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Measuring the Disutility of Imprisonment to Offenders

Andrew Torre, School of Accounting, Economics and Finance and Darren Wraith Queensland University of Technology

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Measuring the Disutility of Imprisonment to Offenders

Andrew Torre and Darren Wraith
School of Accounting, Economics and Finance
Deakin University and
School of Mathematical Sciences
Queensland University of Technology

Address for correspondence:
Andrew Torre,
School of Accounting, Economics and Finance,
Faculty of Business and Law
Deakin University.
221 Burwood Highway, Burwood,
Victoria, Australia. 3125.
E-mail address:
andt@deakin.edu.au

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Abstract

Recently, quite a lot of work has been done on deducing parameters from observed decisions using dynamic programming models, and Wolpin (1996) provides a good introduction to this literature. While a dynamic programming framework to this problem has not been utilised in this paper, the concept of bringing together actual decisions and a constructed model to explain these to infer an unobservable parameter is the same. For more discussion of the dynamic programming methodology and related issues, the reader is referred to Wolpin’s paper. Our alternative framework is to undertake a calibration exercise based on defendants’ optimal plea decisions for three different offences. For representative ex ante combinations of plausible parameter values for the cost of a guilty plea and expected cost of a trial we generate a very large sample of values of the discount rate at which a defendant would be indifferent between either plea. The median r value of our distributions is interpreted as the defendant’s willingness to pay to delay the cost or expected cost of imprisonment, and hence a measure of the disutility of imprisonment. Alternatively, our estimates can be interpreted as implicit premiums over and above the unskilled wage rate.
Introduction

The economic theory of optimal deterrence and imprisonment assumes that in choosing sentence length and the probability of apprehension, society’s objective is to minimise total social costs. These costs comprise the net harm generated by individuals’ acts + the enforcement costs of apprehending individuals with probability P + the public costs of operating prisons + the disutility suffered by those who are imprisoned (Polinsky & Shavell, 1999A; Polinsky & Shavell, 1999B; Polinsky: 2004; Polinsky, 2007). While the empirical literature contains dollar estimates of the first three components of total social cost, estimates of the fourth are sparse.

Providing credible values of this parameter is an important issue for two reasons. First, since the optimal incarceration rate occurs where marginal social benefits are equal to the marginal social cost of imprisonment, estimates of the psychic cost of deprivation of liberty to offenders are required for assessing the efficiency with which resources are allocated to prisons. Given the large amounts of money spent on this form of punishment, plausible estimates of total social cost are required for cost-benefit studies of correctional institutions. Second, this parameter has important implications for the optimal combination of severity and
apprehension probability to achieve a given amount of deterrence (Polinsky & Shavell, 1999B).

The purpose of this paper is to attempt to fill this void by measuring imprisonment disutility using a novel method of ascertaining the rate at which offenders discount their foregone illegal income during the period of their incarceration as revealed in their plea decisions. An important advantage of our methodology is that the outcome of this exercise translates directly into traditional willingness to pay monetary measures of offenders’ welfare losses.

2. The Theoretical Model

We assume that the defendant is not on bail, legally aided and risk neutral\(^1\), which enables us to write the first cost identity in its simplest form, i.e. the cost of the guilty plea or prosecutor’s final offer is equal to:

\[
C = (Y, D, r, t) \quad (1)
\]

where, \(Y\) is the offender’s foregone legal or illegal income while on remand waiting for the court hearing until the final disposition of the

\(^1\) The assumption of risk neutrality is commonly used in analysing the economics of criminal sanctions (Polinsky, 2007.; Polinsky & Shavell, 1999A & 1999B; Polinsky, 2004). This assumption generates mid point estimates of the parameter being measured in this paper. Introducing risk aversion and risk taking would provide a lower bound and upper bound estimate of the parameter respectively.
case, and then during the duration of the sentence \( D \), \( r \) is the offender’s discount rate and \( t \) is the time elapsing from the time of remand until the final court hearing at which the offender is sentenced.

