure 3.6
hiring an additional $Q_m Q_m'$ slaves. Once again, if the area of $A'AG_m Q_m'$ exceeds the areas of $S'A'AG$ and $SGDD'$, then the planter will introduce and utilize the plow.

What determines the size of the respective cost and savings areas is the elasticity of $MC_h$. Underlying $MC_h$'s elasticity is the elasticity of the hiring market supply. The more slaves available for hire, the greater the elasticity of supply and hence the greater benefits from introducing the plow. Therefore, a hiring market alone will not necessarily lead to the introduction of labor saving devices. The elasticity of supply in the hiring market will be the determining factor.

Because Jamaica did not have a substantial hiring market, Jamaican planters were forced to operate with a fixed labor supply determined by peak labor demand. This was more expensive than the flexible labor system that Louisiana growers operated under. Louisiana planters' cost reductions resulted because labor costs were not incurred over the entire harvest cycle. Moreover, a flexible labor market allowed Louisiana planters to benefit from labor saving devices whereas Jamaican planters derived no benefits from such devices. Thus, the Louisiana planter opted for the capital intensive plow to save expensive labor while the Jamaican planter used his surplus labor to accomplish the same tasks.
THE REFINING PROCESS: THE CASE OF STEAM POWER

One of the reasons peak labor demand came during the harvesting season was that this was also the refining season. The cane had to first be ground, then have the impurities defecated out with the use of lime, then be clarified and finally be crystallized into sugar. In the period 1800 to 1850, the process was revolutionized by the introduction of steam power and the vacuum pan. These inventions substantially improved the yield and quality of the sugar being produced. After 1860, the centrifugal would improve the refining process even further. The question to be addressed here is whether Jamaica and Louisiana adopted the new technologies.

By the end of the eighteenth century, the majority of planters used the three vertical roller mill to crush the cane in order to extract the saccharine substance. However, this mill was quickly being replaced by the more efficient three horizontal roller mill. Both types of mills were powered by either animal, water, or wind power. When animals were used, they were either cattle, oxen, horses or mules. The disadvantage of these animal powered mills was


the slow rate of extraction. More importantly, animal powered mills did not allow a continuous operation. The mills were constructed with a beam to which the animals were yoked. The animals powered the mill by continuously encircling the mill; thereby, revolving the center roller. Slaves hauling the cane to the mill had to stop to allow the animals to keep the mill revolving. As a result, a continuous operation was impossible. Water and wind power were not available at all locations and did not provide continuous power. A planter using a wind mill risked losing his crop to fermentation if there were a poor wind during the harvest season. Steam power thus offered a continuous operation at a constant rate of revolution. Ward Barrett in regards to steam wrote, "the combination of higher extraction and milling rates in the new steam driven horizontal mill gave it great competitive advantage."\(^{14}\) According to Barrett, steam mills yielded higher extraction rates than animal, wind or water powered mills.

In order to understand whether Jamaican and Louisiana planters would adopt the steam engine, one must assess Barrett's statement on the superiority of the steam powered mill. The most common measure of efficiency for which there is recorded data is the rate of extraction of syrup. This rate can be expressed in a number of ways: the amount of cane that could be ground in one hour or the hourly rate of

\(^{14}\) \textit{Ibid.} p. 149.
extraction as a percentage of the sugar cane's weight before grinding. In order to assess the efficiency improvements of the new technology, an examination of the old technology is necessary.

Michael Craton, in his study of Worthy Park, a Jamaican sugar plantation, assessed the efficiency of the early mills. In regard to their efficiency he wrote:

Mills varied up to 50% according to their power source. Water mills turned fastest, most continuously and reliably, and were cheapest to run once installed; wind power was cheap but capricious as the wind itself; animal power turned mills slowly and was relatively expensive, but efficient as to the juice extraction.

Eric Williams in his study of the Caribbean sugar islands reached similar conclusions:

The ingenio [a water powered mill] was twice as efficient as the trapiche [an animal powered mill]. In Brazil it was estimated that the capacity of a trapiche was 25-35 cart loads of cane every twenty-four hours to produce 840 pounds of sugar, while a hydraulic mill could grind 40-50 cart loads and extract 1120 to 1960 pounds of sugar in the same period.

Ward Barrett disagreed with the findings of both Williams and Craton when he wrote there was "little difference in extraction rates between the animal and water driven mills." Fortunately, contemporary evidence of the period

15 Michael Craton, p. 2.
17 Barrett, p. 156.
allows these claims to be evaluated.

In 1831, the United States Congress commissioned a study of the cane sugar industry. Written by R. S. McCulloch, the final report provided data that allows the efficiency claims to be evaluated. McCulloch cited the conclusions of M. Casseca, a chemistry professor at the University of Havanna. This professor conducted experiments on this question and his data appear in Table 3-1. From this data, it appears that water and oxen powered mills were equally efficient in terms of extraction of juice. The type of cane entered into the mill logically made a difference in the quantity of syrup extracted since different varieties of cane contained different amounts of saccharine substance. Thus, while there may have been slight variations in the efficiency of these mills, they did not vary by as much as 50%.

