Journal of Quantitative Criminology, Vol. 7, No. 3, 1991

Estimating the Numbers of Prison Terms in Criminal Careers from One-Step Probabilities of Recidivism

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A method of using estimates of "one-step" probabilities of recidivism, i.e., conditional probabilities of individuals returning to prison for the jth time given release for the $(j-1)$st time, to estimate the numbers of prison terms expected to be accumulated by the individuals, is presented. The method is illustrated by calculating the expected numbers of prison terms separately for racial and gender groups in a large data base of Western Australian prisoners. The recidivism probabilities for these data were estimated by fitting Weibull "mixture" models to the (possibly censored) times to recidivate. The probabilities increase strongly as j increases from 1 to 6, then level off. Large differences between them are due to racial and gender group and these are reflected in the differing expected prison career durations for these groups. The effect of interventions which might lower recidivism is discussed in the light of the method as applied to these estimates.

KEY WORDS: recidivism probabilities; criminal careers; failure distributions.

1. INTRODUCTION

The precursors of chronic or serious offending continue to fascinate penologists, who traditionally have sought to find predictable patterns which are sufficiently reliable to direct effective interventions. Prevention of crime by early identification and correction might be achieved, it is thought, by careful examination of the characteristics of known offenders. This aim has not been abandoned just because such known offenders do not represent the population of all offenders. Common sense has prevailed to the extent that attempts continue to be made to address prevention for even this specially constructed group.

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A vehicle for distinguishing between offenders and nonoffenders or between high- and low-risk offenders has been the "criminal career" paradigm. A focus for recent research in this area has been the Panel on Research on Criminal Careers, under the auspices of the United States National Academy of Sciences. [See the report of the Committee on Research on Law Enforcement and the Administration of Justice (Blumstein *et al.*, 1986).] Criminal career research, in the view of this panel, has a variety of important policy uses, including "... identifying variables associated with the most serious offenders (in terms of their criminal careers) so that such information may be used by decision makers, within legal and ethical constraints, to anticipate future criminal activity by an offender about whom they must make a processing decision."

In addition, the panel included as important research topics the identification of factors viewed as predicting future criminal activity, "improving identification of high risk offenders," the designing of effective programs for them, and the assessment of the incapacitative effects of current or proposed imprisonment policies. A hoped-for outcome of the research would be a better use of scarce resources and better research programs (Blumstein *et al.*, 1986, p. 29).

Blumstein *et al.* (1986, p. 1) isolate four key dimensions to criminal careers, of which three are relevant to the present study: the frequency of commission of crimes, the length of time an offender is active, and the seriousness of the crimes committed. (The other criterion, participation rate, is not relevant here since we do not attempt to measure involvement in offending). We address a crucial question: How many terms of imprisonment constitute a criminal or prison career?

Blumstein *et al.* (1986, 1988a) have emphasized the distinction between research that focuses on criminal careers and research on "career" criminals, in order to acknowledge the particular problems of applying incapacitation policies, and the need to describe the pattern of offending untainted by any presumption of career specialization or progression to worse behavior. In this regard they stimulate debate about what constitutes "professional," habitual, and dangerous offending and provide a means for estimating the size and nature of recidivism.

In the work of Blumstein *et al.*, the interest is in the frequency or "incidence" of offending over time. An important distinction is drawn between the prevalence of offending (the proportion of offenders in a population) and the frequency of offending. Their research found that while the prevalence of offending declined with age (most offenders in their data were aged 15–21), the frequency and severity of offending for older active offenders did not. Adult records (prison or arrest) may thus be a useful basis for estimating the length of criminal careers. The dimensions of length of time an offender is active (duration) and the seriousness of the offences committed are fundamental parameters to be measured.

The aim of the present paper is relatively modest. We concern ourselves only with presenting a method to estimate the total number of prison terms a prisoner will be expected to serve, based on estimates of recidivism probabilities. (If arrest records were available, the same method could be applied to obtain the expected number of rearrests of an offender, based on estimates of probabilities of rearrest.) Since numbers of prison terms and lengths of imprisonment vary widely between offenders, even within the same race, gender, offense, and age group, only a statistical answer to this question can be expected. In other words, only estimates of the distribution of the number of prison terms and of the expected number of prison terms to be accrued in the course of a "career" can be hoped for. Such calculations can be made if one-step probabilities of recidivism, rearrest, or reconviction, etc., are known or estimates of them can be made. By "one-step" probabilities of recidivism, we mean conditional probabilities of returning to prison for another term given a previous release from prison, or arrest, etc.

