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The NSW Prison Population Simulation Model: A policy analysis tool

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Aim: *To describe a simulation model of the NSW prison system and demonstrate its utility as a tool for examining the effects of changes to the criminal justice system that influence the number of prisoners in custody*

Method: *The model consists of four states (bail, remand, custody and parole) and a set of parameters governing flows into and out of those states as well as lengths of stay in each state. Data for the model were sourced from police, court and correctional databases.*

Results: *The prison system is extremely sensitive to changes in the percentage of persons refused bail. A one percentage point change in the percentage of persons refused bail by a court increases the remand population by 7.66 per cent, the sentenced prisoner population by 6.03 per cent and the parole population by 6.15 per cent.*

Conclusion: *It is feasible to build a simple model of the prison system which is easy to maintain but nonetheless useful in analysing the likely consequences of changes in arrest, bail and sentencing policy.*

Keywords: *Simulation model, prison, parole, bail, policy, criminal justice system.*

INTRODUCTION

During the 1970s, recognition of the need for early warning of court and prison congestion stimulated interest in building computer simulation models of the criminal justice system (Nagel, 1977). The simulation models which have been developed are all designed to mimic the flow of cases through various stages of the criminal justice system (e.g. arrest, remand, trial, imprisonment). They do this, essentially, by making assumptions about the proportions of cases which currently pass through various stages of the criminal justice system during particular time periods. Policy simulations are carried out by changing these assumptions and parameters, then examining how this affects the flow of cases through the simulated justice system. A change to bail policy, for example, can be explored by changing the proportion of people granted bail in the model and comparing (say) the effects on people in custody before and after the change.

Early attempts at simulation model building were designed to represent the operation of the justice system in very considerable detail. In its original formulation, for example, the JUSSIM model, developed by the United States Justice Department, simulated the effect of police resources on the flow of individuals into the courts, distinguished by crime type, age and sex, through the courts, the flow of individuals from the courts to prison and the flow of recidivists released from prison back into the courts (Chaiken et al., 1977). A similar approach was adopted by the Home Office in Britain (Morgan, 1985). Some model builders have sought to achieve even more exacting goals. The DOTSIM model, for example, was designed to simulate the flow of individual cases (rather than groups of cases) though the justice system (Chaiken et al., 1977).

In general, the more detailed a model's representation of the justice system, the greater the range of policy simulations it can be used to conduct. A model which describes the relationship between police resources and arrest rates, for example, can be used to simulate the effect of changes to police resources on arrest rates. One where the user simply uses arrest rates as the input to the justice system cannot. A model which tracks individual cases through the justice system can be used to examine the effect of policy changes on court waiting times whereas one which simply tracks the flow of groups of cases cannot. A model which attaches costs to each stage of processing can be used to calculate the cost of changes to policies affecting the flow of individuals through the justice system whereas one which simply models those flows without costing them cannot.

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Unfortunately, the increase in functionality which comes from making simulation models more complex comes at a price. The wider the range of policy questions a model is expected to answer, the more parameters that must be estimated in order to run the model. This makes model maintenance more difficult, more time consuming and more expensive. The magnitude of these problems became apparent during the Bureau of Crime Statistics and Research's (BOCSAR) first attempt to develop a simulation model of the NSW criminal justice system during the early 1990s. The model simulated the passage of individual cases through the criminal justice system by assigning probabilities to the likelihood of a given case passing from one processing stage to another within the system. Random numbers were used to determine the actual number of cases passing from stage to stage in a particular time period. Individual cases were distinguished according to their offence type and plea and whether the defendant was remanded in custody. The outcomes of court processing were also modelled in considerable detail (e.g. whether adjourned, whether convicted, penalty type and amount). The model was very powerful — it could identify the effect of an increase in arrest rates, for any one of a large number of different offences, on average court delay or the likelihood of the prison population exceeding a certain level. Unfortunately the number of parameters required just for the Local Court module of the model exceeded five hundred. The data required to estimate many of these parameters could only be obtained through expensive and time consuming research studies. Over time it became clear that the work required in servicing such a model was simply not worth the return on investment.

A more prudent and more practical approach is to model components of the criminal justice system that are of particular concern and only at a level of detail sufficient to answer basic questions about their operation. For our purposes one of the most important components of the criminal justice system is the prison system. In contrast to the courts, which have some degree of elasticity in their capacity to respond to surges in demand, the capacity of the prison system to respond to changes in demand for prison beds is over the short term very limited. A surge in demand for prison accommodation resulting from a change to (for example) police, sentencing or bail policy can easily outstrip current prison capacity. Recent experience in NSW underscores this point. In the two years between December 2013 and December 2015, the NSW prison population rose by 19 per cent (an additional 1,943 prisoners). The growth was not (for the most part) a consequence of rising crime. In fact most major categories of crime in NSW have been stable or falling for the last 15 years. The growth in imprisonment rates was mainly due to a combination of more effective policing (resulting in higher arrest rates for serious offences), longer periods on remand (due to delays in the District Criminal Court) and an increase in the percentage of convicted offenders given a prison sentence by the courts (Weatherburn et al., 2016).

In this report we present a model developed by BOCSAR designed to mimic the flow of people into and through the correctional system. This model has been implemented in two ways; a probabilistic activity based model and a deterministic equation based model. We follow Livingston, Stewart and Palk (2006) in trying to find the optimal trade-off between model power and model simplicity. The model is the first stage of a larger project to model the flow of people through the criminal justice system as a whole. We begin by describing the model, the data required to build it and the sources from which the required data were obtained. Results from validation testing and sensitivity are then presented. In the section that follows we present the results of some sample simulations that illustrate the sensitivity of the correctional system to changes in the factors that affect it. In the final section we discuss likely future developments.

METHOD

THE STRUCTURE OF THE MODEL

The model is structured around its critical function, which is to output the number of people on remand, on bail, who are sentenced or who are on parole at any time, given a set of input parameters. The model has a single entry point, which represents a court decision to grant bail, refuse bail or sentence an individual. Inside the model an individual's legal status is represented by one of four states; remand (bail refused), bail (bail granted), convicted (convicted with custodial penalty) or on Parole. Input parameters govern the likelihood of transitioning from one status to another and the length of time that is spent in each status. These parameters represent things like the likelihood of having bail refused and the length of sentence which are discussed in more detail below. Individuals can exit the model from any of the four states.

In this section we describe in detail the structure of the model. Figure 1 below shows the structure of the prison model. The probabilities that govern the transitions between these states are labelled $p_{a\text{-}j}$. We begin by describing these probabilities and then turn our attention to the parameters that determine how long an individual stays in any given state.