**TABLE 3-1**

<table>
<thead>
<tr>
<th>Cane Type</th>
<th>Power Source</th>
<th>Juice Extracted</th>
<th>Bagasse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ribbon</td>
<td>water</td>
<td>45%</td>
<td>55%</td>
</tr>
<tr>
<td>Creole</td>
<td>steam</td>
<td>35</td>
<td>65</td>
</tr>
<tr>
<td>Othaheite</td>
<td>oxen</td>
<td>56</td>
<td>44</td>
</tr>
<tr>
<td>Othaheite</td>
<td>water</td>
<td>57</td>
<td>43</td>
</tr>
</tbody>
</table>


The next step is to determine the efficiency of steam powered mills. Fraginals in his study of the Cuban sugar

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18 U. S. Cong. S. doc. 209, p. 46.
economy provided data from a Cuban planter, Villa Urritia, which can be used to compare the efficiency of oxen and steam powered mills. The data which appears in Table 3-2 came from Urritia's La Mella mill in Limonar, Cuba. The Jamaican train which is referred to in the table was a system of open kettles used to evaporate the moisture from the syrup. The mixed evaporation system which is also referred to in the table was a system of open kettles and a vacuum pan. From this data, it appears that steam powered mills did not dramatically increase sugar yields. Instead, it appears that the steam engine in conjunction with the vacuum pan was the big boost to sugar yields.

TABLE 3-2
VILLA URRITIA SUGAR YIELDS PER GIVEN WEIGHT OF CANE PROCESSED 1830-1843

<table>
<thead>
<tr>
<th>Year</th>
<th>Manufacturing Process</th>
<th>Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>1830</td>
<td>ox powered mill and Jamaican train</td>
<td>3.02</td>
</tr>
<tr>
<td>1831</td>
<td></td>
<td>3.97</td>
</tr>
<tr>
<td>1832</td>
<td></td>
<td>3.33</td>
</tr>
<tr>
<td>1833</td>
<td></td>
<td>3.26</td>
</tr>
<tr>
<td>1834</td>
<td></td>
<td>3.72</td>
</tr>
<tr>
<td>1835</td>
<td></td>
<td>4.51</td>
</tr>
<tr>
<td>1836</td>
<td></td>
<td>4.02</td>
</tr>
<tr>
<td>1837</td>
<td>steam powered mill and Jamaican train</td>
<td>3.94</td>
</tr>
<tr>
<td>1838</td>
<td></td>
<td>3.31</td>
</tr>
<tr>
<td>1839</td>
<td></td>
<td>3.03</td>
</tr>
<tr>
<td>1840</td>
<td></td>
<td>3.56</td>
</tr>
<tr>
<td>1843</td>
<td>steam powered mill and mixed evaporation system</td>
<td>5.91</td>
</tr>
</tbody>
</table>

Source: Fraginals, p. 124.

If the steam mill did not provide efficiency gains in

terms of extraction rates, what benefits did it provide? One possibility is that the steam mill allowed continuous operations which the oxen mill did not. Moreover, a steam mill could be erected anywhere whereas a water mill required a swiftly running stream. However, the big advantage of the steam mill was that it did not require the maintenance of large animal stocks. Slaves were notoriously bad in their treatment of stock animals and were needed to care for these animals. Therefore, if the steam powered mill was utilized, it offered labor savings over the oxen powered mill.

Since the steam mill was a labor saving device, one would expect its introduction into Louisiana which occurred gradually. The most commonly cited date for the first steam powered mill in Louisiana is 1822. However, there is evidence that experiments with steam powered mills began at least two years earlier. In 1838, the United States Government, fearful of the number of boiler explosions, commissioned a study of steam engine use. Among the questions the study asked of steam engine owners were the use of the engine, the date of construction, and how long the mill was in use. While questionnaire returns did not include all the


steam engines in the state, among the engines listed were
four steam mills that began operation in 1820 or 1821.
There might have been more because the study only recorded
mills that were still in operation in 1838.

More important than a precise dating of the first steam
mill is the dating of the steam mills widespread adoption.
Noel Deerr estimated that by 1830, Louisiana had 100 steam
mills. 22 Sitterson cited the 1830's and 1840's as the period
of widespread acceptance. 23 The government documents allow a
more precise dating. The first of these is the report on
the steam engine which has already been mentioned and the
other is the study of the cane sugar industry commissioned
in 1831. 24

The report on the cane sugar industry was compiled by
G. Davis and included the number of sugar plantations and
steam mills in the state in 1829. This information appears
in Table 3-3 and shows that by 1829 less than 12% of the
sugar plantations were using steam power. The 1838 census
of steam engines provided the data in Table 3-4 which is the
number of steam mills erected in Louisiana from 1820 to
1838. The one major drawback to this table which has

22 Deerr, p. 553.
23 Sitterson, p. 43.
24 U. S. Cong. House. Sugar Manufacturing in the Unit-
209.1.
already been noted is that it only contains mills that were
still in operation in 1838. The two documents do however
give a sense of the introduction of steam. In 1829, there
were 54 engines and at least one-third of these were
erected after 1825. Moreover, many plantations began to
purchase steam engines around 1830. There does not exist a
good document that reveals the number of mills in Louisiana
in the 1840's and 1850's, but if three Texas counties, Braz-
eria, Wharton, and Fort Bend are typical, they provide evi-
dence for the 1850's. Sitterson found that in 1855 there
were 40 sugar plantations in the three counties 32 of which
were using steam power. Thus, between the 1830's and
1850's, the steam engine came into widespread use in Louisi-
ana.

