Re-arrest probabilities for the 1984-1993 apprehended Western Australian population

R.G. Broadhurst* and N.S. Loh**

Crime Research Centre, Law School, University of Western Australia.

** Senior Research Fellow ** Research Officer*

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Abstract

A large population of all persons arrested by police in Western Australian for the first time between April 1, 1984 and June 30, 1993 (n=146,038) are followed-up to determine if they have ever been re-arrested.. Details of their offences, bail status, occupation, age, place of birth, sex and race were available. Survival or failure rate analysis was applied to calculate the probabilities of re-arrest and the time to fail for those who were re-arrested. Estimates of the probability of re-arrest for the main sex and race groups were as follows: 0.52 for male non-Aborigines, 0.36 for female non-Aborigines, 0.88 for male Aborigines and 0.85 for female Aborigines. Significant variations in the probability of re-arrest and/or the time to re-arrest for different age groups, the number of times arrested, occupational status, offence group, place of birth and bail status were observed. Co-variate analysis (Maller 1993) of non-Aboriginals (n=51,302) found with the offence of "driving under the influence" (DUI) was undertaken to test the significance of differences in probabilities of re-arrest for sub-groups. Non-Aboriginal males with a prior arrest, in younger age groups, "blue collar" occupations and whose bail status was unknown had higher risks of re-arrest for a repeat DUI than other groups. Non-Aboriginal females with a prior arrest or in "blue collar" occupations also were found to have significantly higher risks of re-arrest. Non-Aboriginal probabilities of re-arrest for either definition of recidivism were for males: 0.47 for *any* offence and 0.31 for *repeat* DUI; and for females 0.34 for *any* offence and 0.20 for a *repeat* DUI. The results are discussed in the light of estimates of re-imprisonment and the utility of offender risk assessment.

Key Words: recidivism, longitudinal study, re-arrest, censored data, survival analysis and drink driving.

Introduction

Estimates of recidivism are useful in assessing the effect of penal policies and the utility of specific interventions upon offending behaviour. In Australia such estimates have been calculated for the reconviction or re-imprisonment of selected populations of prisoners or convicted persons (for example N.S.W. Department of Corrective Services, 1972, N.S.W. Bureau of Crime Statistics, 1979, Homel 1980, South Australia 1989 and Thompson 1989, Broadhurst et al. 1988, Broadhurst and Maller 1990, 1991, 1992) but no estimates of the probabilities of re-arrest for an Australian sample are known to the authors. This paper reports estimates of re-arrest for a population of persons arrested in Western Australia for the first time since April 1 1984. The data collected provide an opportunity to calculate base rates of the probability of re-arrest and to explore the fundamental dimensions of "criminal careers" (see Blumstein et al. 1986).

This paper has the more limited goal of describing the data and method for the calculation of probabilities of re-arrest, and providing an overview of the general risks of re-offending for the major sex, race, age and offence groups found in the arrest population of Western Australia. From this analysis comparisons with related work on the probabilities of re-imprisonment are discussed. In addition to this general overview, an example of the analysis of a particular offence (driving under the influence DUI) is also detailed to highlight both the data and method. The database and the analysis address questions such as; "What is the chance of someone (or a specific sub-group) arrested being arrested again?"; and "What is the chance of someone arrested for a certain offence being arrested for the same offence again?", to be given a statistical answer. These questions help monitor the effect of policies designed to reduce the likelihood of re-offending. They begin to answer questions like: "How effective are the mandatory fines following arrest for driving under the influence?" and "Do juvenile diversion schemes reduce the risks of re-arrest?". From information on the nature of punishments (derived from court and prison data) it is possible to examine the effects of different interventions, the presumed role of deterrence and other goals of punishment. In this paper the first steps of a more complex process of evaluation are taken.

The results reported here relate to research-in-progress based on the development of a comprehensive individual unit record collection designed to link data from police, courts and correctional services (see Ferrante 1993). [1]

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[1]Court records are poor and incomplete and data relating to fines are omitted. We rely on correctional

1.2. Data and Method

The data comprise apprehension records of the Western Australian Police Service collected over the period April 1 1984 to June 30 1993. About 757,000 charges were found involving 518,915 arrest events[2] and 208,059 distinct persons. As the task of this research was to estimate probabilities of re-arrest, it was important to establish the order and timing of arrest events, from the time of first arrest. Thus the sample was refined to exclude all cases who had an arrest record prior to our start date of April 1 1984.[3] Some 62,000 cases were excluded because they had arrest records prior to April 1 1984, leaving 146,038 of the 208,059 distinct persons in the data base, arrested for the first time between April 1 1984 and June 30 1993 (Note, 21 cases were arrested on the censor date). Persons arrested for the first time since April 1 1984 acquired a total of 313,308 arrests by the cut-off date June 30 1993. Cases arrested in 1984 were able to be followed-up for a maximum of 9.25 years, those arrested in 1985 for 8.25 years, and so on until the cut-off date. Subjects, on average, were followed up for 4.9 years.[4]

Because the probability of arrest is dependent on the amount of follow-up time, the data is said to be censored, since insufficient time had elapsed, in some cases, between arrest and the chances of re-arrest. At the extreme, an individual arrested on the cut-off date of 30 June 1993 would have had no opportunity to be re-arrested and ordinarily including such cases would seriously bias estimates of re-arrest. A statistical method, known as failure or survival rate analysis, is utilised to account for such bias and permits accurate estimates of the ultimate probability of arrest to be calculated. In previous work on the probabilities of re-imprisonment in the West Australian prison population, a Weibull mixture model (or split population model) was fitted with good results to the cumulative failure distribution of prisoners released for the first time (see Broadhurst et al. 1988 and Broadhurst and Maller 1990, 1991).

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records for retrospective data. A complete longitudinal record including juvenile data is yet to be built.

[2]An arrest event was defined as a charge laid on a given date, if more than one charge was laid on the same day it was only counted as one arrest. The rule assumed that an individual would not be arrested more than once a day.

[3]Finding an arrest record prior to the initial collection start date (April 1 1984) depended on determining the sequential fingerprint based identification numbers that were issued prior to that date by the Bureau of Crime Intelligence. The date of arrest and the issue of a unique identifier was subject to delay and the start date reflects the need to account for the lag between arrest and formal identification.

[4] Average follow-up time varied slightly according to race and sex.

In addition Maller (1993: see also Broadhurst and Maller 1992) developed a method for handling co-variates in censored populations which enabled tests for interactions between sub-groups to be conducted. This method enables maximum likelihood estimates of the fitted parameters, in this case the Weibull (see model [1] below), to be calculated for sub-groups of interest (for example, sex, race, age etc.) and by comparing the log likelihood (-2LogL) values between them, approximate a chi-square with degrees of freedom equal to the differences in the number of parameters (assuming the null hypothesis of no differences between groups). The same methods including the factorial analysis noted are applied to this population of persons arrested for the first time.

The mixed Weibull method can be described as follows: the failure time of an individual (T) is assumed to have the distribution function

$$\text{Prob}\{T \leq t\} = P.[1-\exp(-(\lambda t)^{\alpha})], \quad t \geq 0 \qquad [1]$$

where lambda is greater than 0 ($\lambda > 0$) is related to the rate of failure and alpha ($\alpha > 0$) is the 'shape' of the Weibull. These are parameters characterising the Weibull distribution of failure time (for those who fail). P is a parameter representing the probability of ultimate or long term failure (1 - P is the probability of long term success). The value of P and the associated 95% confidence intervals are reported for all estimates and the parameters λ and α reported for the co-variate analysis.

The data is illustrated by showing the Kaplan-Meier estimator of the cumulative failure distribution of the actual data (as shown by the dotted line) and the fitted Weibull mixture model (the smooth line). The median time to fail in months is also reported as a summary measure of the time to fail. The data (as seen in Figure 1) may be described as having a "long tail", that is, failures occur long after the first arrest and therefore the mean time to fail is usually a poor description of failure time.

An important caveat to the estimates (especially the time to fail parameter) is that they are not adjusted for time spent in custody. Linked data containing prison records will enable the follow-up time to be corrected to count only the time that an offender is exposed to the risk of re-arrest. Consequently, estimates will be conservative since, for the more serious offenders, "time-out" from offending caused by imprisonment is not taken into account. In addition, arrests that occur outside the jurisdiction are not included and therefore, for some cases, a full history of police charges is not available. Although Western Australia is a relatively isolated and closed jurisdiction, compared to others, considerable interstate travel occurs and

offenders leave the jurisdiction or arrive. At present no adequate national data base exists for tracking offenders across jurisdictions. This missing arrest information will also tend to produce under-estimates of the probability of re-arrest.