Alleged offenders (defendants) enter the court system at a rate per simulated day, I. Each individual arriving in court may be refused bail (with probability p_a) and enter the remand population, granted bail (with probability p_b) and enter the bail population or have the case against them dismissed or get a non-custodial penalty (with probability $1 - (p_a + p_b)$ and exit the system. There are three ways out of remand. A defendant initially refused bail may subsequently be granted bail (with probability p_d) and enter the bail population. Alternatively, a defendant on remand may become a sentenced prisoner (with probability p_e) and move to the sentenced prisoner population. The third possibility is that a defendant is acquitted and leaves remand for release and exits the system. The probability of this occurring is given by $1 – (p_d + p_e + p_j)$. The parameter p_j (associated with the dotted line between remand and parole) is designed to account for the fact that a small number of individuals breach parole, are caught, re-enter the court system, are remanded in custody until their case is heard and are then returned to parole.

There are three ways out of bail. An individual on bail may have their bail revoked and move to remand (with probability p_c). Alternatively, they may be convicted and become a sentenced prisoner (with probability p_f). Finally they may be acquitted and leave the system. This last event happens with probability $1 – (p_c + p_f)$.

There are likewise three ways to exit the sentenced prisoner population. A sentenced prisoner may be released to parole (with probability p_g) and enter the parole population. Alternatively, they may be returned to remand (with probability p_i). This happens when a sentence is appealed or when a short sentence has been served but the defendant is placed on remand pending the finalisation of a more serious charge or charges. Finally they may be directly released (with probability $1 – (p_g + p_i)$).

There are two ways out of parole. A prisoner on parole may be returned to the sentenced prisoner population because they've breached one of the conditions of their parole order. This happens with probability p_h. Alternatively; they may complete their parole period and be released from parole (with probability $1 – p_h$). Note that if they are charged with a new offence, the model treats them as a new alleged offender.

The length of time each individual spends in each state is governed by the input parameters. These input parameters differ between the two implementations. The activity-based model randomly selects delay from a distribution of lengths of stay in each state (in baseline simulations these distributions are made up of actual lengths of stay). The equation-based model on the other hand uses an average length of stay in each state.

DATA SOURCES AND PARAMETER ESTIMATION

We now turn our attention to the sources of data and methods used to estimate the parameters. The section that follows explains the model validation process.

Three data sources were used to estimate the models parameters,

- Computerised Operational Policing System (COPS)
- JusticeLink (Courts)
- Custody (Corrective Services New South Wales [CSNSW])

Data required for the model was extracted for two years between 2013 and 2014.

Table 1 describes the parameter, the data source(s) involved in its estimation and the operational definition of the parameter.

Rather than estimating model parameters by following a cohort of offenders from entry until exit from the criminal justice system, parameters were estimated by examining various groups as they moved from state to state over the particular period of interest. The parameters can be divided into two groups, according to the source(s) of data used in their estimation. Each group is described below.