It is substantially harder to date the introduction of
steam power into the refining process in Jamaica, but it is
clear that planters did use the steam mill. Noel Deerr pro-
vided some evidence in his study. He cited 1808 as the year
the first mill was constructed, but it is unlikely that they
were used on a widespread basis that early. Deerr's other
piece of evidence is far more illustrative. Examining the
records of the steam engine manufacturing company, Boulton
and Watt, he found that between 1802 and 1852, 148 steam
engines were built and 56 of these went to Jamaica.26

25 Sitterson, p. 43.
27 Deerr, p. 553.
### TABLE 3-3
STEAM POWERED MILLS IN LOUISIANA IN 1829

<table>
<thead>
<tr>
<th>Parish</th>
<th># of Plantations</th>
<th># of Steam mills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bayou Rapides</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Lake of the Cross</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Mount Pleasant</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Point Coupé</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>West Baton Rouge</td>
<td>21</td>
<td>5</td>
</tr>
<tr>
<td>East Baton Rouge</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>Iberville</td>
<td>50</td>
<td>5</td>
</tr>
<tr>
<td>Ascension</td>
<td>39</td>
<td>4</td>
</tr>
<tr>
<td>St. James</td>
<td>70</td>
<td>5</td>
</tr>
<tr>
<td>St. John the Baptist</td>
<td>50</td>
<td>3</td>
</tr>
<tr>
<td>St. Charles</td>
<td>47</td>
<td>13</td>
</tr>
<tr>
<td>Jefferson</td>
<td>31</td>
<td>17</td>
</tr>
<tr>
<td>Barrataria</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Orleans</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Plaquemines</td>
<td>29</td>
<td>9</td>
</tr>
<tr>
<td>St. Bernard</td>
<td>25</td>
<td>3</td>
</tr>
<tr>
<td>Centilly</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Opelousas</td>
<td>14</td>
<td>0</td>
</tr>
<tr>
<td>Lafayette</td>
<td>19</td>
<td>0</td>
</tr>
<tr>
<td>St. Martin</td>
<td>46</td>
<td>0</td>
</tr>
<tr>
<td>St. Mary</td>
<td>102</td>
<td>2</td>
</tr>
<tr>
<td>Bayou Lafourche</td>
<td>41</td>
<td>1</td>
</tr>
<tr>
<td>Lafourche Interior</td>
<td>74</td>
<td>1</td>
</tr>
<tr>
<td>and Bayou Terre Bonne</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>701</strong></td>
<td><strong>74</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th># of mills erected that year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1820</td>
<td>2</td>
</tr>
<tr>
<td>1821</td>
<td>2*</td>
</tr>
<tr>
<td>1822</td>
<td>0</td>
</tr>
<tr>
<td>1823</td>
<td>0</td>
</tr>
<tr>
<td>1824</td>
<td>0</td>
</tr>
<tr>
<td>1825</td>
<td>2</td>
</tr>
<tr>
<td>1826</td>
<td>1*</td>
</tr>
<tr>
<td>1827</td>
<td>3</td>
</tr>
<tr>
<td>1828</td>
<td>6</td>
</tr>
<tr>
<td>1829</td>
<td>6</td>
</tr>
<tr>
<td>1830</td>
<td>16</td>
</tr>
<tr>
<td>1831</td>
<td>8</td>
</tr>
<tr>
<td>1832</td>
<td>5</td>
</tr>
<tr>
<td>1833</td>
<td>3</td>
</tr>
<tr>
<td>1834</td>
<td>4</td>
</tr>
<tr>
<td>1835</td>
<td>8</td>
</tr>
<tr>
<td>1836</td>
<td>3</td>
</tr>
<tr>
<td>1837</td>
<td>1</td>
</tr>
<tr>
<td>1838</td>
<td>1</td>
</tr>
</tbody>
</table>

*1 mill in each of these years was used as a sugar, saw and grist mill. Source: House Document 21, pp. 303-308.
Unfortunately, the time period is so large that it does not allow precise dating, but it does indicate that Jamaican planters were opting for the steam mill.

At this point one must ask why did Jamaican planters reject the plow and adopt the steam mill when they were both labor saving devices. The answer can be seen by reexamining the model presented in section 2. The labor saving that resulted from the steam mill came during that portion of the year when the planter was facing \( D_h \), his peak labor demand. Previously, it was shown that the planter needed \( OQ_{nh} \) labor to produce a given amount of sugar. With the introduction of the steam engine, the planter could reduce his labor needs. This effect is demonstrated by the shift from \( D_h \) to \( D_h' \) in Figure 3-7 which is the peak labor demand curve faced when a steam mill is employed. This allowed the planter facing a labor constraint to reduce his costs over the entire year by twice the area of \( B'BQ_{nh} \) in Figure 3-7. As long as these gains paid for the investment of the mill, the planter opted for the steam mill. The gains to a Louisiana planter operating with a hiring market are depicted by the area of rectangle \( Q_{nh}D'DQ_{nh} \). This gain occurred because the planter had to hire less labor to meet his peak demand because he has reduced that demand. Note that the Louisiana planter only accrued cost reductions in the period of peak demand while the Jamaican planter accrued cost savings over the entire year because his total labor force has been reduced.
Figure 3-7
The difference between the steam mill and the plow was the period in which they saved labor. The plow saved labor when the Jamaican planter already had a surplus. Whereas, the steam mill saved labor when the planter had to meet his peak labor demand. Therefore, the Jamaican planter accrued cost savings from the introduction of the steam powered mill while there were no cost reductions from the use of the plow. In Louisiana, where planters could adjust their labor supply to demand, there were benefits derived from using labor saving devices throughout the year. Thus, Louisiana planters used both the plow and the steam mill.

CONCLUSIONS

It has been shown that Louisiana and Jamaica sugar planters made different factor of production choices depending upon their labor constraints. Jamaican planters, working with a fixed labor supply, opted for labor intensive means of production unless they were operating on their peak labor demand curve. Thus, they used slaves instead of draft animals. Louisiana planters who could adjust their labor supply, opted for capital intensive means of production. Planters in both regions, when they faced their peak labor demand curve, opted for capital intensive means of production such as the steam powered sugar mill.

