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Monitoring trends in re-offending among adult and juvenile offenders given non-custodial sanctions

Nadine E. Smith & Craig Jones

Internationally, governments are making renewed efforts to reduce rates of re-offending. Measuring progress against this objective is difficult because officially recorded reconviction rates are determined not only by how effective the justice system is in dealing with offenders but also by the characteristics of offenders coming to court in the first place. The current research describes the development of a technique known as the Group Risk Assessment Model (GRAM), which adjusts for the characteristics of offenders coming before the courts in order to obtain more accurate estimates of trends in re-offending over time. Separate logistic regression models were developed for juvenile and adult offenders given non-custodial sanctions in 2002. For juvenile offenders, age, sex, Indigenous status, prior convictions and concurrent convictions were found to be highly predictive of subsequent reconviction. For adult offenders, these same offender characteristics, in combination with the jurisdiction in which the offender was dealt with and the offenders' most serious index offence, were found to provide a good model of reconviction likelihood. An application of the models in relation to the 2003 and 2004 adult and juvenile offender cohorts revealed that there had been a statistically significant decrease in rates of reconviction among juveniles convicted in 2004 but not among adults convicted in 2004. The observed reconviction rates among the 2003 adult or juvenile cohorts were not significantly different from the expected rates given the characteristics of those cohorts.

KEYWORDS: recidivism, prediction, juvenile offenders, offender characteristics, Group Risk Assessment Model (GRAM)

INTRODUCTION

Rehabilitation is enjoying something of a renaissance internationally, thanks largely to the emergence of a substantial body of evidence showing that it is possible to reduce re-offending rates among offenders coming into contact with the criminal justice system (MacKenzie 2002). The renewed interest in rehabilitation, however, has focussed attention on the problem of how to measure the overall impact of government efforts to reduce re-offending. One way to monitor trends in recidivism is to observe officially recorded rates of re-arrest, reappearance in court, reconviction or reimprisonment (Blumstein et al. 1986; Farrington 1989; Tarling 1993). One of the problems with using these indicators, though, is that they are influenced both by the effectiveness of a government's correctional policies and by the profile of offenders coming into contact with the criminal justice system. If police decide to focus greater effort on arresting repeat offenders, for example, the reconviction rate may rise even if the programs being run by correctional authorities are effective in reducing the risk of further offending.

A number of studies have shown that there is considerable continuity in criminal behaviour over the life course and some scholars have argued that this continuity is due to stable underlying differences between individuals (Nagin & Farrington 1992). These stable underlying attributes make it possible to accurately predict the likelihood of reconviction from information about the criminal history and other characteristics of individuals coming before the court system. Indeed, some of the strongest predictors of recidivism tend to be static risk factors inherent in individuals such as age, prior contact with the justice system or family rearing practices, although dynamic (i.e. potentially alterable) risk factors such as substance abuse, associating with crime-prone peers and social achievement have also been shown to play a significant role (Gendreau, Little & Goggin 1996). One way to measure improvements in

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reoffending, then, is to develop a formula that predicts what the re-conviction rate should be (based on the profile of offenders coming before the court system) and then compare the predicted to the observed reconviction rate. If a government's correctional policies are working, the observed reconviction rate should be lower than expected, given the characteristics of offenders coming before the courts. If the policies are not working or making things worse, the observed reconviction rate should be the same or higher than expected.

The UK Home Office has demonstrated the feasibility of this approach by adapting the Offender Group Reconviction Scale (Copas & Marshall 1998) to make predictions about the expected reconviction rates for adult and juvenile offenders separately (Cunliffe & Shepherd 2007; Whiting & Cuppleditch 2006). The adult model takes into account age, sex, prior custodial episodes, the rate at which an offender builds up convictions, the length of an offender's criminal career, the type of offence for which the offender was convicted on the current ('index') occasion and the offenders' total number of prior convictions (Cunliffe & Shepherd 2007). The model for juveniles was based on the same factors but excluded the number of previous convictions, and included both the number of different types of prior offences and the index sanction history (e.g. if the offender was cautioned, whether it was their first caution, Whiting & Cuppleditch 2006). Overall, the models were found to be quite good at discriminating recidivist from non-recidivist offenders and therefore provided a useful tool for monitoring trends in reconviction.

THE CURRENT STUDY

The current study describes the first phase of research undertaken to construct a risk-adjustment model in Australia, similar to that developed by the UK Home Office. Information on all adults and juveniles who were convicted in NSW in 2002 was extracted from the Bureau of Crime Statistics and Research Re-offending Database (ROD).[1] Subsequent contacts with the justice system were then observed for a period of two years to determine which members of the cohort had been reconvicted for at least one further offence committed within that two-year time frame. A broad range of offender characteristics was examined to gain an understanding of the contribution that these characteristics make to reconviction risk. A variety of model diagnostics were then explored to determine how well the final model discriminated recidivist from non-recidivist offenders. Finally, the utility of the methodology in predicting reconviction among subsequent cohorts of offenders was examined. One avenue where improvements were made to the Home Office approach was in the development and presentation of confidence intervals around the observed and predicted rates of reconviction. This enabled us to test whether there had been any statistically significant deviations in rates of reconviction over time.