2. NUMBER OF PRISON TERMS IN CRIMINAL CAREERS

Our procedure for estimating the number of terms in a prison career proceeds in two stages: we require estimates of probabilities of recidivism, then from these we estimate the distributions of the numbers of prison terms. In this section we assume that the recidivism probabilities are given and show how to calculate from them the distribution of the number of terms.

Suppose then, that p_j denote conditional probabilities of an offender's return to prison, or rearrest, etc., for the jth time, given release for the $(j-1)$st time, $j=2, 3, \ldots$, with p_1 = probability of returning or rearrest after the first release. Then the distribution of the number of rearrests or prison terms can be calculated as follows:

$$q_1 = \text{Prob}\{\text{exactly 1 term}\} = 1 - p_1$$
$$q_2 = \text{Prob}\{\text{exactly 2 terms}\} = (1 - p_2)p_1 \tag{1}$$

and similarly,

$$q_j = \text{Prob}\{\text{exactly } j \text{ terms}\} = (1 - p_j) \prod_{k=1}^{j-1} p_k \tag{2}$$

Thus

$$E\{\text{no. of terms}\} = \sum_{j\geq 1} jq_j = \sum_{j\geq 1} j(1-p_j)\prod_{k=1}^{j-1} p_k$$
$$= \sum_{j\geq 1}\prod_{k=1}^{j-1} p_k \qquad (3)$$

where we interpret $\prod_{k=j}^{j-1}$ as 1 throughout. The summation in Eq. (3) extends to infinity and we assume here that it converges. In practice the sum may usually be truncated at $j=9$ or $j=10$ (say), or values of p_j greater than 9 or 10 may all be taken as equal to p_9 or p_{10}, as we do in Section 5.

Similarly we can calculate conditional distributions of extra prison terms, given those already observed. Suppose that an offender currently has a record of j terms. Then

$$q_{j+1,j} = \text{Prob}\{\text{exactly } j+1 \text{ terms} \mid j \text{ terms}\}$$
$$= \text{Prob}\{\text{exactly } j+1 \text{ terms}\}/\text{Prob}\{j \text{ terms}\}$$
$$= 1-p_{j+1}$$
$$q_{j+2,j} = \text{Prob}\{\text{exactly } j+2 \text{ terms} \mid j \text{ terms}\}$$
$$= (1-p_{j+2})\prod_{k=1}^{j+1} p_k \Big/ \prod_{k=1}^{j} p_k$$
$$= (1-p_{j+2})p_{j+1}$$

Similarly we obtain

$$q_{m,j} = (1-p_m)\prod_{k=j+1}^{m-1} p_k, \qquad m>j \qquad (4)$$

for the probability of accruing exactly m prison terms given that j terms have already been accumulated.

These probabilities have a predictive value in that an individual with j prison terms currently in his/her record has for his/her total number of offenses the expectation

$$\sum_{m>j} mq_{m,j} = \sum_{m>j} m(1-p_m)\prod_{k=j+1}^{m-1} p_k$$

To apply the above formulae, estimates of the one-step probabilities p_j are required. In some cases these may be known from total follow-up data as by Farrington *et al.* (1988). In Section 3 we give estimates of p_j derived from a large data set of Western Australian prisoners. In Section 5, the estimates are applied to calculate the expected numbers of prison terms.

3. ESTIMATING ONE-STEP PROBABILITIES OF RECIDIVISM

The data set used for illustration in this paper has been discussed in detail by Broadhurst *et al.* (1988) and Broadhurst and Maller (1990). It consists of the entire population of 16,433 prisoners released for the first time between 1975 and 1987 from Western Australian prisons. Furthermore, the total prison records up to a cutoff date (30 June 1987) are available for these prisoners, giving us the opportunity to study longitudinal or "criminal career" aspects of their offending behavior. The data, although recording all custodial events, are limited to the extent that they exclude convictions, resulting in a noncustodial intervention.

