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Assessing the Relative Benefits of Incarceration: The Overall Change Over the Previous Decades and the Benefits on the Margin

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ASSESSING THE RELATIVE BENEFITS OF INCARCERATION: THE OVERALL CHANGE OVER THE PREVIOUS DECADES AND THE BENEFITS ON THE MARGIN

Abstract

A given level of incarceration will pass a traditional cost-benefit test only if the marginal benefit from the last prisoner incarcerated equals the marginal cost of locking him up. This paper shows that the three most critical values that need to be estimated to implement such a cost-benefit analysis are 1) the elasticity of crime with respect to incarceration, 2) the dollar value of the crime avoided by the marginal incarceration, and 3) the social costs inflicted by that marginal incarceration (in terms of locking up the prisoner, losing his or her productive contributions if free, and other costs imposed on the inmate and society resulting from incarceration). Depending on the values chosen for these three items, enormously different conclusions about the optimal level of incarceration are possible. Even if the policy of incarceration meets this cost-benefit test, it is still possible that society would benefit from a reallocation of resources away from incarceration to other modes of crime-fighting. For example, spending more on police and less on prisons might well be advisable. Moreover, under certain circumstances, targeted social spending would seem to be capable of generating similar crime reductions at lower social cost than incarceration.

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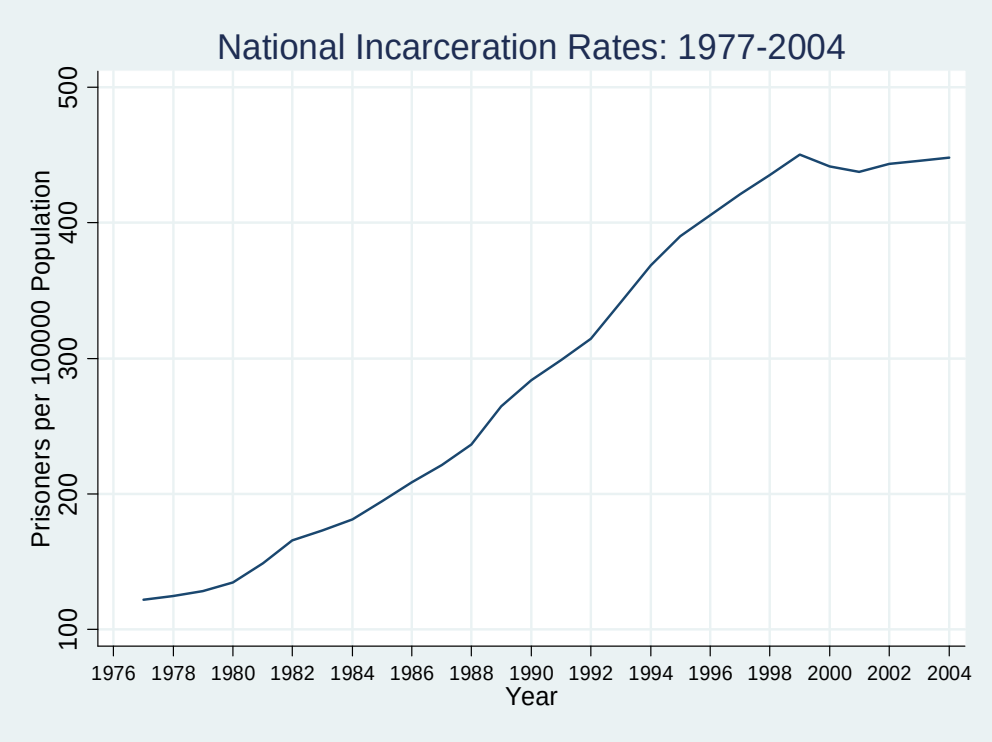
I. Introduction[2]

In June 1956 Dwight Eisenhower signed a bill launching the interstate highway system in the United States. Over the next twenty years, close to 40,000 miles of super highways were built across America. As the era of massive federal highway building came to an end in the mid-1970s, it was replaced by the next massive public works project in America: the boom in prison construction. Just as scholars have debated the extent and value of the stimulus to economic growth that followed from the $114 billion spent on road construction, there has been spirited debate over the value of the comparable expenditure spent in building the vast array of roughly one-thousand-person prisons and other facilities that now warehouse over 2.1 million Americans in federal or state prisons or local jails (Harrison and Beck 2005). After three decades of prison expansion, approximately 700 out of 100,000 Americans are behind bars; over the period from 1933 and 1973, this figure oscillated between approximately 100 and 120 per 100,000.[3] Except for Russia, which is only somewhat behind the United States, no other country in Europe or Asia incarcerates its citizens at even half the rate of the U.S.[4] Figure 1 illustrates the steady growth in the U.S. incarceration rate from the mid-1970s until the leveling off at the end of the twentieth century.

[2] The introductory section draws heavily from Donohue (2007).
[3] Bernard Harcourt (2007) shows that prior to the massive deinstitutionalization movement in the late 1960s, roughly the same proportion of Americans were institutionalized as today, but in that period most were kept in state mental hospitals instead of jails and prisons.
[4] The rate of incarceration in Russia is 628 per 100,000. International Centre for Prison Studies, 2006/2007.

FIGURE 1



Source: Bureau of Justice Statistics (2005).
Note: This graph only includes state prisoners (excluding local jail inmates and federal prisoners).

A. The Debate Over The Incarceration Boom

The debate over the value, impact, and wisdom of the American experiment in mass incarceration has been highly polarized: one camp strongly opposes the incarceration increase, while the other contends that, if anything, the country would benefit from even further growth in the prison population (Donohue 2007; Zimring and Hawkins 1988; DiIulio 1996). Some ardent supporters of incarceration rely on Gary Becker's (1968) work on the economics of crime to justify their claims. In Becker's model, increases in the cost of criminal activity will lead a subset of potential criminals—who he argues will rationally weigh the costs and the benefits of potential criminal acts—to choose not to commit crimes. Though Becker did not favor mass incarceration as the optimal strategy for deterring crime, some have used Becker's theory to support increased incarceration, and in many states this approach has become the centerpiece of their anti-crime

policy. Given the dramatic decline in crime over the last decade and a half, supporters of mass incarceration contend that the high cost of incarceration has been well worth the price.

Critics of the rise in incarceration disagree: they contend that incarceration's net effect is not crime reducing, or they argue that the attendant social costs have not been fully appreciated. Some opponents of mass incarceration argue that there is little proof that increased incarceration deters crime. They argue that, while incapacitation may temporarily prevent criminal activity, the negative consequences for those who are incarcerated may enhance subsequent levels of criminal misconduct and negatively impact the communities to which inmates belong.[5] An innovative study by economists Keith Chen and Jesse Shapiro (2007) raises the possibility that, rather than deterring discharged inmates from future criminality, harsher prison conditions may actually stimulate further criminal activity. Chen and Shapiro exploit the fact that prisoners in their sample are assigned to prisons based on a security-level score to assess the effects of prison conditions on prisoners whose scores lie close to the cutoff points. Inmates on opposite sides of the dividing line are relatively equal in their initial criminality characteristics but are exposed to substantially different prison conditions. Chen and Shapiro, using an admittedly with a small sample, find

> no evidence that harsher confinement conditions reduce recidivism. If anything, our estimates suggest that moving an inmate over a cutoff that increases his assigned security level from minimum to above-minimum security tends to increase his likelihood of rearrest following release…. [Moreover,] if all inmates were housed in above-minimum rather than minimum security facilities, they would be 41 percentage points more likely to be re-arrested in the year following release (3, 22).

Political scientist Amy E. Lerman (chapter 5, this volume) provides a psychological explanation for the Chen and Shapiro's finding of increased rates of recidivism. Using a similar empirical approach based on assignment to higher-security prisons in California, Lerman finds that, for those with more limited prior criminal involvement, assignment to a higher-security prison has a criminogenic influence on attitudes relating to anger and violence. These two important papers underscore an essential point: crime is too complex a phenomenon to expect a

[5] The "incapacitation effect" refers to the idea that imprisoning an individual curtails his criminal activity for the duration of his sentence.

simple "Beckerian" price-theoretic model to have universal explanatory power.[6] Not only can "raising the price" generate unintended negative or offsetting effects, but also, even if Becker's theory is directionally correct, it offers little insight on the five questions that are the lynchpins of determining whether U.S. incarceration levels are optimal:

1. What is the magnitude of any incarceration-induced drop in crime?

2. What is the monetized value of this decrease in crime?

3. What is the marginal cost of incarceration needed to generate these marginal benefits in crime reduction?

4. Does this cost-benefit calculus suggest that a certain level of incarceration is efficient?

5. Could a reallocation of resources to alternative crime fighting strategies achieve the same benefits at lower social costs?

The current debate on incarceration has been polarized in part because the empirical literature has not yet generated clear and unequivocal answers to these key questions.

B. The Core Concepts Underlying the Optimal Level of Incarceration

A fundamental concept in estimating the optimal level of incarceration is the elasticity of crime with respect to incarceration—that is, the percentage by which crime will change in response to a percent increase in incarceration (Donohue 2005). More specifically, this elasticity, often symbolized by η, can be defined as:

$$[1]\ \eta = (\%\Delta C)/ (\%\Delta P)= (\Delta C/C) / (\Delta P/P),$$

[6] Chen and Shapiro's study will need to be replicated on a larger data set to confirm the finding that as one moves from being the "worst prisoner" in a lower-security prison to the "best prisoner" in a higher-security prison, recidivism rates rise. In addition, additional research will be needed to identify whether the psychological effects that Lerman identifies are the product of the harsher prison experience, which presumably can be mitigated, albeit at some greater risk of escape or interprison violence; or whether they are the presence of the relatively harsher fellow inmates, whose influence may be harder to mitigate.

where C stands for the number of crimes, and P stands for the number of prison inmates. Once we have an estimate of η, we can continue to the second step in estimating marginal benefits: calculating the number of crimes prevented by incarcerating the marginal prisoner (that is, the last offender entering the prison system). In the literature, this value is usually known as λ, the marginal effectiveness of incarceration (Spelman 2000b).[7] So, if we want the effectiveness in decreasing crime of incarcerating the last criminal, we let $\Delta P = 1$ in equation [1], which yields:

$$[2] \qquad \lambda_{reported} = \Delta C = \eta * (C/P).$$

Since estimates of η usually rely on FBI data on *reported* crimes, equation [2] only captures incarceration's impact on *reported* crimes, as opposed to *actual* ones. Accordingly, we need to adjust equation [2] to account for nonreporting:

$$[3] \quad \lambda_{total} = \lambda_{reported} / R = (\eta/R) * (C/P),$$

where R represents the fraction of crimes that are reported.[8] To continue, if we multiply λ_{total} by what each prevented crime would have cost society if it had been committed, we get a monetary estimate of the marginal benefit (MB) of incarceration (that is, the benefit from locking up the last offender incarcerated):

$$[4] \quad MB = \lambda_{total} * CPC = (\eta/R) * (C/P) * CPC,$$

[7] In bottom-up studies, λ usually represents criminals' yearly offense rate (i.e., how many crimes they commit per year), which is a slightly more narrow concept that what we call "marginal effectiveness" here (since we also include any deterrent effect of incarceration on crime).

[8] Conversely, studies that estimate λ using inmate surveys and self-reports, often called incapacitation models, should not be adjusted for reporting. Survey-based estimates are unaffected by whether a crime is or is not reported. It is the econometric studies that use FBI *reported* crime data that must be adjusted.

where CPC stands for average social cost of a single FBI index I crime. Accordingly, MB represents the aggregate monetary cost of all crime prevented by the marginal incarceration. Finally, we can compare this MB to the marginal costs of incarceration (that is, the costs of imprisoning the last offender). If the marginal benefits exceed the marginal costs, then this simple cost-benefit calculus posits that incarcerating the last offender was cost effective.

Although conceptually straightforward, carrying out a cost-benefit analysis is complicated by the fact that we do not have precise estimates of η, λ, nor of the costs of crime and incarceration. Section II will discuss the existing estimates of the elasticity of crime with respect to incarceration (η) and the number of crime averted by locking up one more prisoner (λ), which is derived automatically from the elasticity for any given level of incarceration. Importantly, λ will be falling as the level of incarceration grows even if η remains constant; this implies that the marginal benefits of incarceration fall as incarceration grows. Next, we will examine how to monetarily value the reduction in crime that results from increased incarceration. Many vexing issues exist. For example, what is a social cost that should count in this calculus versus what is a mere transfer that should not count? How does one value intangibles such as pain and fear of crime? Are the social costs of murder profitably estimated by a single per-murder cost or are certain murders (perhaps in battles between criminals) less socially costly? After discussing the benefits emerging from increased incarceration, we then explore the costs of incarceration—from the mundane (the operating costs of a prison) to the philosophical (whether the lost utility and lost earnings of prisoners should count as social costs). We conclude by discussing ways in which reallocation of sums spent on incarceration to other crime-fighting approaches might be socially advantageous.

II. Estimates of the Elasticity of Crime with Respect to Incarceration, η

In the next two subsections, we discuss prior estimates of the elasticity of crime with respect to incarceration, and then offer our best estimates of this elasticity.

A. Literature Overview

Two different approaches have been used to provide estimates of the elasticity of crime with respect to incarceration. The first approach—what economist William Spelman (2000a) calls "bottom-up" research—has mainly focused on estimating λ by surveying criminal offenders. Researchers following this approach calculate estimates of the annual crime rate of active offenders and then use this rate to determine λ_{total}. Once this value has been obtained, one can use the formulas set forth in the previous section to estimate η, the elasticity of the crime rate with respect to the imprisonment rate.

In interpreting the estimates from this approach, it is important to note that there are at least two distinct mechanisms through which incarceration affects crime: incapacitation and deterrence. The first mechanism affects crime rates by removing criminals from society so that they are physically unable to commit more crimes.[9] The second mechanism assumes that the threat of incarceration increases the cost to the perpetrator of committing crime, thus deterring potential criminals from engaging in some criminal activity. Bottom-up research only accounts for the effect of incapacitation. In cases where there is a deterrent effect, bottom-up estimates of λ underestimate the marginal effectiveness of incarceration.[10]

A second approach uses econometric methods to directly estimate the elasticity of crime with respect to incarceration. Typically, the researcher runs regressions on large panel databases

[9] My colleague Ian Ayres also notes that as one locks up more individuals, one gets another crime-reducing benefit by removing a group that is often at high likelihood for crime victimization. To the extent, however, that we merely shift the location of their victimization from the street to the prison (where it may be less likely to be reported), we may be exaggerating the crime-reduction benefits of incarceration. While solitary confinement is an effective incapacitative strategy to protect the inmate from crimes by others and protect others from crimes by the inmate, most prisoners are not subjected to this treatment but mix with other prisoners on a daily basis. Considerable unreported criminal violence is inflicted on inmates during these prison interactions.

[10] Bottom-up estimates must also be adjusted downward to account for the replacement rate, which is the rate at which others take on the criminal activity of individuals who have been incarcerated. For example, if a gang member is incarcerated, he may simply be replaced by someone else who commits the same amount of crime. With perfect replacement, a properly adjusted bottom-up estimate of λ should be zero. For market-mediated crimes, such as selling illegal drugs or prostitution, any effort to jail suppliers will lead to wage increases designed to entice replacement workers.

designed to explain the array of factors that influence crime, including the level of incarceration. Although this approach does not permit separate identification of the deterrence and incapacitation effects, it captures both: assuming the models are correct, they provide an overall estimate of the impact of incarceration on crime (Liedka, Piehl and Useem 2006). The following table summarizes the η estimates of some of the most influential papers:

TABLE 1

Estimates of the Elasticity of Crime with Respect to Incarceration

Elasticity Estimates			Model Description	Comments
Spelman (1994)				
All index crimes		-0.16	Incapacitation Model: based on self-reported criminal behavior of inmates	* Does not capture any potential effect from deterrence
90% Confidence Interval		[-.12, -.20]		*Based primary on Rand's 1978 prison and jail inmate surveys in California, Michigan, and Texas
				*Incapacitation models usually come up with estimates from about -.10 to -.30 (Spelman 2000)
Marvell and Moody (1994)				
All index crimes		-.16	State-Year Panel Data: 49 states, 1971-89 (1973-1989 for some specifications)	* For a variety of reasons, they see their estimates as a lower bound (p.133)
Violent Crime	(95% CI)	-.06 ± .11^		* The -.16 estimate becomes -.205 if they run the regression for 1978-1989 (a change they attribute to better data for later period.)
Property Crime	(95% CI)	-.17 ± .06^		
Murder		-.065 (.085)		* After running Granger test of causality, they conclude that simultaneity is not a major problem. Nevertheless, in their conclusion, they acknowledge that simultaneity cannot be totally ruled out, so their figures may under-estimate the true effect of incarceration
Rape		-.113* (.052)		
Assault		-.056 (.053)		
Robbery		-.260 **(.059)		
Burglary		-.253** (.031)		*Wilson (1994) is also consistent with these results
Larceny		-.138 **(.026)		
Vehicle Theft		-.200** (.048)		
Levitt (1996)				
All index crimes		-.31^	State-Year Panel Data: 50 states and DC, 1971-1993	*Accounts for simultaneity of crime and incarceration by using prison overcrowding litigations as an instrumental variable (regressions actually include 10 indicator variables corresponding to changes in prison overcrowding litigation).
Violent Crimes	(95% CI)	-.38* ± .36		
Property Crimes	(95% CI)	-.26* ± .24		
Murder		-.147 (.373)		* Since instrument is not perfect, standard errors become much larger.
Rape		-.246 (.250)		
Assault		-.410(.249)		
Robbery		-.703* (.309)		*Results are corroborated by Witt and Witte (2000) using national time series
Burglary		-.401*(.172)		
Larceny		-.277 (.147)		
Vehicle Theft		-.259 (.235)		

Becsi (1999)				
All index crimes		-.087** (.015)	State-Year Panel Data: 50 states and DC, 1971-1994	* Accounts for simultaneity of crime and incarceration * Runs additional regressions only on murder and vehicle theft because data for these variables is better (less underreporting)
Violent Crimes		-.046* (.022)		
Property Crimes		-.091** (.015)		
Murder		-.063 (.034)		
Vehicle Theft		-.198**(.032)		
Spelman (2000)				
All index crimes		-.40**(.15)	State-Year Panel Data: 50 states and DC, 1971-1997	* Accounts for simultaneity using prison over-crowding litigation as an instrument, using Levitt (1996).. * He also tests a nonconstant elasticity model and confirms his hypothesis that the effect of incarceration grows with scale (results shown here are for constant elasticity model).
Spelman (2005)				
Violent Crimes	(state avg.)	-.44	Texas: County-Level Panel Data, 1990-2000	*Study is based on Texas counties, raising issues of external validity. Texas prison expansion was massive, even in comparison to a large national average. *There are several advantages to using county-level data. For example, he can include local jail inmates. *Addresses simultaneity through an instrumental variable approach. His instruments are three indexed variables: (1) law enforcement resources, (2) prosecutor and correctional resources, and (3) police civilianization.
	90% CI	[-.13, -.75]		
Property Crimes	(state avg.)	-.26		
	90% CI	[-.12, -.41]		
Liedka, Piehl, and Useem (2006)				
All index crimes			State Panel Data: 50 states plus DC: 1972-2000	* The elasticity estimate comes from their quadratic elasticity model (see model 1, table 3). In order to get a specific value, we evaluated LPU's results at various incarceration levels. The linear incarceration variable is statistically significant at the 1% level and the quadratic at the 5% level. * Do not account for simultaneity, since they find no evidence that this is a problem. *For reference, they estimate a constant elasticity model, resulting in an estimate of -.072(.044) (see Model 2, Table 2)
evaluated at percentiles using all state-year observations of incarceration from 1977-2004	50th Percentile	-0.03		
	75th Percentile	.016		
evaluated at percentiles using state-year observations for 2004 only	50th Percentile	.025		
	75th Percentile	.043		

Johnson and Raphael (2007)			
Violent Crimes	-.21		
Property Crimes	-.41		* Results shown are from their second IV specification (which includes state and year fixed effects and generates the *largest* elasticity estimates). Hence, these results can be interpreted as an upper bound.
Murder	-0.38		
Rape	-0.44	State Panel Data: 50 states plus DC: 1978-2004	
Assault	0.11		
Robbery	-0.39		*Since their model is not a log-log model, their regression estimates must be evaluated at a specific prisoner-to-crime ratio to derive an elasticity. The authors choose the sample mean for their evaluation. For our purposes, evaluating the results at the 2005 prisoner-to-crime ration is more appropriate.
Burglary	-0.62		
Larceny	-0.32		
Vehicle	-0.50		

Source: Author's compilation.
Note: Estimates denoted with ^ come directly from Table 1 in Spelman (2005) and not from the original paper.
** statistically significant at the 1% level, * statistically significant at the 5% level [two-tailed]; values in parentheses are coefficients' standard errors.