Therefore, the difference in factor of production
selection stemmed from the existence of a fixed labor system or a flexible labor system where a smaller unit of labor could be purchased. The hiring market in Louisiana allowed such units to be purchased, whereas in Jamaica, there was not a substantial hiring market. Moreover, this hiring market in Louisiana resulted because Louisiana was part of a diversified plantation economy while Jamaica was a mono-crop economy.
FOUR: SLAVE PRODUCTIVITY IN JAMAICA AND LOUISIANA

The first three chapters of this study focused on examining the demographic and institutional features of slavery in Jamaica and Louisiana. In this final chapter, the focus shifts to how these features affected slave productivity. More simply stated, this chapter will address the question of which region's slaves were more productive. In order to answer this question, section one will present a productivity measure that can be calculated from available contemporary data. Secondly, the effects of the demographic and institutional features of slavery in the two regions will be used to formulate a hypothesis about which region had higher productivity. Finally, section three will empirically test this hypothesis.

FINDING A MEASURE OF SLAVE PRODUCTIVITY

Slaveowners were not interested solely in slave productivity but in the exploitation of slave labor or more precisely the rate at which they extracted a slave's labor. A highly productive slave was not necessarily a more desirable investment than a less productive slave. This can best be seen by examining a hypothetical example involving two slaves, A and B. It will be assumed that A is both more

1 A tabular view of the following discussion is presented in Table 4-1.
expensive and productive than B. In a year, A contributes $400 in revenue to the estate while B only contributes $335. To examine net contributions to the estate by each of these slaves, the costs of owning them must also be illustrated. It will be assumed that the maintenance costs, the costs of feeding, clothing, and caring for slaves, are $75 for A and $60 for B. The planter must also pay a depreciation charge since a year of the slave's labor has been used. For simplicity, it will be assumed that both slaves will live for ten years after their purchase. Therefore, the depreciation of the slave in any year will be 10% of the initial investment. In order to calculate this expense, the initial values of the slaves must be known. A and B's initial values were $1000 and $500 which means that their depreciation costs were $100 and $50 a year respectively. The total cost of maintaining these two slaves totals $175 for A and $110 for B. It is now possible to calculate their net contributions to the estate by subtracting these costs from the revenue contributions. After performing this operation, one discovers that both contributed $225 to the estate. Clearly, while A is more productive, A is not necessarily more beneficial to the planter than B.

The reason productivity is not the sole important factor is that the owner extracts different amounts of labor from the two slaves. In the case of A, the owner only extracts 56.25% of the slave's labor while in S he extracts 67.16%. Thus, the rate of extraction or exploitation is the
TABLE 4-1
REVENUE CONTRIBUTIONS TO AN ESTATE
BY TWO HYPOTHETICAL SLAVES

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Investment</td>
<td>$1000</td>
<td>$500</td>
</tr>
<tr>
<td>Depreciation</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>Maintenance Costs</td>
<td>75</td>
<td>60</td>
</tr>
<tr>
<td>Total Cost</td>
<td>175</td>
<td>110</td>
</tr>
<tr>
<td>Output Value</td>
<td>$300</td>
<td>$335</td>
</tr>
<tr>
<td>Net Contribution</td>
<td>225</td>
<td>225</td>
</tr>
<tr>
<td>Rate of exploitation</td>
<td>56.25%</td>
<td>67.16%</td>
</tr>
</tbody>
</table>

more important factor. If one planter can extract more labor than another, he will have a cost advantage. While this example involved only two slaves the principle still holds when one is discussing the efficiency of the total labor force as well.

Optimally, one wants to compare the rate of exploitation in Louisiana and Jamaica. This rate can more formally be written as:

\[
\frac{\text{the value of output generated by labor} - \text{labor costs}}{\text{the value of output generated by labor}} \times 100.
\]

In order to calculate this rate, one needs to know the value
of output and labor costs. To calculate labor costs, one must know maintenance costs and the depreciation costs which means that the value of the slave labor force must be known. More importantly, one must have this data on a plantation level basis to compare the regions. In chapter two, it was hard merely to find population data broken down into age cohorts and now the size of the labor force, output, output price, maintenance costs, and the value of the labor force are needed. Unfortunately, such extensive data sources do not exist. One can find estimates of the value of a child slave, a prime age male or female and the like, but one cannot proceed to calculate the value of a labor force from these values unless the age breakdown of the labor force is known. The data on the 12 Jamaican plantations which broke the population into age cohorts did not give any data on production and in Louisiana age data was used on the parish level so this reconstruction approach cannot be used. Therefore, while one wants to compare and calculate exploitation rates, the data needed just does not exist. As an alternative, a simple productivity ratio will be used as a proxy for an exploitation rate. This ratio will be defined as the total output divided by the size of the labor force. In other words, this ratio is the agricultural yield per worker. The value of output was used in the exploitation rate which was price times output. Since the comparison here is in terms of sugar, the output is the same in both regions and it can safely be assumed that planters received
the same price for their products in a given year. In the exploitation rate, labor costs were also deducted from the value of output. These costs were the costs of maintaining slaves and depreciation. The maintenance costs were the costs of sustaining slaves and once again it is safe to assume that these costs were roughly the same in both regions. The only cost that remains is depreciation which is a function of the value of the slave force. Until 1808, when there was an open slave trade in both regions, one would have expected fairly uniform prices, but after that date, there were two separate distinct internal markets. As a result, one would expect there to be different price structures in the two markets. Therefore, how good a proxy the productivity ratio is for the exploitation rate depends on how similar these price structures were. Unfortunately, there is little scholarly research devoted to studying these price structures. Nevertheless, data source constraints force the use of these simple productivity ratios as a proxy for exploitation rates.