Broadhurst *et al.* (1988) and Broadhurst and Maller (1990) demonstrated success in fitting a Weibull mixture model to the distribution of time to first recidivism in the present data set. This model has the form

$$\text{Prob}\{T < t\} = P \cdot [1 - e^{-(\lambda t)^{\alpha}}], \qquad t \geq 0 \tag{5}$$

where T is the random variable denoting the (possibly censored) time to first return to prison, and P, λ, and α are parameters to be estimated. Parameter P measures the probability of ultimate return to prison, i.e., it is the recidivism probability, while λ is related to the rate of return for those that do return. (The inverse of λ is approximately proportional to the mean and median times to return.) The parameter α measures the "shape" of the distribution; see Broadhurst and Maller (1990) and Broadhurst *et al.* (1988) for further discussion and references on the Weibull distribution. In the above papers, estimates of P were used to demonstrate significant differences among races, genders, ages, and many other groupings, in recidivism probabilities.

Other authors have used parametric models to describe distributions of recidivism times and estimate probabilities of ultimate return to prison. Maltz and McCleary (1977) and Maltz (1984) introduced this kind of model to criminology, using the exponential distribution. The Weibull is a simple generalization of the exponential, to which it reduces when the shape parameter α in Eq. (5) is equal to 1. The extra generality allowed by the parameter α gives a significantly better fit in our data, where values of α less than 1 are obtained. This reflects the fact that the cumulative distribution of failure time, in our data, tends to be concave.

Schmidt and Witte (1988) use the log-normal distribution in a recidivism context. But a log-normal failure distribution, with its nonmonotone hazard, would not be appropriate for our data, with their concave failure distribution. Nevertheless, our method of calculating expected numbers of prison terms applies also to return probabilities obtained from the Schmidt and Witte (1988) split log-normal models or by any other means. For example, Farrington *et al.* (1988) give, in their Table 2, exactly these probabilities for juvenile reoffenders.

There is no difficulty in principle in extending the use of such models to describe the distribution of the time to fail for the second, third ..., jth, recidivism, given release from prison on the $(j-1)$st imprisonment. The estimate of the parameter P representing the probability of recidivism after the jth release is then used as the estimate of p_j for the calculations in Section 3. In our case the model (Eq. 5) fits the jth failure distributions well, as it proved to be in the case of the first return to prison. In practice the numbers returning for a second, third, or more times, fall away rapidly, and in the present data set we attempted only to estimate up to the tenth recidivism. Except for Aboriginal prisoners there are too few cases to make reliable estimates even to this extent.

4. FITTING THE ONE-STEP MODELS TO WESTERN AUSTRALIAN DATA

The Weibull mixture model [Eq. (5)] provided a good fit to the distributions of failure times for each of the first to ninth returns to prison, when fitted separately to each race and gender group. Plots of the fitted distributions are given in a report by the authors to the Australian Criminology Research Council (Maller and Broadhurst, 1989) but are not reproduced here. Tables I and II show the estimated probabilities of recidivism P for up to 10 returns, i.e., estimates of $p_1, \ldots, p_{10}$, with 95% confidence intervals.

Table I. One-Step Probabilities of Recidivism: Males[a]

	Non-Aborigines		Aborigines	
j	$\hat{P}$(CI)	n	$\hat{P}$(CI)	n
1	0.45 (0.44, 0.47)	11,051	0.76 (0.74, 0.78)	3,639
2	0.63 (0.60, 0.65)	3,538	0.84 (0.82, 0.86)	2,292
3	0.69 (0.65, 0.72)	1,603	0.88 (0.85, 0.90)	1,598
4	0.76 (0.70, 0.81)	803	0.89 (0.86, 0.91)	1,147
5	0.72 (0.65, 0.79)	417	0.88 (0.85, 0.91)	865
6	0.81 (0.68, 0.89)	223	0.93 (0.89, 0.96)	631
7	0.80 (0.66, 0.89)	117	0.91 (0.86, 0.94)	472
8	0.79 (0.54, 0.92)	68	0.94 (0.88, 0.97)	351
9	0.87 (0.69, 0.96)	40	0.95 (0.90, 0.97)	278
10		28	0.95 (0.88, 0.98)	222

[a] j, term number. $\hat{P}$, estimated probability of failing following release from term number j. CI, 95% confidence interval for $\hat{P}$. n, number of individuals released following completion of term number j.