A review of table 1 reveals a disappointing truth for policymakers: the estimates of the elasticity of crime with respect to incarceration do not tightly cluster around a single number, but range considerably. The table provides an array of general crime elasticity estimates, as well as property- and violent-crime-specific estimates and even individual crime elasticities. At the high end (in absolute value), we see estimates of -0.70 for robbery (Levitt) and -0.62 for burglary (Johnson and Raphael). At the low end, sociologist Raymond Liedka, economist Anne Piehl, and sociologist Burt Useem (2006) actually suggest that additional incarcerations beyond the current level will only increase crime (which they attribute to the criminogenic influence of mass incarceration).

As is discussed in further detail in appendix A, the large variation occurs because the various studies are conducted using different econometric approaches and specifications for different data periods. The timing issue is relevant to the important question of whether the

elasticity of crime with respect to incarceration is constant over the last thirty years or whether it has changed as the prison population has swelled over time. Note that a constant elasticity does not mean that the impact on crime from increasing the prison population by one inmate (that is, the marginal benefit of incarceration) will be constant. Remember that the elasticity tells us how much crime will change when the prison population rises by 1 percent. This means that as the prison population rises over time, a single additional inmate will represent a steadily diminishing percentage increase in the level of incarceration. At the same time, as crime falls from the increasing levels of incarceration, a certain percentage decline in crime will imply fewer and fewer crimes averted. Put starkly, a 1 percent drop in crime averts 1 million criminal acts; when there are only 100 crimes, a 1 percent drop in crime avoids one criminal act.

TABLE 2

Marginal Effects on the Number of Index I Crimes From Increased Incarceration Using Constant Elasticities of Crime with Respect to Incarceration (From Five Studies), 1977 - 2005

		Number of Crimes "Averted" by Incarcerating One Additional Prisoner			
Study	**η**	1977	1987	1997	2005
Spelman (1994)	-0.160	-17	-10	-5	-4
Marvell and Moody (1994)	-0.160	-17	-10	-5	-4
Levitt (1996)	-0.310	-32	-20	-9	-7
Becsi (1999)	-0.087	-9	-6	-3	-2
Spelman (2000)	-0.400	-42	-26	-12	-9
Total Number of Crimes		26,780,518	33,235,831	32,993,370	28,892,802
Total Number of State Prisoners		256,806	521,289	1,099,347	1,259,905

Note: The figures listed for each year's crime total are adjusted upward to account for underreporting, as shown in appendix E (FBI 2006). The expected drop in crime from additional increments of incarceration has fallen sharply since 1977.

To illustrate this point for a given elasticity, we can use equation [3] above to compute the number of crimes averted by an increase of one prisoner for differing levels of incarceration and crime. Table 2 illustrates the marginal impact on crime that emanates from five different constant elasticity estimates from table 1, and it shows how the number of crimes averted falls over time. The rows of the table illustrate the impact of the range of constant elasticity estimates as we move from 1977—when the level of crime was below 27 million and roughly 250,000 individuals were incarcerated in state prisons in the U.S.—to 2005—when there were about 29 million crimes and 1 million more inmates were behind bars than there were in 1977. For economist Zsolt Becsi's (1999) elasticity estimate of -0.087 (row 4, table 2), one sees that an added prisoner in 1977 would be expected to lead to nine fewer crimes; however, one more prisoner in 2005 would only avert two crimes. For Spelman's (2000b) higher elasticity of -0.4, though, the added prisoner in 1977 would stop a whopping forty-two crimes; by 2005, the number would have fallen to nine.

Table 2 foreshadows the overall cost-benefit analysis that will be conducted throughout this paper. First, one must choose the appropriate elasticity, which generates the number of crimes averted from incarcerating one extra prisoner. Second, a dollar value needs to be attached to this reduction in crime. Third, the costs of locking up the one extra prisoner must be calculated. Finally, by finding the point at which the marginal cost and benefit of incarceration are equated, an optimal rate of incarceration can be estimated. Once one attaches monetary values to these costs and benefits (for example, say that it costs $30,000 to lock up another prisoner, and the dollar value of the cost imposed by an average index I crime is $10,000), the analysis becomes entirely straightforward. In this case, if two crimes are averted from adding one extra inmate, then it is not cost effective to do so (since the marginal benefit of $20,000 is exceeded by the marginal cost of $30,000). If nine crimes are averted, though, then averting $90,000 in crime costs is a good deal at the price of only $30,000.

B. Picking the Best Estimate of η

Tables 1 and 2 illustrate that there is no clear convergence in the estimates of the elasticity of crime across this group of well-designed studies. As is discussed in appendix A, assumptions about and the treatment of the issue of simultaneity, as well as modeling and data choices, importantly influence the elasticity estimates. Based on a careful review of the literature, Spelman (2000b, 484) concludes that

> our best guess as to the nationwide elasticity should be in the neighborhood of -0.30. Any figure between -0.20 and -0.40 can be defended, and we should not be too surprised to find that the result is anywhere between -0.10 and -0.50.

While this conclusion is reasonable, my own view is that one should lean more towards the lower bound of Spelman's ranges for two reasons. First, although Spelman contends that incarceration becomes more effective as the scale of the level of incarceration increases, Liedka, Piehl, and Useem's (2006) nonconstant elasticity model results, as well as economists Rucker C. Johnson and Steven Raphael's (2006) findings, suggest that the elasticity of crime has been falling as prison populations have risen.[11] Moreover, the research on the community impact and criminogenic effects of incarceration (Walker and Walker 1987; Chen and Shapiro 2007; Lerman, chapter 5, this volume; Johnson, chapter 6, this volume) suggests that Liedka, Piehl, and Useem's (2006) "collateral damage" argument (discussed further in appendix A) should be taken into account. This would presumably tend to lower the estimated benefit flowing from increasing rates of incarceration.[12]

The other reason that one should lean more towards the lower bound of Spelman's ranges is that three of the four studies that offer crime-specific elasticity estimates (Besci 1999; Levitt 1996; Marvell and Moody 1994) find that the elasticity of murder is lower than the elasticity of other crimes (roughly in the -0.06 to -0.15 range). As so much of the social cost of crime is

[11] Johnson and Raphael calculate their elasticity model across two time periods: 1978 to 1990, and 1991 to 2006.

[12] LPU call this phenomenon "accelerating declining marginal returns" (245), which is the exact opposite of Spelman's finding of increasing elasticity of crime as incarceration grows.

associated with the crime of murder, applying a general elasticity estimate to the crime of murder may exaggerate the actual benefits of incarceration. This fact militates in favor of using a separate lower elasticity figure for murder or perhaps making a crude downward adjustment to an overall elasticity estimate.

If the elasticity of crime declines as incarceration rises, then elasticity estimates will depend on the incarceration level during the study's sample time period (see table 1 for time periods). This implies that early studies based on data before 1990 are likely to find a larger elasticity of crime than identically designed studies using more recent data. This is exactly the case for economists Thomas Marvell and Carlisle Moody (1994) and Liedka, Piehl, and Useem (2006), who generate their estimates using the 1971 to 1989 and the 1972 to 2000 time periods, respectively. As a base model, Liedka, Piehl, and Useem ran a constant elasticity model that is similar in design to Marvell and Moody's. While Marvell and Moody find a general elasticity of about -0.17, Liedka, Piehl, and Useem's results suggest something closer to -0.07. Liedka, Piehl, and Useem attribute their lower estimates in part to their inclusion of additional years of data. In considering the importance of this factor, note that the unweighted incarceration rate (state prisoners per 100,000 population) across the years 1977 to 1989 is 177 (standard deviation 46), but it jumps to 393 (standard deviation 59) for the 1990 to 2004 period.[13] In any case, this suggests that, all else equal, recent studies that are based on incarceration data closer to today's levels are probably more useful for current policy analysis.

In addition, it is important to consider that, because of the nature of available data, all econometric studies listed in table 1 use state-prison populations. State-year data for federal prisoners and inmates at local jails is not consistently available, as required for state panel data estimation. In 2004, there were approximately 1,244,311 prisoners under state jurisdiction, 170,535 under federal jurisdiction, and 713,900 serving sentences in local jails (Harrison and

[13] These figures are based on BJS statistics that only account for state prisoners, not inmates in federal prisons or local jails. The comparable number for combined state and federal prisoners (not jails) are mean prison rates of 193 (std dev = 50) for 1977-89 and 437 (std dev = 70) for 1990 – 2004.

Beck 2005). Clearly, a substantial number of incarcerated individuals are not captured by the incarceration variable used in most of the econometric studies. Even if federal and local jail incarcerations have a smaller effect on crime, they must have some impact on the dependent variable of the models (the FBI index-crime rate). This biases the regression's estimates if federal-prison and local-jail inmate numbers are negatively correlated with crime and positively correlated with the independent variable in the model (that is, state-prison population). This is a reasonable assumption as incarceration levels have been growing overall and in all jurisdictions. Omitting federal and local inmates thus causes the coefficient on the independent variable to be negatively biased; it causes us to overestimate the crime-reducing impact of state-prison population (Harrison and Beck 2005).[14]

Based on this evidence, my best guess for the elasticity of crime with respect to incarceration is highly uncertain; it is perhaps most likely to be between -0.10 to -0.15 range, but it is conceivably within the broader interval between -0.05 and -0.40. Recognizing the uncertainty and assumptions that surround elasticity estimates, I present results using this broader elasticity range.

C. Overall Versus Crime-Specific Estimates of η

Rather than identifying a best estimate for the aggregate elasticity of crime with respect to incarceration, one may conceptually prefer to have crime-specific elasticities. Some of the studies presented in table 1 have estimated separate elasticities for each crime type, while other

[14] Ignoring the large and variable share of incarceration provided by federal prisons and local jails conceals other complexities that can be critical for policy evaluation. For example, the cost estimates (per inmate) do not apply to the full range of facilities. Jails are expensive to run because they involve frequent admissions and discharges, which are high cost transactions, and the jails are often small, which prevents economies of scale in building and supervision expenses. Moreover, the focus on index I crimes overlooks the fact that a not inconsiderable proportion of prisoners are incarcerated for drug crimes (particularly in federal prisons). While these incarcerations do appear to reduce the occurrence of index I crimes, their primary goal is to raise the price of drugs. While there are substantial questions about whether these incarcerations achieve their intended anti-drug objectives, one could presumably design a more effective anti-crime incarcerative strategy if incarcerations were limited to those committing index I crimes. Similar concerns apply to the issue of those incarcerated for white collar crime, although here the numbers are far smaller than for drug incarcerations.

studies have run separate analyses for violent and property crimes. Since different crimes involve different economic and social costs, precise crime-specific elasticity estimates could greatly enhance the accuracy of a cost-benefit analysis.

Despite these conceptual advantages, Spelman (2000b) argues against generating crime-specific estimates. One element of imprecision is that the crime-specific models all use the same incarceration variable (state prisoners, regardless of the type of prisoners or reasons for conviction), "making no attempt to disaggregate prison use and obtain a more policy-relevant result" (Spelman 2000b, 477). This makes the estimates imprecise; for example, incarcerating a rapist will not have the same impact on the various index crimes as incarcerating a vehicle thief or a burglar. According to Spelman, "theory is too weak to allow us to distinguish among different crime types, and because the empirical estimates are not statistically significantly different from one another, the most prudent course would be to assume the elasticity for each crime type is about the same, on average" (Spelman 2000b, 484). While crime-specific elasticity estimates should be used with caution, it still is a useful exercise to see how the disaggregated estimates influence the cost-benefit analysis. These results are presented in appendix table B1.

Our ultimate estimates of the optimal level of incarceration in table 12 will assume that murders will respond to increases in incarceration in the same proportion as other crimes and will also have high attendant social costs. But the discussion of appendix table A2 raises the possibility that murder responds less to incarceration and should thus be treated differently in our analysis.[15] Accordingly, appendix tables F2 and F3 will assume that the elasticity for the crime of murder is zero (or alternatively that the social benefit of murders that would be averted is zero), and proceed to assess the optimal level of incarceration on this basis. Obviously, because this will reduce the benefit of incarceration, it will lead to a lower estimated optimal level of incarceration.

[15] From the previous discussion, it might seem natural to also look at an independent elasticity for motor vehicle theft, since it appears to consistently lead to large and statistically significant coefficients. However, we did try a cost-benefit analysis with a separate and higher elasticity (up to three times higher) for motor vehicle theft; the change in results was negligible and hence the analysis was not included.

To the extent one believes that table 12 overstates the benefits from incarceration (because the responsiveness of murder to increased incarceration is smaller than for other crimes or the social costs are smaller than estimated), then table F3 will help to illustrate the sensitivity of our estimates to a different treatment of murder.

III. The Benefits from Prevented Crimes

Once one has an estimate of the elasticity of crime with respect to incarceration, it is straightforward to compute how much crime is prevented by additional increments to the prison population. In order to move from prevented crimes to prevented losses, though, we need to estimate a monetary cost of crime. This task has vexed economists at least since the Wickersham Commission on Law Observance and Enforcement (Shaw and McKay 1931).[16] More than sixty years later, Franklin Zimring and Gordon Hawkins (1995) argued that economists continue to lack a "concept of the costs of crime that is both relevant and rigorous" for evaluating policy. Nonetheless, it is impossible to allocate crime-fighting resources rationally without some effort to estimate the benefits and costs of crime-prevention policies—including incarceration.

A. On White Collars, Terrorists, and the Utility of Thieves

The difficulties in estimating the cost of crime result from both theoretical and practical concerns. The practical concerns relate to data availability and the appropriate methodologies for estimating certain aspects of the costs, such as the intangible costs of fear of crime. The theoretical concerns relate to a host of definitional as well as normative issues.

This paper does not purport to address the full array of criminal activities but limits itself to the seven standard index I crimes defined by the Uniform Crime Reports (UCR) listed in table 4. As a result, all sorts of white-collar crimes (the property losses from fraud, credit-card abuse,

[16] See Wickersham Commission on Law Observance and Enforcement.

and embezzlement alone dwarf the property losses from robbery and burglary) and "victimless" crimes such as drugs and prostitution are ignored. In addition, while the terrorist acts of September 11, 2001, are estimated to have caused at least $33 billion in lost wages, clean up, and reconstruction (Bram, Orr, and Rapaport 2002), terrorism is not a listed UCR index crime, and the FBI explicitly excludes the victims of the September 11 terrorist attacks in its homicide statistics.[17]

Furthermore, to illustrate a conceptual difficulty in determining the contours of crime costs, consider the following example. A thief steals a sedan from a multimillionaire who happens to own dozens of cars. The car is required by the thief to maintain a job and bring her children to school. How should we account for the illegal transfer of property in this case? This depends on whether one is willing to "give criminals full standing in societal benefit-cost calculations" (Ludwig 2006). Economist Philip J. Cook (1983) argues implicitly for inclusion of criminals' utility in calculations of overall societal well-being. For Cook, "social cost"—defined as the costs measured against the well-being of all members of society—is the pertinent measure to estimate the "costs of crime."[18] The practical consequence of using social costs for cost-of-crime estimates is that any transfers between individuals will be excluded from the cost estimates. Similarly, John Donohue and Peter Siegelman (1998) use the social-cost criteria and exclude increased welfare

[17] Accordingly, our estimates of the cost of crime prevention exclude (1) those parts of the homeland security budget – currently around $40 billion and 11% of the total U.S. defense budget – that are used to fight terrorism; and (2) long-term losses due to increased security efforts after the terrorist attacks, which have been estimated to have permanently lowered productivity in the U.S. by between .6 and 1.2 percent (Bram et al. 2002).

[18] One consequence of Cook's definition is that the disutility to prisoners of being incarcerated should count as a social cost. While the issue is complicated, three points should be noted. First, following the Cook approach consistently will raise the estimated cost of imprisonment, while lowering the estimated cost of crime (since the value of stolen goods is not counted). Second, while stolen cash involves a simple transfer from owner to thief, the theft of non-cash property frequently leads to some property damage and may move assets into the hands of lower valued users (which at the least then imposes more transaction costs to sell them back to higher valued users). Thus, even if one wants to treat theft as a transfer, there will still be some attendant social loss that is not a wash between the deprived owner and the victimizing thief. Third, if we do not consider the utility of prisoners, we might mistakenly conclude, for example, that a mass incarceration strategy was less costly than a mass education policy, which obviously raises important normative issues.

payments to criminals' families when assessing the costs of incarceration because such payments are mere transfers within society.