**HOW DEMOGRAPHIC AND INSTITUTIONAL FEATURES AFFECT THE PRODUCTIVITY RATIO**

Since the denominator of the productivity ratio is the number of slaves on the plantation, the age structure of these slaves affect the labor force's productivity. All the slaves did not contribute equally to the estate, but all
slaves had to be maintained meaning they consumed the estate's resources. Young slaves were investments in the future because they consumed more than they produced. Elderly slaves also consumed more than they produced and were a drain on the estate's resources. A rational owner would have chosen to manumit these elderly slaves to avoid the costs of maintaining them, but slave laws in Louisiana and Jamaica prevented owners from doing so by requiring them to post bonds to prevent manumitted slaves from becoming wards of the state. Therefore, owners could not free themselves from the costs of maintaining elderly slaves. A plantation with more elderly and young slaves should have had less output and hence lower productivity than an estate with a labor force comprised entirely of prime age slaves. Thus, a productivity ratio is a function of the age structure of the underlying population.

The analyses of chapters one and two, allow a comparison of the age structure of Jamaica and Louisiana. Optimally, the analysis should be done for the given plantations which are going to be used to calculate the productivity rates, but the age structure of the labor forces on these plantations are unknown. However, since they are assumed to be a representative sample of the regions, other representative samples of the regions can be used for this comparison. Thus, the samples used in chapters one and two

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2 Taylor, p. 155; Patterson, pp. 71-78.
can be utilized to compare age structure although these samples cannot be used to calculate productivity ratios.

In terms of the number of prime age slaves in both regions, the evidence presented in chapters one and two showed that Louisiana had more prime age slaves than Jamaica. The migration flows analyzed in chapter one showed that Louisiana was the recipient of a prime age population flow. While these patterns were illustrated for the period 1850 to 1860, the patterns of the earlier period should have been similar. Unfortunately, the age cohorts used in the 1820 and 1830 censuses are too broad to lead to meaningful migration estimates. However, planters' demands would not have changed: they would still have wanted to purchase prime age slaves. Collins showed that there was substantial migration into Louisiana in the 1820's meaning that there was a prime age population movement into Louisiana. Thus, the region was the recipient of prime age slaves. Jamaica, on the other hand, as was shown in chapter two had a declining prime age population. These two trends can easily be verified by examining the percentage of the population in the prime age years. The populations are broken down into age cohorts as a percentage of the total population in Table 4-2. From this table, it is readily apparent that prime age slaves in Jamaica made up a smaller segment of the population than in Louisiana.

3 Collins, pp. 42-44.
TABLE 4-2

AGE STRUCTURE OF LOUISIANA AND JAMAICA CIRCA 1830

<table>
<thead>
<tr>
<th>Region</th>
<th>% under 18</th>
<th>% 18-42</th>
<th>% over 42</th>
</tr>
</thead>
<tbody>
<tr>
<td>St. John's Parish</td>
<td>35.3*</td>
<td>5*</td>
<td>12.8*</td>
</tr>
<tr>
<td>Jamaica</td>
<td>35.4</td>
<td>35.6</td>
<td>29.1</td>
</tr>
</tbody>
</table>

*Value involved interpolation of age cohorts.

Table 4-2 assumes that a slave did not produce enough output to be considered prime age until that slave reached the age of eighteen. While it is pretty certain that a slave did not generate enough output to offset rearing costs before the age of ten, the exact age when the transition from drain to contributor occurred is hard to determine, but it lay somewhere between ten and eighteen. The extreme in Table 4-2 was chosen because at eighteen, it was customary to label slaves prime field hands, but slaves were used in the fields at earlier ages. According to Stampp, slaves between the ages of ten and eighteen were used to pick peas, rye fodder and gather corn and vegetables which was productive labor. To ensure that the number of productive slaves has not been understated, Table 4-3 redefines the productive cohort to be between the ages of ten and forty-two. From this table the same conclusion is reached: prime age slaves

4 Stampp, p. 57.
made up a larger segment of the population in Louisiana. Moreover, one can also see that the major difference in the composition of the labor force was that elderly slaves made up a larger segment of the population in Jamaica. The percentage of children in the respective populations was approximately equal. The consequence of this was that Jamaican labor forces were less productive than Louisiana labor forces. This does not mean that individual slaves were less efficient, but that as a labor force, they were less productive since they had more elderly slaves in the labor force.

TABLE 4-3

AGE STRUCTURE OF LOUISIANA AND JAMAICA CIRCA 1830

<table>
<thead>
<tr>
<th>Region</th>
<th>% under 10</th>
<th>% 10-42</th>
<th>% over 42</th>
</tr>
</thead>
<tbody>
<tr>
<td>St. John's Parish</td>
<td>19.5</td>
<td>67.6#</td>
<td>1#</td>
</tr>
<tr>
<td>Jamaica</td>
<td>1*</td>
<td>51.4#</td>
<td>29.1</td>
</tr>
</tbody>
</table>

*Value involved interpolation of age cohorts.

The sex composition of the labor force also affected the productivity ratio. The more males on a plantation the greater the output with the same number of slaves. In the case of Jamaica and Louisiana, the evidence presented in chapters one and two showed that sex ratios were approximately equal in both regions. Therefore, one would not expect productivity differentials in the two regions to be attributable to sex composition of the labor forces.

Not only did demographic patterns affect the productivity of slave labor, the capital employed also affected
agricultural yields per slave. Chapter three examined the utilization of capital and labor in the two regions. It was shown that Louisiana planters used more capital and less labor to achieve the same level of output. Therefore, the productivity ratios in Louisiana would have been higher than Jamaican ratios since the additional capital was invested in labor saving devices. Overall, both population structure and factor of production decisions indicate that Louisiana had more productive slaves.