Table II. One-Step Probabilities of Recidivism: Females[a]

	Non-Aborigines		Aborigines	
j	$\hat{P}$(CI)	n	$\hat{P}$(CI)	n
1	0.36 (0.27, 0.47)	720	0.69 (0.62, 0.75)	971
2	0.43 (0.33, 0.54)	153	0.75 (0.67, 0.81)	490
3	0.43 (0.26, 0.62)	48	0.79 (0.72, 0.85)	290
4		14	0.84 (0.76, 0.90)	199
5		9	0.89 (0.79, 0.94)	142
6		8	0.89 (0.80, 0.95)	108
7		6	0.95 (0.85, 0.98)	88
8		3	0.94 (0.83, 0.98)	75
9		1	0.97 (0.67, 0.99)	65
10		0	0.98 (0.53, 1.0)	56

[a] j, term number. $\hat{P}$, estimated probability of failing following release from term number j. CI, 95% confidence interval for $\hat{P}$. n, number of individuals released following completion of term number j.

[Equation (5) was fitted only to those race-sex groups containing sufficient numbers for estimation.] It is apparent, as with our previous work on the first return, that there are large differences in overall recidivism by race and gender. Not unexpectedly, given previous work (Nuttall *et al.*, 1977; Phillpotts and Lancucki, 1979; Maltz, 1984; Ward, 1987; Gottfredson *et al.*, 1974; Blumstein *et al.*, 1986), the probabilities of recidivism increase rapidly with increasing numbers of returns to prison, leveling off after the fourth or fifth return at a high value that is close to certainty in the case of Aborigines. (Female non-Aborigines have numbers that are too small for accurate estimation beyond the second return to prison.) Thus the old adage that previous behavior is the best predictor of subsequent behavior finds support in these results.

5. ESTIMATING THE NUMBERS OF TERMS IN CAREERS FOR WESTERN AUSTRALIAN DATA

The conditional distributions $q_{m,j}$ [see Eqs. (2) and (4)] of numbers of prison terms in the Western Australian data are shown in Fig. 1, for selected values of m and j, as the solid lines. These are calculated from the estimates of p_j given in Table I for male non-Aborigines. A major point, perhaps not unexpected, is that the distributions are highly skewed with extremely long tails; thus (see Fig. 2a) a majority of careers (55%) will consist of only 1 prison term, although the mean number of prison terms is estimated from Eq. (3) to be 2.76 for male non-Aborigines. Note that 95% of the distribution

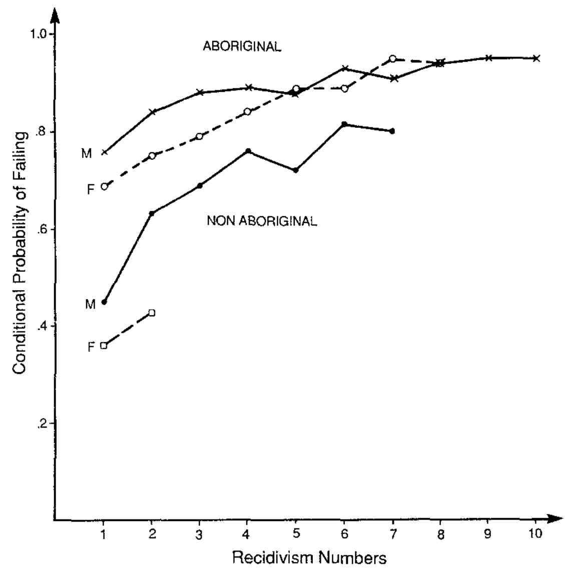

Fig. 1. Conditional probabilities of failure on jth release, given failure on $(j-1)$st release, $j = 2, 3, 4, \ldots, 10$, for race (Aboriginal and non-Aboriginal) and gender groups (male, ×——×; female, - - - -).

extends between 1 and 8 terms (see the righthand arrow in Fig. 2a) so a simple estimate of the number of terms to be expected in a male non-Aborigine's career in this population is 2.76, but lying between 1 and 8 with 95% confidence. The conditional distributions (Figs. 2b–d) are even more skewed and longer tailed.