METHOD

SAMPLE DEFINITION

Data containing the characteristics of all adult and juvenile offenders convicted in a NSW court or dealt with at a Youth Justice Conference[2] in 2002 were derived from the Bureau's Re-offending Database (ROD). Adult offenders were defined for the purposes of this study as those people who were convicted in District, Supreme or Local (Magistrates') Courts, irrespective of their age at conviction. Juvenile offenders were defined as those offenders who were convicted in the Childrens' Court or who had completed the outcome plan resulting from a Youth Justice Conference in 2002, regardless of their age at the time the matter was finalised.[3]

The first finalised court appearance resulting in a conviction for one or more criminal offences in 2002 was defined as the 'index' court finalisation date.[4] People who were sentenced to full-time custody at their index court appearance were excluded because, at the time the data were extracted, it was not possible to make accurate adjustments for the amount of time these offenders spent in custody during follow-up.[5] Research has shown that failing to account for exposure time can impact on the estimated level of re-offending as well as complicating estimates of the relationship between age and patterns of re-offending (Piquero et al. 2001). People who received a custodial sentence during the follow-up period for an offence committed prior to the index conviction were also excluded for this reason. While incarcerated offenders were excluded from the analysis reported herein, research is currently underway to investigate the feasibility of making adjustments for offender characteristics among this important custodial group.

There was some further attrition from the current adult sample because some offenders had missing values for age (n=461) and gender (n=12). Taking these exclusions and missing values into account, there were 62,978 offenders in the adult sample and 3,709 offenders in the juvenile sample.

MEASURING RE-OFFENDING

Reconviction was used as a proxy for re-offending, although the two terms will be used interchangeably throughout this report. Reconviction was counted as a dichotomous (0=no, 1=yes) indicator of whether the offender had an offence proven in any NSW court or had a completed outcome plan resulting from a Youth Justice Conference for an offence committed within two years of the index court finalisation date. Minor regulatory offences (such as parking or speeding infringements) were not counted as reconvictions. The subsequent court matter must have been finalised within 30 months of the index court date but the date on which the offence occurred must have fallen within the 24-month follow-up. This is consistent with the approach

adopted by the Home Office and guards against any changes in reconviction rates brought about by changes in the speed of securing convictions (Cunliffe & Shepherd 2007). This also eliminates the problem of so-called pseudo-reconvictions where people are convicted during follow-up for offences committed prior to the index conviction (Copas & Marshall 1998).

EXPLANATORY VARIABLES

A wide range of potential explanatory variables was explored, some of which could not be included in the same model due to problems with multicollinearity. The following variables were either included in the final regression models or were employed to assess model adequacy:

- **Age:** Age of the offender, in years, on the day their index conviction was finalised;
- **Indigenous status:** Whether the offender identified as being of Aboriginal or Torres Strait Island descent at any court appearance or Youth Justice Conference between 1994 and 2006[6];
- **Disadvantage score:** The Socio-Economic Index For Areas (SEIFA) was employed to explore the relationship between area-level disadvantage and reconviction. This index ranks the level of disadvantage of the offenders' residential postcodes according to a range of aggregate-level factors such as average income and unemployment (Australian Bureau of Statistics 2004);
- **Sex:** Sex of the offender at the time their index matter was finalised;
- **Jurisdiction:** The jurisdiction in which the offender's index court appearance was finalised (Youth Justice Conference, Childrens' Court, Local Court, District Court or Supreme Court);
- **Index offence type:** The principal offence category of the offender's index offence. An offender's principal offence was defined as the offence that attracted the most severe penalty according to the Bureau's penalty ranking system (see NSW Bureau of Crime Statistics and Research 2007, p.141, for more information on penalty rankings);
- **Number of concurrent offences:** Number of concurrent proven offences at the offenders index court appearance;
- **Number of convictions in previous eight years:** Number of prior convictions in the eight years preceding the offender's index conviction. This eight-year period was selected because ROD contains court appearance records back to 1994. Eight years was therefore the maximum time available to observe the prior conviction history for the 2002 cohort. A prior conviction was counted as a finalised court appearance where one or more offences were proven against the offender or where the outcome plan resulting from a Youth Justice Conference had been completed prior to the index conviction.

MODELLING STRATEGY

All analyses were conducted separately for adults and juveniles but the methodology and modelling strategies were identical for both samples. The distribution of the possible explanatory variables was examined first and, where necessary, some variables were re-coded to ensure that each category had a sufficient number of cases for the analyses. Chi-square tests of association were then carried out to explore the bivariate relationship between each of the potential explanatory variables and reconviction. The bivariate relationships between explanatory variables were then examined to identify whether multicollinearity would be an issue in the multivariate regression analyses.

Multivariate logistic regression models were then fitted to determine which combination of explanatory factors was most useful in predicting reconviction likelihood. Three automated modelling strategies were compared to decide on the explanatory factors that should be included in the final models: stepwise regression, forward selection and backward elimination. Any variable that was significant at the 10 per cent level using at least one of these three selection procedures was included in the final model. This more inclusive level of statistical significance was chosen because we were interested in identifying the best overall predictive model rather than modelling the specific relationship between individual explanatory factors and subsequent reconviction.

MODEL ADEQUACY

Once the final models had been selected, multiple indicators of model adequacy were examined to determine how well the models predicted reconviction. The primary approach was to use the method proposed by Hosmer and Lemeshow (2000, p.147). The Hosmer-Lemeshow test involves splitting the sample into 10 equal-sized partitions of reconviction risk based on the predicted probabilities of reconviction derived from the model. People who had many of the characteristics found to be positively associated with reconviction risk would fall in the higher risk deciles and people who had few of the characteristics found to be positively associated with reconviction risk would fall into the lower risk deciles. The proportion within each decile predicted to have a subsequent conviction was then compared against the proportion observed to have had a subsequent conviction. The resulting goodness-of-fit statistic, which follows a chi-square distribution, was examined to determine whether any differences between observed and expected proportions were statistically significant. Because this test is sensitive to small differences between observed and expected values when the sample size is large (Hosmer et al. 1997), plots of the observed against predicted proportions of recidivist offenders were also examined. Several other internal and cross validation procedures were also employed to test how the models performed (see Technical Appendix for details).