Others, including economists William N. Trumbull (1990), Mark Cohen (2005), and Jens Ludwig (2006), prefer to disregard criminals' utility in any social-welfare calculations. Cohen (2005) argues that the value of the stolen car should be included in cost-of-crime figures, as the criminal involuntarily imposes this private wealth reduction. This normative judgment makes a major difference in the costs-of-crime estimates. Economist David Anderson (1999) estimates that transfers account for roughly one-third of the overall costs of crime, thus illustrating the centrality of normative judgments inherent in this exercise. Instead of trying to resolve these normative questions, this paper illustrates their importance by presenting various estimates of the cost of crime based on different assumptions. The effort to highlight the underlying assumptions and methodologies will enable readers to implement their own normative choices in conducting benefit-cost analyses of incarceration.

Recent studies of the cost of crime (Anderson 1999; Cohen 2005) have provided comprehensive estimates of all the costs posed by crime, taking into account the perspective of victims, offenders, taxpayers, and all other affected parties. We follow Anderson and Cohen in this approach, but will present specific details on the bearer of the costs whenever possible.

B. Estimating Intangible Costs of Crime

Crime costs include both tangible and intangible costs. Tangible costs include victims' medical bills, antitheft insurance payments, or expenditures on the criminal-justice system (including court time on criminal matters) that would be tallied in the gross national product (GNP) (Cohen 2005). On the other hand, pain, suffering, and the fear of crime are intangible costs that, while harder to estimate, are social costs of crime. In her 2006 Senate testimony, Mary Lou Leary noted the high percentage of crime victims who develop posttraumatic stress disorder (PTSD). If untreated—and therefore not a tangible cost—this PTSD reduces the quality of life not

just for the initial crime victim, but also for loved ones and friends, in some cases for ten years (Leary 2006). Studies that include intangible costs in their overall cost estimates consistently find that they likely outweigh tangible costs. For example, criminology researchers Ted Miller, Mark Cohen, and Brian Wiersema (1996) found that the intangible costs of a rape victimization are sixteen times the tangible costs.

The primary argument against including intangible costs is the difficulty in accurately measuring them given the absence of market mechanisms that would illuminate valuations through revealed preferences. The main argument for inclusion is that people are willing to pay to avoid becoming crime victims. Consider, for example, the money an average woman would willingly forego to live without the fear of being raped or sexually assaulted. This indicates that people treat the prospect of becoming a crime victim as a real cost. For our purpose, and in line with our comprehensive approach to costs, this paper tries to estimate and include intangible costs whenever possible.

Four different methods have been used to estimate intangible costs of crime: hedonic pricing, wage-rate differentials for risky jobs, jury awards for tortuous injuries, and contingent valuation.

1. Hedonic Pricing Estimates

Economist Richard Thaler (1978) derived a framework, now known as hedonic pricing, from economist Kevin J. Lancaster's (1966) consumer theory and economist Sherwin Rosen's (1974) theoretical model that can be used to estimate the intangible costs of crime. In the crime context, hedonic pricing attempts to gauge the willingness to pay higher property prices to live in a safer neighborhood. With enough controls (that is, size of the house, extras such as having a pool or fireplace, lot size, and local non-crime-related socioeconomic variables), it is possible to estimate:

$$price = \alpha + \beta * crime + \sum \gamma * property + \sum \delta * local + \varepsilon$$

where *price* is the selling price of the house, *crime* refers to the crimes committed in the neighborhood, *property* is a vector of the house and lot characteristics, and *local* is a vector of community characteristics. Estimates of β would give us a sense of how much crime reduces house prices; in other words, it indicates the amount people are willing to pay when choosing where to live in order to avoid crime. Hedonic pricing provides an indirect estimate of intangible costs such as fear of crime or avoidance behavior (for example, not walking down dark streets).

Colinearity across various crime categories makes it difficult to estimate effects of individual crimes with enough precision to unravel their separate effects. Most hedonic regressions are therefore run on either the violent- or property-crime index.[19] One potential shortcoming of the hedonic-pricing regressions is the implicit assumption that the house price is the sum of the house parts (physical or location attributes) without taking interactions into account. Cohen (2005) points out that only a few studies (Hoehn, Berger, and Blomquist 1987) also estimate a local-wage-rate equation in addition to the housing prices.

2. Compensating Wage Rate Differential Estimate

Economists have also estimated intangible costs by looking at wage-rate differentials between risky and less-risky jobs to derive the worth of a statistical life (Vicusi 1998, 2000). This research provides estimates of the value that society puts on the increased incremental risk of dying, which can then be used to estimate the costs of crimes that carry some risk of death.

3. Jury Awards

Cohen (1988) used civil-jury awards to estimate the social costs of similar harms generated by criminal conduct. Combining the statistical-life evaluations and the jury awards, Mark Cohen was able to estimate intangible costs of crime. Mark Cohen, Ted R. Miller, and sociologist Shelli B. Rossman (1994) build on Cohen's initial attempt, ironing out data limitations

[19] William Bartley (2000) is one exception to this, but he cautions that colinearity concerns may explain some of the theoretically implausible estimates in various specifications.

of the original study. Interestingly, all three approaches—hedonic pricing, wage-rate differentials, and jury-award studies— generate broadly similar cost-of-crime estimates.

4. Contingent Valuation with Survey Data

The final approach to estimating intangible costs draws on Thomas C. Schelling's (1968) suggestion that in cases in which market prices are not available, one can simply ask people what they think the benefits are worth. Cook and Ludwig (2000) use this so-called contingent-valuation approach in the crime context, in particular to evaluate the cost of gun violence. Essentially, the contingent valuation asks referendum-style questions about the respondent's willingness to pay to change a social condition.[20] More recently, the same contingent valuation method was used by Cohen and colleagues (2004) to estimate respondents' willingness to pay to reduce violent crime and burglary. They find that the willingness to pay estimates are two to seven times higher than previous estimates. In particular, the ratios of willingness to pay over previous estimates for burglary and armed robbery are 5.7 and 7.3, respectively (Cohen 2005).

Serious questions have been raised as to whether these contingent-valuation assessments accurately capture the true willingness to pay, given the fact that we cannot observe actual payments. Moreover, unless one has a random sample of Americans, there is a danger that the answers of unrepresentative individuals can lead to biased estimates of what the average American would be willing to pay. Moreover, we know that criminals are often victims of crime. Applying the per-victim cost as a measure of the social loss when a drug dealer or other criminal is eliminated may be exaggerating the social cost of murder in the United States, which is itself one of the largest components of the cost of crime.

[20] For example, a question used in Cook and Ludwig's (2000) study reads, "How would you vote on a program to reduce gunshot injuries by 30% that cost $50 more per year in income taxes?" (105). There are several versions of the same question, each with different tax amounts required to pay for the same reduction in injuries. This allows the researchers to create willingness-to pay schedules of the surveyed population.

C. Building on Prior Estimates of the Cost of Crime

Appendix C provides an exhaustive breakdown of the possible factors that need to be considered in estimating the total cost of crime. These fall into three broad categories: costs caused by the criminal act itself, costs from societal reaction to or in prevention of crime, and costs incurred by the offender because of his incarceration. However, gaps in data availability prevent all conceivable costs from being estimated.

Table 3 shows the wide range of cost-of-crime estimates from an array of studies. While some of the studies only address portions of the full array of social costs, the estimates for the "general" focus studies that try to capture all costs of crime range from roughly $1 trillion to $2 trillion per year. For our purposes, however, we are ultimately interested in estimating the marginal cost of crime that could be avoided by an enhanced level of incarceration. Expressed differently, we are interested in the marginal benefit (in lowered social costs of crime) resulting from a marginal increase in incarceration. Table 2 revealed that adding an additional prisoner to the inmate population in 2005 would be expected to generate between two to nine fewer index I crimes (given elasticity estimates ranging from -0.16 to -0.4). We attempt to provide a monetary valuation to the social benefit of eliminating these two to nine crimes.

TABLE 3
Summary of Studies Estimating the Annual Social Costs of Crime

Study	Focus	Elements Not Included	Time Period (Years)	$ (Billions) in 2006 dollars
Ludwig (2006)	General		2004-2005	2,040
Cohen, Rust, Steen and Tidd (2004)	Victim costs of burglary, armed robbery, serious assault, rape and murder	Opportunity cost of criminals, justice system	2000	534
Anderson (1999)	General	-– transfers	1970-1997	2,064 1,334
Collins for *U.S. News and World report* (1994)	General	Opportunity costs and miscellaneous indirect components	1994	990
Cohen, Miller, & Wiersema (1996)	Victim costs of violent and property crimes	Prevention, opportunity, and indirect costs	1987-1990	608
U.S. News and World Report (1974)	General	Opportunity costs and miscellaneous indirect components	1974	1,176
Cohen, Miller, & Rossman (1994)	Cost of rape, robbery, and assault	Prevention, opportunity, and indirect costs	1987	249
Zedlewski (1985)	Firearms, guard dogs, victim losses, and commercial security	Residential security, opportunity costs, and indirect costs	1976-1983	300
Cohen (1990)	Cost of personal and household crime to victims	Prevention, opportunity, and indirect costs	1985	174
President's Commission on Law Enforcement (1967)	General	Opportunity costs and miscellaneous indirect components	1967	645
Klaus (1994)	National Crime Victimization Survey	Prevention, opportunity, and indirect costs	1993	26

Source: Adapted and expanded from Anderson (1999).

What is the social cost of an average index I crime? To generate such an estimate one can compute the average cost of each class of index I crimes and take a weighted average (by frequency of occurrence) across all seven index I categories. The most conceptually straightforward costs included in this calculation are the social costs suffered by the victim of any index I crime. I take these per-crime-category victimization-cost figures from Ted Miller, Mark Cohen, and Brian Wiersema's (1996) study; these figures are presented in the first column of

table 4. Note that I treat these as lower-bound estimates for two reasons. First, these victimization-cost estimates are substantially lower than the social-cost estimates generated by Cohen and colleagues (2004) using the admittedly more speculative contingent-valuation methodology. Second, the value of stolen property is excluded from Miller, Cohen, and Wiersema's estimates; it is assumed to be a mere transfer from the victim to the criminal. Intangible costs, such as diminished quality of life or pain and suffering, however, are included via Cohen's (1998) statistical-life or jury-award method. The comparable upper-bound cost estimates are found in the first column of table 5, using the contingent valuation estimates from Mark Cohen and colleagues (2004) and including the cost of stolen goods as a social cost.

TABLE 4
Social Costs per Crime (Low Estimate)

	Cohen, Miller and Wiersema (1996)	Justice System	Lost Productivity of Offender	Total Low Cost Estimate
Murder	$4,100,418	$119,200	$107,647	$4,327,266
Rape	$121,339	$4,419	$3,938	$129,696
Robbery	$11,158	$6,089	$5,390	$22,637
Assault	$13,110	$3,436	$2,982	$19,528
Burglary	$600	$929	$758	$2,287
MV Theft	$558	$358	$281	$1,197
Larceny	$140	$108	$87	$335

Justice system and lost productivity costs are in present value (discounted at a 5% rate), based on NCVS arrest rate for all crimes, except murder for which the UCR rate is used.

TABLE 5
Social Costs per Crime (High Estimate)

Crime	Cohen, Rust, Steen and Tidd (2004)	Justice System	Lost Productivity of Offender	Total High Cost Estimate
Murder	$11,358,314	$127,049	$107,960	$11,593,323
Rape	$277,518	$12,014	$8,035	$297,567
Robbery	$271,663	$10,754	$8,075	$290,491
Assault	$81,967	$6,213	$3,636	$91,817
Burglary	$29,274	$1,490	$1,216	$31,980
MV Theft	$5,160(a)	$285	$224	$5,669
Larceny	$516(a)	$217	$175	$908

(a) For Motor Vehicle Theft and Larceny, we use CMW (1996) estimates (including transfers) since these crime categories are not estimated in CRST (2004). Justice system and lost productivity costs are in present value (discount rate is assumed to be 5%) based on UCR arrest rate for all crimes.

To complete the low- and high-end estimates set forth in tables 4 and 5, the figures in the first column of each table are supplemented with two more quantitatively minor social-cost items: the lost productivity of those incarcerated for such crimes and the criminal-justice costs that accompany an average index I crime.

1. Lost Productivity Owing to Incarcerating Offenders

One of the benefits of a drop in crime is that fewer individuals need to be arrested, prosecuted, and punished. This involves some obvious savings and some less immediately obvious social benefits. As most individuals who are sent to prison would otherwise be engaging in some socially productive work, the reduction in the need for incarceration gives a form of peace dividend. It eliminates the lost productivity of those individuals who would have committed crimes and then been sentenced to prison. While Miller, Cohen, and Wiersema's (1996) study does not try to estimate this lost productivity of incarcerated offenders, we computed this social cost assuming that the average offender is male and has a high-school diploma but no college education. From the latest available Bureau of Labor Statistics (BLS) data, this offender profile would correspond to an average earning potential of $616 per week. Of

course, locking up a criminal only deprives society of his productive efforts if he was actually working; thus, the estimated forgone earnings must be adjusted to reflect the unemployment of criminals, which is higher than that for the noncriminal population (Buonanno 2003).

Although a 2003 Bureau of Justice Statistics report found that 16.7 percent of newly admitted offenders were unemployed, this number overstates the fraction working before prison admission because it excludes individuals not looking for work (per standard BLS definition). Offender employment before admission varied with educational level from 62 percent (for with less than eleventh grade education) to 87 percent (for those with education beyond high school) (Harlow 2003). I adjusted the average forgone earnings from $616 per week to $462 by estimating that only 75 percent of criminals sent to prison are employed. Assuming that wages reflect social value, these forgone wages of $462 per week are a proxy for the lost societal productivity.

Table 6 uses data on arrest rates, conviction rates, and sentencing rates, combined with estimates of time served in prison or jail to calculate lost productivity (based on the lost wages) for every offense committed in the respective crime category (see appendix tables D1, D2, and D3 for details). Not surprisingly, murder and nonnegligent manslaughter offenders are responsible for the largest loss in productivity, primarily because of their greater likelihood of capture, conviction, and sentencing (and, less importantly, because of their longer expected sentences).[21]

[21] Although it is well established that past incarceration can lead to underemployment of former prisoners (Holzer, chapter 8, this volume), this lost potential productivity is not accounted for because the impact is not yet quantified at a crime-specific level. Exclusion of underemployment effects will bias the benefit from prevented crime downward. Note however that the same exclusion will bias the cost of incarceration downward even more because it is calculated conditional on already being arrested and convicted. Thus, fully accounting for this factor would make incarceration look less appealing than our current estimates show.

TABLE 6
Lost Productivity Due to Incarceration of Offenders for Seven Index I Crimes

			Sentencing Rate (Conditional on Being Convicted)		Days Incarcerated		
	Arrest Rate	Conviction Rate	Prison	Jail	Prison	Jail	Total Lost Productivity ($)
	(1)	(2)	(3)	(4)	(5)	(6)	
Murder	0.84	0.70	0.91	0.04	4253	189	107,647
Rape	0.13	0.47	0.59	0.23	1920	154	3,938
Robbery	0.18	0.47	0.71	0.15	1583	191	5,390
Aggravated assault	0.43	0.23	0.42	0.29	1069	139	2,982
Burglary	0.09	0.50	0.46	0.26	529	88	758
Motor-vehicle theft	0.15	0.18	0.37	0.31	353	88	281
Larceny	0.08	0.09	0.36	0.39	374	94	87

Source: Arrest rate is based on NCVS data, except for murder, which is calculated from UCR numbers. The conviction and sentencing rates are based on table 2 of Hill and Harrison (2004). "Days incarcerated" is based on mean sentence and estimated time served. The "total" column is discounted to present value using a 5 percent discount rate.

Miller, Cohen, and Wiersema's (1996) estimates already include figures for the lost productivity of the victim from lost work days, missed school, and house work. As a result, all victim productivity losses are included in our low estimate, and we only need to put these estimates into current dollars to reflect inflation.

2. Avoided Criminal-Justice-System Costs

The final adjustment to the benefits of avoiding an index I crime is based on the criminal-justice-system costs prevented by increased incarceration (in other words, the costs we are not spending on arresting, processing, and incarcerating criminals due to the reduced crime level from increased incarceration). For example, in 2006 Governor Arnold Schwarzenegger asked California lawmakers to approve nearly $6 billion on new prison construction projects to be able to house an additional 40,000 inmates, a figure of roughly $150,000 for each additional bed. (Martin 2006). Six years earlier, the State of Connecticut reported a slightly lower construction cost to house an additional inmate of $125,000. (State of Connecticut General Assembly, 2000).

Using the previously estimated arrest, conviction, and sentencing rates, we need three items in order to estimate the saved justice-system costs: the distribution of sentences (that is, whether the criminal received a prison, jail, or probation sentence; the estimated time served; and the average cost of the sentence. Daily costs per convicted offender for prison, jail, or probation sentences are conservatively estimated at $70, $67, and $5, respectively.[22] Table 7 presents the calculation of prevented criminal-justice-system costs due to reduced crime. Obviously, this is just part of the overall justice costs; Miller, Cohen, and Wiersema (1996) include other costs, such as police and investigative expenditures.

TABLE 7
Estimating the Avoided Criminal-Justice-System Costs Due to Reduced Crime

			Sentencing Rate			Cost of Sentence			
	Arrest Rate	Felony Conviction Rate	Prison	Jail	Probation	Prison	Jail	Probation	Total
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Murder	0.84	0.70	0.91	0.04	0.05	310162	13785	11400	119,200
Rape	0.13	0.47	0.59	0.23	0.18	139800	11184	8100	4,419
Robbery	0.18	0.47	0.71	0.15	0.14	116571	14091	7650	6,089
Aggravated Assault	0.43	0.23	0.42	0.29	0.29	77598	10059	5850	3,436
Burglary	0.09	0.50	0.46	0.26	0.28	39798	6633	5400	929
Motor-vehical theft	0.15	0.18	0.37	0.39	0.24	26532	6633	3600	358
Larceny	0.08	0.09	0.36	0.31	0.33	27936	6984	5400	108

Source: Author's calculations
Note: Arrest rate is based on NCVS data, except for murder, which is calculated from UCR numbers. "Cost of sentence" is based on mean time served. The remainder of sentenced time is assumed to be under supervision (same costs as probation). Costs of probation supervision are assumed to be five dollars per day per offender (estimates in the literature vary from one to ten dollars). The "total" column is discounted to present value using a 5 percent discount rate.