The present value of expression (1) is given by (2).

\[
C = Y \int_{0}^{t+D} e^{-rx} \, dx - Y \int_{0}^{t} e^{-rx} \, dx
\]

\[
= \frac{Y}{r} (e^{-rt} - e^{-r(t+D)})
\]

(2)

If the not on bail defendant chooses to plead not guilty, the expected cost identity of a trial is equal to:

\[
E(C) = (Y, P, D, r, T)
\]

(3)

Where, \( P \) is the probability of being convicted following a trial, and \( T \) is the time elapsing from the time of remand until the conclusion of the trial. In (2) and (3) therefore, sentence length is in terms of unit of time, so that one unit of prison sentence is equal to one dollar’s worth of disutility to an individual.
The present value expression of (3) is given by (4).

\[
E(C) = \int_0^T Y e^{-rx} \, dx + P \left[ \int_0^{T+D} Y e^{-rx} \, dx - \int_0^T Y e^{-rx} \, dx \right] - (1-P)(0)
\]

\[
= \frac{Y}{r} \left( 1 - P e^{-r(T+D)} - (1-P) e^{-rT} \right)
\]

It is important to note that (3) and (4) are identities not cost functions and are not a hypothesis about the drivers of each plea, consequently, the statements are merely definitional; the cost and expected cost respectively are defined as the defendant’s discounted foregone and expected foregone legal or illegal income during incarceration. Also, we do not attempt to posit a relationship between P and time, since we do not know what P does temporally. In some cases it will increase, and in others it will decrease, consequently it fluctuates randomly. Since there is unlikely to be a deterministic relationship between these two variables, in our subsequent simulation exercise we use a range of constant P values to gauge the sensitivity of our results to these different values.

3. Methodology

The defendant will choose the lower cost option out of (2) and (4), which will change with court delay. When formulating the plea decision, each
offender will confront a large number of plausible combinations of each of the parameter values in (2) and (4). For each combination of Y, t, T, D and P, our methodology is to find values of r, which we denote as r*, that equate the cost of a guilty plea or prosecutor’s final offer with the expected cost of a trial in (2) and (4). This reduces to solving the following expression for r given values for Y, t, D and P:

$$\frac{Y}{r} \left(1 - e^{-r(t+D)}\right) = \frac{Y}{r} \left(1 - P e^{-r(T+D)} - (1-P) e^{-rT}\right)$$

(5)

This exercise does not depend on Y, since Y cancels out, and furthermore algebraic solutions are not possible for (5) only numerical ones. The relative attractiveness of the expected values of the two courses of action is related monotonically to the discount rate, and as a result, the observed pattern of pleas (guilty or not guilty), when combined with values of the key variables yields a set of values for the discount rate r*, that divides the plea space into that where the guilty plea is optimal and conversely. This is illustrated in figure 1 below.
In figure 1 assume that $r^* = 0.5$ where the defendant is indifferent between pleading guilty and going to trial since the cost of the guilty plea or certain prison sentence $C$ equals the expected cost of the trial $E(C)$, or the expected prison sentence. The optimal decision rule is to go to trial if $r < r^*$ since $E(C) < C$ and plead guilty if $r > r^*$ since $C < E(C)$, where $r$ is the defendant’s actual discount rate. Consequently, if the defendant in figure 1 goes to trial, his or her unobservable discount rate must have been $\leq 0.50$, and conversely if the guilty plea is chosen, it must have been $\geq 0.50$.

Alternatively, some parameter combinations could yield curves where at $r < r^*$, $C < E(C)$ and conversely at $r > r^*$ as in figure 2 below.
In this instance, if the defendant elected a trial, his or her discount rate must have been $\geq r^*$ and if the guilty plea were chosen, then $r^*$ would be the upper bound estimate of the true $r$. Substituting all of the possible independent combinations of waiting times, expected sentences and conviction probabilities into (2) and (4) that a defendant would confront ex ante will generate a large distribution of values of $r^*$.

We identify the entire distribution of $r^*$s for three different offences in New South Wales (NSW) murder, aggravated robbery and burglary, which were finalised in the NSW higher courts in 2004.
4. Data

The NSW Bureau of Crime Statistics and Research (Bureau) has been publishing a reasonably comprehensive set of court statistics for the lower and higher NSW court jurisdictions since 1998. For all court levels considerable information is provided, first, trial and sentence cases finalised in each court district or registry and persons charged classified by offence is recorded. A large number of categories of offence is utilised: dangerous and negligent acts endangering persons; abduction and related offences; robbery, extortion and related offences; burglary and break and enter; theft and related offences; deception and related offences; illicit drug offences; weapons and explosives offences; property damage and environmental pollution; public order offences; road traffic and motor vehicle regulatory offences; offences against justice procedures, government security and government operations and miscellaneous offences such as harassment and offences against privacy.

