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The Slave Trade: The Formal Demography of a Global System

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IF THE BEST-KNOWN aspects of African slavery remain the horrors of the middle passage and the travail of plantation life in the Americas, recent work has nonetheless provided some important reminders of the Old World ramifications of slavery (Miller 1988; Meillassoux 1986; Miers and Roberts 1988; Manning in press-a). Millions of slaves were sent from sub-Saharan Africa to serve in households and plantations in North Africa and the Middle East and suffered heavy casualties on their difficult journey. Millions more, captured in the same net as those sent abroad, were condemned to slavery on the African continent. The mortality of captives in Africa, therefore, included not only losses among those headed for export at the Atlantic coast but the additional losses among those destined for export to the Orient and among those captured and transported to serve African masters.

The purpose of this study is to address, at the global level and in analytical terms, the demography of this system of forced labor migration. What was the impact of the slave trade on Africa and on the Orient? How serious was the mortality and the demo-

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graphic disruption brought by the slave trade to these Old World areas? How closely were New World slavery and African demography linked? What were the relative sizes of slave populations in the Occident, Africa, and the Orient? What was the rate at which African societies lost population to the slave trade? How distinctive were the structures of slave population in the Occident, in Africa, and in the Orient?

Figure 1 provides a framework for addressing these questions. It presents the slave trade as a single demographic system, linking the Occident, Africa, and the Orient through the migration of slaves. The hallmarks of this framework are found in both its regional and its analytical structure. It distinguishes the populations within Africa from those in the Occident and the Orient. It divides the population of each

continental region into free, slave, and captive populations (where captives are those in the process of becoming slaves), and it accounts for the liberation of slaves.

The demography of slave trading, in turn, cannot be discussed in isolation from the economics of the slave trade. To phrase the linkage of demography and economics in simple terms, it was the New World demand for African slaves that created a demographic system, a world market for slave labor, spanning five continents in the years from 1700 to 1850.¹ The rising New World demand created a new, westward trade in slaves that competed with the older and smaller oriental trade, which continued to transport slaves across the Sahara and the Red Sea. The willingness of New World planters to pay relatively high prices for laborers brought an expanded supply response from those Africans willing to profit by selling slaves. Once the supply system had developed along the Western Coast of Africa, Africans developed a demand for slaves, especially female slaves, and the dimensions of the slave trade expanded further. The occidental slave trade then peaked at the end of the eighteenth century; in the early nineteenth century, prices for slaves declined as New World purchasers were driven out of the market, step by step, by abolitionist movements. But the lower slave prices only caused African and oriental purchasers of slaves to demand increased numbers, and the total volume of the slave trade changed little until after 1850.

As the nineteenth century proceeded, this global system of the slave trade broke down into a set of isolated, regional slave systems. Large-scale slave trading was suppressed in the Occident,

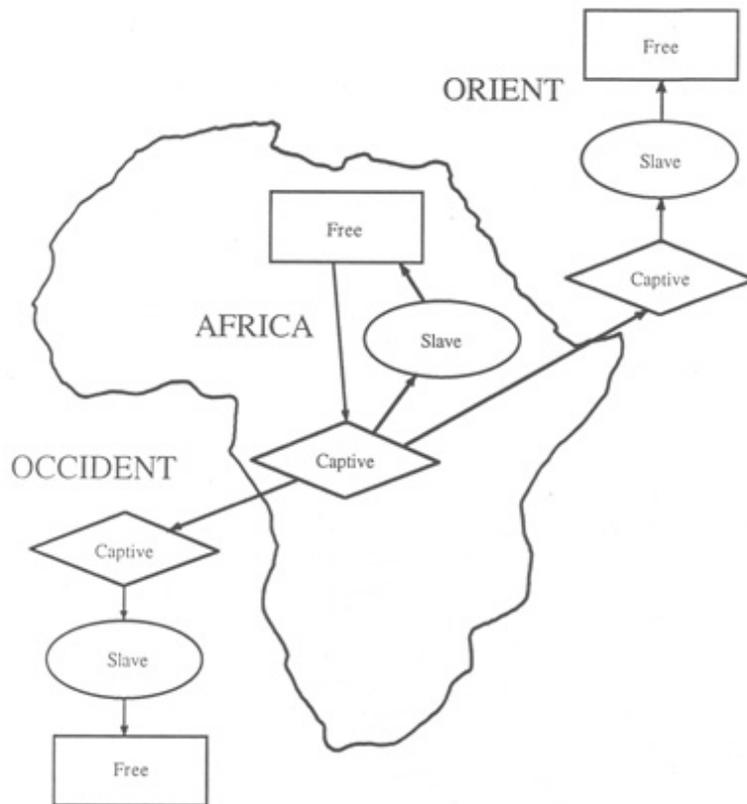


Figure 1 Populations in the slave trade

in the Orient, and finally in Africa. Nevertheless, in each of these areas slavery continued for generations after the end of the slave trade: slave owners reformed their plantations according to new and gentler regimes, within which it was sometimes possible for slaves to reproduce themselves biologically (Manning in press-b).

A cumulative total of over 10 million Africans reached the New world as slaves from 1500 to 1900; closer to 12 million were dispatched in ships from Africa, and over 1.5 million lost their lives in the middle passage. In the same period, some 6 million slaves were sent from sub-Saharan Africa to the Orient, and some 8 million people were enslaved and retained within the African continent. An estimated total of 4 million people lost their lives

as a direct result of enslavement within Africa, while many others died young because of the hard conditions of slave life.²

The occidental slave trade reached an annual average of 70,000 slaves in the late eighteenth century; the combination of the occidental and oriental trades reached an annual average of over 100,000 slaves in the early nineteenth century, and the total number of people captured in Africa and either retained or transported abroad peaked at roughly 150,000 slaves per year in the early nineteenth century.