D. Computing The High Social-Cost-of-Crime Estimate

Combining figures from Miller, Cohen, and Wiersema's study (1996) with the results in tables 6 and 7 provides a broad array of prevented costs reflecting estimates of medical costs, victim services, lost productivity both from the offender and victim, reduced quality of life of the

[22] These figures are conservative in that they only account for the direct tangible costs of incarceration estimates.

victim, death of the victim, police and investigative costs, and incarceration and nonincarceration sanctions (see tables 4 and 5 for crime-specific totals). Missing however are estimates for the fear of crime and any costs imposed by changed behavior patterns in order to avoid becoming a crime victim (for example, avoiding certain areas after sundown or taking a cab instead of walking home).

The contingent-valuation method would presumably capture the costs associated with fear of crime and avoidance behavior; however, in other respects we have to guess what the contingent-valuation respondents included in their cost figures, as data exists only on the survey answers and not on the factors that motivated those responses. But it is reasonable to assume, for example, that the average respondent asked about burglaries considers stolen property to be an imposed cost on the victim rather than a mere transfer to the thief. Similarly, when asked about violent crime, one may assume that the respondent includes fear of crime, potential hospital costs, pain and suffering, and an overall reduced quality of life in his valuation. In particular, nonmarket goods (such as fear of crime, and pain and suffering) should be captured by the contingent valuation of crime. Overall then, contingent-valuation estimates seem able to capture several additional cost elements—fear and avoidance behavior—but may blur other distinct cost categories.[23]

Cohen and colleagues (2004) employ the contingent-valuation method to estimate individuals' willingness to pay for crime reduction. This allows them to compute dollar values for specific crimes, which indicates how much society would value a reduction of crime. Using their findings, a second estimate can be constructed by combining the willingness-to-pay estimate with costs that are assumed not taken into account by the respondents. General criminal-justice-system processing costs and lost productivity from a caught, convicted, and incarcerated offender presumably had little influence on individuals' willingness to pay to reduce crime. Table 5

[23] One cautionary note is that the contingent-valuation questions are based on large reductions of specific crimes (for example, a 30 percent reduction), while a cost-benefit analysis would estimate the impact of a much smaller change in crime.

presents the per-crime estimate of prevented costs using the contingent-valuation method; table 4 presents the analogous estimates of tangible costs based on the aggregation of various costs using jury awards and the value of a statistical life.[24]

E. The Benefit from Avoiding Index I Crimes

Since our cost-benefit analysis relies on an aggregate elasticity of crime (as opposed to crime-specific elasticities) we need to calculate the average cost of some general or unspecified crime. In other words, with the exception of murder, our lambda quantifies how many crimes are prevented by the marginal incarceration, but they do not tell us what types of crime are prevented. Given this, we need to average the crime-specific cost in a way that gives us the probable cost of an average unspecified index crime (with the exception of murder, which we deal with separately). We derive this value by taking a weighted average of the crime-specific costs of crime, where each cost is weighted by the probability of the particular crime occurring. (The crimes are weighted by an adjusted FBI frequency, where the FBI crime numbers are inflated using the crime's reporting rate obtained from the National Crime Victimization Survey [NCVS].)

Table 8 reveals that an average index I crime imposes a social cost of between roughly $5,700 and $27,000. Table F2 reveals that the social cost of the average index I crime would range between $3,350 and $20,000 if murders were excluded.[25] These estimates begin to provide context for the cost-benefit analysis of the incremental incarceration as one compares the number of such crimes that can be avoided with the expense of trying to avoid them. Table 2 presents estimates that locking up an extra prisoner would eliminate two to nine crimes. Using the low end

[24] Differences in justice system and lost productivity estimates are caused by using arrest rates based on two different (UCR and NCVS) crime occurrence statistics.

[25] Murder is treated separately to allow for exploration of the implication that the ability of increased incarceration to reduce crime is lower for murder than for other crimes. Because the social costs of murder are so high relative to other crimes, this difference can substantially impact an overall cost-benefit analysis of incarceration.

of this spectrum and the low estimate for the cost of an average crime, then we see that the marginal benefit (roughly $11,500) is outweighed by the marginal cost (with prisons likely costing more than $25,000 per inmate, per year on average). Conversely, if we accept the higher-end estimates for crimes avoided and cost per crime, then the marginal benefits likely exceed the costs by a substantial margin.

TABLE 8

Average Cost of an Index Crime Using Weighted Cost-of-Crime Estimates, 2005

	Reporting Rate (%)	**Adjusted Low Cost Estimate**			**Adjusted High Cost Estimate**		
		Low Cost Estimate ($)	Weight	Weighted Cost (Low) ($)	High Cost Estimate ($)	Weight	Weighted Cost (High) ($)
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
Murder	100.0	4,327,266	0.0006	2,507	11,593,323	0.0006	6,717
Rape	38.3	129,696	0.0085	1,106	297,567	0.0085	2,537
Assault	52.4	19,528	0.0570	1,112	91,817	0.0570	5,229
Robbery	62.4	22,637	0.0232	524	290,491	0.0232	6,726
Burglary	56.3	2,287	0.1325	303	31,980	0.1325	4,238
Larceny	32.3	335	0.7269	244	908	0.7269	660
Motor-vehicle theft	83.2	1,197	0.0514	62	$5,669	0.0514	291
Average Cost Per Crime				**$5,857.26**			**$26,397.95**

Source: Author's calculations.
Note: To see the detailed derivation of this weighting scheme (as well as two alternative weights that we did not employ), see appendix table E1. The numbers in bold represent the average cost of any index crime, including murder. To see analogous results to this that exclude murder, see appendix table F2.

IV. The Cost of Incarceration

Moving on from the monetary estimates of the value of an incarceration-induced reduction in crime, we now turn to the costs of increasing incarceration. As with the cost of crimes, there are several components to the cost of incarceration, and not all of them are easily documented. Factors to be considered include the direct costs arising from the day-to-day prison operations, the lost wages and productivity of inmates, intangible costs such as the value of the inmate's lost freedom, the psychological cost on the family of the incarcerated, and any

postincarceration lost earning potential due to a criminal record. Furthermore, there are other potential postincarceration costs, including the costs of increased crime from "prison-hardened" criminals, the increased spread of diseases caught in prison through the reentry community, and the net effects of parental incarceration on the children of inmates.

A. Operating Costs

Costs of day-to-day prison operations are most easily estimated since they are documented in state budgets and compiled by the Bureau of Justice Statistics. The lost earnings of incarcerated persons can be estimated reasonably well from demographic information about prisoners and Bureau of Labor wage estimates.

Statewide annual day-to-day prison operations expenditures range from less than $10,000 to more than $50,000 per prisoner, with Arkansas at the low end ($9,257 spent annually per prisoner) and Maine at the high end ($50,545 per prisoner) (Bureau of Justice Statistics 2004b).[26] Table 9 provides more detail on the composition of operating expenditures. The national average operating cost per inmate is $25,797, of which roughly two-thirds are allocated for salary, wages, and benefits.[27] Many studies have viewed these operating expenditures as the sole cost of incarcerating an additional prisoner, but there are other admittedly less easily quantified costs that should also be considered. For one, the public finance literature refers to the deadweight loss of taxation—the fact that distortionary taxes dampen economic activity. Some estimate this amount

[26] In general, northeastern states have the highest costs of incarceration ($37,625 per prisoner), and Southern states have the lowest average costs ($18,768). Local weather conditions and wage levels are among the many factors that explain this wide range of costs. For example, Maine, with only two thousand prisoners in 2004, likely has a higher average per prisoner cost in part because its fixed costs are not spread over a larger inmate population.

[27] This implies daily expenses of about $70 per prisoner. While this estimate makes no provision for other social costs of incarceration, it may not be an entirely unreasonable overall estimate for the states with low operating expenditures. Note that the table provides average costs per prisoner, and we ideally want to capture only marginal costs. One can imagine that adding simply one additional prisoner has a very low marginal cost if prison is not filled to capacity. But perhaps this suggests that we should think of "marginal" in terms of adding (or subtracting) increments of one thousand prisoners. In this case, a state that decides to add one thousand prisoners typically needs to add a new prison. The Table 9 estimates seem more reasonable when thought of in this light.

as equal to approximately one-third of the taxes raised. For now, I do not make an additional adjustment for this factor, but it is probably advisable to think of some amount beyond the actual operating costs as an added social burden of incarceration.

Table 9
Composition of Operating Expenditures

	U.S. Aggregate (1000s dollars)	Per Prisoner
Wages, salary, benefits	21,166,199	16,894
Medical care	3,745,103	2,990
Food services	1,362,021	1,088
Utilities	1,134,427	905
All other (supplies, fees, interest on debt, contractual housing services)	4,909,190	3,920
Total	32,316,940	25,797

Source: Hill and Harrison (2004).

B. Capital Costs

As state prisons already run at near maximum capacity–occupancy levels of state prisons are well over 100 percent capacity in thirty-four states, and they are over 97 percent in an additional eight states (Harrison and Beck 2005)–additional prisoners will likely require prison expansion. Capital expenditures are fixed costs in the traditional sense, and our huge prison construction boom has left us with a situation in which major decreases in incarceration would create excess prison capacity. However, given that state prisons in general do not have any empty cells, capital expenses must be incurred at the margin if there is any call for additional incarceration. Because of this asymmetry, one might want to fully include prison construction costs for assessing increases in incarceration while employing some lesser amount as a measure of the cost savings if incarceration were to decrease. Presumably, a reduction in prisoners in an existing facility will reduce capital costs to some degree because of diminished depreciation

owing to less intensity of use. Again, to allow others to assess our findings based on their particular preferences about the pertinent costs, we provide a range of estimates; capital costs are not included in our low estimate of the cost of incarceration, but they are reflected in more inclusive estimates.

The cost for an additional prison cell varies widely by region and security level of the facility. One way of estimating the capital costs is to look at average costs of some current prison construction projects. For example, in 2006 Governor Arnold Schwarzenegger asked California lawmakers to approve nearly $6 billion on new prison construction projects to be able to house an additional 40,000 inmates., a figure of roughly $150,000 for each additional bed (Martin 2006). Six years earlier, the State of Connecticut reported a slightly lower construction cost to house an additional inmate of $125,000 (State of Connecticut General Assembly, 2000). We use this capital-cost estimate of $125,000 per new bed and assume a prison's lifetime of forty years. The annual capital costs for a newly added prisoner are then slightly over $3,000, or roughly three times the expenditures on food.[28]

C. Lost Productivity

The lost productivity of the incarcerated offenders is a cost associated with increases in incarceration. Productivity is proxied by wage losses of the offender, which amount to an average productivity loss of roughly $25,000 dollars per year of incarceration (assuming the offenders are male with high-school diplomas but no college education, and assuming that 75 percent of offenders were employed before prison). Combining the day-to-day operating costs, with capital expenditure and lost productivity indicates annual costs of slightly over $55,000 per prisoner, per year (or $55,797 in 2006 dollars).

[28] One question to consider is whether the table 9 interest-on-debt figures capture some of the capital costs that are estimated here directly.

Query, though, whether the full value of lost wages should be counted as a social cost of incarceration. The disutility of work is avoided, so presumably this value should be subtracted. Also, the earnings would presumably go at least in part to feeding, clothing, and housing the individual; these amounts are obviated by incarceration (and counted as operating costs of incarceration). The lost tax revenues on legitimate earnings and the amounts that would otherwise have been paid to support others are clearly social losses owing to incarceration. These considerations would indicate using a cost less than the full $25,000 for lost productivity; I estimate this to be approximately $8,000. I therefore will include an intermediate marginal prison-cost estimate of $35,000 in case that the total operating costs, capital costs, and lost productivity estimate of $55,000 is overstated.

D. Other Costs of Incarceration

In addition to the costs of incarceration that we have included thus far, there are several additional costs that incarceration imposes on the offender or society during or after prison. A criminal record can make it difficult to find a job and thereby dampen future earnings (Holzer, chapter 8, this volume; Raphael and Stoll, chapter 2, this volume). AIDS or tuberculosis caught while in prison certainly harms the prisoner and can impact the community. Children deprived of a father or mother as a result of their incarceration may be placed at greater risk for subsequent behavioral problems (less the benefits of removing any abusive parents) (Johnson, chapter 6, this volume). To the extent that incarceration hardens inmates, Keith Chen and Jesse Shapiro (2007) and Lerman (chapter 5, this volume) suggest that it may increase the future criminality of those returned from prison to the community.

There is also debate over whether the value of the lost freedom of prison inmates should be considered a social cost. Some contend such deprivation is the purpose of incarceration, while others point out that the deprivations and impositions of incarceration still reflect a human loss. In any event, this is another cost that is difficult to quantify even for those who conceptually would

like to include it. The size and even the sign of other costs, such as the postincarceration impact on communities, are also sharply debated. Rather than excluding these collateral costs from our analysis, it is useful to add in a reasonable figure to provide an upper bound on the cost of incarceration for the average state (or a more realistic estimate of the cost for a high-operating-cost state). For now, to give a sense of the impact of these other costs, I assume that they increase the marginal cost of incarceration from $55,000 to $80,000. In summary, table 9.3 presents four marginal prison-cost estimates in: $25,797; $35,000; $55,000; and $80,000.

V. The Results of a Marginal Cost-Benefit Analysis

As a means to estimate the optimal level of incarceration, we now turn to a traditional cost-benefit analysis according to equations [1] through [4]. Though considerable uncertainty remains over the best estimates for the elasticity and costs of crime as well as the costs of incarceration, this analysis uses a range of figures that presumably brackets the true figures. One of the central conclusions is that two factors lead to wildly varying predictions about the optimal rate of incarceration: the imprecision in various key estimates and the influence of certain normative choices.

To begin this analysis, I estimate the marginal benefits of incarceration at an aggregate level; that is, using aggregate elasticity estimates and without distinguishing between the different types of crime. The results are presented in table 10; the numbers in columns c through e represent the marginal benefits that derive from the incarceration of the last inmate using various estimates. I think that the most accurate aggregate elasticity estimate for 2005 is likely to be around -0.10 to -0.15, but given the high degree of uncertainty, I present results for elasticity estimates ranging from -0.05 to -0.4.

Table 10 estimates the benefits of adding an additional prisoner using the marginal benefits equation (equation [4]), which must be evaluated at specific crime and imprisonment levels (2005 average values are used here). Once again, we see the influence of the fact, stressed

in table 2 above, that even under the assumption of constant elasticity, incarceration faces diminishing marginal returns (note that P is the denominator of equation [4]). All else equal, the impact on crime of an additional prisoner becomes smaller at higher levels of incarceration. To underscore this, we re-calculated table 10 using sample averages during 1986 (the results are shown in table 11). Clearly, the marginal benefits of an additional incarceration in 1986 were significantly higher than they are today, even when making the same assumptions about the elasticity of crime with respect to incarceration. This fact of sharply decreasing marginal utility alone suggests caution in advocating additional increases in incarceration.[29]

[29] Note once again that this issue of decreasing marginal benefits from incarceration is distinct from LPU's finding that the elasticity of incarceration becomes smaller at higher levels of incarceration: elasticity itself changes. In LPU's words, this implies *accelerating* diminishing marginal returns. The analysis in this chapter adopts the more limited assumption of decreasing marginal utility of incarceration (which derives from the assumption of constant elasticity, which is generated by the log-log regression specification). Similarly, since crime is in the numerator of equation [4], the effectiveness of incarceration is positively related to crime levels. That is, all else equal, incarcerating one more offender will have a smaller benefit in low-crime contexts. Accordingly, the more crime rates improve, the relatively less effective incarceration becomes.

TABLE 10

Marginal Benefit of the Last Prisoner Incarcerated, 2005

(Using a Static Aggregate Elasticity for Incarceration and Crime Levels in 2005)

(a)	(b)	(c)	(d)	(e)
		Total Marginal Benefits		
		(low estimate)	(mean estimate)	(high estimate)
η	**λ**	**$5,857**	**$16,128**	**$26,398**
-0.05	1.147	$6,716	$18,492	$30,269
-0.1	2.293	$13,432	$36,985	$60,537
-0.2	4.587	$26,864	$73,969	$121,074
-0.3	6.880	$40,297	$110,954	$181,611
-0.4	9.173	$53,729	$147,939	$242,149

Source: Author's calculations.
Notes: Column a shows the elasticity of crime with respect to incarceration that is used to predict the number of crimes that will be averted by locking up one additional prisoner (column b). The remainder of the table converts the reduction in crimes shown in column b into monetary values. The low vs. high cost estimates are weighted costs derived for the average crime in table 8. Marginal benefits were quite similar if we also extracted motor vehicle theft from the general elasticity and assigned it an elasticity twice (or even three times) as high. We do not show results for this exercise. λ's are evaluated at 2005 values, when the total number of adjusted index crimes was 28,892,802 (FBI 2006), and the number of state prisoners was 1,259,905 (BJS 2006b). Appendix table F2 provides analogous results that exclude murder from the benefit calculus.

TABLE 11

Marginal Benefit of the Last Prisoner Incarcerated, 1986

(Using a Static Aggregate Elasticity for Incarceration and Crime Levels in 1986)

(a)	(b)	(c)	(d)	(e)
		Total Marginal Benefits		
		(low estimate)	(mean estimate)	(high estimate)
η	**λ**	**$5,857**	**$16,128**	**$26,398**
-0.05	3.338	$19,553	$53,838	$88,124
-0.1	6.677	$39,106	$107,677	$176,247
-0.2	13.353	$78,213	$215,354	$352,495
-0.3	20.030	$117,319	$323,031	$528,742
-0.4	26.706	$156,425	$430,707	$704,990

Source: Author's calculations.
Notes: This table replicates table 10 using 1986 data on the number of crimes and prisoners, while retaining the same crime reporting rate values and cost per crime figures as in table 10 (BJS 2006b). In 1986, the total number of adjusted index crimes was 32,418,219, and the number of state prisoners was 485,553 (BJS 1995). With higher crime in 1986 (than in 2005) and lower levels of incarceration, the marginal benefit of an additional incarceration is roughly three times higher in 1986 than in 2005—even though we use the same constant elasticities as in table 10.