Figure 1. Model of the NSW Prison System

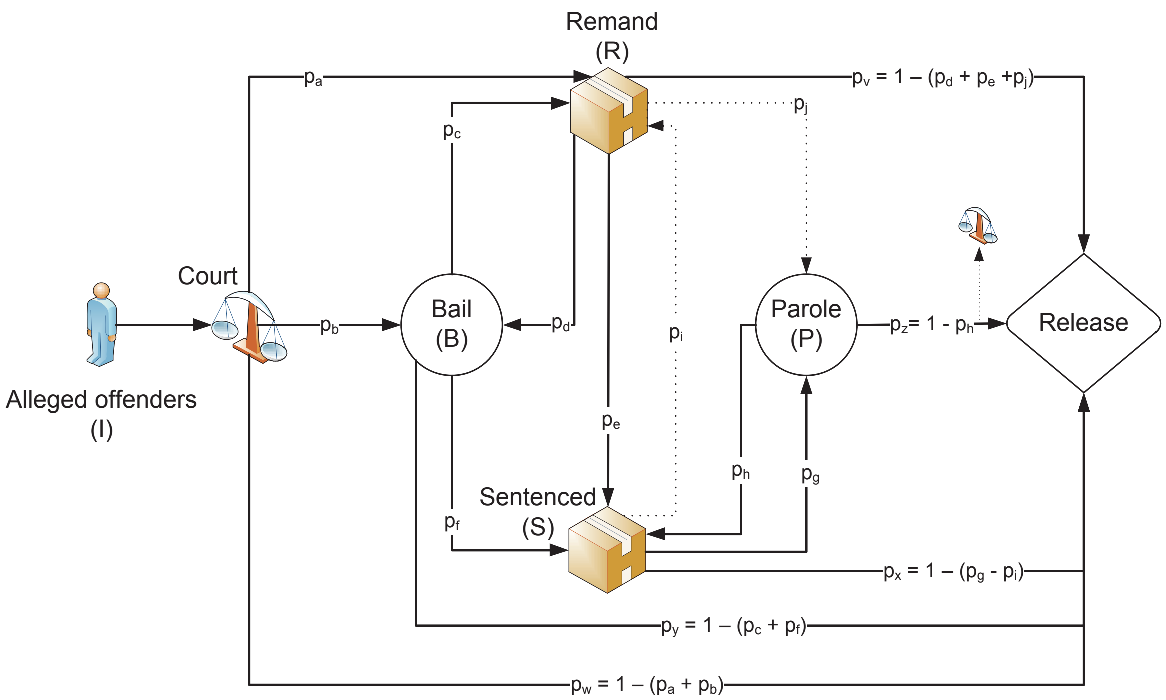


Table 1. Model parameters: data sources and definitions

Description	Para	System	Definition
Court Arrivals (per Day)	I	COPS/ JusticeLink	Number of people with court proceedings finalised on a given day
% Court to Remand	p_a	COPS/ JusticeLink	The percentage of people with court proceedings finalised on a given day who were refused bail at their first court appearance
% Court to Bail	p_b	COPS/ JusticeLink	The percentage of people with court proceedings finalised on a given day who were granted bail at their first court appearance
% Bail to Remand	p_c	COPS/ JusticeLink	The percentage of people with court proceedings finalised on a given day who were granted bail but subsequently refused bail
% Remand to Bail	p_d	Custody	The percentage of people are granted bail when on remand
% Remand to Sentenced	p_e	Custody	The percentage of people who received a custodial penalty while on remand
% Bail to Sentenced	p_f	Custody	The percentage of people who received a custodial penalty while on bail
% Sentenced to Parole	p_g	Custody	The percentage of people who were released on parole when discharged from sentenced custody
% Parole to Sentenced	p_h	Custody	The percentage of people who breached parole conditions and were returned to sentenced custody
% Sentenced to Remand	p_i	Custody	The percentage of people who were sentenced prisoners and were returned to the remand population.
% Remand to Parole	p_j	Custody	The percentage of people who are on remand who are released but are still serving an existing parole period
% Remand to release	p_v	Custody	The percentage of people who are on remand and acquitted of all charges or who do not receive a custodial penalty (nb. Pv = 1 – (Pd + Pe + Pj))
% Court to release	p_w	COPS/JusticeLink	The percentage of people leaving court acquitted of all charges or who do not receive a custodial penalty
% Sentence to release	p_x	Custody	The percentage of sentenced prisoners who are released without any parole period (nb. Px = 1 – (Pg + Pi))
% Bail to release	p_y	Custody/COPS/ JusticeLink	The percentage of people granted bail who are acquitted of all charges or who do not receive a custodial penalty (nb. Py = 1 – (Pc + Pf))
% Parole to release	p_z	Custody	The percentage of parolees who complete their parole order or re-enter custody for a new offence. (nb. Pz = 1 – Ph)
Distribution Remand	R	Custody	The length of time (in days) measured from custody admission date to either release or conviction date
Distribution Bail	B	COPS/ JusticeLink	The length of time (in days) measured from the day bail is granted until it ceases
Distribution Sentenced	S	Custody	The length of time (in days) from conviction day to discharge day
Distribution Parole	P	Custody	The length of time (in days) from discharge day to the end of parole supervision or day of new admission to custody

MODEL PARAMETERS ESTIMATED FROM COPS AND JUSTICELINK

The daily number of persons whose cases are finalised (i.e. I) can be obtained from BOCSAR's court database. Information relevant to p_a can be obtained from COPS; however COPS records are counts of incidents in which an individual was proceeded against to court, not counts of unique individuals proceeded against. The same person may be proceeded against on two separate occasions in a short period of time. It would be a mistake to treat the bail decisions in each case as belonging to different individuals. In order to estimate p_a and p_b, therefore, it was necessary to merge COPS data on persons proceeded against to court with JusticeLink data on court finalisations. This combined dataset was then used to estimate p_a, p_b, p_c and p_w. Bail durations were also extracted from this dataset to determine the distribution of time spent on bail (i.e. B).

MODEL PARAMETERS ESTIMATED FROM CUSTODY DATA

The parameters p_d, p_e, p_g, p_h, p_i, p_j, p_v, p_x and p_z all involve flows either out of custody or from one form of custody (remand) to another (sentenced prisoner). The data required to estimate these parameters were obtained from two datasets provided by CSNSW. The first consisted of data on prisoners discharged from custody. The second consisted of data on prisoners who changed their status from being remanded to being sentenced or vice versa. The dates for status changes were used to derive the number of movements between sentenced and remand (p_e and p_i). The lengths of time one spent in either of those states (i.e. R, P and S) were also be derived from this data.

The parameter p_h, which determines the number of offenders returning to sentenced custody as a result of breaching one or more conditions of parole (parolees committing new criminal offences are treated as new arrivals in court) was obtained by cross-checking the dates on which sentenced prisoners entering custody with the dates on which offenders were on parole. Similarly, the flow from parole to release (governed by p_z) was determined by cross-checking the dates on which parole orders expired with the dates on which sentenced prisoners were accepted into custody.

IMPLEMENTATION OF THE MODEL

As noted earlier, in designing the model, we sought to balance model complexity and model power. This was achieved by avoiding any attempt to include modules dealing with courts, reoffending and community-based orders. This model in its current form is run from standardised datasets and is therefore easy to refresh and maintain. The decision to include two different implementations of the model was also made with a view to improving ease of use.

ACTIVITY-BASED SIMULATION

The activity-based simulation allows individuals to pass from one state to another with a certain probability. Repeated runs of the model are necessary to determine the average number of people in various states of the system. This is time consuming but allows the user to determine the likelihood that any given number of people will be in any one of the states of the model at any particular point in time. It also allows the user to determine how long it will take after one of the model parameters is changed for the full effects of that change to pass through the system. Its probabilistic nature allows confidence intervals to be calculated for results. This type of simulation also caters for complex policy scenarios where multiple parameter changes are made at different points in time. The activity-based model depicts the outcome events in the court and prison system on a daily basis. On each simulated day three things happen;

New Arrivals: A number (I) of new arrivals enter the system. This number represents the number of court finalisations per day.

Daily Movement: All people in the model who are scheduled to move to a new state on this particular day (this will always include all new arrivals) are all assigned a new state based on their current state and the *p*-values relevant to that state. It is important to note that the *p*-value determines which location the person will move to, not the likelihood of them moving as this was already established when they were assigned a length of stay on arrival. It is also important to understand that the parameters p_a through to p_j are probabilities, not proportions. The path a defendant takes through Figure 1 will vary between simulations. That is why multiple simulations must therefore be conducted to obtain estimates of the mean effects of changes in any of the parameters

Length of Stay: Once arriving at the new location, each person is assigned a length of stay. The length of time each individual spends in each state is determined by a random draw from the empirical distributions associated with that state. These empirical distributions of lengths of stay are drawn from actual data (see Appendix 1). These are denoted using B, R, S and P for the empirical distributions of the length of stay in the bail, remand, sentenced prisoner and parole populations respectively.

Both populations in each state and movements along each path are recorded daily and become model outputs to assist in understanding the change in population size over time.

EQUATION-BASED SIMULATION

The equation-based model uses the system of equations shown below. The constants on the right hand side of the equation simply represent the arrivals from court to remand and court to bail. The r_a to r_j variables represent the flow of people on a

$$
\begin{bmatrix}
100\% & 0\% & 0\% & 0\% & 0\% & 0\% & 0\% & 0\% & 0\% & 0\% \\
0\% & 100\% & 0\% & 0\% & 0\% & 0\% & 0\% & 0\% & 0\% & 0\% \\
0\% & -p_c & 100\% & -12\% & 0\% & 0\% & 0\% & 0\% & 0\% & 0\% \\
-p_d & 0\% & -p_d & 100\% & 0\% & 0\% & 0\% & 0\% & -p_d & 0\% \\
-p_e & 0\% & -p_e & 0\% & 100\% & 0\% & 0\% & 0\% & -p_e & 0\% \\
0\% & -p_f & 0\% & -p_f & 0\% & 100\% & 0\% & 0\% & 0\% & 0\% \\
0\% & 0\% & 0\% & 0\% & -p_g & -p_g & 100\% & -p_g & 0\% & 0\% \\
0\% & 0\% & 0\% & 0\% & 0\% & 0\% & -p_h & 100\% & 0\% & -p_h \\
0\% & 0\% & 0\% & 0\% & -p_i & -p_i & 0\% & -p_i & 100\% & 0\% \\
-p_j & 0\% & -p_j & 0\% & 0\% & 0\% & 0\% & 0\% & -p_j & 100\%
\end{bmatrix}
\times
\begin{bmatrix} r_a \\ r_b \\ r_c \\ r_d \\ r_e \\ r_f \\ r_g \\ r_h \\ r_i \\ r_j \end{bmatrix}
=
\begin{bmatrix} I \times p_a \\ I \times p_b \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}
$$

particular path where the subscript letter corresponds to the subscript letter on the *p*-value for that path (e.g. the probability of going from court to remand is p_a; the number of people who go from court to remand is r_a).