As a result of these exports of slaves, the population of the Western Coast of Africa—the region from Senegal to Angola from which most New World slaves were drawn—declined significantly from about 1730 to 1850. Further, since the slaves were removed at the rate of roughly two males for every female, the result was a relative shortage of males on the African continent: adult sex ratios fell to 80 men per 100 women in many areas, and to 50 men per 100 women in such hard-hit areas as Loango and Angola. In the East African region from Mozambique to Kenya, a serious population decline occurred later, from about 1820 to 1890, as slaves were taken both to Muslim areas in Arabia and the Persian Gulf and to European-ruled territories in the Indian Ocean and the New World. The sex ratio of slaves transported from East Africa was, on average, about even.

Mortality in the slave trade, though sometimes exaggerated by those seeking to underscore its immorality, was quite severe. Its severity becomes evident when all of its various elements are catalogued.³ The best-known element of mortality is that of the middle passage. The summary figure of 15% is a good index of overall slave mortality for that voyage, though research has shown that it varied greatly with time, length of the voyage, and age of the slaves. On the New World side must be added the continued high mortality of slaves during the period of their seasoning as well as the normal mortality of slaves, which was higher than that for free persons in the New World.

Slave mortality in Africa had three dimensions, associated with the occidental, African, and oriental trades, respectively. Mortality among slaves headed for the Occident included the deaths of slaves during their capture, transport to the coast, and confinement on the coast in preparation for shipping. Here again an overall average of 15% mortality is a useful guess, though it

varied greatly with the age of slaves and the distance and duration of their journey to the coast. In the African slave trade, we may assume an equivalent 15% mortality among people enslaved and retained in Africa rather than exported. Similarly, for the oriental trade, mortality rates in transportation were comparable to those for the voyage to and across the Atlantic. The combination of the nearly 30% mortality in the occidental and oriental trades with the 15% mortality in the African trade thus yielded, for the global slave trade, a rate of mortality which probably exceeded 20% of all those enslaved, or some 5 million people over three centuries. Most of these people died in Africa.

The rise and fall of this modern, global system of black slavery entailed some remarkable transformations. In 1600 Africans at home and abroad were clearly a minority of the world's slaves; in

1800 they were the overwhelming majority of all slaves. In 1790 there were some 3 million New World black slaves, and they were perhaps the majority of all black slaves. By 1850 that total had risen to 5 million, but by then the population of slaves in Africa had risen to meet it, and went on to exceed it.

New World slaves usually married other slaves (though many male slaves were simply unable to marry for lack of women), and the resulting population was African in ancestry and slave in status. Slaves in the Orient, by contrast, were predominantly female, and they were frequently wedded to their oriental masters. Their children, as a result, were both African and Middle Eastern in ancestry, and often free in status. Today's New World population of 700 million includes roughly 100 million people of African ancestry. It may be true, remarkably, that the African contribution to the Middle Eastern gene pool is roughly of the same proportion as that in the New World -about one-seventh- but that this contribution is spread throughout the population of the Middle East, while it is segregated in the New World.

From 1700 to 1850, the population of sub-Saharan Africa as a whole stagnated or declined in size because of the mortality of captives, the drain of slaves, and continued high mortality resulting from social insecurity. This was precisely the period in which the populations of Europe, the Americas, and Asia began to grow rapidly. So while the African proportion of Atlantic basin population was perhaps 30% in 1650, it had declined to roughly 10% in 1850; adding in the African-descended populations of the

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Occident and Orient would bring the African proportion up to 15% in 1850 (Manning in press-a).

THE MODEL AND ITS POPULATIONS

The remainder of this presentation focuses on the formal structure of the model underlying the interpretations summarized above. The model approximates a continuous process, like most such models, and is expressed in terms of five-year age groups (Keyfitz 1977). All the populations exist at each moment; they change in size and structure in response to their various rates of fertility, mortality, and migration. The populations are the variables in the analysis. The numerous rates of fertility, mortality, and migration are taken as parameters.⁴ The analysis consists of determining which parameters are most important, both theoretically and historically, in setting patterns of population change. In the conclusion I offer a simplified history of the slavery of Africans in terms of changes in these key parameters.

In Africa and for Africans abroad, the broadest distinctions were among the free, slave, and captive populations. In Africa, the free populations were usually the largest, though in a significant number of instances -for example, the Western Sudan in the late nineteenth century- slaves outnumbered the free (Klein 1987). The free populations included those liberated either by manumission or by escape.

The captives, while always the smallest of the three groups, had sufficiently distinctive characteristics that they must be identified and analyzed as populations distinct from the slaves they became. Captives were people recently placed in captivity; they were in transit to their destinations or undergoing training and seasoning (socialization) prior to becoming productive slaves. In demographic terms, the mobility of captives and the extremely poor conditions in which they lived meant that their rates of fertility and mortality were far more unfavorable than those of settled slaves.