In order to illustrate the effect of the censoring in the data base, also plotted in Fig. 2a (as the dashed lines) are the actual proportions of offenders with 1, 2, . . . offenses. Thus 66% of male non-Aborigines in the data have 1 term of imprisonment currently recorded, whereas in the previous section we estimated 55% as the long-term percentage who will have only one term. The discrepancy of 11% is not small and is well outside the 95% confidence interval on the estimate of 55%, which is [53%, 57%]. The difference is due to the large numbers whose records have been censored at one term but who will, with the probabilities estimated in Figs. 2b–d, go on to commit further numbers of offenses. Likewise the mean number of prison terms of non-Aboriginal males in the data is 1.71, a full term short of the 2.76 terms expected to be accumulated by each of them in the long run and, in principle, preventable.

As a simple comparison, we examined the numbers of prison terms of these individuals separately for each year of entry. The data extend from 1975 to 1987, and individuals released in 1975 and 1976 have over 10 years

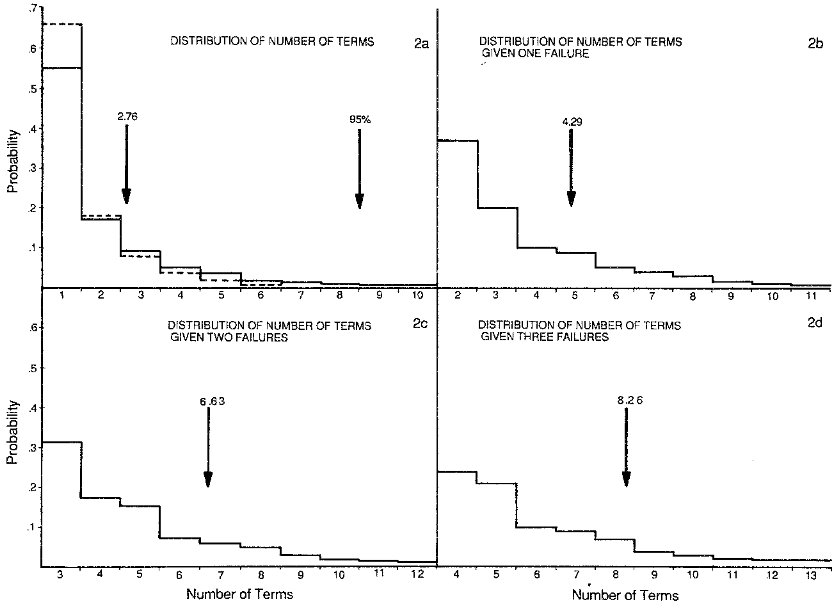

Fig. 2. Distributions of numbers of prison terms as estimated from recidivism probabilities in Fig. 1, for male non-Aborigines. (a) Solid line, estimated distribution of number of prison terms; dashed line, actual distribution of numbers of prison terms in data base. Arrows indicate estimated mean of distribution and 95th percentile. (b–d) Estimated conditional distributions of numbers of prison terms given one, two, or three failures. Arrows indicate estimated conditional means.

of follow-up and may be expected to have accumulated close to their long-run expected numbers of imprisonments, i.e., 2.76 imprisonments. It was found that those entering in 1975 and 1976 had mean numbers of prison terms of 4.0 and 2.5, respectively; thus the 1975 figure in fact is somewhat more than expected and the 1976 figure is almost equal to expectation. From 1977 to 1987, the mean numbers of imprisonments decline progressively from 2.2 to 1.0, as the censoring takes effect.

Table II shows that female non-Aboriginal recidivism is small, so most of their careers are of short duration, at least with respect to numbers of imprisonments, and we do not attempt further analysis of these.

Aboriginal recidivism, both male and female, is, however, very large, as Tables I and II show. Aborigines in Western Australia, a minority 3% of the population, make up at least a third of the prison population and endure third-world status and conditions reflected by their imprisonment rates, recidivism, and morbidity rates, as has been well documented (e.g., Hazelhurst, 1987).

Table III. Expected Numbers of Prison Terms

Gender	Race	Expected number of terms
Male	Aboriginal	11.3
	Non-Aboriginal	2.8
Female	Aboriginal	10.1
	Non-Aboriginal	<2.8

Using the recidivism probabilities in Tables I and II and the methods above, the numbers of imprisonments expected in the long run in their careers are the extremely high figures of 11.3 and 10.1 for males and females, respectively. These figures are much higher than the average numbers of prison terms actually observed in the data base (3.5 and 3.0 for males and females, respectively), and the discrepancy seems larger than can be accounted for on the basis of the censoring alone. For those released in 1975 and 1976 the mean numbers of imprisonments were 8.0 and 5.7 for male Aborigines and 10.5 and 7.6 for female Aborigines, which, apart from the figure of 10.5, which is based on only 53 cases, are still rather lower than the hypothetical expected numbers. We suggest that large numbers of Aborigines are removed from the cycle of reimprisonment, perhaps by illness or death, before achieving their "potential" numbers of imprisonments as predicted by the probabilistic analysis.