Substituting the particular simulation *p*-values in the above allows us to solve the equations for r_a to r_j giving us the number of people travelling on each path during the time period. Using Littles Law (Little, 1961) we multiply the average daily arrival rate for a particular location by the average length of stay in that location to give us the population at equilibrium.

Because one run of the model is sufficient to provide estimates of changes in stocks, the equation-based simulation can be run with a simple spread-sheet interface and it provides much faster results. Although it gives accurate estimates of steady state populations, it is limited in the information it can provide about system dynamics prior to the point where equilibrium has been reached (i.e. where the stocks in bail, sentenced custody, remand and parole are stable). Also, because the model ignores the variability in flows through the criminal justice system it is incapable of providing confidence intervals around its predictions.

MODEL VALIDATION AND SENSITIVITY TESTING

The model was validated by running it with the estimated parameter values and comparing the stock and flow predictions against actual stock and flow data. Tables 2 and 3 show the validation results for 2 sets of parameters calculated between 2013 and 2014. Table 2 allows us to compare actual stock figures to those modelled in both implementations of the model (i.e. activity-based and equation-based). The modelled values in this table represent populations at equilibrium and thus are only ever an approximation of actual populations, which are in a constant state of change.

Table 2 shows us that modelled populations are similar actual populations in 2013 and 2014. This amount of variation is acceptable as an approximation of the prison system. Table 3, below, compares actual flows to modelled ones. The purpose of this comparison is to check that flows into a state are in the

Table 2. Predicted versus Actual Stocks

Year	Stock	Activity Based Model	Lower 95% C.I.	Upper 95% C.I.	Equation Based Model	Actual Populations	% Difference
2013	Remand	2569	2536	2603	2572	2588	-0.6%
2013	Bail	11110	10982	11238	11062	N/A	
2013	Sentenced	7063	7032	7095	7042	6884	2.2%
2013	Parole	4332	4309	4354	4328	4174	3.6%
2014	Remand	2608	2573	2642	2611	2847	-9.1%
2014	Bail	10926	10791	11061	10939	N/A	
2014	Sentenced	7135	7099	7171	7139	7125	0.2%
2014	Parole	4490	4464	4517	4537	4232	6.7%

Table 3. Predicted versus Actual Flows

Year	Flow	Activity Based Model	Lower 95% C.I.	Upper 95% C.I.	Equation Based Model	Actual Flows	% Difference
2013	Yearly flow Court to Remand	8639	8592	8686	8661	8661	0%
2013	Yearly flow Court to Bail	23406	23312	23501	23522	23522	0%
2013	Yearly flow Bail to Remand	3190	3161	3219	3215	3062	5%
2013	Yearly flow Remand to Bail	4021	3990	4052	4040	3671	9%
2013	Yearly flow Remand to Sentenced	6483	6454	6511	6503	6123	6%
2013	Yearly flow Bail to Sentenced	1785	1770	1801	1806	1720	5%
2013	Yearly flow Sentenced to Parole	5388	5363	5413	5395	4882	10%
2013	Yearly flow Parole to Sentenced	668	656	680	668	602	10%
2013	Yearly flow Sentenced to Remand	1010	996	1024	1014	918	10%
2013	Yearly flow Remand to Parole	444	438	450	449	423	6%
2014	Yearly flow Court to Remand	8529	8489	8570	8565	8565	0%
2014	Yearly flow Court to Bail	23338	23248	23428	23438	23438	0%
2014	Yearly flow Bail to Remand	3303	3275	3331	3308	3167	4%
2014	Yearly flow Remand to Bail	3726	3700	3752	3725	3368	10%
2014	Yearly flow Remand to Sentenced	6766	6730	6802	6812	6361	7%
2014	Yearly flow Bail to Sentenced	1787	1769	1806	1793	1717	4%
2014	Yearly flow Sentenced to Parole	5758	5728	5788	5804	5253	9%
2014	Yearly flow Parole to Sentenced	774	763	786	779	704	10%
2014	Yearly flow Sentenced to Remand	1026	1014	1037	1036	938	9%
2014	Yearly flow Remand to Parole	405	399	411	411	384	7%

correct proportion. It is possible that the net flow is correct but too few are coming from one state and too many from another. While this would not have an adverse effect on population sizes it would either under or overstate the impact of changes to the *p*-values governing the likelihood of transitioning between states.

All the predicted flows are within 10% of the actual flows and, in many cases, well below this. Based on this we can see that flows between the states are in approximately the correct proportion meaning changes to *p*-values will not be over or understated when simulating policy change.

SENSITIVITY

One of the key benefits associated with a simulation model of the prison system is that it can be used to assess how sensitive the

Table 4. Parameter Sensitivity

Parameters		Remand	Bail	Sentenced	Parole
% Court to Remand	p_a	7.66%	1.04%	6.03%	6.15%
% Court to Bail	p_b	0.90%	3.21%	1.47%	1.43%
% Bail to Remand	p_c	2.49%	0.34%	1.96%	1.99%
% Remand to Bail	p_d	0.13%	0.47%	0.21%	0.21%
% Remand to Sentenced	p_e	0.13%	0.02%	1.59%	1.48%
% Bail to Sentenced	p_f	0.30%	0.04%	3.55%	3.31%
% Sentenced to Parole	p_g	0.01%	0.00%	0.13%	1.66%
% Parole to Sentenced	p_h	0.06%	0.01%	0.75%	0.70%