The same three broad categories, free, slave, and captive, apply to populations of African descent abroad. Here *abroad* means, primarily, the slave plantation colonies of the Americas, but it also refers to the significant numbers of slaves who were settled in North Africa and the Middle East, in the Sahara Desert, in the

islands of the Indian Ocean, and in Europe. In each of these areas the captives were those newly arrived from sub-Saharan Africa fresh off the boat or the caravan, or undergoing the process of seasoning. The slaves dominated the populations of African descent in these slave-importing regions. In addition, however there were significant numbers of free persons of African descent.

Flows of Migration and Change in Status

The demographic logic of the analysis takes the form of a multiregional, multistage process (Rogers 1985): multiregional because it addresses several geographical and social regions (i.e., African, accidental, and oriental regions; free, captive, and slave populations within each region), multistage because several populations undergo decrement both by death and by out-migration (through enslavement or liberation), and also because people may enter one of several populations either by birth or by in-migration.

Further, the path of migration from one region to another affects the outcome of migration, as migrants experience distinct patterns of fertility and mortality along the way—for instance, the heavy mortality of slaves during the middle passage across the Atlantic. In one sense, this amounts simply to adding more stages to the process described above. In another sense, however, it may be useful to think of the model as assuming *eventful* migration. The migration is assumed to be slow and eventful, rather than rapid, so that the path of the migrants and the events they undergo must be included explicitly in the analysis. This approach contrasts with that of many migration models, in which only destination and not the path of migrants is included; in effect, such models assume migration to be instantaneous (ibid.).

Within Africa, people are assumed to have migrated as a result either of enslavement or of its opposite, liberation. When a man freed his slave wife, the woman's status changed but she was not displaced physically. To utilize the standard analytical simplification, however, we may consider her change from the status of slave to that of a free person as a migration from one population to another. In the New World and other slaveholding areas abroad, migration similarly took place through absorption of the imported captives into the slave population, and through the liberation of slaves by manumission or escape. The liberation of



Figure 2 Reproduction and migration in the African and occidental slave trades

slaves, in this version of the model, is assumed to be uneventful and instantaneous, in contrast to the slow and painful migration of captives.

Figure 2 focuses, for heuristic purposes, on the slave trade from Africa to the New World. It shows, in more detail than Figure I, the various populations and their births, deaths, and migrations.

The divisions I have made are as follows: Free persons in Africa are divided into Source and Captor populations, plus the Liberated; free blacks abroad are divided into the Liberated and the

Free-born. Slaves in Africa are divided into the Enslaved (or first generation slaves) and the Slave-born (subsequent generations of slaves); slaves abroad are divided in the same way. Captives in Africa are divided among the Domestic captives (who are to become slaves in Africa) and the Transit captives (who are to be sent

abroad). Once outside sub-Saharan Africa, the surviving Transit captives become Export captives and ultimately become Enslaved abroad.⁵

Under similar principles, this model could allow for finer distinctions, such as the division of the African population into subpopulations corresponding, for instance, to the western coast, the savanna, and the eastern coast, and could allow for slave raiding of greater or lesser complexity among them. Similarly, the model could distinguish regions in the Occident or the Orient.

Discussion of the model for the case of the slave trade to the New World is sufficient, however, to display its basic properties. Thus, although various populations of slaves abroad—for instance, in Jamaica and in Arabia—differed greatly in composition and reproduction, they may each be described in terms of a single set of variables and parameters; it was the differing values of the variables and parameters which made these two populations so different. Let us turn, therefore, to cataloguing the modifications brought to the populations shown in Figure 2 through the slave trade.

Identification of Key Parameters

The most basic parameters in the analysis are the age-specific rates of birth and death for each population. These rates are assumed to be distinct for the free, slave, and captive populations. Further, among free persons, rates of birth and death are assumed to be different in Africa and abroad, and for Source, Captor, and Liberated populations within Africa. Within slave populations, rates are distinct for the Enslaved and the Slave-born. Among Captives, rates are distinct for Domestic, Transit, and Export, and further distinctions could be made within those groups. The remaining parameters consist of age-specific rates of migration: of capture from the Source population,⁶ of *partition* among captives to be held in Africa and exported, and of *liberation* of slaves (both the Enslaved and the Slave-born).⁷

The simplest assumption for the parameters is that they re-

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mained constant (really, as constant matrices) for any given analysis. Over time, however, it is clear that all the parameters varied. In fact, the life-course and migration parameters might also be treated as functions. Thus the rate of escape was a function of the availability of open land within reach of the slaves; the rate at which captives were exported was a function of the relative prices of slaves in markets in Africa and abroad.

In the discussion below, the parameters are labeled as follows (all are age- and sex-specific):

W: annual rate of capture of persons in the Source population
X = 1 - W: annual proportion of Source population avoiding capture
Y: proportion of captives selected for export
Z: annual rate of liberation of slaves
P = 1 - Q: five-year rate of survival
F: annual rate of female births to women

The main relationships involving the parameters may be summarized schematically as follows:

Source \times W = Captives
Source \times X = Source population remaining after capture
Captives \times Y = Transit captives
Captives \times (1 - Y) = Domestic captives
Slaves \times Z = Liberated
Population \times P = Surviving population
Female population \times F = Female births

The Base Population: Projection of Nonmigrating Populations

We turn now to the specifics of population projections, first for a closed population and then for migration. Let us consider a free African population which is neither losing population through enslavement nor gaining population through the flight of slaves. A projection of the size and composition of this population over time then follows the standard projection for a closed population. As indicated above, this projection is based on an analysis of five-year age groups from 0-4 to 80+, five-year periods, and a single-sex model of reproduction.