THE DATA AND EMPIRICAL EVIDENCE

One can empirically test these hypotheses with data on sugar production and the number of slaves for a sample of plantations in both regions. The output of sugar plantations was more than just sugar: molasses and other foodstuffs were produced. However, in any given year sugar production figures reflect molasses production. Over time, this ratio was not constant since the introduction of the steam engine in conjunction with the vacuum pan improved the quantity of sugar and decreased the amount of molasses produced, but this innovation did not occur until after the 1850's. Moreover, the foodstuffs grown on the plantation were grown for home consumption. Thus, they were actually part of the costs of owning slaves and since the effort here is to approximate an exploitation rate, they should be subtracted from output as wages. Thus, sugar production
figures are a good proxy for output figures.

Even though the number of slaves and sugar production are the only pieces of data needed, historical data are still hard to come by. Fortunately, a group of researchers from Colby College in 1978 collected data for four Jamaican sugar plantations. Louisiana data is easier to find since the United States government took an active interest in sugar production. In 1830, the government commissioned a report on the sugar industry which provided data on nineteen sugar plantations in Plaquemines Parish, Louisiana.⁵ These two data sources will be the basis of a productivity ratio comparison.

Both sources give production figures in terms of hogsheads of sugar. Weights and measures in the early nineteenth century were not standardized and the weight of a hogshead varied with size. Barry Higman using a sample of hogsheads and their respective weights found that the median weight of a hogshead in his sample was 2000 pounds.⁶ This figure was used to standardize Jamaican production figures. Louisiana production figures were standardized with a hogshead equal to 1000 pounds. The government report cited the New Orleans Price Current of November 20, 1830 which stated that "a hogshead generally weighs about one thousand

⁵ H. doc. 62. 1830-1.
⁶ Higman, pp. 235-236.
Another problem with the production figures is that agricultural yields varied from year to year depending upon weather conditions. If the crop were reduced by a flood or frost, this would deflate the productivity ratio. As a consequence, one wants to ensure that when two productivity ratios are compared, one is comparing different slave productivities and not different weather patterns. To prevent this, a three year average of production figures was calculated since it is unlikely that weather conditions were poor in all three years. In fact, the United States government study remarked that 1828 was an exceptional harvest in Louisiana while part of the 1829 crop was destroyed by unfavorable weather conditions. The averaging technique minimizes the effect of these varying weather patterns.

The composition of the labor force also affects the productivity ratio. Optimally, one wants to calculate these ratios with the number of field hands for the size of the labor force. While this could have been done for the Louisiana sample, the Jamaican sample only recorded the number of slaves. If domestic slaves made up a larger component of the Jamaican labor force, this would deflate the productivity ratios. The average percentage of field hands on the 19 Louisiana plantation was 64.7%. Since this ratio

---

7 H. doc. 62. 1830-1., p. 49.
8 Calculated from data provided in H. doc. 62. 1830-1.
for the Jamaican plantations under examination here cannot be calculated, a proxy will be used. Michael Craton's research on Worthy Park, a Jamaican sugar plantation, allows a similar percentage to be calculated. In 1830, field hands comprised 63.3% of the estate's labor force. From the evidence of Worthy Park and the 19 Louisiana plantations, the ratio of field hands to the total labor force was approximately equal in the two regions. Therefore, the fact that total labor force has been used to calculate productivity ratios has not affected the data for comparison purposes.

The productivity ratios can be found in Table 4-4. The Louisiana ratios in every case exceed the Jamaican ratios by at least five pounds per slave. However, this gap is slightly deceiving since the number of slaves used to calculate the Louisiana ratios were the number of slaves owned by the estate and not the total labor force. In chapter three, it was argued that plantation labor forces were smaller in Louisiana because planters could meet peak labor demand periods by hiring labor. Since the total labor force's size is unknown, the number of slaves owned had to be used as a

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9 Craton broke the labor force down into 20 categories. The following categories were considered to be nonfield work:

Domestics; Factory Craftsmen; Factory Laborers; Nonfactory, nonfield; Watchmen; Aged; and Young.

With the remaining categories it was possible to approximate the data in the United States government study. Craton, pp. 180-181.
proxy. This led to an upward bias in the ratio since the labor force was understated. Nevertheless, it is doubtful whether this upward bias could account for the entire differential. Thus, as was expected, agricultural productivity, as reflected in yield per slave data, was higher on Louisiana plantations.

**TABLE 4-4**

**PART C**

**OWNERS OF LOUISIANA PLANTATIONS**

<table>
<thead>
<tr>
<th>Plantation Number</th>
<th>Owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mr. Morgan</td>
</tr>
<tr>
<td>2</td>
<td>Mr. Laneaux</td>
</tr>
<tr>
<td>3</td>
<td>Aug Dupre</td>
</tr>
<tr>
<td>4</td>
<td>J. Saul</td>
</tr>
<tr>
<td>5</td>
<td>Deputy and Lethiec</td>
</tr>
<tr>
<td>6</td>
<td>Chas Reggio</td>
</tr>
<tr>
<td>7</td>
<td>Hx. McCall</td>
</tr>
<tr>
<td>8</td>
<td>V. and V. Duplessis</td>
</tr>
<tr>
<td>9</td>
<td>Lizardy</td>
</tr>
<tr>
<td>10</td>
<td>J. B. Wilkinson</td>
</tr>
<tr>
<td>11</td>
<td>Shephard and Montgomery</td>
</tr>
<tr>
<td>12</td>
<td>Samuel Parkwood</td>
</tr>
<tr>
<td>13</td>
<td>Ve Guesnard and Son</td>
</tr>
<tr>
<td>14</td>
<td>Guerin Brothers</td>
</tr>
<tr>
<td>15</td>
<td>Nicholas Reggio</td>
</tr>
<tr>
<td>16</td>
<td>D. Villere and Lavergne</td>
</tr>
<tr>
<td>17</td>
<td>Uruqhart and Milligan</td>
</tr>
<tr>
<td>18</td>
<td>Felix Forestall</td>
</tr>
<tr>
<td>19</td>
<td>G. B. Milligan and Company</td>
</tr>
</tbody>
</table>