Second, for persons charged the number of offences classified by plea (guilty or not guilty), the outcome of the charges (acquitted or convicted) and penalty imposed are made available. The NSW courts have a wide range of sentence options at their disposal, imprisonment, detention in a juvenile institution, home detention, periodic detention, a suspended
sentence with or without supervision, a community service order, a bond
with or without supervision, a fine, a nominal sentence, a bond without
conviction and no conviction recorded. In addition, the average duration
in months of all penalties except community service orders (average
hours) and fines (average dollars), for each category of offence is
published. A further breakdown of the characteristics of persons charged
who were found guilty shows their sex, age, and average age correlated
with the type of offence. Bail status for persons charged is cross
referenced with the ultimate outcome of their court appearance. Four
possibilities are noted, went to trial, proceeded to sentence only, no
charges proceeded with and all charges otherwise disposed of.

Third, considerable information is provided about court delay confronting
persons charged. This is defined and measured as median duration in days
for three different time periods, arrest to committal, committal to outcome
and outcome to sentence. Waiting time for persons charged is shown for
bail status and the four possible outcomes of the court appearance. For
persons found guilty, prior conviction status by offence type is also
provided. Finally information on the number of appeals against
conviction and severity of sentence classified by defendant bail status is
provided.
For the purposes of this exercise, we needed to generate a representative random sample from all of the actual values of the four observable parameters underpinning our model, actual waiting times and sentence lengths (imprisonment) for a guilty plea and trial respectively. Consequently, rather than relying on the highly aggregated data provided by the Bureau in its published court statistics, we requested all of the information available for each person charged. The latest year for which this could be provided was 2004. Table 1 provides summary statistics for actual waiting time from remand in custody until sentence is passed by the court defined in months, and sentence length (imprisonment in months) obtained from the Bureau (2004) for all persons charged, who were legally aided and not granted bail for the three indicated offences.
Table 1: Summary statistics for actual waiting time and sentence length.

<table>
<thead>
<tr>
<th></th>
<th>Aggravated Robbery</th>
<th>Murder</th>
<th>Burglary</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NG*</td>
<td>G</td>
<td>NG</td>
</tr>
<tr>
<td>Min</td>
<td>4.47</td>
<td>2.30</td>
<td>7.07</td>
</tr>
<tr>
<td>Q1</td>
<td>9.73</td>
<td>6.75</td>
<td>18.57</td>
</tr>
<tr>
<td>Median</td>
<td>13</td>
<td>9.43</td>
<td>22.53</td>
</tr>
<tr>
<td>Mean</td>
<td>15.99</td>
<td>11.59</td>
<td>23.98</td>
</tr>
<tr>
<td>Q3</td>
<td>18.10</td>
<td>14.52</td>
<td>26.82</td>
</tr>
<tr>
<td>Max</td>
<td>39.77</td>
<td>59.50</td>
<td>85.94</td>
</tr>
<tr>
<td>N**</td>
<td>180</td>
<td>113</td>
<td>66</td>
</tr>
</tbody>
</table>

NG* = NG is a not guilty plea and G is a guilty plea. The first row for each of the summary measures is waiting time in months and the second row is sentence length in months.

N** is the number of not guilty and guilty pleas respectively.
5. Results

From the distribution of actual values in Table 1, we took a random sample of 19, 15 and 30 values of waiting time and sentence length in months for the offences of aggravated robbery, murder and burglary respectively. For the unknown variable Y, we assume that income is normally distributed with a mean of $50,000 and a variance of $100,000, (standard deviation $10,000 and range $20,000 to $80,000), although as we have noted the choice of income will have no impact on the position of the curves in figures 1 and 2 because a change in Y will shift both curves by the same proportion so that the value of r* will not change. For P the other unknown, we use three values 0.3, 0.5, and 0.8. Defendants prosecuted for aggravated robbery therefore faced $19^3$ and $19^4$ possible combinations of values of D, t, and Y for a guilty plea and D, T, Y and P for a not guilty plea disposition respectively. In the case of murder the maximum number of feasible combinations was $15^3$ and $15^4$ for the guilty and not guilty plea respectively, and for burglary $30^3$ and $30^4$ for the respective pleas.

For each combination of values of the variables, we searched for an intersection point between the cost of a guilty plea and expected cost of a trial. These values of r* generate a distribution from which it is possible to infer values of individual defendant’s actual discount rates, and are
available from the authors. Given the distribution of the underlying data from which the samples were taken and since the $r^*$ estimates are on a continuous scale, the median is the most likely estimate of $r^*$ for each offence. Consequently, we compared the median values for the three offences to see if they were different from one another using Mood’s Median Test, a non parametric test, which is a more robust alternative to the Kruskal-Wallis test in the presence of outliers in the data (Hollander & Wolfe, 1973). The results for all three offences were found to be significantly different ($p = 0.05$) for all three $P$ values. Our results are presented in Tables 2 to 4 below.
Table 2: Results for Aggravated Robbery