An alternative explanation may be the presence of substantial subgroups with lower recidivism probabilities, who somehow contribute to a shorter number of imprisonments over the whole population. Significant differences in recidivist probabilities have indeed been observed for various subgroups in these data (Broadhurst *et al.*, 1988; Broadhurst and Maller, 1990), but mainly for the case of non-Aborigines. For Aborigines there was a slight but significant decline in recidivism with year of release (1975–1983) and also a decline with increasing age of offender. But neither of these effects nor other significant but small differences in recidivism of subgroups seem sufficient to produce an alternative explanation of the differences found between observed and expected career lengths.

The estimated numbers of prison terms expected from these calculations for the gender and race groups are summarized in Table III.

6. EXAMPLE: EFFECT OF INTERVENTION

We give an example of calculations that illustrate the potential for prediction and evaluation of program performance as well as the scope for incapacitation. We show that, given realistic program goals, at best only modest reductions in prison populations can be hoped for. With the estimates derived so far, suppose that 1000 male non-Aborigines enter prison. We expect them ultimately to accumulate (2.76)(1000) = 2760 imprisonments in total. How many of these are due to "high-frequency" offenders? From Fig. 1,

$$E\{\text{number with 1 imprisonment}\} = (0.55)(1000) = 550$$

$$E\{\text{number with 2 imprisonments}\} = (0.17)(1000) = 170$$

$$E\{\text{number with 3 imprisonments}\} = (0.09)(1000) = 90$$

so a total of 550 + 170 + 90 = 810 men of the original 1000 will be responsible for 550 + 2(170) + 3(90) = 1160 imprisonments. So the remaining 1000 − 810 = 190 men will be responsible for the remaining 2760 − 1160 = 1600 imprisonments, a substantial majority. Thus indeed most imprisonments are due to a small number of offenders in this population.

Suppose now that by programs or some other intervention, the probability of recidivism for male non-Aborigines at the first return to prison could be changed from 0.45 to 0.36, a reduction of 20% [incidentally the difference in recidivism probabilities between prisoners released on parole and those released without (Broadhurst, 1990)]. Then the expected number of imprisonments would be reduced to

$$\begin{aligned} E(\text{new}) &= (1 - 0.8p_1) + (0.8) \sum_{j \geq 2} jq_j \\ &= (0.8)E(\text{old}) + 0.2 \end{aligned}$$

where $E(\text{old}) = 2.76$. Thus $E(\text{new})$ would become 2.41, and about 350 of the 2760 imprisonments would have been averted. This is substantially less than 20%. Going through the calculation of the previous section, we now find that 840 with 3 or fewer imprisonments of the original 1000 men will be responsible for 1110 of the imprisonments, so 160 will be responsible for the remaining 1300. This is not a substantial reduction in number of imprisonments for a fairly large reduction in first-time recidivism probability. And no doubt second, third, . . . , recidivism probabilities are more difficult to influence.

For male Aborigines the situation is somewhat different. Here 440 with 1, 2, or 3 imprisonments ultimately, of an original 1000, will be responsible for only 720 of an expected 11,290 imprisonments. Thus, again, most (in fact, 94%) of the imprisonments will be due to the 56% of male Aborigines accruing 4 or more offenses. If the probability of recidivism at the first offense could be reduced by 20%, from 0.76 to 0.61, the expected number of imprisonments in a career would fall to

$$E(\text{new}) = (0.8)E(\text{old}) + 0.2$$
$$= 9.2$$

for a rather substantial decrease of 2.0 prison terms and 2000 imprisonments overall. This at least holds out the promise of a reasonable return on any investment in programs or policies aimed at reducing specifically Aboriginal imprisonment. In Table IV we list the changes in the expected numbers of imprisonments that would result if the recidivism probabilities in Tables I and II could be reduced to the proportions 0.9, 0.8, 0.7, or 0.6 of their original values. Table IV shows that the distributions of numbers of terms are such that Aboriginal recidivism falls very sharply when one-step probabilities of recidivism are reduced by as little as 10%, whereas male non-Aboriginal "careers" are more difficult to affect.