The Jamaican productivity figures also reflect the demographic trends outlined in chapter two. The region's prime age population was declining which meant that by the late 1820's there were fewer of the most productive slaves in the labor force. This would be reflected by declining productivity ratios over time which was true of all the plantations used in the sample with the exception of the
### TABLE 4-4
PART A-1
JAMAICAN PRODUCTIVITY RATIOS

<table>
<thead>
<tr>
<th>Plantation</th>
<th>Year</th>
<th>HHD</th>
<th>Raw Slaves</th>
<th>Year</th>
<th>HHD</th>
<th>Raw Slaves</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Acton</td>
<td>1817</td>
<td>82</td>
<td>94</td>
<td>1820</td>
<td>61</td>
<td>92</td>
</tr>
<tr>
<td>2</td>
<td>1822</td>
<td>33</td>
<td>90</td>
<td>1823</td>
<td>27</td>
<td>90</td>
</tr>
<tr>
<td>3</td>
<td>1827</td>
<td>33.5</td>
<td>97</td>
<td>1828</td>
<td>43</td>
<td>98</td>
</tr>
<tr>
<td>4 Bog</td>
<td>1817</td>
<td>562</td>
<td>499</td>
<td>1820</td>
<td>400</td>
<td>488</td>
</tr>
<tr>
<td>5</td>
<td>1824</td>
<td>157</td>
<td>408</td>
<td>1827</td>
<td>349</td>
<td>491</td>
</tr>
<tr>
<td>6 Berwick</td>
<td>1817</td>
<td>103</td>
<td>145</td>
<td>1820</td>
<td>103</td>
<td>138</td>
</tr>
<tr>
<td>7</td>
<td>1822</td>
<td>141</td>
<td>138</td>
<td>1823</td>
<td>43</td>
<td>139</td>
</tr>
<tr>
<td>8</td>
<td>1826</td>
<td>129</td>
<td>193</td>
<td>1827</td>
<td>112</td>
<td>178</td>
</tr>
<tr>
<td>9 Exeter</td>
<td>1817</td>
<td>178</td>
<td>192</td>
<td>1820</td>
<td>150</td>
<td>193</td>
</tr>
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<td>10</td>
<td>1822</td>
<td>34</td>
<td>193</td>
<td>1824</td>
<td>50.5</td>
<td>190</td>
</tr>
<tr>
<td>11</td>
<td>7</td>
<td>109.5</td>
<td>191</td>
<td>1828</td>
<td>74.25</td>
<td>192</td>
</tr>
</tbody>
</table>
TABLE 4-4
PART A-2
JAMAICAN PRODUCTIVITY RATIOS

<table>
<thead>
<tr>
<th>Year</th>
<th>Raw HHD</th>
<th>Slaves</th>
<th>3 Year Averages</th>
<th>Average</th>
<th>Productivity Ratios</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Raw HHD</td>
<td>Slaves</td>
<td>Sugar in pounds</td>
</tr>
<tr>
<td>1821</td>
<td>68</td>
<td>93</td>
<td>70.3</td>
<td>92</td>
<td>1407</td>
</tr>
<tr>
<td>1826</td>
<td>53</td>
<td>95</td>
<td>37.7</td>
<td>91.7</td>
<td>753</td>
</tr>
<tr>
<td>1831</td>
<td>31</td>
<td>98</td>
<td>35.8</td>
<td>97.7</td>
<td>716</td>
</tr>
<tr>
<td>1822</td>
<td>237</td>
<td>477</td>
<td>399.7</td>
<td>488</td>
<td>7994</td>
</tr>
<tr>
<td>1828</td>
<td>297</td>
<td>495</td>
<td>267.7</td>
<td>491.3</td>
<td>5354</td>
</tr>
<tr>
<td>1821</td>
<td>81.25</td>
<td>138</td>
<td>95.8</td>
<td>140.3</td>
<td>1915</td>
</tr>
<tr>
<td>1824</td>
<td>77</td>
<td>122</td>
<td>87.0</td>
<td>133</td>
<td>1740</td>
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<td>1828</td>
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<td>128.3</td>
<td>180.7</td>
<td>2567</td>
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<tr>
<td>1821</td>
<td>43</td>
<td>195</td>
<td>123.7</td>
<td>193.3</td>
<td>2473</td>
</tr>
<tr>
<td>1826</td>
<td>125</td>
<td>187</td>
<td>69.8</td>
<td>190</td>
<td>1397</td>
</tr>
<tr>
<td>1834</td>
<td>101</td>
<td>196</td>
<td>94.9</td>
<td>193</td>
<td>1898</td>
</tr>
</tbody>
</table>

*The conversion factor for converting hogsheads into pounds was 1 HHD = 2000 pounds.
# TABLE 4-4