Of course, looking only at marginal benefits is not sufficient to determine optimality; we need to compare the benefits of the marginal incarceration against its costs. So that we can make the appropriate comparison, it is useful to discuss at this stage exactly what is meant by "marginal benefit of the last prisoner incarcerated." Note an important fact about the design of the elasticity models: most of them are at the state-year level. That is, they regress the crime rate on the state prison rate, which is a yearly snapshot of the state prison population (the prison rate is usually either once lagged or contemporaneous to the crime variable). Tables 10 and 11 thus quantify the added benefit of increasing the state prison population by one for a single year. Hence, the marginal cost analogue is the cost of incarcerating an additional state prisoner during a particular year.

There are several reasonable estimates for the marginal costs: we can estimate the costs at $25,797 per prisoner, per year (if we only include the explicit monetary costs of operating the prison system and use a mean national figure); alternatively, we can use an estimate of $55,000 per prisoner, per year (if we add lost productivity and capital expenditures to the operating costs). An intermediate value of $35,000 might be justifiable for a different set of assumptions about capital costs or offender productivity, or for states with below-average operating costs. Alternatively, the costs of incarceration might go well beyond even the $55,000 estimate for high-operating-cost states or if we attach significant monetary values to some of incarceration's other negative impacts. Among these additional effects, one might include the negative impact on the social fabric of communities and families, the disutility to the prisoner of incarceration, enhanced likelihood of future criminality among inmates, the spread of disease such as AIDS and tuberculosis, tax distortions that make the social cost of raising a dollar great than a dollar, and postprison release difficulties in finding employment along with lower wages (Levitt 1996; Holzer, chapter 8, this volume). These additional costs are hard to quantify at the yearly-marginal level; however, they could potentially lead to marginal-cost estimates as high as, say, $80,000.

Returning to the classic efficiency condition, optimality is reached when marginal benefits equal marginal costs. Using equation [4] to define marginal benefits, and setting that equal to marginal costs (on the present assumption that the elasticity η is fixed over the relevant range of interest, that marginal costs take on one of the fixed collar values mentioned above, and that total crime costs will vary with the incarceration rate), we get the following equation:

$$[5]\ \mathbf{MC} = (\eta/P^{*}) * [TC - (TC * \eta * ((P^{*}-P_0)/P_0))] = \mathbf{MB},$$

Where MC is marginal costs, MB is marginal benefits, P^{*} is the optimal incarceration level, CPC is the cost of crime, and P_0 is the current level of incarceration. We can then solve equation [5] for P^{*}, which can alternatively be represented in terms of the change in incarceration from the current level that will generate the optimal level of incarceration (ΔP). If we note that $\Delta P = P^{*} - P_0$, then we can rearrange the equation to solve for:

$$[6]\ \mathbf{\Delta P} = [(\eta * CPC) - (MC * P_0)] / [MC + ((\eta^2 * CPC)/P_0)]$$

Table 12 uses this equation and the fact that the 2005 national prison population (under state jurisdiction) was 1,259,905 (Harrison and Beck 2006) to calculate how the American prison system would have to change in order to reach optimality for various combinations of our elasticity and cost estimates.

Table 12 underscores the point that—based on which figures one adopts for the elasiticty of crime with respect to incarceration, the cost of crime, and the marginal cost of an added prisoner—one could justify essentially any conclusion about incarceration, from massive reductions in the number of inmates to dramatic increases.

My own view for a state with operating costs at the mean is that the social cost of incarceration at the margin would be at least $55,000, and it would be reasonable to use

something close to the high cost-of-crime estimates (with murder costs eliminated). Under these assumptions, a low elasticity (-0.05) would imply the need to considerably reduce the level of incarceration, while a plausible but larger elasticity of -0.1 would imply the need for substantial increases in the prison population. Optimality would be reached with an intermediate elasticity somewhat above -0.075.

If one were persuaded that the low cost-of-crime figures were more appropriate, then combining any elasticity estimate with prison-cost estimates at $55,000 or above would point toward the need for large reductions in the prison level (except when MC is $55,000 and the elasticity is -0.4, which would be roughly optimal). At the plausible elasticities of -0.05 and -0.1 (and MC = $55,000), the decision to opt for the low cost-of-crime estimates would point towards a drop in the prison population of about 1 million from its 2005 level of 1.26 million.

Substantial increases in the prison population would be necessary for higher cost-of-crime estimates and elasticities above -0.1. Note that even with the highest cost of incarceration, if one uses the high cost-of-crime estimates and an elasticity of -0.2, optimality would call for an extra 820,000 prisoners. If the elasticity were as high as -0.3, it would call for a doubling of the prison population.

Some of the conclusions flowing from table 12 are so extreme that they tend to discredit the attending assumptions and estimates on which they are based. Indeed, using a marginal cost of $55,000, the magnitude of the proposed drops in incarceration of close to 1 million for elasticities that are below -0.1 (and a drop of almost 600,000 even for an elasticity of -0.2) suggests either that our current incarceration policy is dramatically inappropriate or that the low cost-of-crime figures are simply unrealistic. Moving down a column in table 12 or moving across a row illustrates that a single step can imply very dramatic shifts in the number of prisoners needed to reach optimality (either upwards or downwards). The bottom line is that considerably

greater refinement in the estimates of three categories—the elasticity, the cost of crime, and the marginal cost of incarceration—is needed before strong policy conclusions can be drawn.[30]

[30] The marginal analysis in appendix table B1 will go awry if there is some major suboptimality in another part of the system. For example, if U.S. drug-enforcement policy leads to massive increases in crime, then table B1 might suggest that greater incarceration is appropriate given this artificially high crime rate. In this scenario, changing drug policy would lower crime, which would automatically lower the estimated benefits of incarceration (thereby reducing the estimated optimal level of incarceration).

TABLE 12

Changes in State Prison Population Necessary to Reach Optimality

(2005 values)

(a)	(b)	(c)	(d)
	A. Optimality Using Marginal Cost = $25,797		
η	low CPCs	mean CPCs	high CPCs
-0.05	-913,903	-158,904	553,662
-0.1	-562,316	790,930	1,891,840
-0.2	62,429	1,838,948	2,827,802
-0.3	503,343	2,069,628	2,703,584
-0.4	763,637	1,982,838	2,377,453
	B. Optimality Using Marginal Cost = $35000		
η	low CPCs	mean CPCs	high CPCs
-0.05	-1,004,002	-439,427	101,332
-0.1	-738,845	312,874	1,210,856
-0.2	-238,279	1,300,062	2,252,358
-0.3	160,316	1,662,828	2,350,620
-0.4	436,217	1,703,113	2,163,553
	C. Optimality Using Marginal Cost = $55,000		
η	low CPCs	mean CPCs	high CPCs
-0.05	-1,096,483	-731,827	-377,148
-0.1	-923,725	-215,965	421,394
-0.2	-576,178	597,948	1,429,565
-0.3	-261,704	1,049,606	1,765,169
-0.4	-5,039	1,235,343	1,775,618
	D. Optimality Using Marginal Cost = $80,000		
η	low CPCs	mean CPCs	high CPCs
-0.05	-1,147,335	-894,573	-646,615
-0.1	-1,027,016	-524,895	-58,464
-0.2	-776,170	123,627	820,394
-0.3	-532,056	569,753	1,255,355
-0.4	-312,975	824,093	1,398,996

Note: The five depicted elasticities apply to index I crimes. CPC stands for cost per index I crime, using the "high" and "low" CPC costs in Table 8, as well as an intermediate value, which is the simple mean of the high and low estimates. The values listed in each cell for an attendant combination of η, CPC, and marginal cost of incarceration reflect the difference between the optimal state prisoner count (P^*) and the number of state prisoners in 2005: 1,259,905 (Harrison and Beck 2006), assuming a constant elasticity for all crimes including murder. That is, these figures tell us how many prisoners would have to be added (for positive numbers) or eliminated (for negative values) from the state prison system to reach the point where the marginal costs of incarcerating an additional prisoner equal its marginal benefits. For an analogous table that excludes murder, see appendix table F3.

VI. Evaluating the Opportunity Cost of Increased Incarceration

Accordingly, in addition to using a cost-benefit analysis, there is a second hurdle that a policy of incarceration must clear. Specifically, we must consider the opportunity costs of incarceration and the relative efficiency of different ways of allocating crime-fighting resources. Besides incarceration, a variety of additional crime-fighting strategies exist—for example, increasing the police force, changing policing strategies, or spending on education or social programs (Donohue and Siegelman 1998).[31] Given these options, we must ask ourselves whether our very heavy reliance on incarceration is the most effective way of allocating resources from our limited crime-fighting budget. "Unless the government spends in such a way that the marginal benefit (the crime reduction achieved from the last dollar spent) is the same for each activity, society will not be fighting crime in a cost-effective manner" (Donohue and Siegelman 1998, 2).

The large drop in crime in New York City in the wake of very large increases in the police force in the early 1990s suggests that, rather than locking up criminals after they commit their crimes, a more cost-efficient strategy may be to discourage crime with a proactive regulatory approach rather than a post hoc pure deterrence or incapacitation strategy. Economists Donohue and Ludwig (2007) argue that the elasticity of crime with respect to police is likely to be higher (at -0.4) than the elasticity with respect to incarceration. If one recognizes that the number of police officers is lower than the number of prisoners, and the cost of hiring a police officer is roughly equal to the social cost of an added inmate, then this would suggest the attractiveness of switching resources from incarceration toward hiring more police (Donohue 2004a).

However, a full-scale inquiry into the optimal level of incarceration would also have to probe whether shifting resources from prisons to social spending might yield net social gains.

[31] For example, a study conducted by Lance Lochner and Enrico Moretti (2004) suggests that government efforts to mandate more schooling may dampen crime.

Donohue and economist Peter Siegelman (1998) offer a thought experiment designed to spell out "the conditions under which it would be possible to reduce spending on prisons, use the money to fund social programs, and reduce the overall crime rate in the process" (2). That study examined the effectiveness in reducing criminal behavior of certain social programs, such as preschool and early-childhood education, family therapy, programs for juvenile delinquents, and labor-market interventions.[32] After assessing these programs, the authors considered a hypothetical choice between two crime-fighting strategies for the future: "(1) increase the prison population by 50 percent over the level in December of 1993, which seems to be the trend of current policy, or (2) maintain the December 1993 level of incarceration and spend the present value of the saved social resources on crime-reducing social programs" (Donohue and Siegelman 1998, 31). [33] The question was thus if the second policy could achieve the same levels of crime reduction as the first.

To focus the inquiry, Donohue and Siegelman's (1998) study estimated that increasing future incarceration rates for a present cohort of three-year-old children by 50 percent beyond the 1993 level would cost (in present value terms) between $5.6 and $8 billion, and future crime rates would be 5 to 15 percent lower than if the incarceration increase had not occurred.[34] Based on an examination of research studies regarding the effects of various social programs, Donohue and

[32] The central focus of most of these programs was not to reduce criminal behavior. Rather, they were focused on improving education, earnings, child behavior, family relations. Nevertheless, many of them also documented the collateral effect of improved criminal behavior in the programs' participants.

[33] To underscore the prescience of this prediction of doubling the prison population, note that the total number of state prisoners in December of 1993 was 879,714. This population grew to 1,316,301 in the year 2004, representing an increase of almost 50 percent over the level of 1993.

[34] There is wide variation in the estimates of the elasticity of crime and the cost of incarceration. In 1998, Donohue and Siegelman generated lower and upper bounds from then existing estimates. They used those bounds to create the figures of $5 to $8 billion costs and 5 to 15 percent crime reduction for the hypothetical situation (implying an elasticity of crime with respect to incarceration of between 10 and 30 percent). The dollar range represented the present value of the future cost of incarceration and was generated by taking today's cohort of three-year-old children as the reference point (mainly because this is the age at which early-childhood programs begin). Hence, the cost of incarceration is the expense that would be required to incarcerate criminals of this cohort in the future, once they reach their high-crime years. However, Donohue and Siegelman also wanted to bring this future cost into the present, which is when the spending on social programs would occur. Therefore, the range of $5.6 billion to $8 billion represented the present value of the future increase in incarceration (with a target incarceration growth of 50 percent).

Siegelman (1998) concluded that the most promising ones were capable of matching the 5 to 15 percent crime reduction if the equivalent incarceration money ($5.6 billion to $8 billion) were reallocated to such programs. For example, the authors document that if the money were used to fund a national targeted program such as the Perry Preschool (Hohmann, Banet, and Weikart 1979), the volume of crime would decrease by 9.3 percent in the worst-case scenario (if $5.6 billion were invested and assuming that the real-life program would be half as effective as the small, pilot study); it would decrease by 20.1 percent in the best-case scenario (using the $8 billion cost estimate and assuming the preschool program would be just as effective as the pilot program).

Importantly, these estimates were based on the assumption that the social spending could be targeted towards those most at risk for future criminal behavior. The targeting issue is important because spending the money on children with low risk of committing future crime leads to only modest benefits, thus costing billions of dollars for little crime-reduction gain. In theory, the targeting problem is solvable if political, legal, and ethical concerns can be addressed. The study showed that even a crude target such as young black males would generate high social benefits if the programs could work in large-scale implementation with reasonable effectiveness. Donohue and Siegelman (1998) thus illustrated that under certain conditions, "increased spending [on] social programs [can] generate crime reductions of the same order of magnitude as the prison spending it replaces" (40). In addition, if one considers that social programs may also have many positive spillovers—such as improving earnings and education for some of the most disadvantage communities in the country—the appeal of social programs becomes further accentuated. It is even more appealing if we consider incarceration's negative spillovers on these same communities (such as on family structure). In summary, considering the question of incarceration from an opportunity-cost perspective reveals a potential inadequacy of the cost-benefit test: even if incarceration passes that test, reallocation away from mass incarceration might be a more sound

and socially beneficial strategy if similar resources can generate greater or equal crime reductions when allocated to social spending (Greenwood et al. 1996).

VII. Conclusion

This paper cannot provide clear policy predictions concerning the optimal level of incarceration. Rather, it provides an exercise of trying to think systematically about the marginal costs and benefits of incarceration in light of the existing literature on prison effectiveness in crime reduction. This can illuminate where we would benefit from more precise estimates of key parameters as well as the importance of resolving difficult philosophical questions. Hopefully this exercise will prove valuable as a means of illustrating the areas of our ignorance and the conceptually important issues that need to be resolved in thinking about optimal crime-fighting policy. It would be helpful to further investigate whether utility of prisoners or their families should count; whether utility of victims' families should count (although perhaps this is implicit in willingness-to-pay estimates); whether pure transfer costs should be included in the cost of crime; and whether the important issue of murder victimization should be treated in a more nuanced way to reflect the different social costs attending the deaths of those involved in criminal behavior.

Moreover, if one widens the lens and focuses not only on a narrow cost-benefit calculation of incarceration but also on alternative crime-fighting approaches, there is reason to believe that alternatives to incarceration might well be more socially attractive than our current reliance on incarceration as the predominant crime-fighting strategy. This broader inquiry also illustrates why some consideration of the human costs of incarceration to inmates is appropriate. Consider two equally costly crime-fighting strategies that led to equal reductions in crime, with one leading to 500,000 extra prison inmates and one leading to 500,000 extra children in preschool enrichment programs. Under these circumstances, my belief is that the preschool enrichment strategy should dominate the punitive approach. This intuition supports the view that

some measure of the costs borne by prison inmates should be included as a social cost of the punitive approach. With so many inmates suffering from mental illness, alternative and more humane forms of handling such individuals may well be more cost effective if the human toll of mass incarceration considered in the calculation.

References

Anderson, David 1999. "The Aggregate Burden of Crime." *Journal of Law and Economics* 42(2): 611-642.

Bartley, William. 2000. "Valuation of Specific Crime Rates: Summary." http://www.ncjrs.gov/App/Publications/abstract.aspx?ID=187771.

Becsi, Zsolt. Federal Reserve Bank of Atlanta. 1999. "Economics and Crime in the States." *Economic Review*. First Quarter: 38-49.

Becker, Gary S. 1968. "Crime and Punishment: An Economic Approach." *Journal of Political Economy* 76(2): 169-217.

Buonanno, Paolo. 2003. "The Socioeconomic Determinants of Crime. A Review of the Literature." Mimeo 63, Milan: Universitádegli Studi di Milano-Bicocca.

Bram, Jason, James Orr and Carol Rapaport. 2002. "Measuring the Effects of the September 11 Attack on New York City." *Economic Policy Review*: 5-20. New York: Federal Reserve Bank of New York.

Bureau of Justice Statistics. 2006. "Criminal Victimization in the United States, 2005 Statistical Tables." *National Crime Victimization Survey.* Washington: U.S. Department of Justice. http://www.ojp.usdoj.gov/bjs/pub/pdf/cvus0505.pdf.

Chen, Keith and Jesse Shapiro. 2007. "Do Harsher Prison Conditions Reduce Recidivism? A Discontinuity-based Approach." *American Law and Economics Review* 9(1): 1-29.

Cohen, Mark. 1988. "Pain, suffering, and jury awards: a study of the cost of crime to victims." *Law and Society Review* 22(3): 537-555.

—. 1990. "A Note on the Cost of Crime to Victims." *Urban Studies* 27(1): 125-132.

—. 2005. *The Costs of Crime and Justice.* London: Routledge.

Cohen, Mark., Ted R. Miller and Shelli B. Rossman. 1994. "The Costs and Consequences of Violent Behavior in the United States," in *Understanding and Preventing Violence:*

Consequences and Control of Violence, Vol. 4. Albert J. Reiss, Jr. and Jeffrey A. Roth (eds). National Research Council. Washington: National Academy Press.

Cohen, Mark, Roland Rust, Sara Steen, and Simon Tidd. 2004. "Willingness to Pay for Crime Control Programs." *Criminology* 42(1)*:* 86-109.

Collins, Sara. 1994. "Cost of Crime: 674 Billion." *U.S. News and World Report* (January 17), cited in "The Aggregate Burden of Crime" by David Anderson. *Journal of Law and Economics* 42: 611-642.

Cook, Philip J. 1983. "Costs of Crime," in *Encyclopedia of Crime and Justice*. Sanford H. Kadish, ed. New York: Free Press.

Cook, Philip J. and Jens Ludwig. 2000. *Gun Violence: The Real Costs*. New York: Oxford University Press.

DiIulio, John. 1996. "Prisons are a bargain, by any measure." *New York Times*. January 16. A19.