<table>
<thead>
<tr>
<th>Measures</th>
<th>P = 0.3</th>
<th>P = 0.5</th>
<th>P = 0.8</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NG &lt; GP</td>
<td>NG &lt; GP</td>
<td>NG &lt; GP</td>
</tr>
<tr>
<td>r*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>Q1</td>
<td>0.32</td>
<td>0.28</td>
<td>0.25</td>
</tr>
<tr>
<td><strong>Median</strong></td>
<td>0.50</td>
<td>0.44</td>
<td>0.38</td>
</tr>
<tr>
<td>Mean</td>
<td>0.55</td>
<td>0.49</td>
<td>0.43</td>
</tr>
<tr>
<td>Q3</td>
<td>0.71</td>
<td>0.64</td>
<td>0.55</td>
</tr>
<tr>
<td>Max</td>
<td>2.61</td>
<td>2.02</td>
<td>1.52</td>
</tr>
<tr>
<td>95% CI</td>
<td>(0.025, 0.975)</td>
<td>(0.025, 0.975)</td>
<td>(0.025, 0.975)</td>
</tr>
<tr>
<td>N**</td>
<td>19,680</td>
<td>15030</td>
<td>11,130</td>
</tr>
</tbody>
</table>

N ** Number of intersection points or values of r* found.
Table 3: Results for Murder

<table>
<thead>
<tr>
<th>Measures</th>
<th>P = 0.3</th>
<th>P = 0.5</th>
<th>P = 0.8</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NG &lt; GP</td>
<td>NG &lt; GP</td>
<td>NG &lt; GP</td>
</tr>
<tr>
<td>R*</td>
<td>r*</td>
<td>r*</td>
<td></td>
</tr>
<tr>
<td>Min</td>
<td>0.03</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>Q1</td>
<td>0.25</td>
<td>0.22</td>
<td>0.13</td>
</tr>
<tr>
<td><strong>Median</strong></td>
<td><strong>0.34</strong></td>
<td><strong>0.28</strong></td>
<td><strong>0.17</strong></td>
</tr>
<tr>
<td>Mean</td>
<td>0.32</td>
<td>0.26</td>
<td>0.17</td>
</tr>
<tr>
<td>Q3</td>
<td>0.40</td>
<td>0.32</td>
<td>0.20</td>
</tr>
<tr>
<td>Max</td>
<td>0.73</td>
<td>0.55</td>
<td>0.38</td>
</tr>
<tr>
<td>95% CI</td>
<td>(0.025, 0.975)</td>
<td>(0.025, 0.975)</td>
<td>(0.025, 0.975)</td>
</tr>
<tr>
<td>N**</td>
<td>5820</td>
<td>4950</td>
<td>3570</td>
</tr>
</tbody>
</table>

N** Number of intersection points or values of r* found.
### Table 4: Results for Burglary

<table>
<thead>
<tr>
<th>Summary measures</th>
<th>P = 0.3</th>
<th>P = 0.5</th>
<th>P = 0.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>NG &lt; GP</td>
<td>r*</td>
<td>r*</td>
<td>r*</td>
</tr>
<tr>
<td>Min</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>Q1</td>
<td>0.38</td>
<td>0.33</td>
<td>0.22</td>
</tr>
<tr>
<td>Median</td>
<td><strong>0.58</strong></td>
<td><strong>0.50</strong></td>
<td><strong>0.34</strong></td>
</tr>
<tr>
<td>Mean</td>
<td>0.60</td>
<td>0.51</td>
<td>0.36</td>
</tr>
<tr>
<td>Q3</td>
<td>0.79</td>
<td>0.65</td>
<td>0.47</td>
</tr>
<tr>
<td>Max</td>
<td>2.05</td>
<td>1.65</td>
<td>1.14</td>
</tr>
<tr>
<td>95% CI</td>
<td>(0.025, 0.975)</td>
<td>(0.025, 0.975)</td>
<td>(0.025, 0.975)</td>
</tr>
<tr>
<td>N**</td>
<td>19170</td>
<td>16140</td>
<td>13830</td>
</tr>
</tbody>
</table>

N** Number of intersection points or values of r* found.

* In tables 2 to 4 inclusive, the numbers have two different interpretations. First, they represent offender willingness to pay estimates to defer the monetary cost of imprisonment per dollar of foregone income by a month, and second, they are an estimate of the offender’s implicit
premium over and above the unskilled wage rate for the three offences. Further discussion is provided in the final section of this paper.
The results of our calibration exercise in tables 2 to 5 are summarised diagrammatically below.

