This paper describes the methodology used by researchers from the Department of Economics at the University of Utah, in conjunction with the Commission on Criminal & Juvenile Justice, to create Utah's Cost-Benefit Model, including sources of data and descriptions of statistical methods used.

Utah Commission on Criminal and Juvenile Justice

Introduction to an Econometric Cost-Benefit Approach

Richard Fowles, Ph.D. & Sofia Nyström
University of Utah, Department of Economics

In 2010, Utah taxpayers' spent over $1.3 billion relating to criminal justice in areas of police, courts, and corrections.[1] This $470 per capita expense is an important and necessary component of public safety cost and is below what other states spend on a per capita level.[2] Nonetheless, with shrinking budgets in the face of slow economic growth, Utah policy makers must be increasingly diligent when making decisions regarding how taxpayers' monies are spent to enhance public safety and reduce crime. This report outlines a new method that provides policy makers with an instrument to better assess the economic efficacy of crime-reducing programs, particularly on those designed to reduce recidivism. It is based on two economic metrics: a taxpayer benefit-cost ratio and a direct measure of the cost per unit of recidivism reduction. Adept decisions by policy makers require that benefit and risk simultaneously be taken into consideration when choosing among recidivism reduction programs. This tool helps accomplish that goal.

This instrument expands and updates Utah's 2005 Cost-Benefit Study published by the Commission on Criminal and Juvenile Justice. It is based on new data designed to accomplish the following objectives:

- To be easily updatable when new information becomes available.
- To flexibly accommodate newly introduced programs.
- To provide an intuitive graphical display of relevant economic information including taxpayer benefit and risk.
- To allow users to readily compare programs designed to provide similar services.

[1] Cost estimate includes expenditures on the state, county, and municipality level. State expenditures were obtained from the Governor's Office of Planning & Budget and include total operating budgets for FY 2010 for public safety, adult corrections, juvenile justice, board of pardons, and the attorney general's office. Case load statistics for district courts were obtained for FY 2008 and allowed us to focus on the criminal and traffic (36 percent) portion of expenditures with respect to courts. All county and municipality expenditures were obtained from the Office of the Utah State Auditor. County level expenditures include total operating budgets for sheriff departments, justice courts, attorneys, and jails. Municipality level expenditures include total operating budgets for local police departments, justice courts, and attorneys for 79 of Utah's municipalities. Some civil expenditures are included for attorneys on the state, county, and municipality level and for courts on the county and municipality level.

[2] See Kyckelhahn (2011). In calculating per capita justice expenditures for the United States, the Bureau of Justice Statistics (BJS) includes both criminal and civil police and judicial expenditures. For this study, we consider mainly criminal expenditures.

This briefing paper outlines the new Utah model including an overview of the total cost of crime, why unit costs are an integral part of cost-benefit analyses, how unit costs are measured, and previews the 2012 Utah Cost-Benefit Model. A discussion of sensitivity analysis concludes.

1. Background

Taxpayer costs associated with crime represent a significant portion of Utah's public spending. In 2010, expenditures related to the criminal justice system exceeded $1.3 billion,[3] which is more than one percent of Utah's GDP.[4] More than 80 percent of these expenditures were devoted to police protection and corrections. More specifically, Utah's taxpayers spent more than $300 million on local police departments, which on average exceeded one fourth of General Fund expenditures. When adding police expenditures on the county and state level, expenditures were close to $600 million. Expenditures related to corrections amounted to roughly $525 million.

These elevated justice expenditures will continue to place a burden on Utah's taxpayers. As additional resources are devoted to crime, fewer resources are available to other important sectors such as education and health care. Though the allocation of scarce resources is a dilemma that policy makers always face, these decisions are even more challenging in less than optimal economic conditions. Better understanding how policy makers can lessen this burden while maintaining high levels of public safety is an important issue and motivates this study. This research is designed to provide analysts and policy makers with a cost-benefit tool that allows them to assess the relative economic benefits and risks associated with adopting particular programs in order to make more efficient choices.

The two methods used in this study are based on a traditional cost-benefit approach and a method that compares programs in terms of their direct unit costs to achieve a one percentage point decrease in recidivism. In the next sections the cost-benefit approach is described and then the unit cost of recidivism reduction is explained. Both methods provide point and probabilistically derived range estimates of program efficiency. Range estimates are provided in terms of upper and lower 80 percent probability values in order to account for effect estimation uncertainty.