APPLICATION OF THE MODEL

To illustrate how the model could be used to adjust for offender characteristics when monitoring trends in reconviction, data were extracted from ROD for the 2003 and 2004 adult and juvenile offender cohorts. The parameter estimates derived from the final 2002 model (using the full sample of offenders) were used to predict what proportion of the 2003 and 2004 offender cohorts would be reconvicted within two years. The predicted reconviction rate was defined as the mean of the individual predicted probabilities across all offenders in the cohort. Ninety-five per cent confidence intervals around the predicted and observed reconviction proportions were calculated using the score method with the continuity correction recommended by Newcombe (1998b). The difference between the predicted and observed rates of reconviction and the associated confidence interval around this difference was then compared using the score approach with the continuity correction recommended by Agresti and Caffo (2000) and by Newcombe (1998a). If the confidence intervals around this difference included zero we concluded that there was no evidence of any change in reconviction rates for that particular cohort of offenders.

RESULTS FOR ADULTS

CHARACTERISTICS OF ADULT OFFENDERS AND RELATIONSHIPS BETWEEN EXPLANATORY VARIABLES AND RECONVICTION

Table 1 shows the distribution of the adult offender characteristics as well as the bivariate (unadjusted) relationships between each of the explanatory variables and likelihood of reconviction within two years. Chi-square tests of association indicated that younger offenders were more likely to be reconvicted within two years, as were men, Indigenous offenders, offenders convicted in a Local Court, those whose index conviction was for a theft or drug offence, offenders with more concurrent offences and offenders with a greater number of proven offences in the previous eight years.

Table 1. Adults: Characteristics of distinct offenders convicted in NSW Local, District and Supreme Courts in 2002 (n=62,978) and the bivariate relationship between offender characteristics and reconviction within two years

Offender characteristic	*N within category (%)*	*% Reconvicted**
Sex		
Male	51992 (82.6)	34.4
Female	10986 (17.4)	30.1
Age (mean=31.7, median=30)		
13-21	12035 (19.1)	40.5
22-29	19241 (30.6)	35.7
30-39	17671 (28.1)	34.7
40+	14031 (22.3)	23.5
Indigenous status		
Non-indigenous	49260 (78.2)	33.7
Indigenous	7544 (12.0)	57.6
Unknown	6174 (9.8)	3.7
Jurisdiction		
Local Court	62268 (98.9)	33.7
District/Supreme Court	710 (1.1)	25.4
Index offence type		
Driving	26495 (42.1)	29.0
Violent/sexual	11450 (18.2)	32.0
Theft	6167 (9.8)	44.0
Drug	3786 (6.0)	39.4
Other/breach	15080 (23.9)	37.3
Number of concurrent offences		
None	38103 (60.5)	30.2
One	12479 (19.8)	36.5
Two or more	12396 (19.7)	41.3
Number of prior conviction in past 8 years		
None	26936 (42.8)	18.8
One	12885 (20.5)	31.2
Two to three	11946 (19.0)	42.7
Four or more	11211 (17.8)	62.2

* *All chi-square tests of association between re-offending and offender characteristics had p-values less than 0.0001, indicating statistically significant bivariate relationships between reconviction and the offender characteristics.*

FINAL LOGISTIC REGRESSION MODEL

The parameter estimates and associated odds ratio estimates for the final model are shown in Table 2. The model in Table 2 suggests that, after adjusting for all other characteristics in the model:

- Women had lower odds of reconviction than men;
- Indigenous offenders had higher odds of reconviction than non-Indigenous offenders; while offenders with unknown Indigenous status had lower odds of reconviction than non-Indigenous offenders[7];
- Younger offenders had much higher odds of reconviction than older offenders;
- Offenders convicted in District or Supreme Courts had lower odds of reconviction than offenders convicted in Local Courts;
- Offenders convicted of violent or sexual offences, theft offences, drug offences or 'other' offences had higher odds of reconviction relative to offenders convicted of driving offences;
- Offenders with more concurrent offences had higher odds of reconviction than offenders with no concurrent convictions; and
- The odds of reconviction increased substantially as an offender's prior conviction history increased.

MODEL ADEQUACY

The Hosmer-Lemeshow test statistic was statistically significant, which suggests that there was a difference between observed and expected frequencies across the 10 partition groups (χ^2=25.37, df=8, p=0.0013). However, as mentioned earlier, this test is highly sensitive to small deviations between the observed and expected frequencies when the sample size is large (Hosmer et al. 1997). Given the large sample size employed for the current analysis, plots of the observed versus predicted frequencies were observed to determine if, and where, these deviations occurred. Figure 1 plots the number of predicted re-offenders against the number of observed re-offenders within the 10 partition groups. It can be seen that the predicted and observed numbers of re-offenders are very close, with the exception of slight deviations for the partition groups six, nine

Table 2. Adults: Final logistic regression model predicting reconviction within two years for offenders convicted in NSW adult courts in 2002 (n=62978)