Mortality in each age group above birth is calculated as the age specific survivorship rate multiplied by the previous population. For the Captors:

$${}_5N_x^t = {}_5N_{x-5}^{t-5} \times \frac{{}_5L_x}{{}_5L_{x-5}} = {}_5N_{x-5}^{t-5} \times {}_5P_{x-5}$$

For survivors to age 80+, the survival rate is taken as T80/T75.⁸ The population in each age group, as estimated for the middle of each five-year period, for Captors, is then

$$\frac{{}_5N_x^{t-5} + {}_5N_{x-5}^{t-5} \times {}_5P_{x-5}}{2} = \frac{{}_5N_x^{t-5} + {}_5N_x^t}{2}$$

Female births in each population are calculated as the age specific annual fertility rate multiplied by the midperiod population, then by five years of exposure, and summed over all childbearing years.⁹

$${}_5B^{f,t} = \sum_{x=\alpha}^{\beta} \left[\frac{({}_5N_x^{f,t-5} + {}_5N_{x-5}^{f,t-5} \times {}_5P_{x-5})}{2} \times {}_5F_x^f \times 5 \right]$$

Survivorship among those born in the current period is calculated as the number of female births multiplied by the female birth survival rate. Male births in each population are calculated as a constant proportion of female births (usually 1.03); survivorship of male babies is determined by the male birth survival rate.

The crude birthrate is then the sum of all male and female births in each five-year period divided by the midpoint population of all age groups totaled. The crude death rate is the sum of all deaths divided by the midpoint population. The crude rate of natural increase is the sum of the birth and death rates.

Population Projection with Migration: Selected Cases

Migration, of course, increases the complexity of population projection, but a few examples are sufficient to illustrate all of the principles involved in the projection of free and slave populations undergoing enslavement and liberation. These examples are presented in this section. Meanwhile, the smaller captive popula-

tions, which logically intervene between those of free and slave, involve still more complexity in projection: they are considered in the following section.

In Africa, the Source population remaining after the loss of Captives in each period is as follows:

$${}_5N_x^t = \frac{({}_5N_x^{t-5} + {}_5N_{x-5}^{t-5} \times {}_5P_{x-5})}{2} \times X_x \times 5,$$

where X_x (or $1 - W_x$) is the annual age-specific rate of retention by the Source population. This is the midperiod Source population multiplied by the annual rate of retention, over five years of exposure.

The Captor population, in turn, gains liberated slaves in each period, where the liberated slaves come from the Domestic slave population (both Enslaved and Slave-born), and Z_x is the annual age-specific rate of liberation to

$${}_5M_x^t = {}_5^C N_{x-5}^{t-5} \times {}_5^C P_{x-5} + {}_5^C M_x^t,$$

where

$${}_5^C M_x^t = \left[\frac{{}^{D1}{}_5N_x^{t-5} + {}^{D1}{}_5N_x^t}{2} + \frac{{}^{D2}{}_5N_x^{t-5} + {}^{D2}{}_5N_x^t}{2} \right] \times {}_5^D Z_x \times 5$$

The Domestic enslaved population gains in-migrants from surviving Captives and loses out-migrants to liberation:

$${}^{D1}{}_5N_x^t = {}^{D1}{}_5N_{x-5}^{t-5} \times {}^{D1}{}_5P_{x-5} + {}^{DC}{}_5N_x^t - \frac{({}^{D1}{}_5N_x^{t-5} + {}^{D1}{}_5N_x^t)}{2} \times {}_5^D Z_x \times 5$$

For the domestic Slave-born population, there is no in-migration (except at birth, as shown below), but there is out-migration because of liberation.¹⁰

$${}^{D2}{}_5N_x^t = {}^{D2}{}_5N_{x-5}^{t-5} \times {}^{D2}{}_5P_{x-5} - \frac{({}^{D2}{}_5N_x^{t-5} + {}^{D2}{}_5N_{x-5}^{t-5})}{2} \times {}_5^D Z_x$$

Births into this population include births to the Slave-born but also all births to the Enslaved. That is, all children born to Enslaved women are treated as members of the Slave-born populations: they face rates of mortality at birth appropriate to the Enslaved populations, though all deaths (as all survivors) in this group of

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infants are accounted for with those of the Slave-born populations. For the Slave-born population, female births to Slave-born women are

$${}^{D2}B^{f,t} = \sum_{x=\alpha}^{\beta} \left[\frac{({}^{D2}{}_5N_x^{f,t-5} + {}^{D2}{}_5N_{x-5}^{f,t-5} \times {}^{D2}{}_5P_{x-5})}{2} \times {}^{D2}{}_5F_x^f \times 5 \right]$$

Female births to Enslaved women are

$${}^{D1}B^{f,t} = \sum_{x=\alpha}^{\beta} \left[\frac{({}^{D1}{}_5N_x^{f,t-5} + {}^{D1}{}_5N_{x-5}^{f,t-5} \times {}^{D1}{}_5P_{x-5})}{2} \times {}^{D1}{}_5F_x^f \times 5 \right]$$

Survivors age 0-4 in the Slave-born population are

$${}^D_5N_0^{f,t} = {}^D_2B^{f,t} \times {}^D_5P_{\text{birth}} + {}^D_1B^{f,t} \times {}^D_5P_{\text{birth}}$$

Projections for Captives

The projection of captive populations involves the further complication that, during any five-year period, captives experience several different rates of fertility and mortality as they move from freedom to captivity to enslavement.