2. The Unit Cost of Crime

A cost-benefit analysis (CBA) is an economic tool that evaluates the cost and benefits that are associated with investing in various programs and projects. With respect to the criminal justice system, a CBA can provide policy makers with a metric that is aligned with the expected return on tax dollars

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[4] Governor's Office of Planning & Budget, Economic Report to the Governor, FY 2011.

spent when investing in programs that aim to lessen criminal activity. Because reduction in criminal activity is not market priced, estimates of benefits arising from lower crime are required. The basis for a CBA involves the statistical estimation of the unit cost and benefits of crime. The unit benefit is the expected reduction in recidivism as a direct result of a parolee being subject to a treatment program. This is then translated into monetary units upon which comparisons can be made.
The unit cost of crime pertains to both taxpayer and victim costs. Taxpayer costs are *tangible* costs that arise from the criminal justice system. These costs include the cost of police, courts, prosecutors, and corrections. Victim costs can be both *tangible* and *intangible* costs. Examples of tangible victim costs are the direct medical expenses and damage to property subject to victims of crime. Intangible victim costs include pain, suffering, and an overall reduction in a person's quality of life (McCollister et al., 2010). These indirect expenditures are challenging to measure and remain a contentious topic. Although, when intangible victim costs that pertain to violent crimes are comprehensively measured, they tend to significantly surpass both taxpayer costs and tangible victim costs. For a comprehensive overview of victim costs and how these costs are estimated, see Miller et al. (1996) and McCollister et al. (2010).

3. Estimation of the Unit Cost of Crime

3.1 Methodology and Data

This is an update of a Cost of Crime study conducted by Fowles et al. (2005) and aims to serve as an easily maintainable and flexible managerial model to assist policy makers and analysts required to choose among competing programs. A primary update is the acquisition of extensive Utah data on police and court costs. In the earlier study, data were collected via a questionnaire of a sample of police, courts, and prosecutors operating costs. This study is based on data from the Utah State Auditor's Office, Utah Administrative Office of the Courts, Department of Corrections and the Governor's Office of Planning & Budget and is described below.

Likely outcomes of a program choice are expressed in terms of an economic benefit/cost ratio with associated risk bands. The unit costs of the criminal justice system are estimated using Utah data and focus on the Uniform Crime Report's definition of Part 1 Crime. Victim costs are limited to tangible costs and uses conservative estimates from McCollister et al. (2010). Regression analyses with respect to police and prosecution were performed using R statistical software, version 2.14.2. Additionally, the model directly assesses programs' unit costs in terms of the price per percentage unit of recidivism reduction. This metric does not require estimation of the unit costs of crime and thus is based on a less restrictive set of assumptions. It does not, however, allow for assessing tangible and intangible benefits of crime reduction. Nonetheless, it does provide a robust way to compare program costs.

3.2 Police and Sheriffs

Detailed cost data were obtained from the Office of the Utah State Auditor. Total operating expenses related to county sheriff and local police departments were extracted from Utah's 29 counties and 79

of its municipalities' annual budgets between 2005 and 2010.[5] These expenditures were put into constant $2010 and aligned with arrest data obtained from the Bureau of Criminal Investigation (BCI). A large sample was used in the estimation of marginal cost (n = 86, N = 516). Various model specifications were explored.[6] A random coefficient model was selected based on the following functional form:

$$COST = \beta_0 + \beta_1 VIOLENT + \beta_2 PROPERTY + \beta_3 POP + \varepsilon^*$$

where COST denotes total operating expenditures for county sheriff and local police departments. VIOLENT represents the number of violent crimes (murder, rape, aggravated assault, and robbery), PROPERTY denotes the number of property crimes (larceny, arson[7], burglary, and motor vehicle theft) and POP is a population variable. β_0 is the intercept term and β_1 and β_2 denote the marginal costs of violent and property crimes. $\varepsilon^* = s + d + \varepsilon$, where s represents the random effect of agencies with respect to β_0, d represents the random effect of agencies with respect β_1 and β_2, and ε denotes the error term.

3.3 Courts and Prosecutors

In the state of Utah, felony crimes are primarily prosecuted by county attorneys in the district courts. With respect to the unit cost of courts, the number of weighted minutes required for each case type and the total case filing count were obtained from the Administrative Office of the Courts for FY 2011. These minutes are, if effect, true marginal costs but are dimensioned in time magnitudes and not in monetary units. However, budget information allowed for the calculation of dollars per minute estimates.[8] These dollars per minute estimates were then multiplied by the number of weighted minutes needed for two levels of felony crimes,[9] which directly gave us the marginal cost for courts.