What is also striking about these results, in general, are the very long careers calculated for Aboriginal prisoners. Given our current understanding of Aboriginal overinvolvement in the criminal justice system, this is not entirely unexpected. Exposure to European custodial regimes and programs has resulted in large proportions of Aborigines in prison, and their recidivism

Table IV. Distributions of Numbers of Terms and Expected Numbers of Terms for Specified Percentage Decreases in One-Step Recidivism Probabilities[a]

	q_j														
	Male non-Aborigines					Male Aborigines					Female Aborigines				
	100%	90%	80%	70%	60%	100%	90%	80%	70%	60%	100%	90%	80%	70%	60%
j															
1	0.55	0.60	0.68	0.77	0.86	0.24	0.32	0.45	0.62	0.77	0.31	0.38	0.50	0.65	0.79
2	0.17	0.18	0.18	0.15	0.11	0.12	0.17	0.22	0.22	0.17	0.17	0.20	0.23	0.22	0.16
3	0.09	0.09	0.07	0.05	0.02	0.08	0.11	0.12	0.09	0.04	0.11	0.12	0.12	0.08	0.04
4	0.05	0.05	0.03	0.02	0.00	0.06	0.08	0.08	0.04	0.01	0.07	0.07	0.06	0.03	0.01
5	0.04	0.03	0.02	0.01	0.00	0.06	0.07	0.05	0.02	0.00	0.04	0.04	0.03	0.01	0.00
6	0.02	0.02	0.01	0.00	0.00	0.03	0.04	0.03	0.01	0.00	0.03	0.04	0.02	0.01	0.00
7	0.02	0.01	0.01	0.00	0.00	0.04	0.04	0.02	0.00	0.00	0.01	0.02	0.01	0.00	0.00
8	0.01	0.01	0.00	0.00	0.00	0.02	0.03	0.01	0.00	0.00	0.02	0.02	0.01	0.00	0.00
9	0.01	0.01	0.00	0.00	0.00	0.02	0.02	0.01	0.00	0.00	0.01	0.01	0.01	0.00	0.00
E	2.76	2.13	1.63	1.34	1.17	11.29	4.63	2.48	1.68	1.31	10.12	3.89	2.19	1.57	1.27

[a] For the indicated race-gender groups, one-step recidivism probabilities as given in Tables I and II have been reduced to the percentages 90%, . . . , 60%, of their original values, and the distributions q_j of numbers of terms and expected numbers of terms (indicated by E), given by Eqs. (2) and (3), have been tabulated. Probabilities q_j listed for "% = 100" and for male non-Aborigines are those plotted in Fig. 2a (solid lines). Note that the summation $q_1 + q_2 \ldots + q_9$ from the table may not equal 1 if there are nonnegligible probabilities of higher numbers of terms than 9.

and "recycling" rates are clearly high (Tables I and II). But it is worth reflecting that an ironic result of the slowly improving health status of Aboriginal Australians will be a predicted increase in the numbers in prison.

7. DISCUSSION

The work described above outlines some of the problems of measurement and analysis that confront the researcher examining one aspect of the criminal careers of prisoners. More work is clearly required, in particular, on the issues of specialization and severity (see, e.g., Stander *et al.*, 1989; Blumstein *et al.*, 1988a; Kempf, 1987, 1988; Klein, 1984).

Blumstein *et al.* (1986) based estimates of prevalence and frequency and the other dimension of "criminal careers" on arrest data so they are not comparable with those calculated from prison records. But the simple methodology presented here to calculate the expected numbers of prison terms in prisoners' careers is easily implemented once estimates of one-step probabilities are available, and of course parallel computations are easily applicable to records based on self-report, arrest, or conviction.

We have used a Weibull mixture model to describe failure rates at the first, second, etc., returns to prison, and this works well in the present data set. Tables I and II demonstrate convincingly that the probabilities of failure increase substantially with each successive return at least for the first three returns, in our data. It is extremely important to emphasize the fact that these probabilities change with successive returns, as cross-sectional studies and census samples frequently fail to control (or control properly) for the strong effect of prior terms of imprisonment on failure rates.