It is assumed that Captives in Africa, be they the Domestic captives retained in Africa or the Transit captives on their way to the coast, suffer one year of exposure to the high mortality rates (and perhaps low fertility rates) of captives in Africa. It is assumed that those who survive to become captives abroad suffer one year of exposure to the high mortality rates (and low fertility rates) of captives crossing the Atlantic, the Sahara, the Red Sea, or the Indian Ocean.

Capture is assumed to take place, on average, in the middle of each five-year period. As a result, in the five-year period of their capture, most captives are exposed to the fertility and mortality rates of the free Source population for the time before their capture, that is, one-half of the period, or 2.5 years. Similarly, those who survive to become slaves within the five-year period are exposed, at the conclusion of their migration, to the fertility and mortality rates of the Enslaved population within Africa, or, alternatively, those of the Enslaved population abroad. The analysis requires, therefore, a decision as to how much exposure each

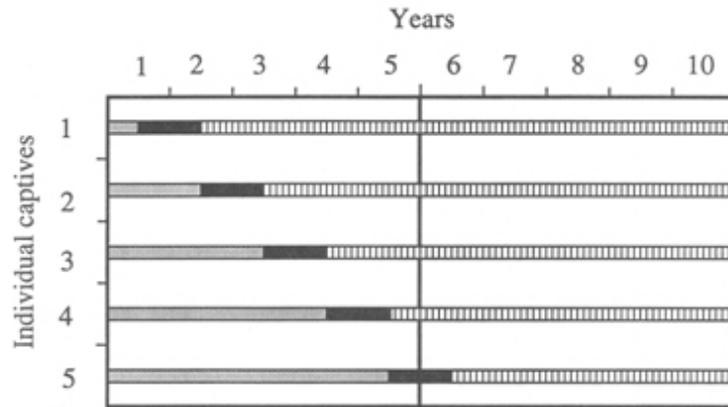
group of captives experienced to the several different rates it faced during the period of capture.

Figure 3 displays a schematic summary of the assumed exposure of migrating Domestic captives to various rates of fertility and mortality. Each of five persons is assumed to be captured, successively, in the middle of the first, second, third, fourth, and fifth years of a given period; on average, capture thus occurs at midperiod. Each captive then experiences one year of exposure to Domestic captive rates of fertility and mortality and during the remainder of the period is exposed to Enslaved African rates. The figure includes 25 person-years of experience: the exposures to each set of rates are totalled and divided by 5 to give the portions of a five-year period for each set of rates. Under these conditions, the averages are 2.5 years of exposure to Source rates, 0.9 years of exposure to Domestic captive rates, and 1.6 years of exposure to Enslaved African rates.

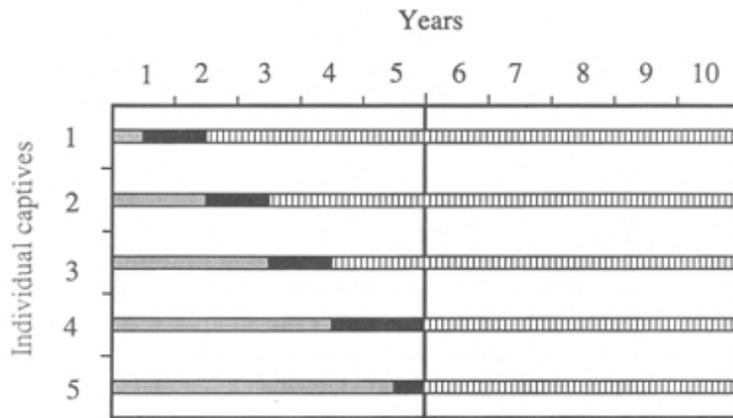
One problem remains: A slave captured in the middle of the fifth year experiences one-half year of exposure to Domestic captive rates in this period, and another one-half year of the same exposure in the next period. To account for this systematically, it would be necessary in each period to account for the equivalent exposure for captives left over from the previous period. This would require a complex system of accounting for a very small population. As a simple and close approximation, therefore, it is assumed that the extra half year of exposure to captive rates takes place in this period rather than in the next, and that a half year of exposure to Enslaved African rates is displaced in exchange from this period to the next. As a result, the average estimated exposure of the five captives is 2.5 years at Source rates, 1.0 years at Domestic captive rates, and 1.5 years at Enslaved African rates.

Figure 4 displays the equivalent exposure for Transit captives and Captives abroad. As before, capture is assumed to take place at midperiod. Captives then undergo one year's exposure to Transit captive rates, one more year's exposure to Captive abroad rates, and the remainder of the period to Enslaved abroad rates.

Average exposures for the captives in a five-year period are 2.5 years' exposure to Source rates, 0.9 years' exposure to Transit captive rates, 0.7 years' exposure to Captive abroad rates, and 0.9 years' exposure to Enslaved abroad rates. Even more complex than before, however, would be the accounting necessary