Donohue, John. 2004a. "Guns, Crime, and the Impact of State Right-to-Carry Laws." *Fordham Law Review* 73:623-652.

—. 2004b. "Clinton and Bush's Report Cards on Crime Reduction: The Data Show Bush Policies Are Undermining Clinton Gains", The Economists' Voice: Vol. 1: No. 1, Article 4, http://www.bepress.com/ev/vol1/iss1/art4

—. 2005. "Fighting Crime: An Economist's View." *Milken Institute Review*, Quarter 1: 47-58.

—. 2007. "Economic Models of Crime and Punishment." *Social Research* 74(2): 379-412.

Donohue, John and Jens Ludwig. 2007. "More COPS." *The Brookings Institution*, Policy Brief #158. Washington: The Brookings Institution.

Donohue, John and Peter Siegelman. 1998. "Allocating Resources among Prisons and Social Programs in the Battle Against Crime." *Journal of Legal Studies* 27(1): 1-44.

Donohue, John and Justin Wolfers. 2006. "Uses and Abuses of Empirical Evidence in the Death Penalty Debate." *Stanford Law Review* 58: 791-846.

Durose, Matthew R. and Patrick A. Langan. 2004. "Felony Sentences in State Courts, 2002." *Bureau of Justice Statistics Bulletin*. Washington: U.S. Department of Justice. http://www.ojp.usdoj.gov/bjs/abstract/fssc02.htm.

Federal Bureau of Investigation. U.S. Department of Justice. 2006. "Crime in the United States 2005." http://www.fbi.gov/ucr/05cius/.

Gilliard, Darrell K. and Allen J. Beck.1996. "Prison and Jail Inmates, 1995." *Bureau of Justice Statistics Bulletin*. Washington: U.S. Department of Justice. http://www.ojp.usdoj.gov/bjs/pub/pdf/pji95.pdf .

Greenwood, Peter, et al. 1996. *Diverting Children from a Life of Crime: Measuring Costs and Benefits*. RAND. http://www.rand.org/pubs/monograph_reports/MR699-1/.

Harcourt, Bernard. 2007. "From the Asylum to the Prison: Rethinking the Incarceration Revolution – Part II: State Level Analysis." Public Law Working Paper No. 155. http://www.law.uchicago.edu/Lawecon/index.html.

Harlow, Caroline Wolf. 2003. "Education and Correctional Population." Bureau of Justice Statistics Special Report. Washington: U.S. Department of Justice. http://www.ojp.usdoj.gov/bjs/abstract/ecp.htm.

Harrison, Paige and Allen Beck. U.S. Department of Justice. Bureau of Justice Statistics. 2005. "Prisoners in 2004." *Bulletin of the Bureau of Justice Statistics*. http://www.ojp.usdoj.gov/bjs/pub/pdf/p04.pdf.

—. 2006. "Prisoners in 2005." *Bureau of Justice Statistics Bulletin*. Washington: U.S. Department of Justice. http://www.ojp.usdoj.gov/bjs/pub/pdf/p05.pdfHill, George and Paige Harrison. Bureau of Justice Statistics. 2004. "Prisoners under State or Federal Jurisdiction." *National Prisoner Statistics Data Series (NPS-1)*. http://www.ojp.usdoj.gov/bjs/data/corpop02.csv.Hoehn, John, Mark Berger and Glenn

Blomquist. 1987. "A Hedonic Model of Interregional Wages, Rents and Amenity Values." *Journal of Regional Science* 27(4): 605-620.

Hohmann, Mary, Bernard Banet, and David P. Weikart. 1979. *Young Children in Action: A Manual for Preschool Educators*. Ypsilanti, Mich: High/Scope Press.

Holzer, Harry, Steven Raphael and Michael Stoll. 2007. "Will Employers Hire Ex-Offenders? Employer Checks, Background Checks, and Their Determinants." in *Do Prisons Make Us Safer? The Benefits and Costs of the Prison Boom*, edited by Steven Raphael and Michael Stoll. New York: Russell Safe Foundation.

International Centre for Prison Studies. 2008. "Prison Brief for Russian Federation." http://www.kcl.ac.uk/depsta/law/research/icps/worldbrief/wpb_country.php?country=118.

Johnson, Rucker. 2007. "The Effects of Increases in Incarceration on Members of Communities that Send/Receive the Majority of Inmates." in *Do Prisons Make Us Safer? The Benefits and Costs of the Prison Boom*, edited by Steven Raphael and Michael Stoll. New York: Russell Sage Foundation.

Johnson, Rucker and Steven Raphael. 2006. "How Much Crime Reduction Does the Marginal Prisoner Buy?" Working paper. Berkeley: University of California, Berkeley, Goldman School of Public Policy.

Klaus, Patsy A. U.S. Department of Justice. 1994. "The Cost of Crime to Victims" cited in "The Aggregate Burden of Crime" by David Anderson. *Journal of Law and Economics* 42: 611-642.

Lancaster, Kelvin J. 1966. "A New Approach to Consumer Theory." *The Journal of Political Economy* 74(2): 132-157.

Leary, Mary Lou (Executive Director, National Center for Victims of Crime). 2006. "The Cost of Crime: Understanding the Financial and Human Impact of Criminal Activity." Testimony to the U.S. Senate Committee on the Judiciary. September 19.

Lerman, Amy. 2007. "The People Prisons Make: Effects of Incarceration on Criminal Psychology." in *Do Prisons Make Us Safer? The Benefits and Costs of the Prison Boom*, edited by Steven Raphael and Michael Stoll. New York: Russell Safe Foundation.

Levitt, Steven. 1996. "The Effect of Prison Population Size on Crime Rates: Evidence from Prison Overcrowding Litigation." *Quarterly Journal of Economics* 111(2): 319-351.

Liedka, Raymond, Anne Piehl, and Bert Useem. 2006. "The Crime-Control Effect of Incarceration: Does Scale Matter?" *Criminology and Public Policy* 5(2): 245-276.

Listokin, Yair. 2003. "Does More Crime Mean More Prisoners? An Instrumental Variable Approach." *Journal of Law and Economics* 46(1): 181-206.

Lochner, Lance and Enrico Moretti. 2004. "The Effect of Education on Crime: Evidence from Prison Inmates, Arrests, and Self-Reports." *American Economic Review* 94(1): 155-189.

Ludwig, Jens. 2006. "The Cost of Crime." Testimony to the U.S. Senate Committee on the Judiciary. September 19. http://judiciary.senate.gov/testimony.cfm?id=2068&wit_id=5749.

Marvell, Thomas B. and Carlisle Moody, Jr. 1994. "Prison Population Growth and Crime Reduction." *Journal of Quantitative Criminology* 10(2): 109-140.

Martin, Mark, "Governor Seeks $6 billion for Prison Projects," *San Francisco Chronicle*, August 2, 2006.

Miller, Ted, Mark Cohen, and Brian Wiersema. 1996. *Victim Costs and Consequences: A New Look*. National Institute of Justice Research Report, NCJ-155282. Washington: U.S. Department of Justice. http://www.ncjrs.gov/pdffiles/victcost.pdf.

Pfaff, John F. 2007. "The Growth of Prison: Toward a Second Generation Approach." *Fordham Law Legal Studies Research Paper No. 976373*. New York: Fordham School of Law. http://ssrn.com/abstract=976373.

President's Commission on Law Enforcement and Administration of Justice. 1967. *Crime and Its Impacts: An Assessment*, cited in "The Aggregate Burden of Crime" by David Anderson. *Journal of Law and Economics* 42: 611-642.

Rosen, Sherwin. 1974. "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition." *Journal of Political Economy* 82(1): 34-55.

Schelling, Thomas C. 1968. "The life you save may be your own" in *Problems in Public Expenditure Analysis*. Samuel B. Chase Jr., ed. Washington: The Brookings Institution.

Shaw, Clifford R. and Henry D. McKay. United States Wickersham Crime Commission. 1931. *Social factors in juvenile delinquency*. Washington: U.S. Government Printing Office.

Spelman, William. 1994. *Criminal Incapacitation.* New York: Plenum Press.

—. 2000a. "The Limited Importance of Prison Expansion" in *The Crime Drop in America*. Alfred Blumstein and Joel Wallman, eds. New York: Cambridge University Press.

—. 2000b. "What Recent Studies Do (and Don't) Tell Us About Imprisonment and Crime." *Crime and Justice* 27: 419-494.

—. 2005. "Jobs or Jails? The Crime Drop in Texas." *Journal of Policy Analysis and Management* 24(1): 133-165.

State of Connecticut General Assembly. Legislative Program Review and Investigations Committee. 2000. "Chapter 5: Options to Manage Growth in Prison Populations." *Factors Impacting Prison Overcrowding*. http://www.cga.ct.gov/pri/archives/2000fireportchap5.htm.

Strnad, Jeff, 2007. "Should Legal Empiricists go Bayesian?" *American Law and Economics Review* 9(1): 195-303.

Thaler, Richard. 1978. "A Note on the Value of Crime Control: Evidence from the Property Market." *Journal of Urban Economics* 5(1): 137-145.

Trumbull, William N. 1990. "Who Has Standing in Cost-Benefit Analysis?" *Journal of Policy Analysis and Management* 9(2): 201-218.

U.S. News and World Report. 1974. "Costs of Crime" cited in "The Aggregate Burden of Crime" by David Anderson. *Journal of Law and Economics* 42: 611-642.

Viscusi, W. Kip. 1998. *Rational Risk Policy*. New York: Oxford University Press.

—. 2000. "The Value of Life in Legal Context: Survey and Critique." *American Law and Economics Review* 2: 195-222.

Walker, Alan and Carol Walker, eds. 1987. *The Growing Divide: A Social Audit 1979-1987.* London: Child Poverty Action Group.

Welsh, Brandon C. and David P. Farrington. 2000. "Monetary Costs and Benefits of Crime Prevention Programs," *Prisons*, edited by Michael Tonry and Joan Petersilia. Chicago: University of Chicago Press.

Zedlewski, Edwin W. 1985. "When Have We Punished Enough?" *Public Administration Review* 45 (Special Issue: Law and Public Affairs): 771-779.

Zimring, Franklin and Gordon Hawkins. 1988. "The New Mathematics of Imprisonment." *Crime and Delinquency* 34(4): 425-436.

—. 1995. *Incapacitation: Penal Confinement and the Restraint of Crime.* New York: Oxford University Press.

Appendix A: Estimating the Elasticity of Crime with Respect to Incarceration

Table 1 of the paper summarizes an array of elasticity estimates that are critical to a calculation of the optimal level of crime. This appendix discusses these studies in greater details and offers insights into why there is such variability in elasticity estimates across the various studies, and it discusses the most plausible range of estimates for this elasticity given the current levels of crime and incarceration.

Spelman (1994) provides one of the most carefully conducted incapacitation studies, based primarily on Rand's 1978 prison- and jail-inmate surveys in California, Michigan, and Texas. Similar incapacitation studies have found estimates somewhere between -0.10 and -0.30 (Spelman 2000). However, if marginal deterrence exists, then these studies underestimate the elasticity of crime with respect to incarceration by ignoring this effect. Unfortunately, we do not know enough about the magnitude of any marginal deterrent effect in order to properly adjust incapacitation-based elasticity estimates. On the other hand, as we have noted, there are also factors that could lead incapacitation studies to overestimate the elasticity (Marvell and Moody 1994; Levitt 1996; and Spelman 2000b).[35] For example, if crime is conducted in groups or if there is a replacement effect (that is, incarcerated criminals are replaced by new ones who enter the "criminal market" to fill in the space created by incarceration), survey-based research might overestimate the elasticity. Spelman (2000b) tries to adjust for all of these factors and ends up with an elasticity estimate of roughly -0.16, as indicated in table 1.

Thomas B. Marvell and Carlisle Moody, Jr. (1994) conducted one of the first studies to use a state-year panel dataset to estimate the impact of incarceration on crime. After concluding that simultaneity is not a problem (based on their Granger causality test),[36] the authors estimate a

[35] Marvell and Moody (1994) contains a useful discussion about how λ's based on surveys and arrest-rates should be adjusted in light of various biasing factors and measurement error.

[36] This actually may say more about the limited value of the Granger causality test than about the lack of a simultaneity problem. More plausibly, Listokin (2003) has found that the level of incarceration does rise

state fixed-effect (or first-differenced) model where the log of crime rates (per 100,000 population) is regressed on the log of state prison population (per 100,000 population), year dummies, and three control variables related to the age distribution of each states' population.[37] Interestingly, their overall elasticity estimate of -0.16 is exactly the same as the incapacitation effect estimate derived by Spelman. This suggests either that one or both estimates are inaccurate, or the marginal deterrent effect from increased incarceration is zero.

Although Marvell and Moody do not find evidence of simultaneity, and neither do Liedka, Piehl, and Useem (2006), other researchers have deemed simultaneity to be a problem and have attempted to control for it. If simultaneity is present—that is, if crime affects prison rates in addition to the impact of incarceration crime—regression results will underestimate the impact of incarceration on crime.[38] Economist Steven Levitt (1996) uses an innovative approach to address this issue. The key insight is that prison overcrowding litigation is a valid instrumental variable for the level of incarceration. Using this instrument with a state-year panel database, Levitt arrives at estimates of elasticity that are significantly higher than previous ones. This suggests that simultaneity is indeed a problem; not controlling for it significantly underestimates the impact of incarceration on crime. Apart from his two-stage least-square (2SLS) approach and some different controls, Levitt's model is generally similar to Marvell and Moody's model. Levitt's variables are first-differenced, and he regresses the log of crime rates on the log of

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mechanically with increases in crime, so the issue of simultaneity is real. Listokin uses abortion rates as an instrument to tease out this mechanical relationship on the grounds that abortion rates in the 1970s influence crime in the 1990s but don't influence incarceration in the 1990s, except through their effect on crime. Based on this instrumental variables approach, his paper concludes that the estimated elasticity of prison admissions with respect to crime is exactly one, as the mechanical theory predicts. Note, however, that these results are based on a model whose main dependant variable is prison admission rates, *not* overall incarceration levels. As Listokin acknowledges, prison release rates and other factors "may cause theoretical and empirical deviations from a strictly mechanical (one-to-one) relationship between imprisonment and crime" (186).

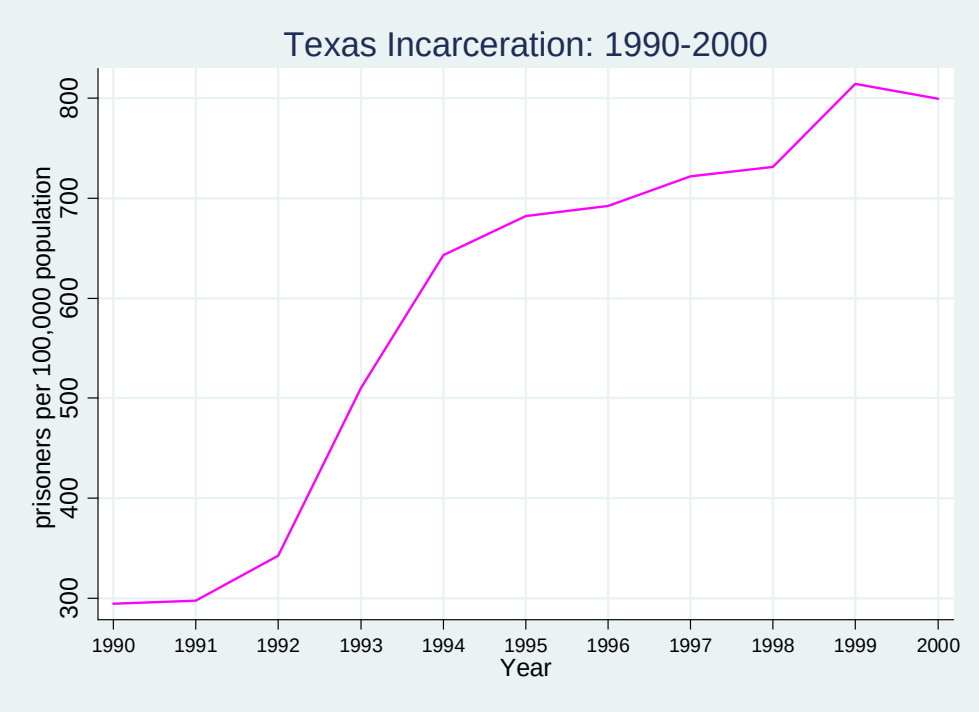
[37] MM also include lagged dependent and independent variables to control for autocorrelation, and they weight the regressions by the square root of population to correct for heteroskedasticity (125-126).

[38] Simultaneity will lead to an underestimation of elasticity because incarceration is expected to *decrease* crime (leading the two series to move in opposite directions) while crime is expected to *increase* incarceration (tending to cause the two series to move in the same direction). If a study does not account for simultaneity, the estimated effect of incarceration on crime for an ordinary least squares regression will actually be some average of the two effects and will thus be biased toward zero.

incarceration rates (once lagged). Like Marvell and Moody, Levitt runs aggregate regressions as well as regressions for each type of index-crime, resulting in crime-specific elasticities. As is frequently the case with this form of estimation, Levitt's 2SLS approach produces much larger standard errors for his coefficients. The 95% confidence intervals around Levitt's estimates are broad enough to cover essentially all values resulting from other studies.