Characteristic	*Category*	*Parameter estimate (standard error)*	*Odds ratio (95% confidence interval)*
Intercept		-1.745 (0.028)	
Sex	Male*		1.00
	Female	-0.155 (0.025)	0.86 (0.82, 0.90)
Indigenous status	Non-indigenous*		1.00
	Indigenous	0.539 (0.028)	1.71 (1.62, 1.81)
	Unknown	-2.036 (0.069)	0.13 (0.11, 0.15)
Age	40+*		1.00
	30-39	0.305 (0.028)	1.36 (1.29, 1.43)
	22-29	0.259 (0.027)	1.30 (1.23, 1.37)
	13-21	0.741 (0.030)	2.10 (1.98, 2.22)
Jurisdiction	Local Court*		1.00
	D/S Court	-0.507 (0.093)	0.60 (0.50, 0.72)
Index offence type	Driving*		1.00
	Violent/sexual	0.075 (0.027)	1.08 (1.02, 1.14)
	Theft	0.329 (0.032)	1.39 (1.31, 1.48)
	Drug	0.178 (0.039)	1.20 (1.11, 1.29)
	Other	0.248 (0.024)	1.28 (1.22, 1.34)
Number of concurrent offences	None*		1.00
	One	0.126 (0.024)	1.13 (1.08, 1.19)
	Two or more	0.234 (0.023)	1.26 (1.21, 1.32)
Number of prior convictions in past 8 years	None*		1.00
	One	0.510 (0.026)	1.67 (1.58, 1.75)
	Two to three	0.908 (0.026)	2.48 (2.36, 2.61)
	Four or more	1.572 (0.027)	4.82 (4.57, 5.08)

** Reference category*

Table 3. Adults: Predicted and observed rates of reconviction among the 2002, 2003 and 2004 adult samples, based on the estimates derived from the final 2002 logistic regression model

Year	*N*	*Observed (95% C.I.)*	*Predicted (95% C.I.)*	*Difference between observed and predicted (95% C.I.)*
2002	62978	33.6 (33.2, 34.0)	N/A	N/A
2003	64945	32.2 (31.8, 32.5)	32.5 (32.2, 32.9)	0.4 (-0.1, 0.9)
2004	68602	31.8 (31.5, 32.2)	32.0 (31.6, 32.3)	0.1 (-0.3, 0.6)

and 10. Among the highest risk group (partition 10), the model overestimates the actual number of re-offenders and it under-estimates slightly for the second highest risk group (partition 9). These plots suggest that the model provides a relatively close fit between observed and expected frequencies (see Technical Appendix for further details of model adequacy).

APPLICATION OF THE MODEL

Table 3 shows the observed and predicted reconviction rates, the difference between observed and predicted reconviction rates, as well as the corresponding 95 per cent confidence intervals for the 2002, 2003 and 2004 offender cohorts. Each of these predictions was based on the estimates derived from the final 2002 model. Because the model was developed on the 2002 cohort, only the observed reconviction rate for this year is presented. In both the 2003 and 2004 cohorts of offenders, the observed proportion reconvicted within two years is slightly below the proportion predicted to re-offend based on the model. However, because the confidence intervals around the difference between observed and predicted reconviction rates include zero for both the 2003 and 2004 cohorts, we conclude that this was not a statistically significant decrease. The evidence therefore suggests that reconviction rates did not change between 2002 and 2003, or between 2002 and 2004.

RESULTS FOR JUVENILES

DISTRIBUTION OF THE OFFENDER CHARACTERISTICS AND RELATIONSHIPS BETWEEN EXPLANATORY VARIABLES AND RECONVICTION

The distribution of the juvenile offender characteristics is shown in Table 4, as are the bivariate relationships between each of the explanatory variables and likelihood of reconviction within two

Figure 1. Adults: Number of offenders predicted to have a further conviction versus the number observed to have a further conviction within 10 deciles of risk

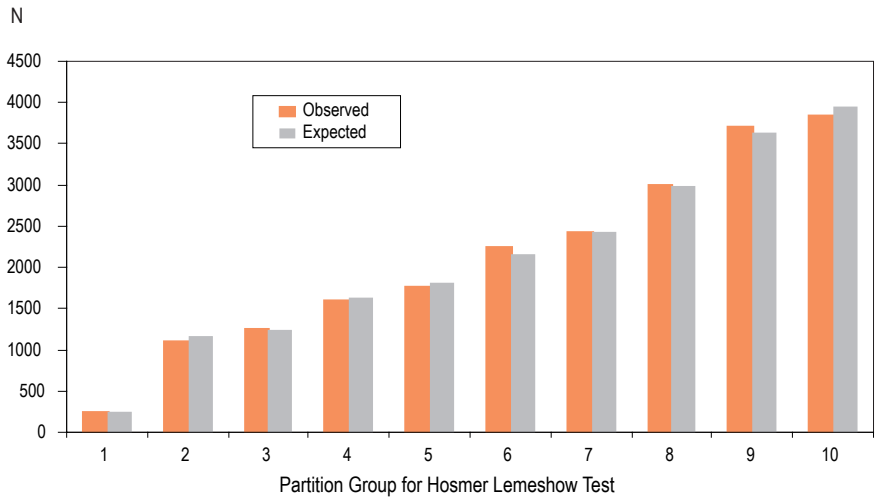

Table 4. Juveniles: Characteristics of distinct offenders convicted in Childrens' Courts or dealt with at a Youth Justice Conference in 2002 (n=3709) and the bivariate relationship between offender characteristics and reconviction within two years