## PART B

**LOUISIANA SUGAR PLANTATION PRODUCTIVITY RATIOS**

<table>
<thead>
<tr>
<th>Location: Louisiana</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Plantation #</th>
<th>Raw 1827</th>
<th>1828</th>
<th>1829</th>
<th>Average (HHD)*</th>
<th>Productivity In Pounds**</th>
<th># of slaves</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>430</td>
<td>610</td>
<td>415</td>
<td>485</td>
<td>4850</td>
<td>191</td>
<td>25.39</td>
</tr>
<tr>
<td>2</td>
<td>333</td>
<td>385</td>
<td>120</td>
<td>279.3</td>
<td>2793</td>
<td>67</td>
<td>41.69</td>
</tr>
<tr>
<td>3</td>
<td>80</td>
<td>124</td>
<td>38</td>
<td>80.7</td>
<td>807</td>
<td>38</td>
<td>21.24</td>
</tr>
<tr>
<td>4</td>
<td>383</td>
<td>390</td>
<td>130</td>
<td>301</td>
<td>3010</td>
<td>105</td>
<td>28.67</td>
</tr>
<tr>
<td>5</td>
<td>204</td>
<td>415</td>
<td>150</td>
<td>256.3</td>
<td>2563</td>
<td>75</td>
<td>34.17</td>
</tr>
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<td>6</td>
<td>76</td>
<td>124</td>
<td>71</td>
<td>90.3</td>
<td>903</td>
<td>27</td>
<td>33.44</td>
</tr>
<tr>
<td>7</td>
<td>180</td>
<td>282</td>
<td>160</td>
<td>207.3</td>
<td>2073</td>
<td>70</td>
<td>29.61</td>
</tr>
<tr>
<td>8</td>
<td>147</td>
<td>147</td>
<td>76</td>
<td>123.3</td>
<td>1233</td>
<td>60</td>
<td>20.55</td>
</tr>
<tr>
<td>9</td>
<td>463</td>
<td>660</td>
<td>168</td>
<td>430.3</td>
<td>4303</td>
<td>159</td>
<td>27.06</td>
</tr>
<tr>
<td>10</td>
<td>290</td>
<td>226</td>
<td>226</td>
<td>247.3</td>
<td>2473</td>
<td>103</td>
<td>24.01</td>
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<tr>
<td>11</td>
<td>190</td>
<td>378</td>
<td>221</td>
<td>263</td>
<td>2630</td>
<td>100</td>
<td>26.30</td>
</tr>
<tr>
<td>12</td>
<td>550</td>
<td>525</td>
<td>240</td>
<td>438.3</td>
<td>4383</td>
<td>98</td>
<td>26.84</td>
</tr>
<tr>
<td>13</td>
<td>150</td>
<td>220</td>
<td>80</td>
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*unstandardized **standardization conversion factor: 1 HHHHD = 1000 pounds.
Berwick Estate. This estate did not fit the pattern because there was a significant change in the plantation's labor force. Between 1822 and 1826, the labor force increased from 122 slaves to 193. It is not possible that natural increase could explain an increase of 59% in four years. Slave purchases, which would have been primarily prime age slaves, probably account for the increase. This and the fact that cultivated land probably also increased accounts for why Berwick Estate did not fit the Jamaican pattern of declining agricultural yields per worker.

CONCLUSIONS

As was expected after an analysis of the demographic and institutional features of slavery in Jamaica and Louisiana, it was empirically shown that Louisiana slaves were more productive than their Jamaican counterparts. This can be explained by two factors: one, there were fewer prime age slaves in Jamaica and two, Louisiana planters used capital intensive means of production to save labor. However, this does not mean that Louisiana planters had a cost advantage because they used more capital than their Jamaican counterparts. Instead, higher productivity ratios in Louisiana means that agricultural yields per slave were higher in Louisiana than in Jamaica.
Conclusions

Institutional and demographic features of slavery led to more productive slaves in Louisiana than in Jamaica. After the Cessation of the African Slave Trade in 1808, Louisiana was the recipient of prime age slave migration while Jamaica was cut off from its supply of slaves. Not only was Jamaica cut off from its supply of slaves, its prime age population was declining as well. The African component of the population had not reproduced itself and was aging. The Creole population, on the other hand, was just beginning to grow. While it was reproducing itself, there were not enough Creoles in the reproductive years to sustain the entire population. The consequence of these two trends was that there was a growing cohort of children and elderly. As a result, the prime age population declined. Therefore, Louisiana's slave population had a larger component of prime age slaves who were more productive than children and elderly.

Louisiana planters also employed more capital than their Jamaican counterparts which led to greater slave productivity. Planting sugar cane with the plow used less labor than planting with the hoe to obtain the same amount of sugar cane. Louisiana planters benefited from using the plow, a labor saving device, because they were able to hire labor to meet their peak labor demand. Therefore, the
existence of a hiring market, where labor could be hired for units of time less than a year, led to more productive slaves.

The reason that Louisiana received prime age slaves and was able to hire slaves was that it was part of a larger more diversified economy. The population inflows came from the Atlantic seaboard. While these flows were not the result of owners deliberately breeding slaves for sale, they resulted from a labor surplus. The soil in this region had become worn out by repeated tobacco crops and it was no longer profitable to grow tobacco on these lands. As a result, labor migrated to more productive lands in the southwest. At the same time, the hiring market existed because cotton planters did not face the same labor demand curves in the harvest cycle that sugar planters faced. After the cotton crop was picked, cotton planters had surplus labor which they lent to sugar growers. Thus, the population inflows were the result of surplus population on the tobacco estates and the hiring market was the result of surplus labor on cotton plantations after the crop was harvested.

Jamaica, which was a monocrop economy, had no tobacco or cotton plantations to provide surplus labor for the sugar estates. As a result, the slave population had a smaller component of prime age slaves, and it was unprofitable to introduce labor saving devices when the planter was not
operating on his peak labor demand curve. Therefore, slave productivity was higher in Louisiana because Louisiana was part of a diversified agricultural economy while Jamaica was a monocrop economy.
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