The marginal cost of prosecution was estimated using a similar technique as for sheriff and local police departments. Total annual operating budgets for Utah's 29 county prosecutors[10] were obtained from the Office of the Utah State Auditor between 2005 and 2010. These expenses were put into constant $2010 and aligned with arrest data obtained from the BCI.[11] A large sample (n = 24, N = 144) was used

[5] The relatively few missing data points were imputed using standard techniques including linear interpolation and averaging.

[6] Models explored and considered included fixed effects, first difference, pooled OLS, random coefficients, and Cobb-Douglas logarithmic models. Various binary variables were considered including a population categorical factor that separated the Wasatch Front areas from the rest of Utah. Sensitivity analyses were performed based on regression results to assure that taxpayer benefit-cost ratios would not be heavily dependent on model choice.

[7] The unit cost of arson is not presented in the final table.

[8] The total operating budget for the district courts was obtained from the Administrative Office of the Courts.

[9] Three levels of felony crimes (felony 1st, felony 2nd, and felony capital) were considered. Capital felony was excluded since it represented less than .07 percent of these three levels of felony crimes. Hence, this study reflects the modal rather than the extreme with respect to murder. Felony 1st and felony 2nd were translated to violent and property crimes. Here we assume that felony 1st and felony 2nd is correlated with the UCR's definition of violent and property crimes. In the future, it would be efficacious to obtain information that breaks this down by offense type.

[10] Because of data inconsistencies, the operating budgets for public defenders were not included.

[11] Here we assume that the number of arrests have a strong correlation with the filing count within the district courts.

for the final regression analysis. Various regression models were explored.[12] A pooled ordinary least square (OLS) model was adopted based on the following form:

$$COST = \beta_0 + \beta_1 MURDER + \beta_2 VIOLENT + \beta_3 PROPERTY + \beta_4 POP + \varepsilon$$

where COST denotes total operating costs for county prosecutors, MURDER represents the total number of murders, and VIOLENT represents the number of violent crimes (excluding murder). β_1, β_2, and β_3 denote the marginal cost of murder, violent, and property crimes respectively. β_0 is the intercept term and ε denotes the error term. The marginal cost of prosecution was then merged with the unit cost of courts to provide a combined unit cost estimate for courts and prosecutors in the state of Utah.

3.4 Corrections

This study is limited to the cost of adult incarceration. The average annual cost of a prisoner was obtained from the Utah Department of Corrections[13] and was used as a constant across all Part 1 Crimes. The average annual cost per inmate was then multiplied with the probability of each indexed crime leading to incarceration to derive the final unit cost estimate with respect to corrections.

The unit cost estimates by function are depicted in Table 1. The unit costs of police, courts, prosecution, and corrections were combined to form a total taxpayer unit cost. The taxpayer and victim unit costs are illustrated in Table 2.

Table 1 – Utah Unit Costs by Function ($)

Crime Type	Police	Courts and Prosecutors	Corrections
Murder	4,509	62,037	30,595
Rape	4,509	5,443	30,595
Robbery	4,509	5,443	30,595
Aggravated Assault	4,509	5,443	30,595
Burglary	880	2,284	30,595
Larceny/Theft	880	2,284	30,595
Motor Vehicle Theft	880	2,284	30,595

[12] Models that were explored included various forms of fixed effects, first difference, pooled OLS, random coefficient, and Cobb Douglas models. The reported marginal cost of prosecution is based on a mixture model.
[13] Utah Department of Corrections, Division of Institutional Operations, Cost Per Day Report, FY 2009.

Table 2 – Utah Unit Taxpayer & Victim Costs ($)

Crime Type	Taxpayer	Victim[a]	Total
Murder	96,530	737,517	834,047
Rape	31,369	5,556	36,925
Robbery	23,414	3,299	26,713
Aggravated Assault	20,355	8,700	29,055
Burglary	10,506	1,362	11,868
Larceny/Theft	10,506	480	10,986
Motor Vehicle Theft	8,671	6,114	14,785

[a] Victim costs are borrowed from McCollister et al. (2010) and are limited to tangible costs. The Utah 2012 study does not use McCollister's crime career costs.