Offender characteristic	*N within category (%)*	*% Reconvicted**
Sex		
Male	3087 (83.2)	61.4
Female	622 (16.8)	48.9
Age (mean=16.1, median=16)		
18+	521 (14.1)	60.3
15-17	2614 (70.5)	57.6
10-14	574 (15.5)	65.9
Indigenous		
Non-indigenous	2112 (56.9)	65.2
Indigenous	972 (26.2)	78.4
Unknown	625 (16.9)	9.6
Number of concurrent offences		
None	1563 (42.1)	57.1
One	860 (23.2)	55.8
Two or more	1286 (34.7)	64.2
Number of prior conviction in past 8 years		
None	2148 (57.9)	49.8
One	609 (16.4)	63.4
Two to three	541 (14.6)	72.8
Four or more	411 (11.1)	84.9

* *All chi-square tests of association between re-offending and offender characteristics had p-values less than 0.01.*

years. Chi-square tests indicated that very young offenders were more likely to be reconvicted within two years, as were men, Indigenous offenders, offenders with two or more concurrent offences and offenders with a greater number of proven offences in the previous eight years.

FINAL LOGISTIC REGRESSION MODEL

Table 5 shows the final model predicting reconviction among offenders convicted in juvenile jurisdictions. The model shows that after controlling for all other factors included in the model:

- Women had lower odds of reconviction than men;
- Indigenous offenders had higher odds of reconviction and offenders of unknown Indigenous status had lower odds of reconviction than non-Indigenous offenders;
- The odds of reconviction decreased with age, with the 10-14 year old age group having the highest odds of reconviction;
- The odds of reconviction increased for offenders with two or more concurrent offences;
- The strongest explanatory factor was the number of convictions in the eight years preceding the offenders' index conviction. The odds of reconviction for offenders with four or more prior convictions were 3.16 times higher than offenders with no prior convictions.

Table 5. Juveniles: Final logistic regression model predicting reconviction within two years of index conviction for offenders convicted in NSW Childrens' Courts or finalised by Youth Justice Conference in 2002 (n=3,709)

Characteristic	*Category*	*Parameter estimate (standard error)*	*Odds ratio (95% confidence interval)*
Intercept		0.364 (0.121)	
Sex	Male*		1.00
	Female	-0.465 (0.102)	0.63 (0.52, 0.77)
Indigenous status	Non-indigenous*		1.00
	Indigenous	0.524 (0.094)	1.69 (1.40, 2.03)
	Unknown	-2.706 (0.145)	0.07 (0.05, 0.09)
Age	18+*		1.00
	15-17	0.050 (0.114)	1.05 (0.84, 1.31)
	10-14	0.428 (0.148)	1.53 (1.15, 2.05)
Number of concurrent offences	None*		1.00
	One	-0.054 (0.099)	0.95 (0.78, 1.15)
	Two or more	0.190 (0.089)	1.21 (1.02, 1.44)
Number of prior conviction in past 8 years	None*		1.00
	One	0.160 (0.105)	1.17 (0.96, 1.44)
	Two to three	0.464 (0.115)	1.59 (1.27, 1.99)
	Four or more	1.151 (0.154)	3.16 (2.34, 4.28)

* *Reference category*

Table 6. Juveniles: Observed and predicted rates of reconviction among the 2002, 2003 and 2004 juvenile samples, based on the estimates derived from the final 2002 logistic regression model

Year	*N*	*Observed (95% C.I.)*	*Predicted (95% C.I.)*	*Difference between observed and predicted (95% C.I.)*
2002	3709	59.3 (57.7, 60.8)	N/A	N/A
2003	3413	61.3 (59.6, 62.9)	63.3 (61.6, 64.9)	2.0 (-0.3, 4.3)
2004	3276	59.0 (57.3, 60.6)	61.9 (60.2, 63.5)	2.9 (0.5, 5.2)

MODEL ADEQUACY

The Hosmer and Lemeshow test statistic was not statistically significant (χ^2=7.50, df=8, p=0.484), which indicates that there was no significant deviation between observed and expected frequencies within each of the 10 partition groups (see Technical Appendix for further details of model adequacy).

APPLICATION OF THE MODEL

Table 6 shows the observed proportion reconvicted, the proportion predicted to be reconvicted, the difference between the observed and predicted proportions, as well as the associated 95 per cent confidence intervals for the 2002, 2003 and 2004 offender cohorts. As for adults, only the observed reconviction rate is presented for the 2002 juvenile cohort.

In both the 2003 and 2004 cohorts of juvenile offenders, the observed proportion reconvicted within two years was below the proportion predicted to re-offend based on the model. This decrease was not statistically significant for 2003, which suggests

that reconviction rates did not change between 2002 and 2003. However the decrease was statistically significant for 2004, which suggests that, after adjusting for the characteristics of offenders coming to court in 2004, the actual reconviction rates were around three per cent lower than expected.

This is an interesting result given that the observed reconviction rates in 2002 and 2004 were so similar (59.0% in 2002 and 59.3% in 2004). The 95 per cent confidence interval of the difference between these reconviction rates suggests no change in reconviction (0.3%, 95% C.I. = –2.0 to 2.6). If we had based our judgement on whether there had been a reduction in re-offending simply by comparing the actual 2002 and 2004 reconviction rates, we would have mistakenly concluded that there had been no reduction in re-offending. However, the significant difference observed after adjusting for offender characteristics suggests that there were more high-risk offenders dealt with in Childrens' Court or at a Youth Justice Conference in 2004 and this 'washed out' what appears to have been a reduction in re-offending among that cohort. In other words, changes in the demographic characteristics of the offender cohorts masked genuine reductions in re-offending over that time.