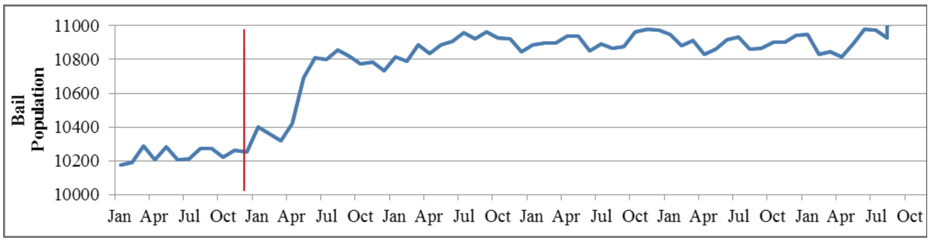
Table 5. Effect of a seven per cent increase in court appearances

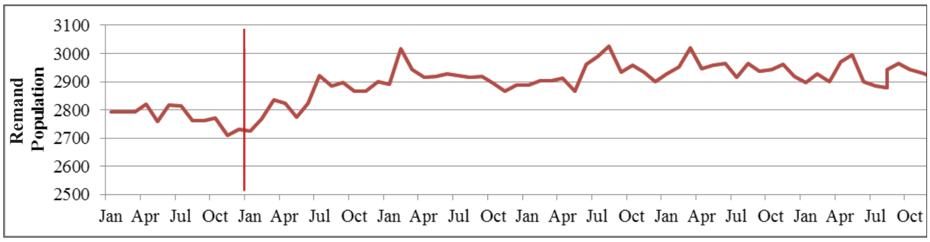
Scenario Description: It is believed that a new policing policy will increase the number of court arrivals by 7%. We are interested in understanding the impact and timing of impact to the adult male prison population.

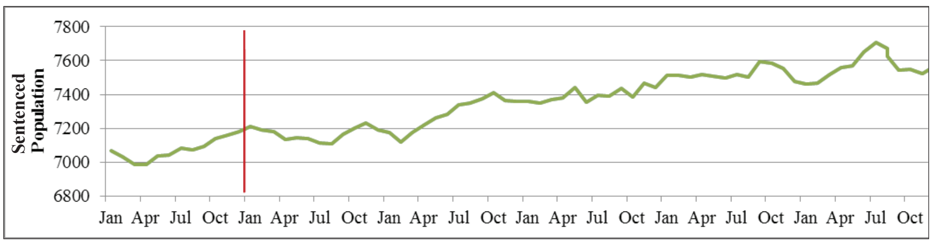
Select Baseline: Baseline parameters set off most recent complete dataset for adult males

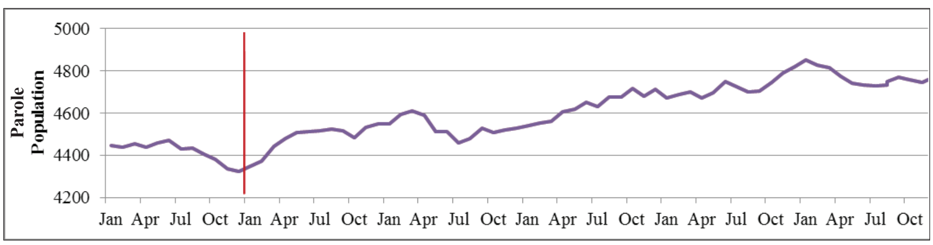
Change Appropriate Parameters: For this scenario we will increase the number of defendants entering the system each day (I) by 7%

Stock	Δ
Bail	7%
Remand	7%
Sentenced	7%
Parole	7%
Flow	**Δ**
Court to Remand	7%
Court to Bail	7%
Bail to Remand	7%
Remand to Bail	7%
Remand to Sentenced	7%
Bail to Sentenced	7%
Sentenced to Parole	7%
Parole to Sentenced	7%
Sentenced to Remand	7%
Remand to Parole	7%









system is to changes in the parameters that affect it. Table 4 shows the effect on the remand, bail, sentenced prisoner and parole populations of a one percentage point change in each of the parameters affecting flows through the model, when holding the other parameters at default/baseline levels. For the purpose of this exercise we have assumed that changing one parameter has no effect on the values of other parameters.

It is obvious from Table 4 that changes in p_a exert large effects on the remand, sentenced prisoner and parole populations.

SAMPLE SIMULATIONS

In this section, we give three examples of changes to the justice system that can be examined using the simulation model – an increase in the number of court arrivals, a reduction in bail revocations and the removal of prison sentences less than 6 months duration. These sample simulations use a combination of the 2 implementations described above. Both implementations provide equivalent figures for populations at steady state. When the probabilistic model is run multiple times the average size of the population between runs approaches that of the equation based model as the number of runs increases, thus the equation based model has been used to calculate the steady state populations and overall change in population while the activity based probabilistic model has been used to show the rate at which that change occurs.

There are three steps involved in running these simulations.

1. Establish the baseline: this involves selecting an appropriate time period to run the baseline on, setting the values of the model parameters to those applicable to that time period and running the model until the stocks have stabilised.
2. Changing the appropriate parameters: this will involve translating the proposed policy or scenario into changes to the model parameters.
3. Comparing the results of the baseline to the scenario: these differences give us an understanding of what we would expect to happen if the criminal justice system remained constant and only these parameters changed.

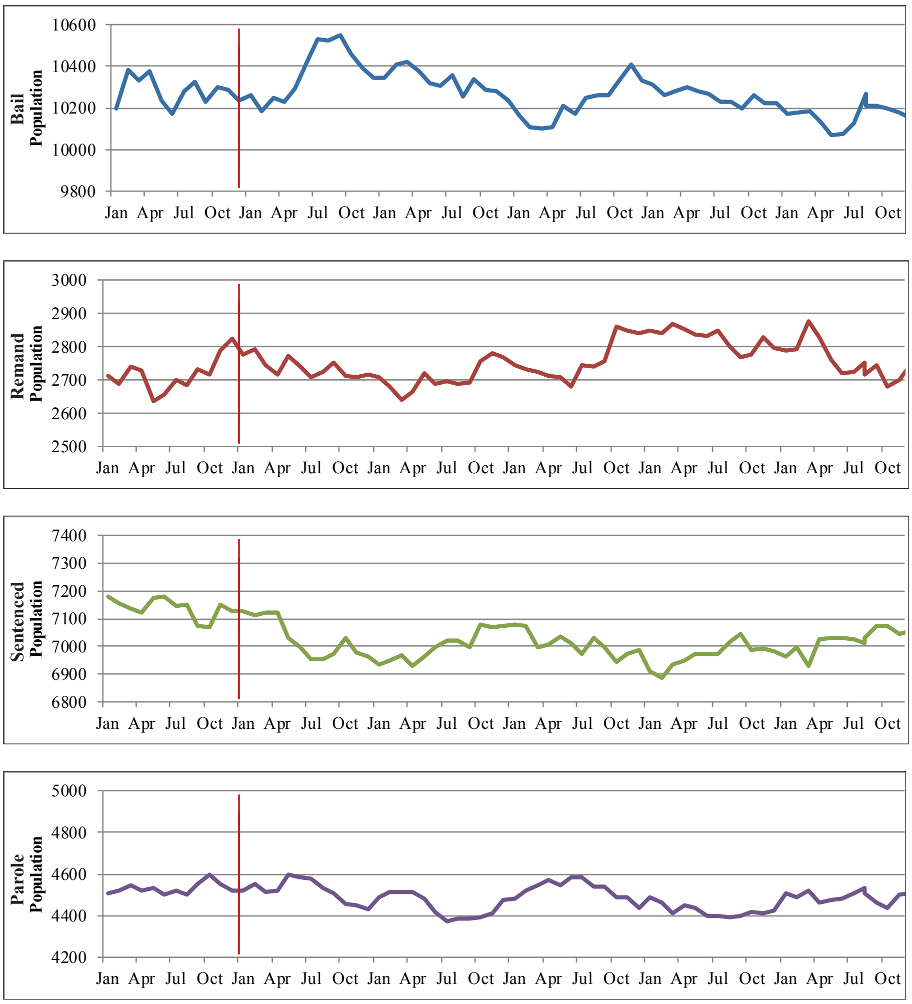
Table 6. Effect of a five per cent reduction in technical parole breaches