We now have a good idea of the probabilities of failure for "persistent" prisoners, and the numbers of prison terms expected to occur in their criminal careers can be estimated, with important implications for our understanding of the ultimate utility of interventions. From the point of view of the evaluation of aims and objectives by decision makers, such estimates contribute to the formulation of priorities. Incapacitation strategies can also be evaluated from the perspective of the duration of careers, but it is important to distinguish between the ability to estimate the proportion of persistent recidivists in the aggregate and the accurate prediction of individual recidivists; the latter problem is not addressed here.

It is commonly argued (Blumstein *et al.*, 1988b; Farrington, 1989) that some of those who enter the prison will ultimately progress to more and more serious crime and that this process can be mapped through the study of criminal careers. The duration of careers is addressed in the present paper by examining the records of institutionalized offenders over a period of 12 years. We have shown that only a small number of prisoners acquire large numbers of terms and, consequently, account for a high proportion of all imprisonment. This group represents a core of high-risk recidivists that has long attracted the interest of those who give high priority to preventive goals. Recent work on seriousness and progression also supports the view that those who have long careers tend to progress to more serious offending—in short, become worse (Stander *et al.*, 1989; Maller and Broadhurst, 1989).

Blumstein and colleagues have been at pains to point out to critics such as Gottfredson and Hirschi (1986, 1988) that criminal career research is not able to justify "incapacitation" policies because of insufficiently accurate prediction, important ethical conflicts, and strategic considerations. What is stressed is a different perception of the crime problem, as being not only a juvenile and youth phenomenon, but one that has an important adult dimension—especially with regard to the frequency and severity of crime. Thus the problem of the duration of criminal careers, the issue of progression to more serious/frequent offending, and a mechanism for interfering with these developments deserves, they argue, high priority in policy formulation.

In fact, according to this work and that of others (West and Farrington, 1977; Petersilia *et al.*, 1977; Petersilia, 1980; West, 1982; Farrington and Tarling, 1985; Greenberg, 1985), on criteria both of frequency and of severity, older offenders seem to account for very significant proportions of crime. In other words, repeat offenders or recidivists (especially those who continue into adulthood) contribute to a disproportionate amount of the worst crimes and crime in general. This is an observation of very long standing (Radzinowicz and Hood, 1986). In policy terms this has led to the view that such recidivists might be anticipated and incarcerated for longer periods than others in order to extend the benefit of such incapacitation to potential victims. The "habitual criminal" and special sentences for him/her thus return to the center of criminal justice policy.

However, the probabilistic analysis presented in this paper uses only "average" or overall probabilities of recidivism to predict the expected number of prison terms in a career. Such an analysis, as we have stressed, falls short of the kind of predictive accuracy required to implement effective incapacitive policies. There are two major ways by which the method could, and should, be refined and extended. First, in order to understand the evolution of criminal careers over an individual's lifetime, it will be important to estimate the actual duration of a career (total period of imprisonment or total period of offending), rather than just the career as reflected by the number of prison terms. Second, recidivism probabilities vary with many factors other than race and gender of prisoner, and age, in particular, of the prisoner is important in the current data set. The incorporation of these effects in a more sophisticated model than that given here is the subject of our current research. Preliminary results from this suggest that the conclusions of the present work remain valid.

The parameters of participation, frequency, seriousness, and duration of criminal career, specified by the National Academy of Sciences panel on criminal career research (Blumstein *et al.*, 1986) as the necessary elements in properly distinguishing between low- and high-risk offenders, are extremely difficult to measure. Furthermore, the analysis of these characteristics implies the availability of high-quality longitudinal data sets of individual offenders over long periods of time with the recording of all details, although even with incomplete data records we can employ statistical methods to estimate risks or test for differences between groups of offenders. But all of this is dependent on the accuracy of offending records. [Offense self-report studies (despite methodological difficulties) may provide the necessary additional information absent from official records.] As yet no such comprehensive individual data base has been described in terms of the criminal career paradigm, and the National Academy's review of a number of disparate studies measuring separately aspects of participation, frequency, and duration of offending shows that current research does not yet suffice. In this regard it must be said that the theoretical speculations and crime control policies advocated by criminal career researchers (e.g., prediction, classification, and incapacitation) advance well ahead of the available data. While statistical sophistication exists to examine criminal careers, comprehensive records to match this sophistication in criminology as yet do not.

ACKNOWLEDGMENT

We are grateful for referee and editorial assistance that has greatly improved the paper.

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