**Murder (median estimate):**

\[ P = 0.3 \]

\[ r^* = 0.33 \]

\[ Gp \quad NGp \]

\[ P = 0.5 \]

\[ r^* = 0.28 \]

\[ Gp \quad NGp \]

\[ P = 0.8 \]

\[ r^* = 0.17 \]

\[ Gp \quad NGp \]
Aggravated Robbery (median estimate):

\[ P = 0.3 \]

\[ r^* = 0.50 \]

\[ E(C) \]

\[ Gp \]

\[ PV \]

\[ N Gp \]

\[ C \]

\[ P = 0.5 \]

\[ r^* = 0.44 \]

\[ Gp \]

\[ N Gp \]

\[ C \]

\[ E(C) \]

\[ P = 0.8 \]

\[ r^* = 0.38 \]

\[ Gp \]

\[ N Gp \]

\[ C \]

\[ E(C) \]
Burglary (Median estimate)

\( P = 0.3 \)

\[ r^{*} = 0.36 \]

\( P = 0.5 \)

\[ r^{*} = 0.50 \]

\( P = 0.8 \)

\[ r^{*} = 0.58 \]

Figure 3: Results of the simulation exercise
6. Discussion

Our estimates are subject to a number of different interpretations. First, as we have already noted, since the payoffs are foregone income or costs, the inferred median values of $r^*$ are the defendant’s willingness to pay to defer the monetary cost of punishment by incarceration by a month/$ of income. For example, in the case of murder given a value of $P = 0.3$, for those defendants who pleaded guilty the best estimate of their maximum willingness to pay to defer certain punishment by a month is $0.33c/$ of income, and for those defendants who elected to go to trial, this is the most likely lower bound estimate of their maximum willingness to pay to defer uncertain punishment. Quite clearly, these are also estimates of the disutility of certain and uncertain incarceration respectively for this group of defendants, who were processed in the criminal justice system. Identical interpretations for the other two offences follow and Table 5 summarises the estimates for all three offences and values of $P$. 
Table 5: Summary: Willingness to pay to defer the monetary cost of certain/uncertain punishment per dollar of income by a month.

<table>
<thead>
<tr>
<th>Offence</th>
<th>0.3</th>
<th>0.5</th>
<th>0.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Murder.</td>
<td>0.33c/$1</td>
<td>0.28c/$1</td>
<td>0.17c/$1</td>
</tr>
<tr>
<td>Aggravated Robbery</td>
<td>0.50c/$1</td>
<td>0.44c/$1</td>
<td>0.38c/$1</td>
</tr>
<tr>
<td>Burglary</td>
<td>0.58c/$1</td>
<td>0.50c/$1</td>
<td>0.36c/$1</td>
</tr>
</tbody>
</table>

A second way of construing our results is that they represent implicit premiums over and above the unskilled wage rate for each of the three offences, and they provide further evidence of significant returns to some criminal offences against property, in this instance aggravated robbery and burglary. For example, according to Stevenson et. al. (2001) the estimated median value of weekly earnings for burglars in NSW is $2,000 yielding an annual income of $104,000. Our results for burglary in particular can be thought of as supplementing and supporting these authors’ estimates. The estimation of returns from different offences and why they persist is an important avenue of future research into the formulation of crime reduction policies.
While we have followed tradition and called the $r$ parameter in our expressions a discount rate and suggested two interpretations, it is important to note that our estimates of $r$ are most unlikely to measure these individuals’ rates of time preference for the multitude of other choices, which they have confronted and will confront throughout their lives. Frederick et. al. (2002) after reviewing all of the studies, which purport to measure implicit discount rates as reported by the median or mean respondent, and finding tremendous variability skewed toward high discounting well above market interest rates, ponder the meaning of time preference. They reject the notion reflected in the simple DU model that a person’s time preference can be captured by a single discount rate. Rather, studies purporting to measure time preference capture a multitude of distinct considerations and there is no reason to expect discount rates to be consistent across different choices.

Analytically, the authors suggest that time preference should be unbundled into more fundamental human motives, impulsivity, compulsivity and inhibition. These can be measured reliably and predict human behaviours in a highly sensible way. For example, compulsivity predicts repetitive behaviours and impulsivity best predicts visceral behaviour such as aggressive behaviour on the road. Both of these are also highly significant predictors of money related behaviour. In the case
of our study where offenders confront certain or uncertain punishment and foregoing legal or illegal income, we have most likely captured in a broad sense and have been able to convert to monetary willingness to pay measures, the aftermath of human impulsivity and compulsivity.
References


