



A micro-simulation model of the juvenile justice system in Queensland

Michael Livingston, Anna Stewart and Gerard Palk

The criminal justice system is a complex process involving police, courts and corrections. Historically these component parts have tended to act autonomously yet their actions impact on each other. Increasingly criminal justice policy-makers have come to recognise the need to understand the long term impacts of policy changes across the whole system. To effectively and efficiently manage the criminal justice system, policy-makers require analytical tools to project the relative effects of changes to policies based on current system information. Simulation models potentially offer a mechanism for assessing the short and long term effects of policies. This paper describes the development of the Queensland Juvenile Justice Simulation Model (QJJSM), which is currently being used in the Queensland juvenile justice system.

Toni Makkai
Director

Introduction

This paper examines the use of simulation models in criminal justice systems. The criminal justice system is generally understood to refer to the government and non-government agencies that deal with crime and criminals. Thus, the criminal justice system broadly encompasses: crime prevention, policing, the court system and corrections including both incarceration and community-based supervision. Planning and management of this system (e.g. estimating prison requirements, measuring the impact of policing changes, examining alternative sentencing options etc) is necessary to ensure that the limited resources available are put to the best possible use.

There has recently been a range of significant technical advances in policy impact analysis and the development of theoretical and policy simulation models. Models are being used across government and non-government organisations to assist in decision making. Modelling is used extensively in engineering, management, and human services areas such as health and education. Despite this trend, applications of this technology within the criminal justice system are only beginning to be explored due to the complexity of the systems and the lack of suitable data (see Lind, Chilvers & Weatherburn 2001). Further, the traditional training of the policy analyst and professional decision-maker within criminal justice system agencies involves little exposure to disciplines, such as statistics, operations research and programming, that are involved in the development of simulation models. Consequently, a professional culture conducive to the use of models and simulations in decision making has been slow to develop.

Nevertheless, there is increasing awareness of the benefits that could result from policy simulation modelling of the criminal justice system. The development of such models allows for the simulation of proposed practice, policy, and legislative changes, providing decision-makers with information

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GPO Box 2944
Canberra ACT 2601
Australia
Tel: 02 6260 9272
Fax: 02 6260 9293

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pertaining to the short and long term consequences of any such changes. Simulation scenarios ask the 'what if' questions. They are like mini experiments that identify the downstream impact on the system of a proposed change if everything else was held constant. Of course, systems are extremely dynamic and models do not and cannot predict the future. Rather, models provide predictions on the basis of past trends and take into account what is known about a particular system. As such, policy simulation modelling provides decision-makers with additional information that assists them in making rational decisions on the optimal use of scarce resources.

When justice system simulation models have been developed, they have often been overly complex and it has proved difficult to engage policy-makers with the technology and to maintain the models over time. This has led to a number of models that have taken substantial effort to build falling quickly into disuse and obsolescence. This paper describes a parsimonious micro-simulation model of the juvenile justice system in Queensland, briefly outlines the methods that have been used to ensure policy-makers utilise the model and presents an example scenario to demonstrate the usefulness of the model.

Simulation modelling in criminal justice

Over the past four decades a range of criminal justice models have been developed. Unfortunately, many of these models remain undocumented as much of the literature in this area is in the form of in-house government reports and unpublished documentation. This section provides a brief history of simulation modelling in a criminal justice context. A more detailed review of this field is available in Stewart et al. (2004).

Simulation modelling of the criminal justice system developed during the 1970s primarily in the United States

(e.g. Stollmack 1973) as the need for evidence-based planning for court and correction systems was recognised. This original work focused on simple stock and flow models that allowed the effect of minimal system changes to be examined. Throughout the 1980s justice system modelling increased in sophistication, with JUSSIM and JUSSIM 2 (Blumstein 1980) modelling the flow of individual cases through the system. These models also incorporated information on the underlying population structure and attempted to model reoffending behaviour. These models, along with similar work in the United Kingdom (Morgan 1985) were hampered by the level of detail they attempted to incorporate. While increases in model complexity provide a wider range of policy options that can be explored, they also necessitate a greater range of data and depend on a larger number of assumptions. Data dependencies were particularly problematic for the JUSSIM models with Blumstein (1980) noting that few jurisdictions collected the necessary data to make use of JUSSIM.