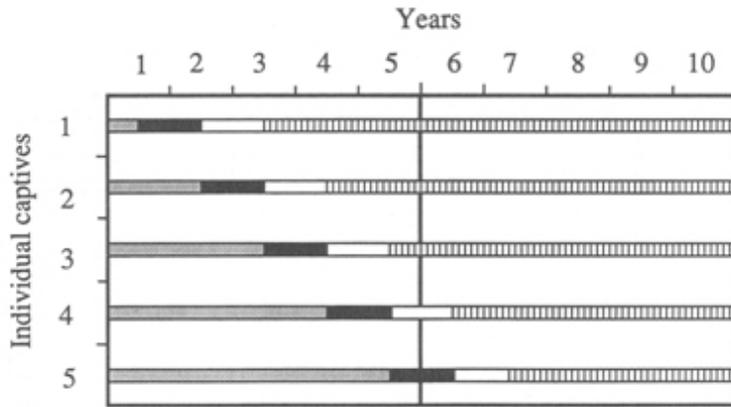
A. Initial estimate



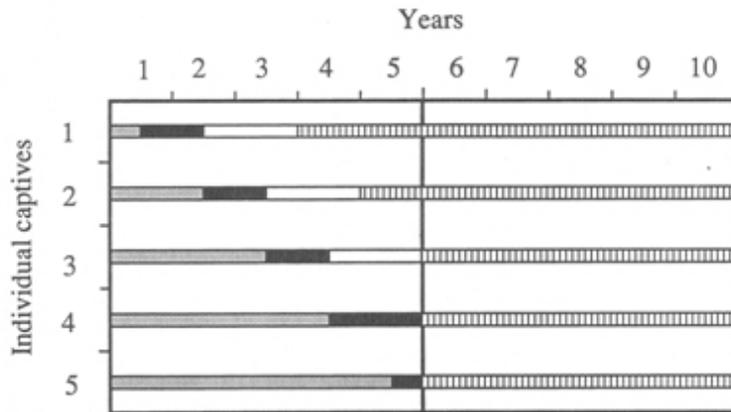
B. Modified estimate

- Exposure to Source rates
- Exposure to Captive African rates
- Exposure to Domestic Slave rates

Figure 3 Exposure of new Domestic captives



A. Initial estimate



B. Modified estimate

- Exposure to Source rates
- Exposure to Captive African rates
- Exposure to Captive Abroad rates
- Exposure to Enslaved Abroad rates

Figure 4 Exposure of new Export captives

to keep track of the 0.5 years' Transit captive exposure and the 1.5 years' Captive abroad exposure in the following period. By the same logic as above, therefore, Enslaved abroad exposure in this period is exchanged for captive exposure in the next period, and the results remain a close approximation of the more accurate but more complex formulation. In sum, the allocation of the 5.0 years' exposure of these captives is 2.5 years at Source rates, 1.0 years at Transit captive rates, 1.0 years at Captive abroad rates, and 0.5 years at Enslaved abroad rates. (These varying periods of exposure must be kept in mind when one calculates, as we do below, the number of person-years lived in each period for calculations of crude rates of birth, death, and growth.)

These rates of exposure may now be used in calculating the fertility and mortality of migrating captives. For Domestic captives, the number of captives for each age and sex is the midperiod Source population multiplied by the annual enslavement rate (X) and by the complement of the partition rate (1 - Y), which gives the number of captives intended for slavery in Africa:

$${}^D C N_x^t = \frac{({}_5 N_x^{t-5} + {}_5 N_{x-5}^{t-5} \times {}_5 P_{x-5})}{2} \times {}_5 X_x \times 5 \times (1 - {}_5 Y_x)$$

Survivorship for Domestic captives is the product of three rates of survival over a period of 5.0 years: those of the Source population (2.5 years), of Domestic captives (1.0 year), and of Enslaved Africans (1.5 years):

$${}^D C N_x^t = {}^D C N_{x-5}^{t-5} \times {}_{2.5} P_{x-5} \times {}^D C P_{x-5} \times {}^{D1} P_{x-5}$$

Fertility among Domestic captives is the sum of three rates of fertility, multiplied by the midperiod female population for each childbearing age group:

$${}^D C B_x^{f,t} = \sum_{x=\alpha}^{\beta} \left[\frac{({}^D C N_x^{f,t-5} + {}^D C N_x^{f,t})}{2} \times (2.5 \times {}_5 F_x^f + 1.0 \times {}^D C F_x^f + 1.5 \times {}^{D1} F_x^f) \right]$$

Survivors among the newborn female Domestic captives are calculated as female births multiplied by the product of the three

birth survival rates, at the relevant exposure. Male births, as elsewhere, are 1.03 times female births, and survivorship is determined by male birth survival rates.

Surviving Domestic captives enter the Enslaved population in Africa as in-migrants. That is,

$${}^{D1} N_x^t = {}^{D1} N_{x-5}^{t-5} \times {}^{D1} P_{x-5} + {}^D C M_x^t,$$

where

$${}^{D1} M_x^t = {}^D C N_x^t.$$

The captives sent abroad first enter the Transit population, then the Export captive population, and the survivors join the Enslaved population abroad. The initial Transit population in each period is the complement of the initial Domestic captive population:

$${}^5CEN_x^t = \frac{({}_5N_x^{t-5} + {}_5N_x^{t-5} \times {}_5P_{x-5})}{2} \times {}_5X_x \times 5 \times {}_5Y_x$$

Survivorship for the Transit population is calculated as the product of two survival rates over the 3.5 years of each five-year period which the average exported captive spends in Africa:

$${}^5CEN_x^t = {}^5CEN_x^{t-5} \times {}_{2.5}P_{x-5} \times {}^1DC_{1}P_{x-5}$$

Fertility among Transit captives is the sum of two rates of fertility:

$${}^5CEB^{f,t} = \sum_{x=\alpha}^{\beta} \left[\frac{({}^5CEN_x^{f,t-5} + {}^5CEN_x^t)}{2} \times (2.5 \times {}_5F_x^f + 1.0 \times {}^1DC_{5}F_x^f) \right]$$

Survivors among the Transit captives leave sub-Saharan Africa as Export captives.