Scenario Description: The number of technical parole breaches will be reduced by 5%

Select Baseline: Baseline parameters set off most recent complete dataset for adult males

Change Appropriate Parameters: For this scenario we will reduce the proportion of people going from parole to sentenced (p_h) by 5%.

Stock	Δ
Bail	0%
Remand	0%
Sentenced	-0.5%
Parole	-0.5%
Flow	**Δ**
Court to Remand	0%
Court to Bail	0%
Bail to Remand	0%
Remand to Bail	0%
Remand to Sentenced	0%
Bail to Sentenced	0%
Sentenced to Parole	0%
Parole to Sentenced	-5%
Sentenced to Remand	0%
Remand to Parole	0%



It is important to remember that the model parameters reflect the state of the criminal justice system in NSW in the past. To estimate the effect of a parameter change on the number of people on bail, sentenced custody, remand and parole, therefore, the predicted percentage change in these stocks should be applied to the current stocks in these states, not the stocks that existed at the time the baseline was established. For example, to determine the reduction in the number of sentenced prisoners flowing from the abolition of sentences of six months or less, the current population of sentenced prisoners should be reduced by 6%.

Tables 5, 6, and 7 give example simulation outputs for policies involving an increase in the number of court arrivals (Table 5), a reduction in bail revocations (Table 6) and abolishing sentences of six months or less (Table 7).

Increasing the flow into the model by 7% has (not surprisingly) increased all of the stock and flow in the model by that same 7%. Working out the magnitude of the change in this example is trivial. The simulation can, however, help understand the timing of this change. If we focus on the two custodial states (viz. remand and sentenced), we find that the most of the growth in the remand population occurs within 6 months, whereas it takes three years for most of the change in the sentenced prisoner population to occur.

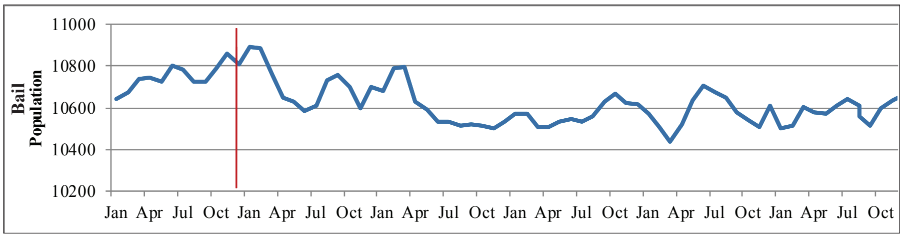
Table 7. Effect of abolishing sentences of six months or less

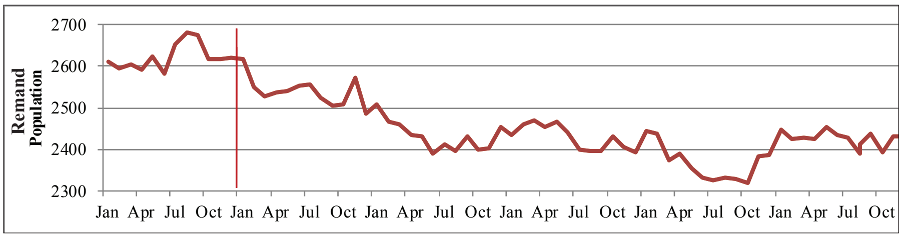
Scenario Description: Sentences of 6 months or less will be replaced with non-custodial penalties

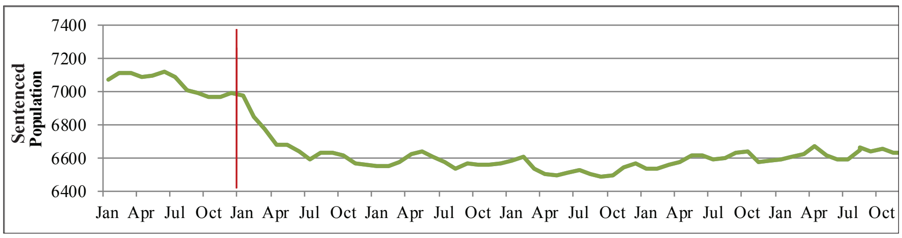
Select Baseline: Baseline parameters set off most recent complete dataset for adult males

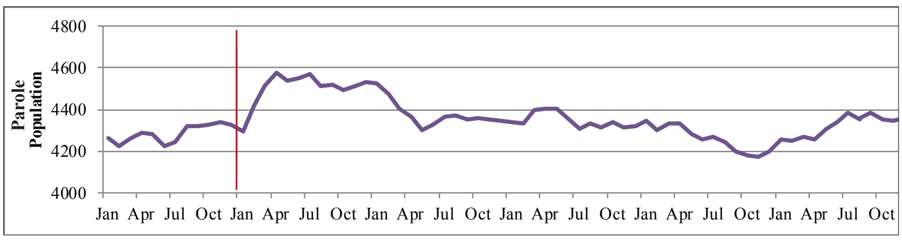
Change Appropriate Parameters: For this scenario we will change 5 parameters. The distribution used for length of stay in sentenced custody (S) will be altered to remove all stays less than 183 days relating to 6 month or less sentences. Parameter Pa will be altered to reflect the reduced proportion of people refused bail (because they were charged with a crime that now carries a non-custodial penalty). Parameters pe and pf will be altered so that those who would have received a sentence of less than 183 days will now be released with a non-custodial penalty. Lastly parameter pg will be increased, as a greater proportion of people becoming sentenced will now be eligible for parole given parole does not apply to those receiving a 6 month or less custodial penalty.