Data was available only for a *few* items for each arrest event race, sex, age, bail status, place of birth, occupation (including a part record of those "unemployed"), offence and offence count. Thus while the data refers to a large population of persons arrested in Western Australia it does not contain many factors (e.g. educational, employment, mental health, marital status and, drug or alcohol use) often found to be associated with differential risks of re-arrest.

The first three offences (if there were more than three offences they were selected according to a standard severity index) were recorded and classified (Australian National Classification of Offences [ANCO]).[5] Generally, only the most serious offence at each arrest event is used to classify the offence history of a subject. The additional offences (if recorded) are helpful, however, in exploring the nature of criminal careers. This offence information provides a more accurate basis to determine the extent and rate that criminal careers escalate (i.e. offending becomes more severe over time) or become repetitious or specialist in nature. Finally, while data quality is generally adequate, high levels of missing values occur for some variables, particularly for data collected in 1984 and 1985. The population of persons arrested for the first time is briefly described and summary results of survival or failure rate analysis reported in the following section.

1.3. Demographic factors

1.3.1. Race and Sex

A distinguishing factor of the Western Australian criminal justice system (and most other Australian jurisdictions) is the high level of Aboriginal involvement. Consequentially differential risks of re-arrest for the race groups were anticipated. Estimates of the probabilities of re-imprisonment showed Aborigines to have much greater risks than non-Aborigines and as expected this difference was also found to occur with probabilities of re-arrest.

Race is collected by police on the basis of a physical assessment of the

[5] For details of the severity protocol see Appendix 2 , Broadhurst, Ferrante and Susilo (1990).

offender by the arresting officer and duly recorded. Fortunately the error rate is tolerable for this task and the mis-recording of Aboriginality is estimated to occur in only about one in twenty cases. In a record check study comparing police race records (officer identified) with prison records (self-report) it was estimated that the police were likely to misclassify the race of the arrestee in about 3.2% of comparable cases, however, most error resulted in Aborigines being misclassified (Broadhurst, Ferrante and Susilo 1991:28).

Overall, male non-Aborigines made up 66.8% (n=97,572) of the "first time" arrest population, male Aborigines 3.8% (n=5,518), female non-Aborigines 21.5% (n=31,440), female Aborigines 2.3% (n=3,323), and unknown race or gender 5.6% (n=8,183)[6]. Females accounted for 24.4% of non-Aboriginal arrestees, 37.6% of Aboriginal arrestees and 21.6% of those of unknown race. Thus, after adjusting for missing or unknown race, 6.4% of the population arrested for the first time since 1984 were Aborigines. Since we are concerned here only with the likelihood of re-arrest we have not counted those arrested prior to 1984. Excluding those with prior arrest under-estimates the proportion of Aborigines in the arrest population at any time. Nearly one in five (18.8%) of the distinct persons apprehended annually are Aborigines (see Broadhurst, Ferrante and Loh 1992). Approximately 2.7% of the Western Australian population is of Aboriginal descent and they are therefore over-represented in the first arrest population by a factor of about 2.4 and by a factor of about 7 in the general arrest population[7]. The very high re-cycling suggested by these differences is confirmed for Aboriginal arrestees (see below).

Probabilities of a further arrest were calculated for the sex-race sub-groups arrested for the first time using model [1] above (see Table 1). The probabilities of re-arrest were: 0.52 for male non-Aborigines, 0.36 for female non-Aborigines, 0.88 for male Aborigines, and 0.85 for female Aborigines. Note that the difference between female and male Aboriginal re-arrest was not significant but differences between the races and the non-Aboriginal sex groups were statistically significant[8]. As expected, re-arrest probabilities were higher than the re-incarceration probabilities reported by Broadhurst and Maller 1990[9]. The potential utility of comparisons

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[6] A significant proportion (6076 of 8183) of unknown cases were males of unknown race.

[7] The 1991 population census found 41,779 Aboriginal and Torres Strait Islanders in Western Australia and we found 21% or 8841 arrested for the first time between 1984-93. The 1992 annual statistics show 6907 distinct Aborigines arrested or an amazing 16.9% of the total Aboriginal population compared to 0.2% of the non-Aboriginal population.

[8] As judged by the 95% confidence intervals reported for the Aboriginal sex groups.

[9] They report probabilities of re-imprisonment for a population of Western Australian prisoners released for the first time from prison between 1975-1987 and updated to 1990 (Broadhurst 1993) of 0.43 for male

between re-imprisonment and re-arrest are discussed below.

The overall sex-race results are reported in Table 1 and the cumulative failure distributions for the sex-race groups are shown in Figure 1. Given the large differences found in the probability of re-arrest (for any offence) between the races and the sex-race groups these groups are usually distinguished in subsequent analysis. Note tables describe the ultimate probability of re-arrest (P), the 95% confidence interval (CI) of P, the median time to fail in months (md), the number of cases failing by the cut-off date June 30, 1993 (n-fail) and the total number of cases available (n).

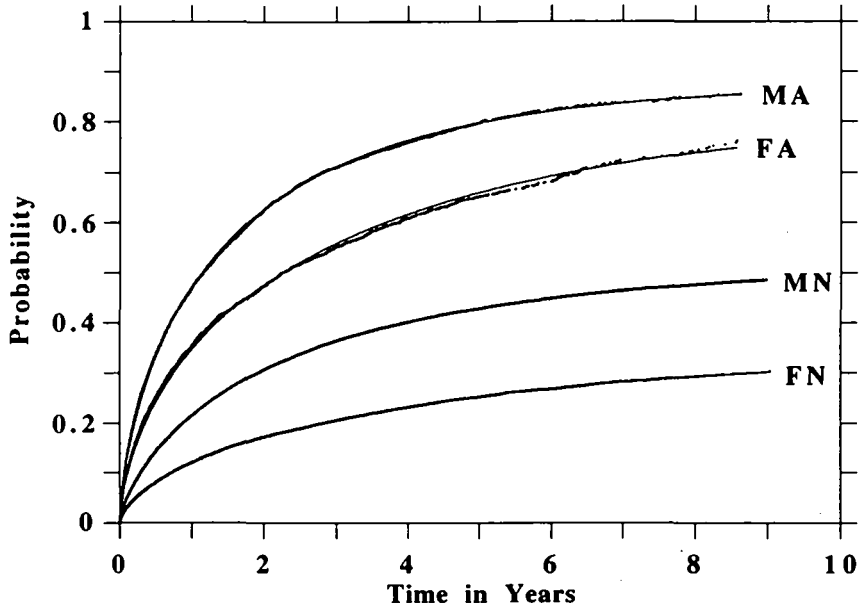
Table 1: Probabilities of re-arrest by sex and race

Males	**Non-Aborigine**	**Aborigine**	**Unknown**
P	0.518	0.883	-
CI	0.51, 0.52	0.86, 0.90	-
md	17.2	10.7	-
n	97572	5518	6076
n-fail	38013	4042	340
Females			
P	0.361	0.849	-
CI	0.34, 0.38	0.79, 0.89	-
md	26.9	18.7	-
n	31440	3323	1672
n-fail	7233	1958	94
Unknown			
P	0.143	-	-
CI	0.09, 0.21	-	-
md	6.0	-	
n	197	16	222
n-fail	25	7	11

Legend: P= ultimate probability of failure; CI = 95% confidence interval; md = median time to fail; n = number of subjects; and n-fail = number of subjects failing by the cut-off date June 30 1993.

non-Aborigines, 0.76 male Aborigines, 0.35 female non-Aborigines and 0.66 for female Aborigines.

Figure 1. Cumulative re-arrest probabilities by sex and race (1984-1993)
dotted line - - - - Kaplan-Meier estimator
smooth line ------- fitted Weibull model [1.]



legend: MA=male Aborigine; FA=female Aborigine; MN=male non-Aborigine; FN=female non-Aborigine.

3.2. Age

As is typical of offender populations the overall age of arrestees was skewed toward the younger age groups. About half of the Aborigines and one fifth of the non-Aboriginal arrestees were juveniles (under the age of 18). However, a large proportion of Aborigines (8%) had no age recorded compared to non-Aborigines (0.1%), (see appendix Table A[10]). Young offenders (under 21 years of age), accounted for 43% of male non-Aborigines but 71% of male Aborigines. Similar age distributions were found amongst prisoners and younger prisoners at first imprisonment were

[10]Note the arrest data excludes all cases of juveniles appearing before a Children's (Suspended Proceedings) Panel and all cautions which were introduced from October 1991.

found to have significantly higher risks of re-imprisonment than older prisoners (Broadhurst and Maller 1990).