DISCUSSION

The aim of this investigation was to apply and extend techniques initially developed by the Home Office to measure changes in rates of re-offending in an Australian cohort of offenders. As with many other investigations of this nature, the strongest predictor of reconviction in both the juvenile and adult models was having a greater number of prior convictions. The odds of reconviction for an adult who had four or more prior convictions were almost five times greater than an offender with no prior convictions. Similarly, the odds of reconviction for a juvenile with four or more prior convictions were more than three times higher than a juvenile with no prior convictions. Both samples revealed that the odds of reconviction were also greater for men, Indigenous offenders, younger offenders and those with a greater number of concurrent offences at their index appearance. For the adult model, the jurisdiction in which the offender was convicted and the type of offence for which they were convicted at the index court appearance also made significant independent contributions to the predicted likelihood of reconviction.

The importance of adjusting for the characteristics of offenders was evidenced by the application of the models to later cohorts of offenders. Looking only at the observed (unadjusted) rates of reconviction between 2002 and 2004, one would be led to conclude that rates of reconviction among adult offenders were decreasing (from 33.6% in 2002 to 31.8% in 2004). However, after adjusting for changes in the characteristics of offenders coming to court in these years, there was no detectable difference in rates of reconviction beyond what would be expected by chance alone. This adjustment suggests that the apparent decreasing trend in rates of reconviction observed for adults was brought about by a decrease in the ratio of high to low risk offenders coming before the courts over this three-year period. The opposite conclusions were reached for juvenile offenders. The observed reconviction rates suggested that there had been no discernable change in reconviction over this three-year period. In 2002, 59.3 per cent of juveniles were reconvicted within two years. The proportions for 2003 and 2004 were 61.3 per cent and 59.0 per cent respectively. However, after adjusting for the characteristics of offenders coming to court in 2003 and 2004, the 2004 cohort were reconvicted at a significantly lower rate than would have been expected based on the characteristics of that cohort. Both the internal and cross-validation procedures (some of which are presented in the Technical Appendix) demonstrate that the models were able to adequately discriminate recidivist from non-recidivist offenders.

These results reflect the findings of the UK Home Office researchers. Looking only at the unadjusted rates of re-offending among adults between 2000 and 2003, for example, there did not appear to be any consistent upward or downward trend in rates of reconviction. However, after adjusting for the offender characteristics between cohorts, the researchers were drawn to conclude that there had been a meaningful drop in rates of reconviction (Shepherd & Whiting 2006). For juvenile offenders, on the other hand, what looked to be a large decrease in reconviction rates between 2000 and 2004 was observed to be much more modest after adjustment for the characteristics of the 2004 cohort (Whiting & Cuppleditch 2006). Collectively, these findings suggest that it is critical to make adjustments such as these when measuring trends in reconviction. The advantage of the approach adopted here is that confidence intervals around the observed and predicted rates of reconviction have been provided to assist readers in determining whether any differences between observed and predicted rates of reconviction are statistically significant.

One of the limitations associated with the models developed here is that they do not account for all of the characteristics of offenders coming before the courts in a given year. Significant changes in the unmeasured characteristics of offenders could produce spurious variations in observed reconviction rates within any given year. If, for example, police were to run a large-scale street-level drug law enforcement operation, there might be an increase in the number of drug-dependent offenders appearing in court in a particular year. Because drug dependent offenders tend to commit crimes at a higher rate than non-dependent offenders (Stevenson & Forsythe 1998) and because drug dependence is not overtly accounted for in the model, this cohort might have elevated observed rates of reconviction. However, it is important to bear in mind that two conditions are necessary for omitted variables to

become problematic in this analysis: (a) there would have to be little or no correlation between the omitted variable and the variables that have been included in the models and (b) the intervention would have to add or remove a significant number of offenders from the courts who possess the given characteristic in a given year. It is difficult to conceive of any offender characteristic that would satisfy both of these conditions. It is worth noting that there was a very close fit between the observed and predicted reconviction rates at different levels of the variables that were not included in the final models (area-level disadvantage for the adult model and index offence type for the juvenile model – see Technical Appendix). While we concede that omitted variables might have some additional power to discriminate recidivist from non-recidivist offenders, the overall impact would probably be relatively minor.

Two additional cautionary remarks are required in closing. The first relates to the treatment of changes in reconviction risk over time. If Government programs or any other external factors succeed in making offenders less likely to re-offend, the relative contribution that different offender characteristics make to reconviction risk may change over time. This signals the need to periodically recalibrate the models to account for the dynamic nature of reconviction propensity. Rather than treating these models as final we therefore intend to periodically re-fit the models to refine our estimates of the contribution different characteristics make to reconviction likelihood.

The final point to note is that this instrument has been designed to predict reconviction likelihood among groups of people and it is not intended to identify whether an individual is likely to re-offend within a given time period. This is an important distinction to make. In the UK, the development of the Offender Group Reconviction Scale led to quite rancorous public debate amid claims that, should such a model be used to make sentencing decisions for individual offenders, it would equate to "administering justice by formula" (Copas & Marshall 1998 p.169). The last two decades has seen a burgeoning academic debate about the relative merits of using actuarial versus clinical judgements in risk assessments to guide treatment decisions (see for example, Webster, Hucker & Bloom 2002). Beginning with a report published more than 20 years ago by the RAND Corporation (Greenwood 1982), there has been a lot of contentious criminological debate around the selective incapacitation of offenders who are deemed, through actuarial means, to be at high risk of re-offending. The models developed in this paper use a probabilistic methodology to estimate whether an offender will be reconvicted within 24 months. It is inevitable that there will be false positives, where offenders who are predicted to re-offend do not go on to re-offend. This might be acceptable if the model were used to triage an individual into a more in-depth risk assessment or into treatment programs designed to reduce their likelihood of re-offending. However there are both ethical and moral objections to be taken into account when making sentencing decisions that could significantly disadvantage an individual based only on the probability of reconviction derived from the models reported herein.