Stock	Δ
Bail	-1%
Remand	-9%
Sentenced	-6%
Parole	0%
Flow	
Court to Remand	-10%
Court to Bail	0%
Bail to Remand	-1%
Remand to Bail	-9%
Remand to Sentenced	-17%
Bail to Sentenced	-59%
Sentenced to Parole	0%
Parole to Sentenced	0%
Sentenced to Remand	-24%
Remand to Parole	-9%









Reducing the number of parole revocations by 5% only has a very small effect on the sentenced population; reducing it by approximate 0.5 per cent. It will take three years for the majority of this change to occur.

Abolishing sentences of 6 months or less reduces the sentence prisoner population by approximately 6% within 12 months of the policy coming into effect (red vertical line). The remand population also reduces by 9% over approximately 18 months. These reductions in populations are a result of the reduced flow of persons into remand and sentenced custody.

DISCUSSION

The model has been designed to help policy makers and planners evaluate the effect of different policies on the number of people on bail, in sentenced custody, on remand or on parole. This represents a significant step forward on the present situation where the effects on the prison system of various possible changes to the justice system must be guessed at if they are considered at all. Users of the tools provided here can make informed judgements about the consequences of various policy options without having to wait to find out what effects they have on the prison system. That said; it would be a mistake to think that the tools described here remove all subjective judgement from the policy assessment process.

Judgements must still be made about the effect of various policies on input to the system. In Table 6, for example, we explored the effect of a 7% increase in the number of new court appearances. In most cases, however, we will not know whether a particular policy will increase the number of court appearances by 7%. Judgement, aided by consultation with experts in the field, is required to reach this conclusion. To take another example, in Table 7 we explored the effect of a 5% reduction in the number of technical breaches of parole. The model tells us nothing, however, about the effect of any particular policy on the number of parole violations. We must 'guestimate' or assume the effect on the breach rate ourselves. The model only comes into play when determining the effect on the prison population of a given sized reduction in the number of technical breaches.

Judgement must also be exercised in determining what parameters in the model are likely to be affected by a particular policy. For example, the model allows us to examine the effect of a change in the percentage of defendants refused bail without changing the parameters governing how the number of offenders receiving a prison sentence and the length of their sentence. If (in reality) courts are more likely to impose a prison sentence on an offender who has been in custody on remand, increasing the number of defendants on remand may have an effect on the number of sentenced prisoners. There is no easy way to determine what set of parameter changes best captures the likely effect of a new policy. In some cases past research may be of assistance. In most cases decisions about what set of parameter changes best captures the immediate effects of a policy change can only be done in consultation with subject-matter experts.

The model also has some practical problems which, though, not serious, certainly make updating of the parameters more difficult. One of the limitations in the model is in the use of court data. The current method only includes people who have a finalised case. The reason for this is because many people have multiple charges that get combined in the court system on a certain date and this finalisation date is an important factor in converting court appearances and charges into individual people (not double counting). The problem that this causes is that we have to wait for new arrests to have their case finalised in court before they can be represented in the model.

The process we use to estimate model parameters could also be improved. Ideally we would 'tag' a group of individuals entering the court system, track their movements between various states and measure the time spent in each of these states using a single source of data. Lack of adequate historical data makes a retrospective analysis of this sort impossible. The time required to conduct a prospective study would force us to wait at least two years for all 'tagged' cases to exit the system. As noted in connection with our discussion of Group A and Group B parameters, we have adopted a compromise approach, taking different cohorts of defendants/offenders and using these cohorts to estimate different groups of parameters. Proceeding in this way means that there is bound to be some overlap between members of one cohort and members of another and this may introduce error into the parameter estimation process.

Despite these limitations, the model greatly reduces the uncertainty surrounding the effects of a particular policy on the prison system. Once a decision has been made about which set of parameter changes best reflects the likely impact of a policy, the consequences for the prison system can be immediately determined. The approach adopted here, moreover, could easily be extended to capture court or police operations in more detail. It could be extended to separate the flows associated with different groups of defendants/offenders (e.g. males and females, persons charged with different offences). It could also be integrated with prison forecast models so as to establish a credible 'baseline' scenario against which to assess the impact of policy changes. That would represent a substantial advance on the guesswork that often surrounds policy making in the criminal justice system.

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APPENDIX 1

DISTRIBUTIONS OF LENGTH OF STAY FOR MALES 2013 - 2014

Cohorts for these distributions are determined by the year the person leaves that location. Empirical distributions are used as an alternative to fitting probability distributions (mixed distributions). This provides a simple yet accurate (due to our large sample sizes) representation of the length of stay distribution for each state. The following graphs show the actual distributions in each of the states imputed by the model.