Table 2 shows the results of the analysis by age groups for males by race. The probability of re-arrest is highest for those arrested for the first time under the age of 18 years and lowest for those over the age of 40 years. Although for Aborigines (of either sex) the reduction in probabilities of re-arrest with increasing age were less orderly or pronounced than for non-Aborigines, differences were still observed. For example, the probability of re-arrest for male non-Aborigines under 18 was 0.78 but 0.31 for those over 40 years of age and for male Aborigines 0.95 for juveniles to 0.48 for those over 40 years of age. Female re-arrest probabilities also followed a similar pattern of decreasing risks with increasing age. Female non-Aboriginal juveniles had a 0.52 probability of failing compared to 0.20 for those 40 years and over, while female juvenile Aborigines had a 0.86 probability of re-arrest compared to 0.53 for those over 40 years of age.

Also striking was the general increase in the median time to fail (for those who fail) the older the offender at first arrest. For example, the median time to fail for a male non-Aboriginal juvenile was 14 months but 46 months for those over 40 years of age. Likewise the median time to fail for male Aboriginal juveniles was just under 8 months but over 20 months for those over 40 years of age. However, the median time to fail is often not a good locater of the distribution of the time to fail.

Generally the analysis of age as a factor in the probability of re-arrest shows that young offenders are likely to have significantly higher risks of re-offending. Age like race and sex is therefore a significant factor in the probability of re-arrest and a potential source of interactions. Thus differences in the probabilities of re-arrest by age requires that it be treated as a co-variate in subsequent analysis.

Table 2: Male probabilities of re-arrest by age at first arrest

Age group	*Non-Aborigines*	*Aborigines*
<18 years		
P	0.78	0.95
CI	0.77, 0.79	0.94, 0.96
md	13.7	7.9
n/n-fail	21158/13887	2999/2565
18-21 years		
P	0.61	0.88
CI	0.60, 0.62	0.83, 0.92
md	16.7	14.0
n/n-fail	20718/9498	917/650
21-25 years		
P	0.45	0.82
CI	0.43, 0.46	0.56, 0.95
md	18.1	25.3
n/n-fail	16842/5602	417/224
25-30 years		
P	0.41	0.87
CI	0.39, 0.43	0.17, 0.99
md	19.7	32.4
n/n-fail	12518/3701	287/134
30-35 years		
P	0.42	0.53
CI	0.38, 0.46	0.33, 0.71
md	30.0	20.8
n/n-fail	8038/2048	175/57
35-40 years		
P	0.43	0.74
CI	0.35, 0.51	0.13, 0.98
md	44.5	25.3
n/n-fail	5959/1311	102/41
>40 years		
P	0.31	0.48
CI	0.26, 0.36	0.32, 0.65
md	45.8	20.3
n/n-fail	12215/1902	219/65
unknown age		
P	0.68	0.92
CI	0.41, 0.86	0.75, 0.98
md	-	-
n/n-fail	124/64	402/306

1.3.3. Bail Status

The charge record also contains information about the b: or custodial status of the alleged offender at arrest or whether the matte: as proceeded by way of summons. The bail status of the arrest is someti es regarded an approximate guide to the severity of offences and the stat· of the offender. Differences arising from bail status and offence are discu d below. Bail is routinely applied to those offenders arrested for drink-dr .ng offences and other minor matters are usually proceeded by way of summons. In the cases of offenders dealt with by way of summons no "arrest", in the sense of being taken into police custody, has occurred.

Unfortunately, about one in twelve (8.3%) records did not record bail status at arrest (higher levels of non-recording were found for Aborigines - 10.0% compared to 2.8% after adjusting for missing race). The absence of this information was closely related to those cases where other information such as race or sex was also absent. Most arrestees were bailed or dealt with by way of summons at first arrest - but females (especially non-Aborigines) were much more likely to be dealt with by way of summons than males, a function of the differences in offences between the sexes. Aborigines were more likely to be held in custody than non-Aborigines 19.1% compared to 14.3%) and males more likely than females (14.9% compared to 10.9%). Release on bail tends to be somewhat contingent on the past record of the alleged offender and the severity of the offence. Variation in the risks of re-arrest by bail status were found depending on the offence category in question. Thus differences in the probability of re-arrest arising from bail or custodial status in subsequent events of arrest reflect potential interactions with prior arrest and offence type.

Generally custodial status at arrest did not appear to significantly vary *probabilities* of re-arrest for males of either race but the *median time* to fail was much shorter for those held in custody compared to those released on bail or summonsed (for example, male non-Aborigines dealt with by summons had a median time to fail of 19.5 months compared to 14.6 months for those held in custody). Female offenders dealt with by way of summons had lower probabilities of re-arrest than those held in custody or bailed and had longer median times to fail (i.e. for female non-Aborigines 0.38 and 0.42 for bail and custody compared to 0.27 for summons and for female Aborigines 0.79 and 0.83 for bail and custody compared to 0.69 for summons).[11]

[11]There was a slight (but insignificant) tendency for males dealt with by summons to have higher risks of

This difference persisted after controlling for age, thus irrespective of age those summonsed had lower risks of re-offending than those bailed or held in custody. Intriguingly, those cases whose bail, custody or summons status was unknown at arrest had uniformly high re-arrest probabilities and shorter median time to fail irrespective of race or sex. Some differences in the probabilities of re-arrest do, however, emerge for male non-Aborigines when different age groups are considered (or controlled for). While probabilities (and time to fail) declined, as noted, generally with age there were also lower risks of re-arrest for those summonsed compared to those bailed or in custody. For example, juvenile male non-Aboriginal probabilities of re-arrest were 0.78 for bail, 0.79 for custody, and 0.75 for summons but for those over the age of 40 years the probabilities were 0.31, 0.33 and 0.21 respectively. (For Aborigines a somewhat similar tendency was observed, however, the small number of cases and large confidence intervals rendered analysis unreliable.)

1.3.4. Occupation

A simple ten group occupational code (adapted from the Australian Standard Classification of Occupations) was used to summarise descriptions of the occupations of persons arrested. However, 26.5% of male non-Aborigines (31.9% of female non-Aborigines) and 68.4% of male Aborigines (70.7% of female Aborigines) could not be classified or were unknown. Included in the unclassified occupational category were many cases were the police description was simply "unemployed". Unfortunately, police recording practices were not standardised and the employment status of arrestees was not routinely recorded. Nevertheless, where the occupational status was positively recorded as "unemployed", these cases were also flagged as unemployed and the remainder classified as strictly unknown. Table 3 shows the distribution of occupations by sex and race and demonstrates that arrested males are mostly from "blue collar" occupations. (Note the high level of missing data for females). Combined with these deficiencies interpreting this variable proves problematic since occupation is only a crude guide to income and social class.

The self-reported occupational status of offenders also varied probabilities of re-arrest. Generally for those classed in "white collar" occupations lower probabilities of re-arrest were observed compared to those in "blue collar" occupations. However, as Table 3 shows, Aboriginal offenders were

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re-arrest. The summons was applied most frequently to driving related offences, however, lower risks were found for females summonsed, irrespective of race.

poorly represented in some occupational groups (insufficient cases in "white collar" jobs) and thus useful comparisons could not be made. Nevertheless the results did tend to indicate that those in skilled or semi-skilled occupations appeared to have lower risks of re-arrest. For example, male non-Aboriginal offenders in professional (P=0.33) and clerical occupations (P=0.39) had lower than average probabilities of re-arrest, whereas labourers P=0.58) and tradesmen (P=0.54) had higher than average risks of re-arrest.

Table 3a: First time arrestees by occupation at first arrest

occupational group	*non-Aborigine*		*Aborigine*	
	M %	*F* %	*M* %	*F* %
1. Not in workforce*	2.2	11.6	2.2	8.6
2. Managers & admin	5.5	2.4	0.6	0.2
3. Professionals	3.8	3.4	0.8	0.8
4. Para-professionals	2.8	3.0	1.3	1.0
5. Trade persons	23.9	2.8	5.2	0.5
6. Clerks	2.6	10.4	1.0	3.0
7. Salespersons & service	4.7	13.7	0.4	1.7
8. Plant & machine operators	7.5	1.3	1.9	0.1
9. Labourers & related	20.4	19.3	18.1	13.2
10. Unclassified & unknown**	26.5	31.9	68.4	70.7
total	100.0	100.0	100.0	100.0

* pensioners, domestic duties, students etc,; ** includes unemployed.

For non-Aboriginal females outcomes were less consistent and confidence intervals overlapped between the occupational categories. For offenders, tagged "unemployed", the probabilities of re-arrest were uniformly higher than those whose status was "unknown" (for example, 0.82 compared to 0.49 for male non-Aborigines) but because employment status was not specifically recorded this result is suggestive rather than conclusive.