For Export captives, finally, mortality is calculated over the 1.5 years of each five-year period which the average export captive spends abroad.¹¹

$${}^5CEN_x^t = {}^5CEN_x^{t-1.5} \times {}^1CE_{1}P_x \times {}^{E1}_{0.5}P_x$$

Fertility among Export captives is:

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$${}^5CEB^{f,t} = \sum_{x=\alpha}^{\beta} \left[\frac{({}^5CEN_x^{f,t-1.5} + {}^5CEN_x^t)}{2} \times (1.0 \times {}^1CE_{5}F_x^f + 0.5 \times {}^{E1}_{5}F_x^f) \right]$$

Survivors among the Export captives enter the Enslaved population abroad as in-migrants at the end of the current period.

That is,

$${}^5E1N_x^t = {}^5E1N_x^{t-5} \times {}^5E1P_{x-5} + {}^5E1M_x^t,$$

where

$${}^E_5M_x^t = {}^{CE}_5N_x^t.$$

Of the many elaborations which could be made to this model, let us mention those which seem most relevant to issues which have been discussed in the slave trade literature, Captives headed for service in Africa could be divided into those marching and those undergoing seasoning. Transit captives could be divided into those marching and those living in barracoons. Captives abroad could be divided into those on ships and those undergoing seasoning.

Population Projections for the Liberated

Where Captives are defined here as people captured within the current five-year period, the Liberated population includes any person liberated during this *or a previous* five-year period. As noted above, it is assumed that the migration from slavery to freedom is instantaneous and uneventful, while the migration from freedom to slavery is fraught with peril. The Liberated population in Africa, for instance, is calculated as the forward projection of the previous Liberated population plus the number of liberated immigrants from both the Enslaved and the slave-born populations.¹²

Calculating Crude Demographic Rates

For each population, we may use the information from the above population projections to calculate crude rates of birth, death,

migration, growth, and decline. The crude rate of migration for any population, for instance, depends on the age-specific rates of birth, death, and migration and on the age and sex composition of that population. (The age-specific rates of birth, death, and migration are taken as data, or sometimes by assumption, in the model.) All of these crude rates can be calculated in straightforward fashion from the population projections outlined above.

Thus, the crude birthrate in Africa during any period is calculated as the total of births among Free, Slaves, and Captives divided by the midperiod population total for Free, Slaves, and Captives (excepting Captives who have been sent abroad). The crude birthrate among Africans abroad is calculated as the total of births among Free, Slaves, and Captives abroad divided by the midperiod population total for Free, Slaves, and Captives abroad. Death rates are calculated similarly.¹³

Some additional useful variables may be calculated for study of the slave trade and expressed in terms of crude rates. One of these is *excess deaths*: deaths occurring because of the slave trade over and above those which would have occurred in the African Source population.

Four distinct rates of African population loss provide a useful composite picture of the demographic toll of the slave trade. The *crude rate of out-migration* from Africa is calculated as the midperiod Transit population divided by the midperiod total for Free, Slave, Domestic captive, and Transit populations. The *crude growth rate* of African population is calculated as the number of births less the number of deaths among the Free, Slaves, and Captives in Africa, less the number of out-migrants (Captives abroad), divided by the midperiod total for the Free, Slave, Domestic captive, and Transit populations. The *crude rate of decrement* in African population leaves out the births; it is calculated as the number of deaths among Free, Slaves, and Captives in Africa plus the number of out-migrants (Captives

abroad), divided by the midperiod total for Free, Slave, Domestic captive, and Transit populations. The *crude rate of enslavement* decrement in African population is calculated as the number of excess deaths among Captives in Africa plus the number of out-migrants, divided by the midperiod African population total.

In addition, the model allows for the aggregation of migrants into *cumulative totals*. The best-known example of a cumulative

total is Curtin's estimate of 9.6 million slaves landed in the New World between 1500 and 1850. This type of figure, while often quoted in migration studies, has an analytical weakness in that, because it has no dimension of time, it cannot be compared to a population at risk. Nonetheless, a substantial body of historical research and debate is built on cumulative totals of African slave migrants (Curtin 1969; Thomas 1968). The model allows for the estimation of cumulative totals not only for captives arriving in the New World but for the number of captives, enslaved, liberated, and even excess deaths, and for the Orient and within Africa.

Practical implementation of the formal model requires that one link it to historical data on slave populations. While data are very scarce for many of the variables specified in the model, the process of migration links the variables sufficiently closely that limited historical data may provide important insights into broad patterns of slave demography. Information on the age and sex composition of slaves making the middle passage (Export captives, in the terminology used here) yields powerful inferences about the age and sex composition of the population remaining in Africa. Estimated growth rates of New World slave and free black populations, respectively, suggest limits for the estimation of equivalent rates in Africa.

On the other hand, for certain crucial variables the absence of sound historical data greatly weakens the analytical and predictive power of the model. We face a serious shortage of data on overall rates of capture and on the age and sex breakdown of captives; on the rates of partition among domestic and export slaves; and on the rates of mortality for captives within Africa. Similarly, we need more information on rates of fertility and liberation (Manning 1988).