Figure A1. Distribution of days spent on bail for males in 2013 and 2014

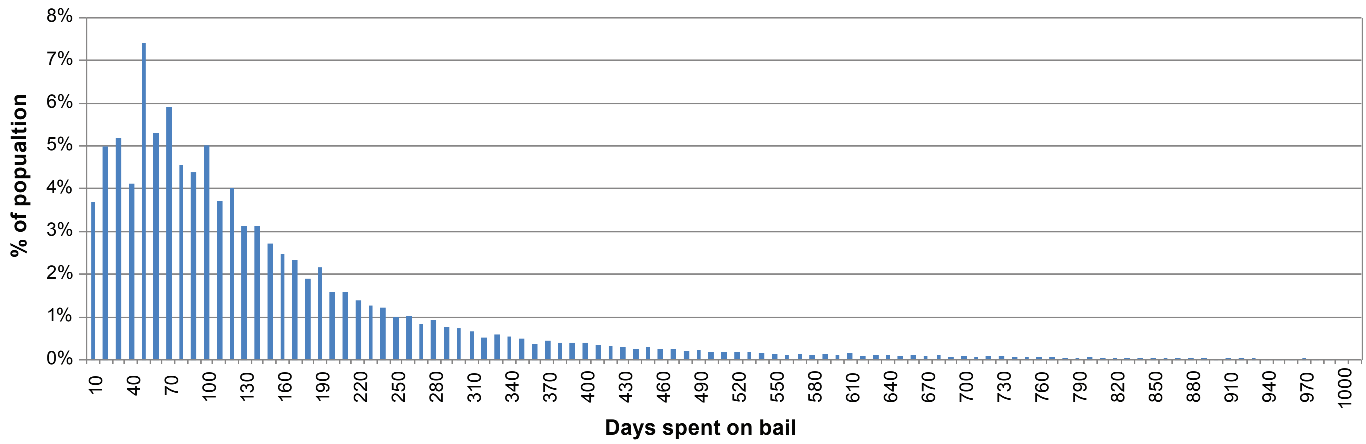


Figure A2. Distribution of days spent on remand for males in 2013 and 2014

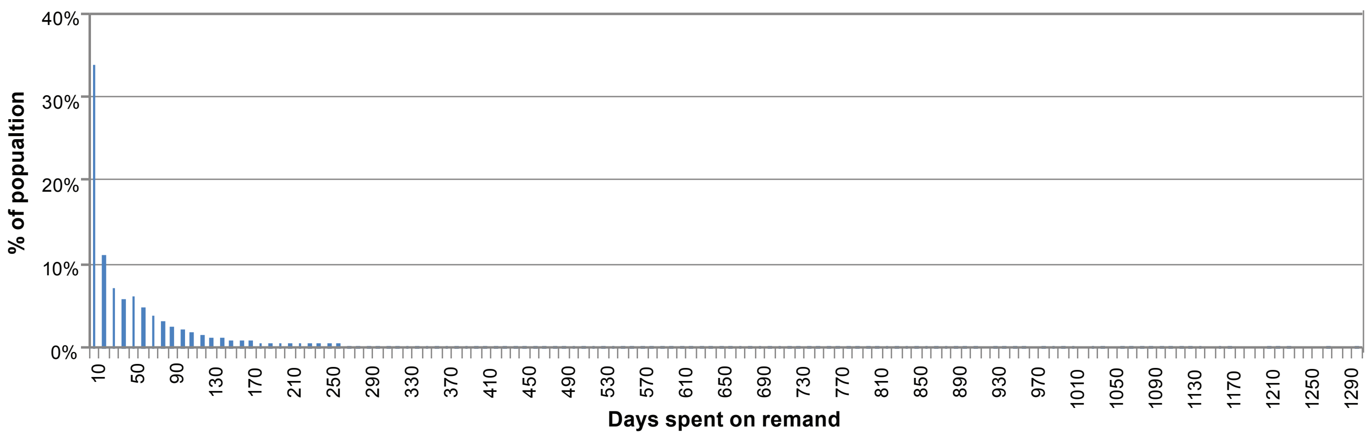


Figure A3. Distribution of days spent in sentenced custody for males discharged in 2013 and 2014

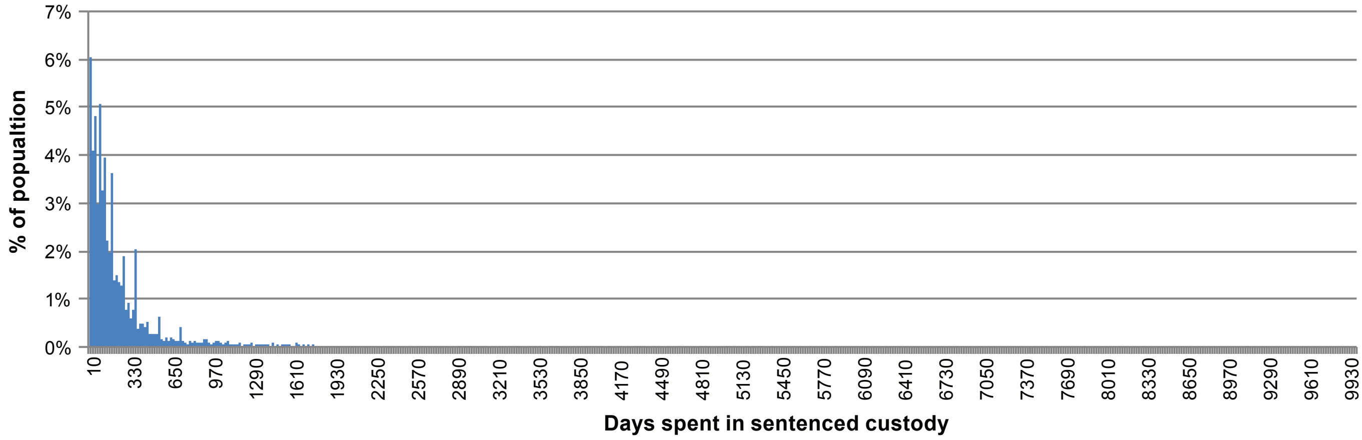
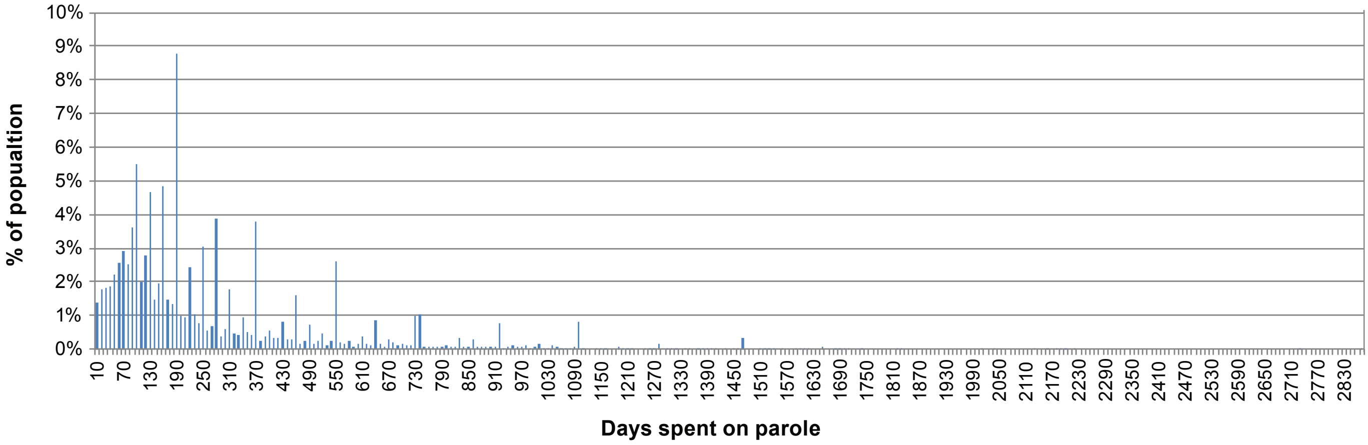


Figure A4. Distribution of days spent on parole for males finish parole in 2013 and 2014



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