Collapsing the occupational classification into four categories comprising domestic/pensioners (Table 3a group 1), "white collar" (group 2,3,4, 6, and 7), "blue collar" (group 5, 8, 9) and; unknown (group 10) enabled a clearer picture of the differences in risks of re-arrest. Table 3b shows estimates of re-arrest for male non-Aborigines. While the data suggests a

similar trend for male Aborigines too few cases in the "white collar" category permitted reliable estimation or comparison. Table 3b confirms the earlier observation that "white collar" offenders have lower risks than "blue collar" or "unknown" male non-Aboriginal offenders. For female non-Aborigines significantly lower risks are found for those offenders classified as "not in workforce" (P=0.26) compared with "white collar" (P=0.34), "blue collar" (P=0.36) and "unknown" (P=0.41). Note, however, that although "unknown" non-Aboriginal females have higher estimates of re-arrest this was not sufficient to distinguish them from females "not in the workforce". Similarly, lower estimates of the risk of re-arrest for Aboriginal women classified as "not in workforce" were also found.

Table 3b: Occupational status and re-arrest for male non-Aborigines

Occupational group	*P*	*CI*	*md*	*n*	*n-fail*
Not in workforce*	0.404	(0.35, 0.46)	21.7	2153	541
White Collar	0.396	(0.38, 0.42)	26.1	18982	5090
Blue Collar	0.555	(0.55, 0.56)	16.9	50619	21939
Unknown	0.547	(0.54, 0.56)	14.5	25818	10443

* pensioner or domestic or other unpaid duties.

1.3.5. Place of Birth

Data on the place of birth of arrestees was also collected. Like occupation, birthplace is problematic since birthplace is only a crude indicator of ethnicity. It is also roughly correlated with the attrition of cases from the jurisdiction, that is, certain birthplaces have very low probabilities of re-arrest because cases may have "self-censored" by leaving the jurisdiction following arrest or imprisonment. Moreover, in a significant proportion of cases, birthplace was not recorded (for example, 12.9% of male non-Aborigines, 13.1% of female non-Aborigines, 11.4% of male and 13.8% of female Aborigines[12]). It is assumed that the large number of Aboriginal cases where no data was recorded were, of course, born in Australia.[13]

[12] About two-thirds (69%) of cases were race or sex data was absent also did not record place of birth.

[13] The sex-race proportions excluding "unknown" cases were: 37% of male non-Aborigines were born in WA (39% of females); 23% (19% of females) elsewhere in Australia; 6% (4% of females) in New Zealand; 16% (17% of females) in Europe; 3% (4% of females) in Asia; and 2% (2% of females) in other places. Most Aborigines were born in WA (75% of males and 79% of females) or elsewhere in Australia (13% of males and 7% of females) and the remainder were unrecorded or born outside Australia.

Not surprisingly the majority of arrestees were born in Western Australia or elsewhere in Australia. After adjusting for missing information 69.1% of male non-Aboriginal arrestees were born in Australia and 83.7% of male Aborigines. While 84.1% of male Aborigines were born Western Australia (WA) only 42.4% of male non-Aborigines were born in the jurisdiction. Similarly, 67.9% of female non-Aborigines were born in Australia (45.4% in WA) and 99.5% (91.8% in WA) of female Aborigines. Those male non-Aborigines born overseas comprised 6.7 from New Zealand (5.1% of females), 17.9% from Europe (19.5% of females), 3.4% Asia (4.8% of females) and 2.8% (2.6% of females) from other parts of the world. The probabilities of re-arrest varied significantly for the birthplace groups.

Those born in WA had higher probabilities than those born elsewhere, including those born in other Australian states. For example male non-Aborigines born in W.A. had an estimated ultimate probability of re-arrest of 0.57 (95% confidence interval 0.56-0.58) compared to 0.47 (0.46 to 0.48) of those born in other states, 0.48 (0.46-0.50) for those born in New Zealand and as low as 0.38 (0.34-0.42) for those born in Asia and 0.32 (0.27-0.36) for those born in the U.S.A. or Canada. Similar trends are observed for female non-Aborigines. Aborigines (males) born in WA also had much higher probabilities of re-arrest (0.90) than those born outside the jurisdiction (0.73). As noted earlier, these significant differences are not necessarily assumed to be a function of cultural or structural differences between jurisdictions, since case attrition from the jurisdiction is the more likely explanation.

1.4. Offence Type and Number of Arrests

1.4.1. Offence Type

Table 4 describes the distribution of general offence categories by the race and sex groups and the results of the analysis. Depending on race or sex considerable differences occur in the nature of offending at first arrest.[14] Aborigines were more likely to be arrested for good order, against person and theft offences and non-Aborigines more likely to be arrested for drug and driving/motor vehicle offences. As Table 4a demonstrates, a very large proportion of offenders, regardless of sex or race, were "arrested" for traffic offences - mostly drink driving related offences.

[14]About four out of five cases of unknown race were arrested for good order offences and this probably accounts for the higher levels of missing data noted.

Table 4a: Major offence at first arrest by sex and race*.

	males			females		
offence group	% *non-Abor*	% *Abor*	% *unk*	% *non-Abor*	% *Abor*	% *unk*
against person	6.5	10.2	1.2	3.4	10.3	0.9
robbery	0.2	0.2	0.0	0.1	0.1	0.0
theft	24.2	43.9	3.0	48.7	45.8	8.9
damage	3.1	7.0	0.4	1.2	5.1	0.2
good order	14.4	22.1	83.3	8.4	26.5	76.7
driving	38.1	13.2	5.2	25.6	9.2	4.8
drugs	12.6	2.6	0.9	11.9	2.3	1.2
other offences	0.9	0.7	4.9	0.6	0.5	6.6
welfare/unknown	0.1	0.1	0.9	0.1	0.2	0.7
total	100.0	100.0	100.0	100.0	100.0	100.0

* Note 435 cases of unknown sex are excluded and percentages are rounded to the first decimal point.

Re-arrest probabilities are calculated for the major ANCO groups and shown in Table 4b. However, while differences were observed for non-Aborigines, offence type did not significantly vary re-arrest probabilities for Aborigines. Non-Aboriginal male offenders arrested for driving/traffic offences had the lowest probabilities of re-arrest (except for a small number of cases in a range of miscellaneous offences) while those involved in theft, damage or good order offences had higher probabilities of arrest than for drug offences or offences against the person. Differences in the probability of re-arrest for females also tended to show a somewhat similar pattern (but at a lower risk) to the males, except that those arrested for theft had risks as low as those for driving offences. However, confidence intervals were larger and consequently estimates for females were less reliable (see Appendix Table C).

Note the small number of cases found in either the "welfare" or unknown offence categories (eg. 5 male Aborigines of whom 3 failed by the cut-off date and 87 male non-Aborigines of whom 41 had been re-arrested by the cut-off date) in Table 4a did not permit reliable estimation of failure probabilities[15]. Consequently these offence categories are not reported in subsequent tables. Table 4b describes the re-arrest probabilities for very broad categories of offending which tends to obscure differences between more discrete categories.

[15]For females 14 of 44 non-Aborigines and 3 of 6 Aborigines had been re-arrested by the cut-off date.

Table 4b: Male re-arrest by race and offence group

ANCO group	*Non-Aborigine*	*Aborigine*	*unknown*
against person			
P	0.492	0.876	*
CI	0.46, 0.52	0.76, 0.94	-
md	19.1	13.9	-
n/n-fail	6314/2141	562/365	71/4
robbery/extortion			
P	0.736	-	*
CI	0.50, 0.89	-	-
md	17.0	-	-
n/n-fail	154/79	12/8	3/0
break and enter/theft			
P	0.585	0.917	*
CI	0.57, 0.60	0.90, 0.93	-
md	14.8	7.8	-
n/n-fail	23572/10575	2425/1984	182/17
damage			
P	0.620	0.898	*
CI	0.59, 0.65	0.83, 0.94	-
md	13.1	11.2	-
n/n-fail	3026/1535	386/300	24/0
good order			
P	0.647	0.912	*
CI	0.63, 0.66	0.87, 0.94	-
md	15.4	13.0	-
n/n-fail	14011/7020	1217/898	5063/289
drug offences			
P	0.533	0.822	*
CI	0.52, 0.55	0.65, 0.92	-
md	15.8	15.5	-
n/n-fail	12297/4917	144/87	58/2
motor vehicle offences			
P	0.421	0.763	*
CI	0.41, 0.43	0.63, 0.86	-
md	21.7	22.4	-
n/n-fail	37186/11491	729/367	319/16
other offences			
P	0.350	0.899	*
CI	0.27, 0.44	0.71, 0.97	-
md	22.0	5.0	-
n/n-fail	925/214	38/30	300/7

*iteration on boundary or diverged and therefor estimate unreliable

The re-arrest probabilities for some select offences are described in Table 5 for male non-Aborigines. Male Aborigines are not reported since little variation was observed. Some of the rarer offences, such as homicide, could not be accurately described by survival analysis when distinguished by race and sex because of the small numbers found (iterations either diverged or "bounded"). For example, there were 191 male homicide cases at first arrest of whom 35 had been re-arrested and 52 female cases of whom 4 had been re-arrested by the cut off date. In such cases the likelihood of long prison sentences would mean few cases would have been released long enough to reliably estimate risks of re-arrest .