4. The Utah 2012 Cost-Benefit Model

The Utah 2012 cost-benefit model works as follows. Taxpayer unit costs are multiplied by the expected conditional probabilities that given release, an offender will recidivate.[14] This provides the expected base cost of recidivism without a parolee given access to the treatment program under consideration. The expected cost of recidivism (with the program) is then calculated by incorporating the effect size.[15] The Benefit-Cost Ratio (BCR) is derived by subtracting the expected cost of recidivism (no treatment) with the expected cost of recidivism (given treatment) and then dividing the remaining sum by the unit cost of the program. A BCR greater than one indicates the potential for a positive return on tax dollars spent while a BCR less than one implies a more costly program. Both point and range estimates for each of the participating programs are provided.

It is important to note that this study aims to provide policy makers with information that highlights the programs that are *grouped within a broad category of related programs* that gives the largest return on tax dollars spent. It might well be the case that necessary programs viewed as a group do have BCRs less than one. The BCR metric should only be used to compare programs within a reasonable classification. An alternative procedure (which requires far fewer assumptions than a BCR) is to evaluate the cost per unit effect. The cost per unit effect simply illustrates the cost per percentage effect and can be a valuable interpretation of the cost and benefits that are associated with investing in an intervention program.

The *taxpayer effect* is an important part of the Utah cost-benefit model and depicts the expected number of dollars saved (or lost) for each program participant. It is derived by subtracting the expected cost of recidivism (no program) by the expected cost of recidivism (with program) and the unit cost of the program. The *victim effect* is calculated in a similar manner as the taxpayer effect. Adding the taxpayer effect with the victim effect produces the total expected effect of investing in a particular program (per program participant).

[14] This was done with Bayes' theorem across all indexed crimes based on data obtained from the Bureau of Justice Statistics and calibrated with 2011 data from the Utah Department of Corrections based on 3-year recidivism statistics.
[15] The effect size is the anticipated percentage reduction in recidivism that is due to the program's implementation.

5. Sensitivity Analysis

Model uncertainty is inherent in all statistical analyses.[16] Various statistical tests can be performed to discern model misspecification but typically are based on the assumption that there is a true model. [17] With advances in computing power, it is now very inexpensive to explore the model space and to measure how influential model choice is on a focus statistic. This exploration is called sensitivity analysis. In this study, the focus statistic is the BCR. Sensitivity analyses were performed over the regression models discussed above. These analyses included monitoring how the BCR statistic responded to forcing the magnitude of the unit cost estimate for each crime type by 50, 100, and 200 percent. Sensitivity analysis concluded that our estimates were *not sensitive* to these alterations; large changes in unit costs of crime did not translate to large changes in the BCR statistic. This result is due to the fact that the expected costs of recidivism average overall crime types and effects of a particular crime type are attenuated by their associated probabilities.

[16] It should be noted that regression models utilized in this research are designed not for inference, but to summarize the multivariate relationship between crime and taxpayer criminal justice expenditures. As mentioned earlier, regression specification uncertainty leads to the invalidation of the use of inferential statistics, such p-values or t-statistics. These statistics are only valid conditional on the assumption that the considered regression is true. Utilizing observational, as opposed to experiment data, such assumptions are rarely, if ever, valid (see, for example, Hill (1985)). In lieu of providing such measures, this research instead pays attention to sensitivity analysis relating to the primary metric of interest: the benefit-cost ratio.

[17] See, for example, Leamer (1978).

References

B. M. Hill (1985). Some Subjective Considerations in the Selection of Models. *Econometric Reviews*, 4, 191-246.

E. E. Leamer (1978). *Specification Searches: Ad Hoc Inference with Nonexperimental Data.* New York: Wiley & Sons.

K. E. McCollister, M. T. French, & H. Fang (2010). The Cost of Crime to Society: New Crime-Specific Estimates for Policy and Program Evaluation. *Drug and Alcohol Dependence, 108*(1), 98-109.

M. A. Cohen (2005). *The Costs of Crime and Justice*. New York: Routledge.

R. Fowles, E. C. Byrnes, & A. O. Hickert (2005). The Cost of Crime: A Cost/Benefit Tool For Analyzing Utah Criminal Justice Program Effectiveness. Utah Commission on Criminal and Juvenile Justice & the Criminal and Juvenile Justice Consortium, University of Utah.

S. Aos & E. Drake (2010). WSIPP's Benefit-Cost Tool for States: Examining Policy Options in Sentencing and Corrections. Washington Institute for Public Policy.

T. Kyckelhahn (2011). Justice Expenditures and Employment, FY 1982-2007-Statistical Tables. U.S. Department of Justice. Bureau of Justice Statistics.

T. R. Miller, M. A. Cohen, & B. Wiersema (1996). *Victim Costs and Consequences: A New Look*. Research Report. Washington DC: National Institute of Justice.