More recent attempts to model the justice system in the United Kingdom rectified some of the problems of the earlier attempts and the Flows and Costs model was widely used for almost a decade (Henderson 2003). However, the model was not generally accepted outside of the Home Office and has recently been superseded by a micro-simulation model of the justice system in England and Wales that is more flexible and dependent on less data (Henderson 2003). In the United States, criminal justice modelling has also moved towards micro-simulation with the National Council of Crime and Delinquency developing PROPHET, a flexible micro-simulation tool primarily used to project prison populations that is currently in use in over 30 American states (Austin, Cuvelier & McVey 1992).

In Australia, most modelling work has been conducted within government and little has been published. The

development of a detailed model of the New South Wales justice system that was highly complex, dependent on a vast amount of data and subsequently costly to maintain and infrequently used by the non-technical policy-makers that were its target audience is discussed by Lind, Chilvers and Weatherburn (2001). This model was subsequently replaced by a much simpler stock and flow model.

Lind, Chilvers and Weatherburn (2001) provide an overview of the reasons behind the difficulties inherent in developing simulation models of the justice system, particularly emphasising the exhaustive data requirements of many models and the difficulty of engaging non-quantitative policy analysts with technical computer-based models. Furthermore, they offer a framework for developing criminal justice models that will be accessible to decision-makers and relatively simple to maintain. In particular, they emphasise the need to develop the simplest model capable of the desired analysis, design the model so that the parameters necessary can be largely obtained from existing data sources, and make the model as user friendly as possible.

Queensland Juvenile Justice Simulation Model

The model described in this paper attempts to simulate the passage of offenders through the juvenile justice system in Queensland. This system is managed by the Department of Communities and deals with offenders who have committed offences between the ages of 10 and 16.

Purpose of QJJSIM

The majority of simulation models developed in justice system settings have focused on the prediction of prisoner numbers over time. However, an analysis of youth detention numbers in Queensland highlighted the volatile nature of the detention system. Between

1997–98 and 2003–04 the average detention population decreased by 32 percent without any substantial changes to offending numbers, legislation or policy. Instead, this change was affected largely by internal practices (e.g. ensuring parole was provided as soon as legally possible) that, due to their informality and the resulting lack of available data, are almost impossible to model. This, combined with the small numbers of young people detained in Queensland (an average of 99 in 2003–04), meant that a model designed to predict detainee numbers into the future was almost doomed to failure.

Instead, the QJJSM was developed to provide a tool for policy-makers and legislators to estimate the *relative* impact of prospective changes to the system in the medium term. Thus, the model was designed to assess ‘what if’ type questions, with the underlying assumption that, apart from the system change being modelled, the only changes to the juvenile justice system relate to demographic changes. Therefore, the focus of the model is on a comparison over time between the current system and the proposed changes. An example of this is provided below.

Type of model

The QJJSM model was developed in conjunction with stakeholders from a range of Queensland Government departments and it became clear that these stakeholders were interested in a model that incorporated both the way individuals moved through the system and the broad numbers of young people at various points in the system (e.g. in detention). Of the two main types of model that had been developed in other jurisdictions (stock and flow, micro-simulation), only micro-simulation models allow the simulation of individual offenders, making this the most appropriate model structure, allowing sophisticated models of individual behaviour as well as aggregated outputs.

Broad schema

Using the framework described by Lind, Chilvers and Weatherburn (2001), the QJJSM was based upon the simplest possible schema of the juvenile justice system in Queensland (Figure 1). The model simulates the initiation of new offenders, the commission of offences, the court decision making process and the reoffending behaviour of offenders.