Table 5 does show substantial variation in the probabilities of re-arrest depending on the nature of the principal offence which led to the first arrest. Taking the base rate probability of male non-Aborigines failing at 0.52 we can see that robbery (0.73), break and enter (0.82), vehicle theft (0.76), receiving/handling stolen goods (0.65) and minor good order offences (0.78) exceeded the base rate while only drink driving (0.41) was significantly lower (the subject of detailed analysis below). An examination of the effect of custody status and offence type on probabilities of re-arrest tended to confirm the tendency for those dealt with by way of summons to have lower risks of re-arrest and confirm the observation that those whose status was not recorded had higher risks. The exception being female non-Aborigines, who when were summoned generally produced significantly lower risks of re-arrest, irrespective of offence type. However, in the case of drug offences and motor vehicle theft, those dealt with by summons actually had higher risks of re-arrest. Variations depending on sex, race, age and offence classification and sub-type appear to suggest complex patterns which warrant detailed co-variate analysis not attempted here.

Table 5: Re-arrest probabilities for select offences (male non-Aborigines)

non-sexual assault		**traffic drugs**	
P	0.487		0.539
CI	0.46, 0.51		0.46, 0.61
md	15.4		17.1
n/n-fail	4572/1678		788/281
robbery		**drink driving**	
P	0.726		0.406
CI	0.54, 0.86		0.39, 0.42
md	14.4		23.0
n/n-fail	144/78		31671/9324
break and enter		**possess/use drugs***	
P	0.819		0.533
CI	0.79, 0.84		0.51, 0.55
md	9.8		16.0
n/n-fail	3886/2538		7790/3128
fraud & misappropriation		**receiving**	
P	0.506		0.645
CI	0.47, 0.55		0.59, 0.69
md	16.9		12.9
n/n-fail	3724/1370		1430/706
motor vehicle theft		**manufacture/grow drugs**	
P	0.764		0.465
CI	0.73, 0.80		0.42, 0.51
md	10.3		17.4
n/n-fail	1446/952		1664/537
Resist/hinder police		**dangerous/reckless driving**	
P	0.543		0.509
CI	0.51, 0.57		0.48, 0.54
md	13.1		18.5
n/n-fail	3530/1519		3364/1331
Driver's license		**other good order****	
P	0.529		0.784
CI	0.49, 0.56		0.76, 0.80
md	14.0		16.0
n/n-fail	1775/717		7328/4429

* excludes 40 cases arrested for importation of drugs;

**drunkenness, prostitution and other offences against justice.

1.4.2. Careers - Persistent Offenders

The number of subsequent arrests to the cut-off date gives an indication of the proportion of the population persisted with offending (though inaccurate because of censoring). For example, of the 5,518 male Aborigines arrested for the first time, 2,251 (40.8%) had been arrested at least five times by the cut-off date, and 8,262 (or 8.5%) of the 97,572 male non-Aborigines had been arrested at least five times. The proportions of females with at least five arrest were 2.9% of non-Aborigines and 23.8% of Aborigines. (Table B in the Appendix describes the distribution of arrest events for the population including unknown race or sex cases.)

It has often been observed that a prior record of offending substantially increases the risk of subsequent offending. Indeed given further arrests in this population the probability of re-arrest increases. In the case of Aboriginal offenders re-arrest probabilities approach absolute certainty of arrest after several episodes. Table 6 shows that given one prior arrest the probabilities of a subsequent arrest (and so on) increase rapidly for non-Aborigines to the point where differences in recidivism by race and sex are eventually overwhelmed. Moreover, in the case of male non-Aborigines, the time to fail falls very rapidly from, nearly a year and a half for the first re-arrest to a few months by the seventh or so arrest. However, relatively large proportions of non-Aboriginal offenders, even those with 3 or 4 arrests, desist from offending. Although probabilities approach certainty of arrest, given several prior arrests, small numbers continue to desist (or perhaps die or leave the jurisdiction).

In contrast, male Aboriginal offenders reach virtual certainty of re-arrest very rapidly (after 3 or 4 arrests) and the time to fail falls from less than a year to a couple of months. Although far fewer females persisted with offending than males, their re-offending behaviour (in terms of the risks of recidivism) was more similar to their male counterparts than dis-similar. In rough terms, female probabilities of re-arrest (given 1 to n arrests) are about one step behind the males. Eventually females reach near certainty of re-arrest, coupled with rapidly declining exposure or failure times. Note, however, that the likelihood of female non-Aborigines desisting remains relatively high even after several arrests and, as the number of available cases falls, the reliability of probability estimates (see the 95% confidence intervals) is less certain. The orderly, progressive increase in the risks of re-arrest and the decline in the time to the next arrest which is observed so well for male non-Aborigines does not occur so neatly for the other sex-race groups.

Table 6: Probabilities of re-arrest by number of arrests

Male

Arrest events	non-Aborigines			Aborigines		
#	*P (CI)*	*md*	*n*	*P (CI)*	*md*	*n*
1	0.52 (.51, .52)	17.2	97572	0.88 (.87, .90)	10.7	55[illegible]
2	0.68 (.67, .69)	11.6	38013	0.92 (.91,.94)	6.9	404[illegible]
3	0.78 (.77, .79)	8.9	20033	0.94 (.93, .96)	5.3	3244
4	0.84 (.82, .85)	6.9	12268	0.95 (.94, .96)	4.1	2649
5	0.86 (.85, .87)	5.8	8262	0.96 (.95, .97)	3.6	2251
6	0.89 (.88, .91)	4.9	5818	0.97 (.96, .98)	3.2	1942
7	0.89 (.88, .91)	3.9	4259	0.98 (.96, .99)	3.0	1691
8	0.92 (.90, .94)	3.6	3229	0.98 (.96, .99)	2.9	1493
9	0.94 (.92, .95)	3.3	2538	0.98 (.96, .99)	2.4	1311
10	0.94 (.92, .96)	3.1	2045	0.99 (.97,1.00)	2.6	1175
11	0.94 (.92, .96)	2.6	1658	0.98 (.96, .99)	2.1	1049
12	0.96 (.94, .98)	-	1357	0.99 (.97,1.00)	-	943
13	0.97 (.94, .98)	-	1156	0.98 (.97, .99)	-	860
14	0.98 (.96, .99)	-	979	0.99 (.97,1.00)	-	789

Females

Arrest events	non-Aborigines			Aborigines		
#	*P (CI)*	*md*	*n*	*P (CI)*	*md*	*n*
1	0.36 (.34, .38)	26.9	31440	0.85 (.79, .89)	18.7	3323
2	0.56 (.53, .59)	14.6	7233	0.89 (.84, .92)	8.9	1958
3	0.70 (.67, .74)	9.3	2814	0.88 (.85, .91)	5.5	1366
4	0.77 (.73, .81)	6.6	1496	0.94 (.90, .96)	5.2	1026
5	0.82 (.77, .87)	5.4	907	0.91 (.88, .94)	3.6	792
6	0.81 (.76, .85)	3.5	593	0.93 (.89, .96)	2.8	633
7	0.89 (.82, .93)	4.1	416	0.95 (.91, .97)	2.6	519
8	0.83 (.77, .88)	2.5	311	0.96 (.90, .98)	2.9	440
9	0.90 (.83, .94)	2.8	228	0.97 (.92, .99)	3.0	366
10	0.92 (.85, .96)	1.8	183	0.95 (.90, .97)	2.1	312
11	0.90 (.80, .95)	2.4	154	0.97 (.91,. 99)	2.4	274
12	0.92 (.79, .98)	2.1	119	0.96 (.92, .98)	1.6	234
13	0.97 (.83,1.00)	-	94	0.98 (.90,1.00)	-	209
14	0.95 (.73, .99)	-	85	0.97 (.90, .99)	-	183

1.5. "Unknowns"

The group classed "unknown" mostly comprise cases where race information is missing. Less than 6% (5.6%) of males and 4.6% of female cases lacked information on race and only 0.3% lacked information on both sex or race. The bulk of these cases are arrested (at first arrest) for good order offences and few appear to persist. In other words, their overall affect on estimates is slight but their exclusion tends to inflate estimates for

the sex-race groups. Overall, the estimated probabilities of re-arrest for the unknown race or sex groups are low or incalculable (see Table 1) but when combined with some other missing factor may generate misleading or incomprehensible results.