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NOTES

1. ROD uses a probability matching technique based on the offenders' name, date of birth and a unique criminal identifier known as a CNI to identify all criminal court appearances by the same person since 1994 (see Hua & Fitzgerald 2006 for more information).

2. Youth Justice Conferences were introduced under the Young Offenders Act 1997 as an alternative to formal court proceedings. Each Conference is facilitated by a trained convenor and involves the young offender meeting with the victim, their family and other supporters to discuss the impact of their offending on the victim and to negotiate a means by which to pay restitution to the victim or the community (Daly & Hayes 2001).

3. As a result of defining adults and juveniles by the jurisdiction in which they were dealt with, some offenders in the juvenile sample were aged 18 years or older at the time of finalisation and some offenders in the adult sample were aged less than 18 at the time of finalisation. This is because some juveniles can be dealt with in adult courts (e.g. for driving offences) and some adults can be dealt with in juvenile jurisdictions if they were juveniles when they committed the offence. The authors felt that it made more sense to define adults and juveniles according to court jurisdiction in this context because, for the most part, it is the agencies responsible for the respective jurisdictions who are also responsible for programs designed to reduce rates of offending.

4. All minor regulatory offences (such as parking infringements) were excluded from the list of possible index offences.

5. People sentenced to periodic detention (n=1009) and home detention orders (n=155) were included in the analyses. While some of these offenders may have breached their orders and been sentenced to full-time custodial sentences during the follow-up, the likely impact on overall reconviction rates was thought to be relatively minor.

6. This more inclusive definition of Indigenous status was employed because there is a high degree of undercounting of Indigenous status on individual court records. This is because information bearing on Indigenous status is collected by the NSW Police Force when legal proceedings are commenced against alleged offenders and this information is then linked to the defendant's court record. Some people do not have information on Indigenous status if, for example, they were not proceeded against in person or if they were proceeded against for a traffic offence.

7. This lower odds of reconviction makes sense given that Indigenous status is less likely to be known for offenders who are not proceeded against in person or who do not need to appear in court to have their matter heard. These offenders tend to have fewer prior offences than people whose Indigenous status is known.

TECHNICAL APPENDIX

Several other means of assessing the adequacy of the models were employed in addition to the Hosmer-Lemeshow test statistic. Firstly, the authors examined ROC curves, which plot the proportion of true positives (those predicted to re-offend who are observed to re-offend) against false positives (those predicted to re-offend who do not actually re-offend) at any given cut-off point for re-offending. The area under the curve (AUC) was calculated to determine how well the model discriminated recidivist from non-recidivist offenders. Put simply, the AUC can be interpreted as the likelihood that an offender who has a subsequent conviction will have a higher predicted probability of re-offending than a person who does not go on to have a further conviction (Hosmer & Lemeshow 2000, p.162). This statistic takes a value between 0.5 and 1.0 where, as a rule of thumb, Hosmer and Lemeshow (2000) suggest that scores greater than or equal to 0.9 provide 'outstanding' discrimination, scores between 0.8 and 0.9 provide 'excellent' discrimination, scores

between 0.7 and 0.8 provide 'acceptable' discrimination and models yielding AUC scores equal to 0.5 predict the outcome at no better than chance.

While the AUC derived from the full model provides a useful indication of the internal validity of the model, it is limited by the fact that it tests the model against the same data used to develop the model. Three cross-validation methods were employed to test how well the models performed against offenders upon whom the model was not developed. The first method was to use the 'leave-one-out' cross-validation approach (SAS Institute Inc. 2004). This method involved estimating the coefficients using all data points except for one and then estimating the probability that the 'dropped' offender would re-offend based on these coefficients. This was repeated across the entire sample by dropping one observation at a time and re-estimating the coefficients. The predicted probabilities of reconviction over all iterations were then aggregated using a one-step approximation and the AUC was again calculated to determine how well the model discriminated recidivist from non-recidivist offenders.

The second cross-validation method was to randomly divide the original dataset into two separate 50 per cent samples: a 'training' sample and a 'holdout' sample. The model fitted to the training sample was used to derive predicted probabilities of reconviction for each person in the holdout sample. AUC statistics were then calculated for both the training and holdout samples to (a) ensure that the training sample behaved comparably to the full sample model and (b) to see how well the parameter estimates derived from the training sample predicted reconviction among the holdout sample.

The final cross-validation method was to assess how accurately the model performed in predicting re-offending among subgroups of offenders, particularly those that are comparatively small. This is important because the model could perform very well overall but under- or over-predict reconviction within some subgroups of offenders. To test this aspect of model adequacy, the predicted and observed probabilities of reconviction were examined within subgroups of both the training and holdout samples. The subgroups examined among the adult sample were age and SEIFA disadvantage score. For juveniles, subgroups of age and index offence were examined.