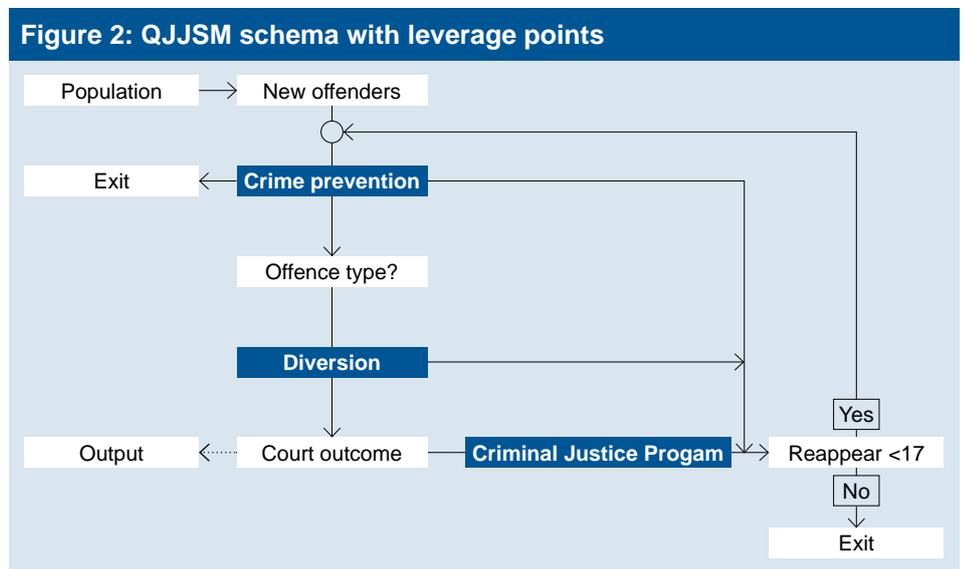
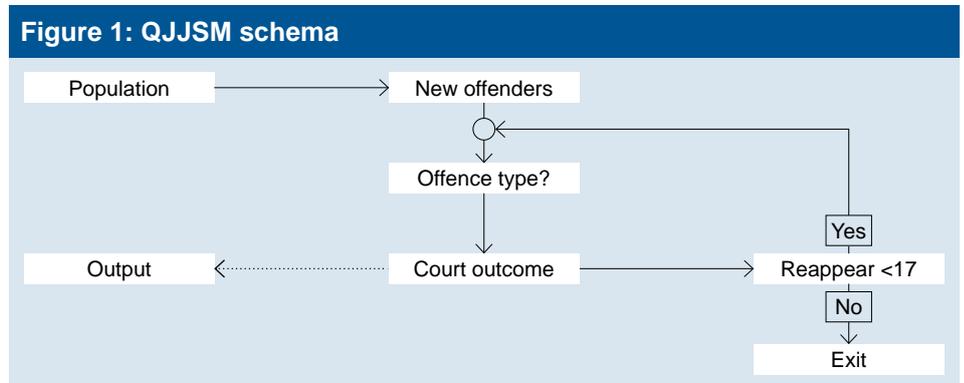
This level of simplicity had a number of benefits. First, it captured the crucial components of both the system behaviour (court outcomes and supervision) and the individual offender behaviour (initiation, desistance and reoffending) required. Secondly, the model’s simple structure made it easy to explain to policy-makers and thus avoided alienating the model’s user base through over complexity. Finally, the structure of the final schema ensured that the data required to parameterise the model were readily

available in administrative datasets maintained by the Queensland Department of Communities.

Three leverage points were added to the schema to model the points within the system where policy changes can be implemented: crime prevention, pre-court diversion and post-court intervention (Figure 2). Specific examples of these leverage points are discussed below. System leverage points are components of the juvenile justice model where the implementation of a program, policy or legislative change may result in a reduction in offending.

Building the model

The QJJSM was constructed in the proprietary micro-simulation package Extend. Extend is a flexible and easy to use package that allows the construction of simulation models using a wide array of predefined ‘blocks’.



Thus, simply adding and manipulating task-specific blocks could implement the vast majority of model functionality. Extend also allowed for the implementation of a built in database with a dynamic link to Microsoft Excel, providing a method for automatically maintaining and updating the model parameters as more recent data became available. Extend also allows users to develop their own blocks to implement the system's leverage points. These blocks allow the user to specify the details of their prospective program or policy using a clear, well-organised user interface.

The model developed in Extend was constructed according to the schema already presented. Thus, new offenders (items in the micro-simulation model) enter the system from the general population. Demographics (age, sex, Indigenous status and region) are assigned to offenders based on probabilities derived from administrative data provided by the Department of Communities. Offenders are assigned an offence type based on the offence types committed by their demographic group in real appearance data (e.g. 32 percent of non-Indigenous male appearances will be for theft and related offences) and are given a court outcome (based on number of prior appearances, type of offence and gender). Following the court outcome, offenders either reappear before the age of 17 (offenders move into the adult system once they have turned 17) or leave the system. Those who reappear return to the first section of the model and are assigned a new offence when their next appearance occurs.

The model is based around administrative data collected by the Department of Communities and incorporates population projections from the Australia Bureau of Statistics. These data were analysed to develop offending rates, offence probabilities, sentencing models and models of reoffending and desistance. Separate analyses were conducted for each stage

of the system and included a series of logistic regression models for the court decision and survival analysis for reoffending. See Stewart et al. (2004) for a detailed technical report, including parameter estimation.

Using QJJS

For the QJJS to be useful for comparative policy analysis, it is necessary to provide mechanisms for the user to implement their proposed changes to the system. These mechanisms take the form of leverage points, already briefly discussed above.