A curious observation is that for some cases or sub-groups with high levels of missing information the estimates of re-arrest are much higher than for other groups. For example, for those race-sex groups where age or bail status was unknown, higher estimates of risk were observed than the relevant base rate for the sex-race group. Although, for males of "unknown" race, age had an uncertain effect on re-arrest probabilities (rather than the decline observed with an increase in age) but this would not be unexpected if the proportion of Aborigines varied significantly in one age group compared to another (as indeed they do). If we assume the missing information is randomly distributed (which may not be the case) then higher estimates are indeed difficult to fathom. However, it is apparent that no clear assumption of randomness (within groups) can be made.

The absence of the defining characteristics of race, sex or age render our results meaningless. Nevertheless this "unknown" status remains an intriguing problem since it is possible, in some circumstances, for the results to be interpreted as indicating a "characteristic" and not a random effect.

1.6. Co-variate analysis of censored arrest data

Detailed co-variate analysis of a sub-group of offenders selected on the basis of the presence of a charge of driving under the influence (DUI) is undertaken in the following section. This example should serve to illustrate some of the ways a "criminal career" can be explored and help to shed light on the risks of re-arrest for a selected or targeted group.

1.6.1. Driving under the influence (DUI)

In this section we briefly illustrate the co-variate or factor analysis required to define the relative risks of re-arrest for various sub-groups arrested for DUI offences. A number of interesting questions arise in relation to DUI repetition or recidivism . For example: "What is the impact of random breath testing RBT?"; Are there different risks of re-arrest for technical offences (the 0.08 or 0.05% blood alcohol level) and drunk driving?"; "Is there a relationship between DUI and other dangerous or "bad" driving offences?"; and "Do mandatory penalties. reduce the risk of

re-arrest?" We confine ourselves in this paper to estimating the probabilities of re-arrest for a further DUI offence.

DUI offences include basically two types of driving offences either drunk driving or driving with a blood alcohol reading in excess of 0.08 blood alcohol level (or 0.05 in the case of probationary drivers). Large numbers of Western Australian drivers are routinely stopped for "breath tests" (RBT has been legally in force since 1988) and offences of this nature constitutes the largest single group of offenders, comprising 27% of all charges laid annually (see Broadhurst et al. 1993:36,39). For those found in excess of 0.08% blood alcohol level, substantial fines and license suspension are mandatory and for those in excess of 0.15% blood alcohol, larger fines and longer suspensions are mandatory. In addition, terms of imprisonment may be imposed for repeat offenders (see the Western Australian *Road Traffic Act 1974*, S63 & S64). Because little differences in recidivism were observed for either offence and to simplify analysis both offences were grouped together.

Our approach differs in two important ways from the general base rate estimates described above. Firstly, we search the entire record of each offender to find the first time an arrest for DUI is recorded regardless of whether it occurred on the *first* , *second* or *nth* arrest. Moreover, all offences recorded for each arrest event are included and not just the major offence. Thus our population is the subset of offenders who have at any time been arrested for a DUI offence. This re-definition of the target population substantially increases the number of cases of interest available for analysis. For example there were 31,671 male non-Aborigines whose arrest for the first time was for DUI (see Table 5) but this number increases to 42,482 cases whose DUI arrest occurred anywhere on their record.

Secondly, as well as estimating the probability of re-arrest for any offence, we look for a further arrest for DUI. Thus, in this instance, we are concerned to estimate the probability of the repetition of a DUI offence. For evaluative purposes this is usually the more salient question. Hence we can make simple comparisons between the likelihood of re-arrest for any offence compared to the likelihood of re-arrest for the same offence. In addition we can always compare the risks of re-arrest for a specific group with the overall or base rate risks of re-arrest.

So in Table 7, comparing the probability of re-arrest for *any* offence or *repeat* DUI offence for those cases arrested for the **first time** for DUI, we can see that significant proportions are likely to repeat the offence. For this

offence we observe that about two in five males (0.41) are likely to be re-arrested for *any* offence (inclusive of another DUI offence) given a first arrest for DUI and just over one in four (0.27) will be re-arrested for *repeat* DUI offence. Thus about two-thirds of those that are re-arrested are arrested for another DUI.

Table 7: Non-Aboriginal probabilities of re-arrest by varying definitions of recidivism - first DUI arrest cases only.

group	*any offence*	*repeat DUI*
males		
P	0.41	0.27
ci	0.39, .0.42	0.26, 0.28
n	31671	32420*
n-fail	9324	5769
females		
P	0.32	0.21
ci	0.28, 0.36	0.17, 0.26
n	7558	7720
n-fail	1373	797

* Note the slight increase in the number of cases is due to the inclusion of the second and third offences (if) recorded at first arrest in the selection criteria. Thus in the case of females a further 162 cases of DUI and for males a further 751 cases were found in the population whose major or first offence was more serious than DUI at first arrest.

In Table 8 the population comprises all cases *ever* arrested for a DUI offence followed to determine if they were *ever* re-arrested for *any* offence or if they were ever re-arrested for another *repeat* DUI offence. The results of Table 8 can be compared with those of Table 7 which is concerned only with those arrested for the **first time** for a DUI. The results are interesting since, although the overall probabilities of re-arrest are moderately higher (as expected given the larger pool of offences available), for males with a DUI anywhere on the record, the relative proportion who are re-arrested for another DUI is virtually the same as those arrested for the first time for a DUI offence. That is, about 31% or two-thirds of the 47% estimated to be re-arrested for another DUI offence. A similar result, but with significantly lower risks is observed for female non-Aboriginal DUI offenders. For Aboriginal DUI offenders, the same relationship is observed between the risks of re-arrest for any offence and another DUI offence, except that the risks are substantially higher. For example, 64% or four-fifths of the 81% of male Aborigines who were

rearrested were arrested for another DUI - a proportion exactly replicated for female Aborigines.

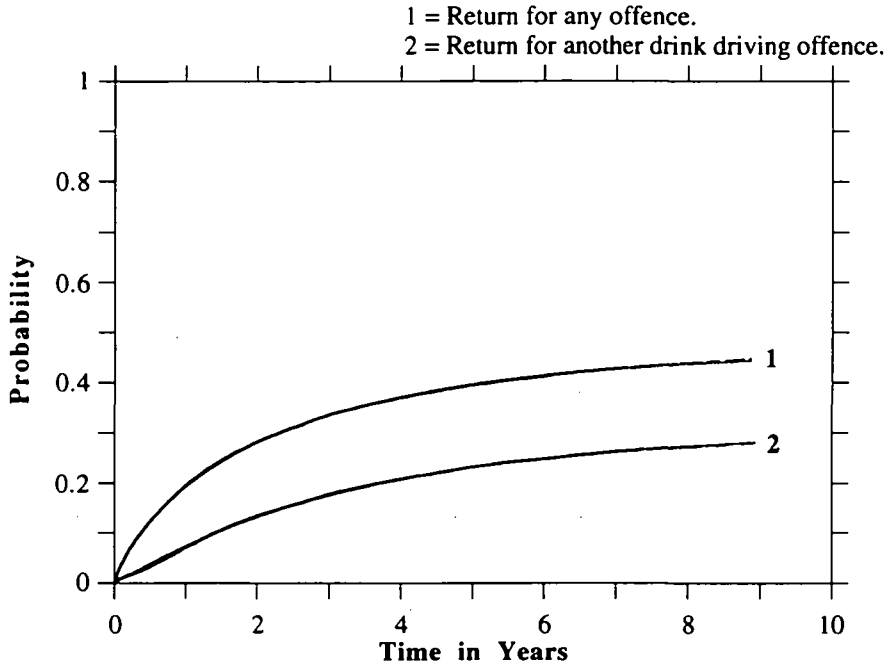
Table 8: Non-Aboriginal probabilities of re-arrest by arying definitions of recidivism - any DUI arrest cases.

group	*any offence*	*another DUI*
male		
P	0.47	0.31
ci	0.46, 0.48	0.30, 0.32
n	42482	42482
n-fail	15223	8597
female		
P	0.34	0.20
ci	0.31, 0.36	0.18, 0.22
n	8820	8820
n-fail	1864	998

Figure 2 illustrates the difference in both the probabilities of re-arrest and the speed of re-arrest depending on the definition of recidivism for male non-Aborigines. The cumulative distribution for those re-arrested for *any* offence shows that the likelihood of re-arrest is both higher and sooner than the distribution for those who re-arrested for *repeat* DUI offence. Note, the closeness of the fit between model [1] and estimator is such that Figure 2 appears to be one rather than two lines (dotted and smooth) for each definition of recidivism.

A difficulty with the population chosen on the basis of a DUI anywhere in the arrest record is that prior record for another offence may change the relative risks of re-arrest. The effects of such co-variates on the risks of re-arrest are reported in Table 9.

Figure 2. Cumulative re-arrest probabilities for male non-Aboriginal DUI offenders by differing definitions of recidivism
dotted line - - - - Kaplan-Meier estimator
smooth line ------- fitted Weibull model [1.]