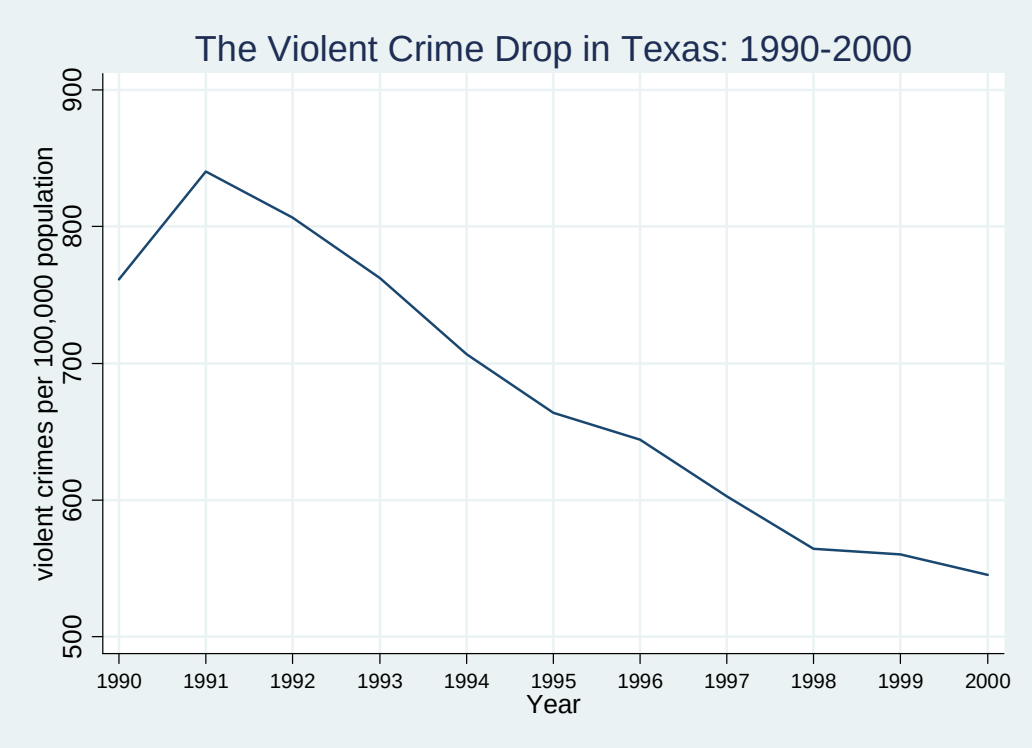
Recently several studies have been published that use new datasets or employ new analytical methods. For example, Spelman (2005) estimates the elasticity of crime using a Texas county-level panel dataset. He argues that Texas county-level data is more accurate and solves several of the problems associated with more aggregated data sets. Also, working at the county level allows him to collect data for several instrumental variables that he uses to control for simultaneity. As shown in table 1, Spelman generates elasticity estimates that are comparable to, but somewhat higher than, Steven Levitt's estimates. The upper end of Spelman's confidence interval for the elasticity of violent crime is -0.75. In my view, this number is too high, but this value may simply reflect the large standard errors that often attend instrumental-variables estimation. There are reasons to cautious about extrapolating from this study in trying to tease out the causal impacts of incarceration. First, it is based on a single state over a single decade. Second, the particular decade was a period of virtually unparalleled growth in Texas' level of incarceration (as seen in figure A1); also, it was a time when substantial drops in crime were common, even in states that did not resort to such dramatic increases in incarceration. Figure A2 illustrates the sharp monotonic decreases in violent-crime rates in Texas starting 1991.

FIGURE A1



Source: Bureau of Justice Statistics (2004). Only includes state prisoners (excluding local jail inmates and federal prisoners).

FIGURE A2



Source: Federal Bureau of Investigation 2006.

A quite different view of the value of incarceration comes from a still more recent study by Liedka, Piehl, and Useem (2006). The authors use a fifty-state panel data set that covers the period from 1972 to 2000, specifically testing whether the elasticity of crime changes as the level of incarceration rises. The study explicitly considers not only the incapacitation and deterrence benefits of increased incarceration, but it also tries to test for a third mechanism—the collateral damage of mass incarceration. The concern is that very high levels of incarceration might "increase crime because of the damage done to communities and the social network of young men and women."[39] Although Liedka, Piehl, and Useem's model is quite similar to that of Marvell and Moody, and it contains state and year fixed effects, it includes higher-order incarceration variables that allow the elasticity of crime to vary over levels of incarceration.[40] With varying statistical significance, Liedka, Piehl, and Useem's specifications suggest that the elasticity of crime becomes smaller at higher incarceration levels, and it actually becomes positive above some threshold level of imprisonment. They interpret as support for the collateral-damage hypothesis. The results for their quadratic model, evaluated at various incarceration levels, are shown in table 1. Essentially, they suggest that, over their entire sample period, incarceration had a small dampening effect on crime; however, at current high levels of incarceration, the adverse consequences of incarceration have caused the sign on the crime elasticity to turn positive.

B. How Modeling Choices Influence the Estimates of η

The range of estimated elasticities, albeit problematic for policymakers, is not surprising to econometricians. There is a great deal of model uncertainty in estimating crime models, and, with widely varying specifications and approaches, the range of estimates is predictably large (Donohue 2004b; Donohue and Wolfers 2006). One approach to resolving this uncertainty is to adopt a Bayesian model averaging approach, and this may well be a sensible way to advance this process further (Strnad 2007).

[39] Liedka, Piehl, and Useem (2006) test the nonconstant-elasticity and the collateral-damage hypotheses through three models: a quadratic, a polynomial, and a spline model of incarceration. In addition, they use a Granger causality test to see whether simultaneity between crime and incarceration is a problem. Like Marvell and Moody (1994), they find no evidence of this; consequently, their model does not control for simultaneity.

[40] Liedka, Piehl, and Useem (2006) adjust their standard errors to account for first-order serial correlation.

To provide one example of how modeling choices that are frequently not discussed (let alone justified) can reflect very different implicit links between incarceration and crime, consider the evidence presented in table A1. The table shows the average annual growth rate for incarceration and homicide rates, starting in 1977, for the nation and the ten highest and lowest states (ranked by the magnitude of the growth rates in incarceration).[41] The growth rate (b) from a particular state is derived from estimating the following equation:

$$\ln(\text{incarceration rate or homicide rate}) = a + b * \text{year}.$$

From 1977 to 2004, the incarceration rate grew nationally by 5.5 percent per year; meanwhile, over that same period (albeit ending in 2003), the homicide rate declined an average of 1.3 percent per year (of course obscuring much movement in the homicide rate, which first went up and then down). Leading the way in this prison growth rate were New Hampshire (7.7 percent annually) and Wisconsin (7.2 percent annually). While New Hampshire experienced a robust average annual murder-rate decline of 2.3 percent, Wisconsin actually saw an annual murder-rate growth of about 1 percent over the period from 1977 to 2003. At the other end of the spectrum, North Carolina had the smallest annual percentage growth rate in incarceration (2.3 percent), followed by Maine with a 2.8 percent incarceration growth. Both these states experienced a healthy decline in homicide rates, although Maine's decline of about 2.6 percent per year was almost twice that of North Carolina.

[41] The crime statistics come from the Federal Bureau of Investigation's *Crime in the United States* (Federal Bureau of Investigation 2006). Incarceration data comes from Bureau of Justice Statistics(Harrison and Beck 2005).

TABLE A1
Changes in Incarceration/Homicide Nationally and by Selected States

Geographic Unit	Average Annual Percent Change in Incarceration Rate (1977 to 2004)	Average Annual Percent Change in Homicide Rate (1977 to 2003)
United States	5.54***	-1.281***
States with the ten highest annual percent changes in incarceration		
New Hampshire	7.71***	-2.32***
Wisconsin	7.19***	1.04***
Colorado	7.16***	-2.38***
Washington, D.C.	7.05***	2.88***
Mississippi	7.02***	-1.03***
Idaho	6.92***	-2.76***
California	6.91***	-2.57***
Connecticut	6.91***	-1.33***
Pennsylvania	6.86***	-0.31
North Dakota	6.78***	-0.81
States with the ten lowest annual percent changes in incarceration		
Oregon	4.29***	-3.16***
Nebraska	4.23***	-0.29
Georgia	4.14***	-2.61***
South Carolina	3.72***	-1.91***
Washington	3.60***	-1.64***
Florida	3.46***	-3.71***
Nevada	3.42***	-2.52***
Maryland	3.39***	0.43
Maine	2.85***	-2.645***
North Carolina	2.33***	-1.38***

Source: Author's calculations.
Note: Reported year coefficients are from the following state-year regressions:
ln (incarceration rate) = a + b (year) + e (1977 to 2004)
ln (homicide rate) = a + b (year) + e (1977 to 2003)
Incarceration data include only state prisoners (Harrison and Beck 2006).
*** and ** indicate significance at the 1 percent and 5 percent level, respectively.

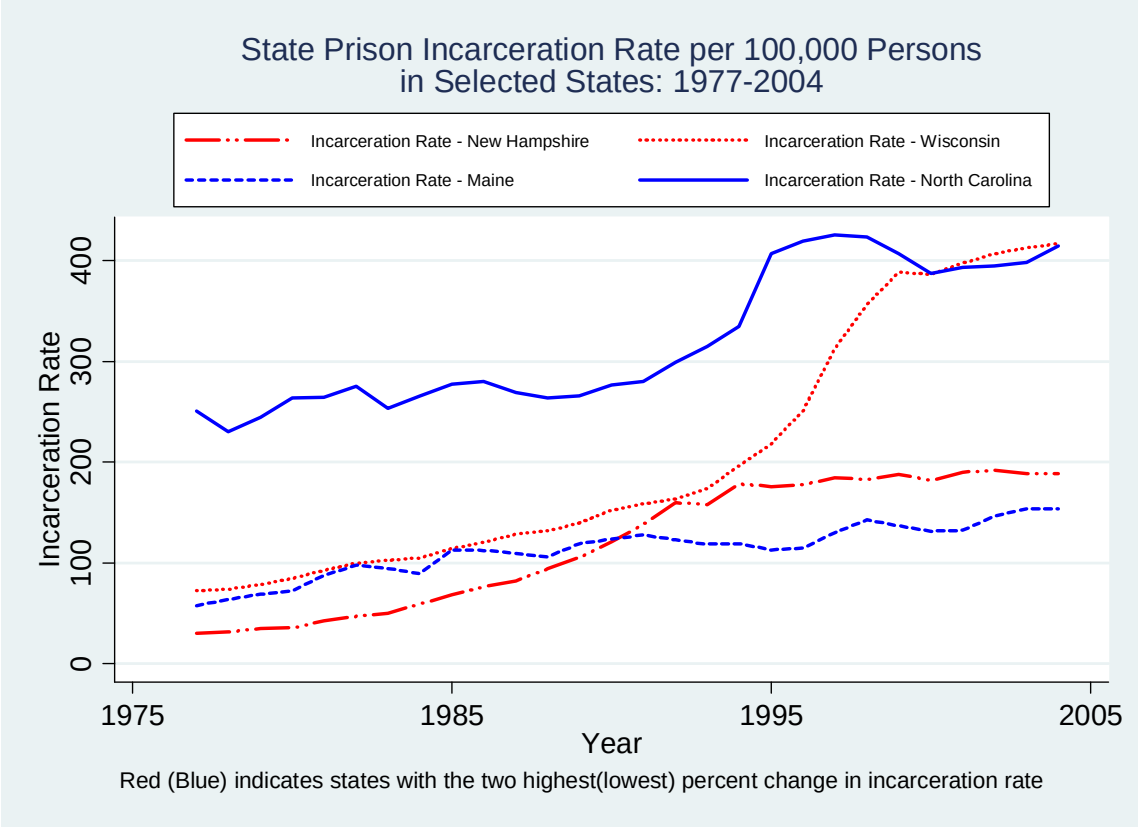
To return to the central issue of the impact of modeling choices, studies that include the natural log of the incarceration rate as their key explanatory variable—as do the econometric studies in table 1 with the exception of Rucker Johnson and Steven Raphael's study (2006)— implicitly constrain their estimated impact on crime to be the same across states for equal proportionate changes in the incarceration rate, regardless of overall incarceration levels. However, the data in figure A3 raise

questions about this assumption. For example, if we compare the incarceration rate of North Carolina (the slowest growing state in terms of incarceration-rate change) with that of New Hampshire (the fastest growing state), we see that North Carolina still incarcerates prisoners at double the rate of New Hampshire, even after twenty-seven years of much faster prison growth in the latter. Presumably, New Hampshire was sending out a message to potential criminals that the risks of incarceration were growing substantially over this period, which would certainly be relevant to issues of deterrence. Still, in terms of taking bodies off the street, North Carolina was still far ahead of New Hampshire: in 2004, the former state's prison system contained 35,434 inmates while the latter only had 2,448 (see figure A3 for more detail). It is this larger absolute number of inmates that is relevant to the likely incapacitative benefit of incarceration: a 1 percent increase in incarceration in North Carolina would take an additional 350 criminals off the street, while a 10 percent increase in New Hampshire would only remove 250. From the perspective of the econometrician, the lesson is that it would not be surprising different approaches to specifying the effect of incarceration on crime result in very different elasticity estimates. Logging the incarceration rate will not generate the same result as using the level (or the level as well as the annual change).

There are other ways in which a mere rate of incarceration measure may obscure important crime-fighting differences between states or otherwise fail to reflect the true relationship between incarceration and crime. Spelman (2000b) notes that

> some states, such as Hawaii, New York, Massachusetts, and Wisconsin, incarcerate a small proportion of their offenders but hold them for long terms—a de facto incapacitation strategy. Other states, such as Alabama, Georgia, Mississippi, and North Carolina, incarcerate more offenders for shorter terms—a deterrence strategy. If one of these strategies is more effective than the other, this should be reflected in each state's elasticity and marginal offense rate (473).

FIGURE A3



Source: Author's compilation.
Notes: Only includes prisoners under state jurisdiction and excludes local jail inmates. Over the 1977 to 2004 period, New Hampshire went from 261 state prisoners (30 per 100,000 population) to 2,448 prisoners in 2004 (188 per 100,000). The second fastest growing state, Wisconsin, went from 3,347 (72 per 100,000) to 22,966 (417 per 100,000). For the slow growth states, Maine went from 637 (58 per 100,000) to 2,024 (153 per 100,00), and North Carolina from 14,250 (251 per 100,000) to 35,434 (415 per 100,000). Nationally, the state prison population rates per 100,000 rose from approximately 122 in 1977 to 448 in 2004 (Hill and Harrison 2006).

Furthermore, states also vary in the types of criminals that they incarcerate (for example, drug offenders versus violent offenders), which can also influence the effectiveness of their prison system. Despite these reasons to expect the elasticities to differ among states, most panel studies in table 1 estimate a single national aggregate elasticity. Clearly, important policy-relevant information might be lost if the models used are too sparse or too aggregated. In a recent paper, John Pfaff (2007) argues that "even setting aside the problem of endogeneity, the dynamic relationship between crime and total incarceration is complex

and … ignored" in many of the models that study the impact of incarceration rates on crime. More work is needed to refine the model specifications in light of these dynamic complexities.

One can narrow the range of divergent results shown in table 1 by limiting one's focus to only Ordinary Least Squares (OLS) estimates of the elasticity of crime with respect to incarceration. This comparison is presented in table A2. For example, though Levitt (1996) corrects for simultaneity using an instrumental variable, he also provides results for simple OLS regressions that do not correct for simultaneity. Similarly, Liedka, Piehl, and Useem, while focused on developing a nonconstant elasticity model, present results for a constant elasticity specification that resembles that of Marvell and Moody (1994). By comparing overlapping specifications, we can potentially discern certain trends or patterns in the results, even if this exercise cannot resolve the major debates about issues such as simultaneity or nonconstant elasticity.

TABLE A2

OLS Estimates of Incarceration Elasticities Across Four Studies

	MM (1994)	**Levitt's OLS (1996)**	**Becsi (1999)**	**LPU's Constant Elasticity Results (2006)**
Time Period >	1971/73- 1989	1971-1993	1971-1994	1972-2000
All Index Crimes	-0.16(--)	--	-.087** (.015)	[1]-.063(.046) or [2]-.072 (.044) ^
Violent Crimes	-.06 ± .11	-0.099** (.033)	-.046* (0.022)	--
Property Crimes	-.17 ± .06	-0.071**(.019)	-.091** (.015)	--
Murder	-.065 (.085)	-.138 (.177)	-.063 (.034)	--
Motor Vehicle Theft	-.200** (.048)	-.081* (.039)	-.198**(.032)	--

Notes: * statistically significant at the 5% level; ** 1% level. Levitt's estimated elasticity for motor vehicle theft using OLS (shown in table as -0.081) is far lower than his IV estimate of -0.259, which is not far from the ones presented in this table for MM and Becsi

^ LPU's first estimate is for a model that includes only three controls (those in MM 1994), while the second set of results corresponds to a model with a wider set of controls, along the lines of Levitt.

-- paper does not run the regression in question.

Table A2 highlights that, even after eliminating major sources of difference by focusing only on OLS estimates, there is still more variation in the elasticity estimates than a policymaker would prefer. With the potential exception of motor-vehicle theft, which seems more responsive to incarceration and is consistently statistically significant, elasticity estimates tend to be in the range of -0.06 to -0.10 (although correcting for simultaneity could well increase these estimates). Though hard to certain owing to large confidence intervals, the elasticity estimates for all "index crimes" from the simple OLS models seem to decrease in more recent time intervals. This would be consistent with the idea that incarceration becomes less effective with higher overall levels of incarceration. As previously mentioned, this conclusion is supported by Johnson and Raphael (2007), which finds elasticities in the range of Levitt's (1996) for the 1978 to 1990 period, while finding significantly smaller effects for the 1991 to 2004 period. Furthermore, the OLS estimates of the elasticity of murder conducted by Marvell and Moody (1994) and by Becsi (1999) seem consistently low and statistically insignificant. Indeed, we have yet to see any study that generates statistically significant results for the elasticity of murder. Levitt's OLS estimate for murder is higher, though it is also very far from being statistically insignificant.

Of course, even while looking at the most similar specifications, these studies still have differences that complicate efforts at direct comparison. To begin with, though Marvell and Moody, Levitt, and Becsi analyze similar time periods, Liedka, Piehl, and Useem's (2006) study extends much further. If the effect of incarceration changes over the sample period, we cannot directly compare results (though differing results can buttress the hypothesis of changing elasticity with levels of incarceration). Furthermore, while Becsi and Levitt use similar control variables, Marvell and Moody use a much more limited set of controls. As Liedka, Piehl, and Useem's results show, using the full set of controls leads to somewhat larger estimates of the elasticity. In addition, the definition of some of the main variables is different across studies. Marvell and Moody and Levitt first difference all variables. With one exception, all the studies control for state and year fixed effects (Becsi does not include year dummies).

One feature of all of these studies is that they try to estimate the extent to which a change in incarceration will influence crime in the short-term via incapacitation and general deterrence (usually one year after the incarceration increase). These models will be incorrectly specified, though, if the impacts from incarceration are more enduring. Such net long-term effects would reflect the cumulative influence of benign factors such as specific deterrence and rehabilitation, as well as any counterproductive criminal amplification induced by exposure to a criminal population (Chen and Shapiro 2007; and Lerman, chapter 5, this volume). If these net long-term effects are undesirable, elasticity estimates based on short-term estimates may give an unduly optimistic picture of the benefits of increased incarceration. Alternatively, if the net long-term effects only buttress the short-term effects, then the current elasticity estimates may be downwardly biased.