MODEL ADEQUACY FOR ADULTS

Table A1 shows the AUC statistics and the corresponding 95 per cent confidence intervals derived from the full sample model, the 'leave-one-out' cross-validation procedure, the 50 per cent training sample and the 50 per cent holdout sample. In each case, the AUC was between 0.73 and 0.74. The fact that the AUC was stable across both the internal

Table A1. Adults: Area under the curve (AUC) statistics and 95% confidence intervals for the four methods of obtaining predicted probabilities among the adult sample (n=62,978)

	N	*AUC (95% CI)*
Internal validation process		
Full sample of 2002 data	62978	0.736 (0.732, 0.740)
External validation processes		
Full sample of 2002 data, leave-one out	62978	0.734 (0.730, 0.738)
50% training sample of 2002 data	31490	0.736 (0.731, 0.742)
50% holdout sample of 2002 data	31488	0.736 (0.730, 0.742)

Table A2. Adults: Observed rates of reconviction for selected subgroups of the training and holdout samples, compared with predicted rates of reconviction derived from the adult training sample

	Training sample			*Holdout sample*		
		Observed	*Predicted*		*Observed*	*Predicted*
	N	*%*	*%*	*N*	*%*	*%*
Total	31490	33.5	33.5	31488	33.7	33.7
Age subgroup						
13-21	6139	40.3	40.3	5896	40.8	40.0
22-24	3921	36.7	35.4	3920	37.4	35.8
25-29	5648	34.8	35.7	5752	34.8	36.3
30-34	4805	36.3	35.2	5012	35.8	35.9
35-39	3899	32.6	33.9	3955	33.3	33.7
40-44	2994	28.9	26.3	2918	27.4	25.8
45-49	1854	23.5	23.8	1750	24.9	24.0
50-54	1063	19.0	21.3	1153	17.6	21.2
55+	1167	13.8	18.0	1132	17.0	18.6
Disadvantage group						
0 - 25% percentile	9193	37.7	35.8	9129	38.9	36.1
25% - 50% percentile	9078	35.3	35.7	9137	35.6	35.8
50% - 75% percentile	6399	33.7	32.7	6364	33.4	33.0
75% - 100% percentile	5298	27.3	28.7	5309	25.7	28.6

and cross-validation procedures suggests that the model performs well on both the data from which the model was derived and on external samples of offenders. The absolute value of the AUC indicates that the model discriminated recidivist from non-recidivist offenders at an acceptable level (Hosmer & Lemeshow 2000).

Table A2 shows that the predicted and observed proportion of recidivist offenders was very similar for both the age and disadvantage subgroups. The only large discrepancy was between the observed and predicted proportions for the 55 and older age category in the training sample and the 50-54 age category in the holdout sample. Other than these divergences, the close concordance between the predicted and observed reconviction rates suggests that the model performs well among subgroups of offenders from both the training and holdout samples.

MODEL ADEQUACY FOR JUVENILES

The AUC statistic and corresponding 95 per cent confidence intervals derived from the four validation procedures are shown in Table A3. The AUC statistics ranged between 0.74 and 0.76 for each of these methods, which indicates that the model performed well both internally and externally and that the model provided an acceptable level of discrimination.

Table A4 shows that the predicted and observed proportions of recidivist offenders were very similar for most of the subgroups. There was some discrepancy between the observed and predicted proportions of re-offenders among the 10-13 and 18+ age groups (from the holdout sample), for offenders whose principal offence was for drugs (among the training sample) and for offenders who index offence was for driving (among the training sample). Some variation was expected for the juvenile sample because the number of offenders within some of the subgroups was very small. Overall, however, the concordance between the predicted and observed reconviction rates was surprisingly accurate, which suggests that the model performs well among subgroups of both the training and holdout samples.

Table A3. Juveniles: Area under the curve (AUC) statistics and 95% confidence intervals for the four methods of obtaining predicted probabilities among the juvenile sample (n=3,709)

	N	*AUC (95% CI)*
Internal validation process		
Full sample of 2002 data	3709	0.758 (0.743, 0.774)
External validation processes		
Full sample of 2002 data, leave-one out	3709	0.744 (0.728, 0.761)
50% training sample of 2002 data	1855	0.757 (0.734, 0.779)
50% holdout sample of 2002 data	1854	0.758 (0.735, 0.780)

Table A4. Juveniles: Observed rates of reconviction for selected subgroups of the juvenile training and holdout samples, compared with predicted rates of reconviction derived from the juvenile training sample

	Training sample			*Holdout sample*		
		Observed	*Predicted*		*Observed*	*Predicted*
	N	*%*	*%*	*N*	*%*	*%*
Total	1855	60.1	60.1	1854	58.4	58.9
Age						
10-13	109	74.3	69.6	111	68.5	68.9
14	161	62.1	65.3	193	62.7	60.1
15	300	56.7	58.0	295	56.6	57.4
16	422	58.3	58.2	448	56.7	57.2
17	595	59.0	58.4	554	57.4	56.4
18+	268	62.3	62.3	253	58.1	63.6
Index offence type						
Violent/sexual	394	57.6	56.6	392	55.1	58.3
Robbery	163	49.7	49.7	158	43.7	45.8
Theft	667	66.0	65.7	660	63.5	64.8
Drug	85	52.9	57.4	83	51.8	54.7
Driving	120	45.0	53.3	126	44.4	44.6
Other/breach	426	62.9	61.0	435	64.4	60.2

NSW Bureau of Crime Statistics and Research - Level 8, St James Centre, 111 Elizabeth Street, Sydney 2000
bcsr@agd.nsw.gov.au • www.bocsar.nsw.gov.au • Ph: (02) 9231 9190 • Fax: (02) 9231 9187
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