As noted in the earlier section on methodology it is possible to account for the effect of co-variates or factors by applying a statistical modelling approach to test for differences and interactions between groups or factors that appear to vary recidivism. These factors or sub-groups are handled in a general linear manner by assuming the parameters of the Weibull model [1] are functions of these factors or co-variates (and assuming individuals fail independently). The method parallels the analysis of variance applied to normal or uncensored data by maximising the likelihood estimates for each of the fitted Weibull parameters (ultimate probability, lambda and alpha) in model [1] for each of the sub-groups. The log likelihood value (-2logl) calculated approximates a chi-square with degrees of freedom equal to the difference in the number of parameters. This enables us to interpret the model in the same way that regression analysis is used for normal

distributed data. Moreover, we can also partly avoid the complexities of regression methods and the interpretation of regression (partial) coefficients. In the summary table below we report only the "best" model as determined by the chi-square test of the -2logl values.

Table 9: Probabilities of re-arrest for a *repeat* DUI by sex-race

Group	*n*	*n-fail*	*P*	*ci*	*lambda*	*alpha*	*-2logl*
male Abor	1796	668	0.64	(.58,.70)	.024	1.001	132858.3
male non-Abor	42482	8597	0.31	(.30,.32)	.023		
female Abor	561	132	0.58	(.35,.78)	.014		
female non-Abor	8820	998	0.20	(.18,.22)	.018		
all	53659	10395	0.30	(.29,.31)	.022	0.997	133778.7

Probabilities of male non-Aborigines re-arrest for a *repeat* DUI by co-variates

Group	*n*	*n-fail*	*P*	*ci*	*lambda*	*alpha*	*-2logl*
Prior Arrest							
no prior	32420	5769	0.27	(.26,.28)	021	1.024	109082.9
prior	10062	2828	0.46	(.44,.48)	.026		
Age							
<21 yrs	13229	3901	0.45	(.43,.47)	.023	1.018	108798.4
21-34 yrs	20493	3600	0.26	(.25,.27)			
35+ yrs	8752	1093	0.19	(.18,.20)			
Occupation							
not in workforce	511	77	0.27	(.22,.33)	.023	1.020	109605.5
white collar	10217	1496	0.21	(.20,.22)			
blue collar	25347	5890	0.34	(.33,.36)			
unknown	6407	1134	0.30	(.28,.32)			
Custody status							
bail	34938	6909	0.30	(.29,.31)	.023	1.022	109949.6
custody	6319	1370	0.30	(.29,.32)			
summons	324	52	0.25	(.19,.32)			
unknown	901	266	0.48	(.43,.52)			
All	42482	8597	0.30	(.29,.31)	.024	1.022	110030.0

Table 9 (cont.): Probabilities of female non-Aborigines re-arrest for a *repeat* DUI by co-variates

Group	*n*	*n-fail*	*P* *ci*	*lambda*	*alpha*	*-2logl*
Prior Arrest						
no prior	7720	797	0.21 (.17,.26)	.013	0.950	13915.8
prior	1100	201	0.32 (.25,.40)	.023		
Occupation						
Not in workforce	553	65	0.22 (.16,.28)	.016	0.946	13985.8
white collar	4624	490	0.20 (.17,.23)			
blue collar	1793	253	0.27 (.22,.33)			
unknown	1850	190	0.21 (.17,.26)			
All females	8820	998	0.22 (.19,.26)	.015	0.924	14037.2

* Note occupational category includes pensioners, domestic duties etc..

Table 9 summarises the co-variate analysis for the limited number of factors available from the arrest record of DUI offenders. Typically we find differences in the rate of failing (λ) or the proportion failing (P) or both but rarely for the shape parameter (α). The analysis shows that sex-race was a significant factor in varying the risks and rate (or speed) of re-arrest for another DUI given at least one prior arrest for this offence. Males and Aborigines had higher risks than either females or non-Aborigines. Although the difference in estimates of the probability of re-arrest between the sexes for Aborigines was not large, males (and similarly for non-Aborigines) were re-arrested very much sooner than females for another DUI. Further analysis was confined to non-Aborigines and although age, prior record, occupation and custodial status were observed to significantly vary risks for males, only prior record and occupation did so for females. With the exception of prior arrest, only the proportion or probability of re-arrest varied and not the rate or speed of re-arrest.

Table 9 shows that for male non-Aborigines: younger offenders, those with prior arrests, in "blue collar" occupations or whose custodial status was unknown had higher risks of re-arrest for *repeat* DUI compared to others. For female non-Aborigines a prior arrest and a "blue collar" occupation were found to significantly increase the risks of a further arrest for DUI.

1.7. Discussion and Further Research

The results have described the variations in the risks of re-arrest according to the limited variables or factors available from the summary arrest data. Some of these factors such as occupation, employment status and place of birth were of dubious value and therefore of limited assistance in assessing the relative risks of re-arrest, although the latter was helpful in monitoring attrition. However, race, sex, age, offence, bail status and number of arrests all produced variable risks and are therefore fundamental factors useful in distinguishing differential risks of re-arrest. Similar factors were also useful in distinguishing differential patterns of re-imprisonment (Broadhurst and Maller 1990).

Many more factors or variables were available for investigation from the prison record and additional data is necessary to clearly define the relative risks of re-arrest for different groups. Apart from marital, employment, release and educational status (which were found to be relevant for estimates of re-imprisonment) information relating to the mental health and drug use of offenders has also been implicated in varying the risks of re-offending (Gottfredson and Gottfredson 1993).

Re-arrest cumulative failure distributions (see Figure 1) are very similar to re-imprisonment distributions (see Broadhurst and Maller 1990 and Broadhurst 1993). Re-arrest, if it occurs, shows the expected faster rate of failure and higher proportion failing than estimates of re-imprisonment (this similarity also holds for subsequent terms of prison or episodes of arrest).

The similarity of re-arrest and re-imprisonment distributions raises the possibility that imprisonment or other penal interventions may have little direct bearing on the probabilities of re-arrest. Thus the search for a measure useful for assessing the effectiveness of imprisonment without resort to random (and unethical) allocation of controls and treatments may be satisfied by a comparison between the probabilities for re-arrest and re-imprisonment. However, there are difficulties in such an assumption, since differences may still be masked by the character of offenders dealt with by different penal responses to arrest. Nevertheless, statistical means (such as the co-variate or factorial analysis illustrated for DUI) for controlling for differences in groups can be applied to minimise the relevance of selection factors.

Table 10 shows such a general comparison between re-arrest and re-imprisonment (including police lockup prisoners). However, it must be

noted that although the two populations overlap we have yet to create the necessary linked data (that is joining individual prison/police lock-up records with individual arrest records) to compare the arrest and prison sub-group from the same population over exactly the same time period (see below).

Table 10: Probabilities of recidivism: re-arrest compared to re-imprisonment

Sub-group Re-arrest (1984-93) Re-imprisonment (1979-1991)

	P	*CI*	*n*	*P*	*CI*	*n*
Male						
non-Aborigine	0.52	(.51, .52)	97572	0.44	(.43 ,.45)	16825
Aborigine	0.88	(.86, .90)	5518	0.76	(.74, .77)	6656
Female						
non-Aborigine	0.36	(.34, .38)	31440	0.41	(.33,.50)	1553
Aborigine	0.85	(.79, .89)	3323	0.72	(.69, .75)	2632

Table 10 follows up our population of persons arrested for the first time between 1984 and 1993 (a maximum of 9.25 years) and compares their risks of re-arrest with the risks of re-imprisonment of a population of prisoners released for the first time from prisons or police lock-ups between 1979 and 1991 (follow-up a maximum of 12.5 years)[16]. Since we are unable to directly compare the arrest and prison groups because they comprise different populations (albeit the prison group is a partial subset of the arrest population), followed-up for different periods and of course using different criteria of recidivism, we can only suggest testable hypotheses.

The key proposition would be: does imprisonment reduce the probability of re-arrest? A statistical answer could be provided by estimating the probability of re-arrest for those offenders arrested for the first time who are subsequently incarcerated (or serving a non-custodial order) and compare them on as many of the relevant factors (age, race, sex and offence) with those arrested but not incarcerated.[17] Thus, the task of comparing the effectiveness of various interventions (arrest, non-custodial

[16]Estimates of the probability of re-imprisonment are higher (especially for females) than those published by Broadhurst and Maller (1990) because the data also includes those offenders who served (usually very short periods) time in police lock-ups.

[17]As conviction records are not available our hypothesis is constructed upon arrest data. However, arrest and conviction are highly correlated with approximately 95% of lower court and nearly 90% of superior court defendants plead guilty.

orders, and imprisonment) can be estimated for the same general population. Furthermore, more accurate measures of the frequency, duration and severity of criminal careers can be determined.