Leverage points

The three leverage points included in the QJJS are crime prevention, pre-court diversion and post-court intervention. These are based on the broad crime prevention literature (e.g. Farrington 1994) and were developed in consultation with policy-makers and potential model users. All leverage points allow programs to be targeted at specific sub-groups of offenders based on their gender, Indigenous status, type of offence, offending history, age and region.

CRIME PREVENTION

Crime prevention in QJJS works in two main ways: developmental crime prevention and situational crime prevention. Developmental crime prevention strategies attempt to provide assistance to at risk children *prior* to their initiation into offending (e.g. through parenting and primary school-based programs). When successful, developmental crime prevention programs prevent a young person who would otherwise have commenced an offending career from ever initiating. In the model, a successful early intervention program will intercept a new offender before their first offence and will exit them from the system preventing both their first offence and all subsequent offending.

In contrast, situational crime prevention stops only one specific offence from taking place. Situational crime prevention depends on reducing the opportunity and increasing the risk to the offender of offending and therefore may not have a long-term impact on a young person's offending behaviour, but can prevent specific offences from taking place. These programs generally rely on target-hardening measures such as improved security.

PRE-COURT DIVERSION

Pre-court diversion programs take place after an offence has been committed but before the offender has been through the court process. These programs attempt to reduce the likelihood of a young person reoffending by processing their offence in a less formal way (e.g. a community conference) and there is evidence that offenders diverted in this way have a reduced likelihood of reoffending (Trimboli 2000). In the model, a young offender who is eligible for a pre-court diversion does not go through the court process, instead proceeding to the reoffending decision with a reduced likelihood of reoffending.

POST-COURT INTERVENTION

Post-court interventions are strategies either mandated by the sentencing magistrate or implemented by the Department of Communities as part of a supervision or detention order. They include a wide range of interventions aimed at reducing the likelihood of an offender reappearing in the system. These include educational, employment and rehabilitation programs. In the model an offender will commit an offence, go through the court process and, if subject to a post-court program, will subsequently have a reduced likelihood of reoffending.

Policy analysis with QJJS

The primary purpose of the QJJS is the analysis of proposed changes to policies in the juvenile justice system. The model does not aim to predict precisely what will happen in the future

as there are too many influential factors that cannot be modelled accurately (e.g. law and order political campaigns). Instead, the model provides a baseline set of data assuming that the current system behaviour will remain stable over the time period modelled, with only the underlying demographics changing. This baseline model provides a set of standard outputs that can be used for comparison with proposed system changes.

Once the baseline results have been recorded, the user can include one or more prospective programs at the leverage points. The model is then re-run with the proposed programs included and the relative reduction in traffic through the juvenile justice system can be examined. Due to the nature of micro-simulation models, the results of the modelling exercise can be broken down by any number of factors. For example, the user can broadly explore the overall reduction in court appearances or can examine the reduction in detention orders given to Indigenous females over each year of the program. Furthermore, the model allows some simple cost-benefit analysis by incorporating the costs incurred by the Department of Communities (the cost of court appearances and supervision of detention and community-based orders) under each scenario.

Modelling an early intervention program with QJJS

As an example of the QJJS's use, we model a family-based counselling program aimed at five to ten year olds commencing in 2001. This program is targeting young people who have yet to have any contact with the juvenile justice system (as only young people aged between 10 and 16 are dealt with by the juvenile justice system). A meta-analysis of evaluated family-based intervention programs demonstrated that a 12 percent reduction in the initiation of juvenile offending could be achieved (Farrington 1994).

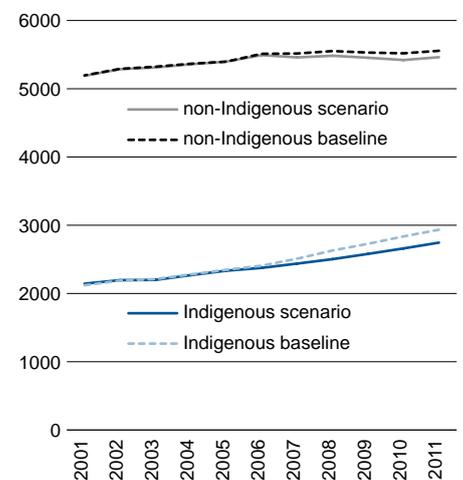
Consequently, we assume that this program in the QJJS will prevent 12 percent of generated new offenders from commencing an offending career. We assume that this program will be implemented in North Queensland and Far North Queensland.