CONCLUSION: A "PARAMETRIC" HISTORY OF THE AFRICAN SLAVE TRADE

I conclude with a simple application of the model, describing the rise and fall of black slavery in terms of changes in the five types of Parameters included in the model: rates of capture, partition, liberation, fertility, and mortality.

Rates of capture in Africa increased from the sixteenth to the early nineteenth centuries, not only for Africa as a whole but for

most regions on the continent. For East Africa and the northern savanna, rates of capture roughly doubled in the early nineteenth century. Rates of partition, initially biased heavily toward export, moved gradually toward retention of more slaves in Africa; in the early nineteenth century, as New World demand declined, partition rates moved sharply toward retention. Rates of liberation were generally higher in Africa and the Orient than in the Occident and were probably higher in the Orient than in Africa. Rates of liberation rose sharply in the New World in the mid-nineteenth century and rose somewhat later in the Orient. Rates of liberation in Africa may actually have declined in the mid-nineteenth century as slavery expanded rapidly, but they rose at the turn of the twentieth century.

The fertility of slave-born persons was higher than that of the Enslaved in the New World; perhaps the same was true in Africa. It is not likely that fertility rates changed significantly for a given type of population during the slave trade. Mortality rates probably fluctuated with changing local conditions; the expansion of

the slave trade or of slave labor in a given area tended to raise mortality levels in the short run, but the maturation and systematization of the slave trade or slavery allowed mortality rates to decline. Mortality rates declined generally in the Occident and the Orient during the nineteenth century, but not in Africa. Captive survival rates improved with the passage of time (most clearly for the middle passage), though exposure to them increased as the voyages of slaves became longer. For instance, many nineteenth century slaves going to Brazil came to the Angolan port of Luanda from distant Lunda or Kazembe or took the long ocean route from Mozambique.

By about 1850, the slave export rates collapsed to zero: the New World was cut off from the import of African slave labor, and slavery was replaced by new labor systems. The same came to be true for North Africa, the Middle East, and the Indian Ocean by about 1900. In sub-Saharan Africa, slavery continued to expand until the European conquests of the late nineteenth century. From the 1890s to the 1930s, African slavery survived in a regulated state. Rates of capture declined almost to zero and rates of liberation increased. That is, African slavery continued well into the twentieth century, with no more slave imports but with local

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"slave dealing"; it was comparable in many ways to slavery after 1807 in the U.S. and the British West Indies.

NOTES

- 1 The period of the large-scale Atlantic slave trade was from 1650 to 1850. In a more detailed interpretation (Manning in press-a), I argue that, within this period, the years 1700-1850 were the time of a world market in slave labor and the years 1730-1850 were the time of general decline in the population of West and West-Central Africa.
- 2 These and succeeding quantitative estimates of the impact of the slave trade are based on a simulation analysis. For details on the simulation, see Manning and Griffiths 1988 and Manning 1988. For the estimates themselves, see Manning in press-a. The demographic model on which the simulation is based is the subject of the present article; see also Manning 198f.
- 3 For instance, Buxton (1839) assumed that fully 50% of those captured died before embarkation at the Atlantic coast. At the same time, he neglected the capture and mortality of the large number of slaves retained in Africa.
- 4 The variable s and the parameters are each matrices, with dimensions of age and sex: in this case, 2 sexes by 17 age groups (0-4 to 80+).
- 5 For each population in Figure 2, one may catalog the sources of in-migration and the directions of out-migration. For instance, the Enslaved abroad receive in-migrants from the Export captives and send out-migrants to the Liberated and (via birth) to the Slave-born. The Slave-born, in turn, receive in-migrants as births from the Enslaved abroad and send out-migrants to the Liberated.
- 6 Two possible modifications may be noted here. People already in slavery could be captured and carried off to a new slavery. More broadly, instead of dividing the African population into discrete Source and Captor populations, with only the Source at risk of capture, one could assume that any free African was at risk of capture, or that Source and Captor populations raided each other.
- 7 The single schedule of rates of liberation could reasonably be broken down into separate schedules for manumission and escape. The manumission schedule would include high rates for the young and old and for females; the escape schedule would include high rates for adults and for males.
- 8 N is population by age group (subscript 5 indicates five-year age groups, and x indicates ages x to $x + 5$; superscript C is the index for Captors, and t indicates time t). L indicates the number of life-table persons living in each five-year age group; P indicates the probability of survival, in this case from age $x - 5$ to age x . T indicates the total number of life-table person-years lived in the indicated age group.
- 9 B is the total number of births, where superscript $t!$ and t refer to female births and to the period ending at time t , respectively. Alpha and beta are

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- women's minimal and maximal ages of childbirth. F is the annual fertility rate, where subscript 5 refers to five-year age groups and x refers to women's age at childbirth; C is the index for the Captor group.
- 10 This assumes, in effect, that all liberated slaves are manumitted. If it were assumed that some were escapees, one could rewrite the model to include a rate of escape, with the escapees migrating to the Source population.
 - 11 Note the change of indices from previous calculations: the full exposure to mortality comes, on average, within the last half of the period.
 - 12 Here it is assumed that the rate of liberation, Z , is the same for both Enslaved and Slave-born populations. This assumption could, of course, be relaxed.

- 13 For Captive populations, crude rates could be calculated in two ways. The first would include only the births or deaths during the period of capture, transit, and seasoning (one or two years in a five-year period), as a proportion of person-years lived during the one or two years in question. The second would include the births or deaths during a five-year period including capture, as a proportion of person-years lived during the five years. Death rates calculated in the first way would be higher than those calculated in the second way.

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