Prison careers have been examined for the WA 1975-1990 prison population. Striking differences in the duration of careers were observed between the races (Aborigines were found to have very long careers as measured by the number of prison terms). The offences involved in prison careers were characterised as generalist with some evidence of escalation in offence severity as careers unfold (see Broadhurst and Maller 1991 and Broadhurst and Loh 1993). The probability of returning to prison for a more serious offence was also calculated and this showed that between one half and one third of the recidivists returned to prison for offences more serious than at first. For example, although 43% of male non-Aborigines were estimated to eventually return to prison for any offence 23% returned for a more serious offence and; for Aborigines the percentage returning for any offence was reduced from 76% for any offence to 48% for a worse offence. Similar re-definition of recidivism can be incorporated (as shown in the analysis of DUI) in subsequent analysis and will enable qualified risks to be estimated. The time to fail parameter λ can also help distinguish differences in risk by estimating the variance in time to re-arrest between sub-groups.

So far the work described above usually reports re-arrest for any offence, it tells us very little about the "career" of the offender. Offence transitions have yet to be fully tabulated (i.e. first offence by second offence and so on) and nor have co-variate analysis employing different definitions of recidivism been applied. Preliminary examination of arrest "careers" show different patterns than those of prisoners suggesting greater scope for escalation and specialisation (see Broadhurst and Loh 1993). These methods enable the dimensions of duration, frequency and severity (escalation and repetition) of offending to be fully explored. Arrest records provide the most accurate account of offending, short of complete self-reported offending, and thus enable more sensible descriptions of criminal careers.

So far the re-arrest analysis reported has not taken account fully of any potential interactions (for example, age and offence or age and bail status) and detailed analysis should fully examine co-variates. The Weibull distribution (the 'split' or 'mixed' model) has proven to be a suitable description for re-arrest data. Indeed Figure 1 shows a very close fit between the model and the cumulative failure times with perhaps the exception of Aboriginal females where the model slightly underestimates the probability of re-arrest in the first few years and overestimates in later

years. Consequently, we expect subsequent detailed co-variate analysis (particularly by specific offences) to proceed with few problems. However, the classification of offences remains a possible source of confusion. For example, should traffic and driving offences (for the most part DUI offences) be included in "criminal careers" or should they be excluded or is there a case for both approaches?

As noted, the re-arrest probabilities calculated here take no account of the arrestees who subsequently served prison or jail sentences and thus for some period were not exposed to the risk of re-arrest. The probability of re-arrest for this sub-group will be under-estimated. Moreover, many served probation and/or community service orders which might also affect the probability of re-arrest or the time to fail. A combined data base linking the first arrest population with other criminal justice records (including adult correctional records, juvenile conviction records and police lock-up terms) is under development (see Ferrante 1993). This will allow the necessary refinements to the calculation of exposure time and various definitions of recidivism to be compared.[18]

1.8 Conclusion

This paper briefly described the probability of re-arrest for a population of West Australians arrested for the first time between 1984 and 1993. As expected large and significant differences for the sex and race groups were found. These differences suggest that analysis of recidivism will be meaningless unless these groups are distinguished. Aboriginal re-arrest is extremely high and approaches absolute certainty - raising questions about the relative effectiveness of policing practices in a trans-cultural setting. Similarly there are striking differences arising from the age of offenders at arrest and number of arrest episodes. Over three quarters of juveniles arrested for the first time were re-arrested and, irrespective of race, a prior record of arrest increased the risks of further arrest very dramatically. Utilising re-arrest or recidivism estimates as a method of evaluating interventions therefore must take account of these fundamental differences if valid comparisons are to be made.

In the more detailed co-variate analysis of DUI offenders it was found that just under half of those arrested would be arrested again for *any* offence and just under a third for *another* DUI. In addition prior record, sex, age, occupational and custody status varied risks at least for non-Aborigines.

[18]Crude estimates of the number of arrestees who served terms of prison (n=6,500) or community supervision orders (n=13,000) have been made, however, pending improvements to probability matching protocols and data bases, no reliability is attached to these estimates.

The risk of re-arrest for a further DUI offences was therefore shown to vary considerably depending on the sub-group in question. Close examination of these differential risks of re-arrest (and definitions of recidivism) are therefore necessary if the effectiveness of particular policies, such as RBT, are to be evaluated.

Finally the actuarial methods illustrated in this paper hold promise for improving the accuracy of risk assessment or prediction tools. Actuarial or "life-tables" methods utilise whole offender populations (and not samples of offenders), maximise the efficiency of follow-up time and account for the bias of censored cases (using statistical "survival" models) which enable reasonably precise estimates of the probability of recidivism. Combined with appropriate methods of assessing the influence of co-variates, the way is open for the development of advanced prediction tools capable of a degree of self correction and precision hereto denied traditional methods, such as, the Base Expectancy Score (Gottfredson and Gottfredson 1993) and the Re-conviction Prediction Score (Ward 1987).

These traditional approaches have proven relatively robust despite their reliance on weights or "scores" derived from the partial co-efficient of linear (multi-variate) regression.These correlational analysis often depend on poorly defined outcome data based on relatively small samples of offenders or prisoners. However, they are neither state of the art prediction models or unchallenged as Gottfredson and Gottfredson (1993:286) argue by "...the promise of new methods, new models, and new research paradigms". On the contrary, the advance of information technology (the development of large data bases) and improved ways of handling statistical problems such as censoring render such prediction models obsolete[19]. Consequently it is possible to argue the development of actuarial based prediction models of offending have now moved from the realm of the fanciful to the possible.

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[19]The slow adoption by criminologists of survival models suggests a conservative approach to new quantitative approaches that will continue to handicap progress. The methods outlined above will enable old penological questions to be re-vitalised and subjected to scrutiny that eluded earlier researchers.

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Appendix

Table A: Age distribution of persons arrested for the first time *

	males			*females*		
	%	%	%	%	%	%
age group	**non-Abor**	**Abor**	**unk**	**non-Abor**	**Abor**	**unk**
n=	97572	5518	6076	31440	3323	1672
under 18	21.7	54.3	11.6	18.0	46.2	22.5
18 to 21	21.2	16.6	27.1	18.7	16.2	20.1
21 to 25	17.3	7.6	23.1	17.0	12.4	17.0
25 to 30	12.8	5.2	14.3	13.3	9.6	11.4
30 to 35	8.2	3.2	7.2	9.9	5.7	7.2
35 to 40	6.1	1.8	5.0	7.2	3.3	6.1
over 40	12.5	4.0	9.9	15.8	3.8	9.4
unknown	0.1	7.3	1.7	0.1	2.8	6.2
total	100.0	100.0	100.0	100.0	100.0	100.0

* note 435 cases of unknown sex are excluded

Table B: Number of arrests by race and sex

	males			*females*			***unk***
# arrests	*non-Abor*	*Abor*	*unk*	*non-Abor*	*Abor*	*unk*	*unk*
1	97572	5518	6076	31440	3323	1672	435
2	38013	4042	340	7233	1958	94	43
3	20033	3244	47	2814	1366	10	13
4	12268	2649	3	1496	1026	2	5
5	8262	2251	1	907	792	1	3
6	5818	1942	1	593	633	0	2
7	4259	1691	1	416	519	0	1
8	3229	1493	1	311	440	0	0
9	2538	1311	1	228	366	0	0
10	2045	1175	0	183	312	0	0
11	1658	1049	0	154	274	0	0
12	1357	943	0	119	234	0	0
13	1156	860	0	94	209	0	0
14	979	789	0	85	183	0	0

Table C: Female probabilities of re-arrest by offence group

Anco Group offence	*Non-Aborigine*	*Aborigine*
Against Person		
P	0.412	0.899*
CI	0.33, 0.50	0.06, 0.99
md	20.7	41.8
n/n-fail	1069/290	341/158
Robbery/Extortion		
P	0.460	-
CI	0.27, 0.67	-
md	6.5	-
n/n-fail	34/13	4/3
Theft		
P	0.332	0.755
CI	0.31, 0.36	0.71, 0.79
md	26.8	10.7
n/n-fail	15308/3299	1523/944
Damage		
P	0.512	0.779
CI	0.42, 0.60	0.60, 0.89
md	15.9	12.3
n/n-fail	380/151	170/103
Good Order		
P	0.517	0.991*
CI	0.47,0.56	0.78,1.0
md	18.5	21.4
n/n-fail	2626/974	880/584
Drugs		
P	0.428	0.721
CI	0.38, 0.48	0.45. 0.89
md	26.0	23.3
n/n-fail	3741/981	76/37
Driving		
P	0.322	-*
CI	0.28, 0.36	-
md	35.8	-
n/n-fail	8048/1479	306/114

** iteration on boundary or diverged and estimate unreliable*