The effect of this program on the overall number of court appearances for Indigenous and non-Indigenous young people can be seen in Figure 3. The impact of the program is minimal between 2001 and 2007. The program is aimed at five to ten year olds and, as most young offenders do not initiate offending until their late adolescence, it will take at least five years for the majority of the oldest children to commence juvenile offending. It appears that the program has an earlier impact on Indigenous offending, which is consistent with the trend towards earlier commencement of offending for this group. The simulation of this program estimates a reduction of 6.5 percent in the number of court appearances by Indigenous offenders across the Queensland juvenile justice system and a reduction of 1.7 percent in court appearances by non-Indigenous offenders by 2011. This differential effect is due to the high proportion of Indigenous offenders in the regions selected for this program.

The model also provides estimated costs. These costs do not include program-related costs and only reflect the impact on the Department of Communities. The model estimates that the family-based program in two regions would reduce court and supervision costs by around \$10 million over the ten years modelled with an average saving of approximately \$2.5 million per year by 2011.

This example highlights that the benefits resulting from programs targeted at pre-adolescents can take a number of years to have an effect and that a program of this type can have a substantial impact on the juvenile justice system.

Figure 3: Simulation output of total court appearances (baseline and prevention program)



Sensitivity analysis

The aforementioned scenario was replicated with five different values of program efficacy (8 percent, 10 percent, 12 percent, 14 percent and 16 percent) to assess how sensitive the model results were to varying assumptions of efficacy. The results of these replications in 2011 are presented in Table 1.

These results highlight the importance of a reasonable estimation of program efficacy, with reductions in total youth court traffic varying between 0.6 percent and 4.3 percent when efficacy is changed between 8 percent and 16 percent. In terms of costs, this variation in efficacy results in savings between \$0.7 million and \$5.4 million per year by 2011.

Estimates of the efficacy of proposed new programs are generally based around similar programs that have been evaluated in different jurisdictions. Unfortunately, well conducted evaluation studies of crime prevention, diversion and post-court programs in Australian settings are the exception rather than the rule and evaluations of overseas run programs will not necessarily reflect the impact that these programs would have in Australia (Stewart et al. 2004). With

Table 1: Sensitivity of model results to changes in early intervention program efficacy

Model settings	Appearances (2011)	Saving (2011)
Baseline	8490	n.a.
Scenario (8%)	8440	\$0.7m
Scenario (10%)	8390	\$1.5m
Scenario (12%)	8321	\$2.5m
Scenario (14%)	8207	\$4.2m
Scenario (16%)	8126	\$5.4m

these limitations in mind, standard use of the model involves providing results for at least 'best case', 'worst case' and 'most likely' values of program efficacy.

Ensuring the longevity of the QJJS

It is clear that modelling criminal justice systems is potentially of great use to both policy-makers and researchers. However, it is evident that despite the large effort spent developing justice models, they have not often been taken up by decision-makers or become too difficult to maintain and have repeatedly fallen into obsolescence.

The QJJS has been developed with a strong focus on usability. In particular, the level of detail modelled in the QJJS has been restricted to key decision points and attributes so that the modelling process can be easily explained to prospective users. Furthermore, the development of the model in a graphical simulation package (Extend) has resulted in an intuitive interface with which policy-makers can quickly become familiar. This parsimony and ease of use have resulted in a tool that policy-makers understand and

support, ensuring that a wide range of Queensland Government policy-makers were enthusiastic about the use of QJJS for policy assessment.

In addition to ensuring that the QJJS was taken up by users, it was necessary to ensure that the model was easily maintained. This meant that the QJJS was built so that it required only existing Department of Communities administrative data and did not need any additional data collection. Due to the ease of linking Extend with Excel, it was also possible to develop a series of macros based on a standard data extraction that recalculate the model parameters at the end of each financial year. These steps have ensured that the model has been maintained efficiently and accurately reflects the most recent trends in the Queensland Juvenile Justice System.

Conclusions

The model presented in this paper is a parsimonious and easily maintained tool that allows policy-makers to analyse the medium-term consequences of juvenile justice policies before they are implemented. The model has been

developed after careful examination of previous modelling efforts in criminal justice and is designed to engage with both technical and non-technical users. The QJJS has already been used by the Department of Communities to assess the impacts of substantial changes to the juvenile justice system and, with ongoing maintenance and testing, it is hoped that the model will become an integral component of policy and planning in the Queensland Juvenile Justice system.

An online version of this model is available for use at www.griffith.edu.au/jmag

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