Appendix B: Marginal Benefits Using Crime-Specific Elasticity Estimates, 2005

TABLE B1

Marginal Benefits of the Last Prisoner Incarcerated

(evaluated at crime and prisoner values in 2005)

(a)	(b)	(c)	(d)	(e)	(f)	(g)

Panel A: Using Levitt (1996) Crime-Specific Elasticities

	Impact of Incarceration		**Prevented Crimes' Cost**		**Marginal Benefits**	
Crime Type	**η**	**λ_{total}**	Low cost estimate	High cost estimate	Lower estimate	Upper Estimate
Murder	-0.147	0.002	$4,327,266	$11,593,323	$8,452	$22,643
Rape	-0.246	0.048	$129,696	$297,567	$6,238	$14,312
Assault	-0.410	0.218	$19,528	$91,817	$10,457	$49,165
Robbery	-0.703	0.919	$22,637	$290,491	$8,450	$108,432
Burglary	-0.401	1.218	$2,287	$31,980	$2,787	$38,969
Larceny	-0.277	4.613	$335	$908	$1,547	$4,193
Vehicle Theft	-0.259	0.305	$1,197	$5,669	$366	$1,731
Number of Crimes Averted =		7.323		**Total Marginal Benefit =**	$38,295	$239,445

Panel B: Using Marvell and Moody (1994) Crime-Specific Elasticities

	Impact of Incarceration		Prevented Crimes' Cost		Marginal Benefits	
Crime Type	**η**	**λ_{total}**	Low cost estimate	High cost estimate	Lower estimate	Upper Estimate
Murder	-0.065	0.001	$4,327,266	$11,593,323	$3,737	$10,012
Rape	-0.113	0.022	$129,696	$297,567	$2,865	$6,574
Assault	-0.056	0.030	$19,528	$91,817	$1,428	$6,715
Robbery	-0.260	0.340	$22,637	$290,491	$3,125	$40,103
Burglary	-0.253	0.768	$2,287	$31,980	$1,758	$24,586
Larceny	-0.138	2.298	$335	$908	$771	$2,089
Vehicle Theft	-0.200	0.236	$1,197	$5,669	$282	$1,337
Number of Crimes Averted =		3.695		**Total Marginal Benefit =**	$13,967	$91,416

Panel C: Using an Average of the Elasticities of Levitt (1996) and Marvell and Moody (1994)

	Impact of Incarceration		Prevented Crimes' Cost		Marginal Benefits	
Crime Type	**η**	**λ_{total}**	Low cost estimate	High cost estimate	Lower estimate	Upper Estimate
Murder	-0.106	0.001	$4,327,266	$11,593,323	$6,094	$16,328
Rape	-0.180	0.035	$129,696	$297,567	$4,564	$10,472
Assault	-0.233	0.124	$19,528	$91,817	$5,942	$27,940
Robbery	-0.482	0.629	$22,637	$290,491	$5,793	$74,345
Burglary	-0.327	0.993	$2,287	$31,980	$2,273	$31,777
Larceny	-0.208	3.455	$335	$908	$1,161	$3,148
Vehicle Theft	-0.230	0.270	$1,197	$5,669	$325	$325
Number of Crimes Averted =		5.507		**Total Marginal Benefit =**	$26,153	$164,335

Note that the Panel A estimates using Levitt's crime specific elasticities yield high and low end estimates of the cost per crime averted by adding an inmate that are roughly comparable to the fixed general crime elasticities of between -0.3 and -0.4, shown in table 10 of the text.

Appendix C: Typology of Crime Costs

Cost Category	*Party who most directly bears cost*	*Variable or Fixed cost (categorized as transfer)*	Included in our	
			Low Cost Estimate (Reason for Exclusion)	*High Cost Estimate (Reason for Exclusion)*
I. COSTS FROM CRIMINAL ACT				
***Direct Property Losses**			No (transfer)	Implicit
(1) Losses not reimbursed by insurance	Victim	Variable (transfer)		
(2) Losses reimbursed by insurance	Society	Variable (transfer)		
(3) Administrative cost: insurance reimbursement	Society	Fixed		
(4) Recovery by police	Society	Variable		
***Medical and Mental Health Care**			Yes	Implicit
(1) Costs not reimbursed by insurance	Victim/Victim's family/Society	Variable		
(2) Costs reimbursed by insurance	Society	Variable (transfer)		
(3) Administrative overhead of insurance coverage (2) above	Society	Fixed		
***Victim Services**			Yes	Implicit
(1) Expenses charged to victim	Victim	Variable		
(2) Expenses paid by agency	Society	Variable		
(3) Temporary labor and training of replacements	Society	Variable		
***Lost Workdays**			Yes	Implicit
(1) Lost wages for unpaid workday	Victim	Variable		
(2) Lost productivity	Society/Employer	Variable		
***Lost School Days**			Yes	Implicit
(1) Foregone wages due to lack of	Victim	Variable		

education (2) Foregone nonpecuniary benefits of education (3) Foregone social benefits due to lack of education	 Victim Society	 Variable Variable		
Lost Housework	Victim	Variable	Yes	Implicit
****Pain and Suffering/Quality of Life***	Victim	Variable	Yes	Implicit
Indirect Costs of Victimization (1) Avoidance Behavior (2) Expenditures on moving, alarms, guard dogs, etc	 Victim Victim	 Variable Variable	No (data)	No (data)
****Loss of Affection/Enjoyment***	Victim's family	Variable	Yes	Implicit
Death (1) Lost Quality of Life (2) Loss of Affection/Enjoyment (3) Funeral and burial expenses (4) Psychological injury/treatment	 Victim Victim's family Victim's family Victim's family	 Variable Variable Variable Variable	Yes	Implicit
Legal Costs Associated With Tort Claims	Victim or Victim's family	Variable	No (data)	No (data)
"Second Generation Costs" (1) Future victims of crime committed by earlier victims (2) Future social costs associated with (1)	 Future victims Society, victims,etc.	 Variable Variable	No (data)	No (data)
II. COST OF SOCIETY'S RESPONSE ***Precautionary Expenditures/Effort***			 No	 Implicit

(1) Avoidance Behavior	Potential Victim	Variable		
(2) Expenditures on moving, alarms, guard dogs, etc	Potential Victim	Variable		
Fear of Crime	Potential victim	Variable	No	Implicit
Criminal Justice System				
*(1) Police and investigative costs	Society	Both	Yes	Yes
(2) Prosecutors	Society	Both	No	Yes
(3) Courts	Society	Both	No	Yes
(4) Legal fees			No	Yes
(a) public defenders	Society	Both		
(b) private	Offenders	Variable		No
(5) Incarceration costs	Society	Both	Yes	Yes
(6) Nonincarcerative sanctions	Society	Both	No	
*(7) Victim time	Victim	Variable	Yes	Yes
(8) Jury and witness time	Jury/Witness	Variable	No	No
Victim Services				
*(1) Victim service organizations	Society	Fixed	Yes	Yes
(2) Victim service volunteer time	Volunteers	Variable		
(3) Victim compensation programs	Society/Offender	Variable		
*(4) Victim time	Victim	Variable	Yes	Yes
Other Noncriminal Programs			No (data)	No (data)
(1) Hotlines and public service announcements	Society	Variable		
(2) Community treatment programs	Society	Fixed		
(3) Private therapy/counseling	Society/Offender	Variable		
"Overdeterrence" Costs			No (data)	No (data)
(1) Innocent individuals accused of offense	Innocent individuals	Variable		
(2) Restriction of legitimate activity	Innocent individuals	Variable		

(3) Actions taken by offenders to avoid detection (e.g., kill robbery victims to reducechance of being caught)	Society/Offender/ Victim	Variable		
"Justice" Costs			No (data)	No (data)
(1) Constitutional protections to avoid false accusations	Society			
(2) Cost of increasing detection rate to avoid differential punishment	Society	Variable		
III. OFFENDER COSTS				
Incarcerated Offender Costs				
(1) Lost wages	Offender/Family	Variable	Yes	Yes
(2) Lost tax revenue and productivity	Society	Variable	No	No
(3) Value of lost freedom	Offender	Variable	No (data)	No (data)
(4) Psychological cost to family/loss of consortium	Family of offender	Variable	No	No
(5) Health Impact on Community	Society	Variable	No	No
(6) Community cohesion	Society	Variable	No	No
Opportunity Costs				
(1) Cost of time spent on illegal activity	Society	Variable	Yes	Yes
(2) Resources devoted to illegal activity	Offender	Variable	No	No

Source: Adapted and expanded from Cohen, Miller, and Rossman (1994).

Notes: "Implicit" indicates that there is no direct cost measured, but that we can assume that the average respondent in the Cohen, Rust, Steen and Tidd (2004) survey was considering it.

Major differences between high and low estimates are highlighted

Appendix D: Estimating Arrest Rate, Conviction Rate and Sentencing Costs

TABLE D1
Arrest Rates for Index I Crimes

Sector and type of crime	Number of victimizations	Reported Crime UCR		Estimated Number of Arrests		Arrest Rate (based on NCVS)	Arrest Rate (based on UCR)
		Murder	16,692	Murder	14,062		0.84
Rape	191,670	Forcible rape	93,934	Forcible rape	25,528	0.13	0.27
Robbery	624,850	Robbery	417,122	Robbery	114,616	0.18	0.27
Aggravated assault	1,052,260	Aggravated assault	862,947	Aggravated assault	449,297	0.43	0.52
Household burglary	3,456,220	Burglary	2,154,126	Burglary	298,835	0.09	0.14
Motor vehicle theft	978,120	MVT	1,235,226	MVT	147,459	0.15	0.12
Theft	13,605,590	Larceny-theft	6,776,807	Larceny-theft	1,146,696	0.08	0.17
	Source: NCVS 2005 table 91		*Source:* UCR 2005 Table 1		*Source:* UCR 2005 Table 29		

Source: Author's computation.
Note: The arrest rate is proxied by the ratio of total arrests to total NCVS or UCR crimes.

TABLE D2
Conviction Rates, Given Adult Arrests for Index I Crimes

Offense	Number of adults arrested	Number of felony convictions	Felony Conviction Rate
Murder	12,799	8,990	0.70
Rape	23,564	10,980	0.47
Robbery	81,340	38,430	0.47
Aggravated assault	410,892	95,600	0.23
Burglary	201,804	100,640	0.50
Motor vehicle theft	103,664	18,530	0.18
Larceny (excluding MVT)	1,160,085	105,790	0.09

Source: Paige and Beck (2005).

TABLE D3
Cost of Prison, Jail, and Probation for Index I Crimes

	Mean Sentence				Cost of Sentence		
Crime Category	Prison	Jail	Probation	Estimated % Served (1)	Prison ($70/day)	Jail ($67/day)	Probation ($5/day)
Murder/non-neg. manslaughter	225	10	76	63	310162.5	13785	11400
Rape / Sexual assault	100	8	54	64	139800	11184	8100
Robbery	91	11	51	58	116571	14091	7650
Aggravated assault	54	7	39	66	77598	10059	5850
Burglary	36	6	36	49	39798	6633	5400
Larceny	24	6	36	52	26532	6633	3600
Motor vehicle theft	24	6	24	49	27936	6984	5400

Source: Author's compilation.
Note: Estimated time served based on prison sentence; Durose and Langan (2004).
Remaining Sentence is assumed to be under supervision (same cost as probation).
Probation is assumed to cost five dollars per day per offender.
Estimated time served in prison also used for jail time served.

Appendix E: Computing Total Number of Crimes and Average Index I Crime

TABLE E1

Three Different Ways of Weighting Crimes in Order to Derive an "Average Cost of Prevented Crime" Estimate

Crime Type	(a)	(b)	(c)	(d)	(e)	(f)	(g)
	Number of Crimes				**Possible Weights**		
	Reported by FBI	Victimization Survey	Reporting Rate	FBI Figures Adjusted for Reporting Levels	*Weight 1:* Frequency of Each Crime Type (as % of all reported crimes)	*Weight 2*: Frequency of Each Crime Type (as % of all victimizations)	*Weight 3*: Frequency of each Crime Using Adjusted Figures
Murder	16,740	16,740	100.0%	16,740	0.14%	0.08%	0.06%
Rape	94,347	191,670	38.3%	246,337	0.82%	0.96%	0.85%
Assault	862,220	624,850	52.4%	1,645,458	7.46%	3.14%	5.70%
Robbery	417,438	1,052,260	62.4%	668,971	3.61%	5.28%	2.32%
Burglary	2,155,448	3,456,220	56.3%	3,828,504	18.64%	17.35%	13.25%
Larceny	6,783,447	13,605,590	32.3%	21,001,384	58.65%	68.28%	72.69%
Vehicle Theft	1,235,859	978,120	83.2%	1,485,407	10.69%	4.91%	5.14%
TOTAL	**11,565,499**	**19,925,450**		**28,892,802**			

Notes: Values are for 2005. Column (d) is estimated total crime, which is derived by dividing column (a) by column (c), which is the reporting rate from the BJS National Victimization Survey. Hence, it inflates the FBI count of crimes by the reporting rates for each crime type to get an "adjusted count." Thus, like column (b), it adjusts for reporting but is not subject to the potential biases of the victimization survey towards certain crime types. Definitions of crime types are somewhat different for the FBI and the BJS; we tried to choose the categories of the BJS crimes that most closely matched the definition of the FBI's seven-index crimes (for example, by FBI categorization, "assault" only includes aggravated assaults). For example, in the case of burglary, the Victimization Survey only includes household burglaries, whereas the FBI includes all types of burglaries (like commercial). This is another reason to favor the third weight, since it avoids the mismatch (though it does assume that reporting rates are correct despite the slight categorical mismatch between the two sources).

Appendix F: All Steps of Cost-Benefit Analysis Excluding Murder from the Aggregate Elasticity

TABLE F1

Average Cost of an Index Crime (Excluding Murder) Using Weighted Cost-of-Crime Estimates, 2005

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
Crime Type	**Reporting Rate**	**Adjusted Low Cost Estimate**			**Adjusted High Cost Estimate**		
		Low Cost Estimate	Weight	Weighted Cost (Low)	High Cost Estimate	Weight	Weighted Cost (High)
Rape	38.3%	$129,696	0.0085	$1,106	$297,567	0.0085	$2,538
Assault	62.4%	$19,528	0.0570	$1,113	$91,817	0.0570	$5,232
Robbery	52.4%	$22,637	0.0232	$524	$290,491	0.0232	$6,730
Burglary	56.3%	$2,287	0.1326	$303	$31,980	0.1326	$4,240
Larceny	32.3%	$335	0.7273	$244	$908	0.7273	$660
Vehicle Theft	83.2%	$1,197	0.0514	$62	$5,669	0.0514	$292
Average Cost Per Crime				**$3,352.06**			**$19,692.38**

Note: This table calculates the cost of a general index crime (but not including murder) using the same figures as table 8. These numbers are then used in table F2 to estimate the marginal benefit from increased incarceration, assuming no benefit exists in the form of reduced murders.

TABLE F2

Marginal Benefit of the Last Prisoner Incarcerated

(Using a Static Aggregate Elasticity for Incarceration and Crime Levels in 2005, with Murder Excluded)

(a)	(b)	(c)	(d)	(e)
		Total Marginal Benefits		
		(low estimate)	(mean estimate)	(high estimate)
η	**λ**	**$3,352**	**$11,522**	**$19,692**
-0.05	1.146	$3,841	$13,204	$22,567
-0.1	2.292	$7,683	$26,408	$45,133
-0.2	4.584	$15,365	$52,816	$90,267
-0.3	6.876	$23,048	$79,224	$135,400
-0.4	9.168	$30,731	$105,632	$180,534

Source: Author's compilation.

Notes: For a description of the underlying calculations, see the equations in the introduction. λ represents the total number of crimes prevented by incarcerating one additional person. Column b shows how many (non-murder) index I crimes would be averted for the various elasticity estimates in column a. Columns c and d then provide monetary estimates of the column b number of crimes prevented, by multiplying column b by the cost per crime figures computed in table F1. Accordingly, columns c and e provide the low and high cost estimates of the marginal benefits of adding one prisoner to the state prison system. In 2005, the total number of index I crimes, including murder was 28,892,802 (Federal Bureau of Investigation 2006), and the number of state prisoners was 1,259,905 (Harrison and Beck 2006).

TABLE F3

Changes in State Prison Population Necessary to Reach Optimality

(2005 Values, with Murder Excluded)

(a)	(b)	(c)	(d)
A. Optimality Using Marginal Cost = $25,797			
ηgeneral	low CPCs	mean CPCs	high CPCs
-0.05	-1,058,287	-410,465	206,160
-0.1	-846,909	363,514	1,374,006
-0.2	-432,768	1,361,053	2,400,065
-0.3	-77,524	1,711,408	2,445,212
-0.4	193,120	1,737,716	2,222,258
B. Optimality Using Marginal Cost = $35000			
ηgeneral	low CPCs	mean CPCs	high CPCs
-0.05	-1,111,003	-628,489	-163,355
-0.1	-953,099	-25,327	783,555
-0.2	-632,198	865,671	1,831,222
-0.3	-335,799	1,295,861	2,064,135
-0.4	-87,350	1,430,387	1,979,208
C. Optimality Using Marginal Cost = $55,000			
ηgeneral	low CPCs	mean CPCs	high CPCs
-0.05	-1,164,955	-854,577	-551,423
-0.1	-1,063,080	-447,963	114,152
-0.2	-848,018	246,791	1,050,759
-0.3	-633,268	700,145	1,456,885
-0.4	-433,861	940,192	1,552,589
D. Optimality Using Marginal Cost = $80,000			
ηgeneral	low CPCs	mean CPCs	high CPCs
-0.05	-1,194,553	-979,902	-768,713
-0.1	-1,123,985	-691,284	-285,037
-0.2	-971,828	-155,247	496,444
-0.3	-813,065	257,915	951,824
-0.4	-656,688	532,054	1,155,009

Source: Author's compilation.

Notes: The five depicted elasticities apply to index I crimes excluding murder. CPC stands for an estimate of the average cost per crime. "Low" and "high" cost estimates are described in table 8, and the "mean CPC" is the average of the two for each crime type. The number of index I crimes, excluding murder, in 2005 was 28,876,062 (BJS 2006). The values listed in each cell for an attendant combination of η, CPC, and marginal cost of incarceration reflect the difference between the optimal state prisoner count (P^*) and the number of state prisoners in 2005: 1,259,905 (Harrison and Beck 2006). That is, these figures tell us how many prisoner would have to be added (for positive numbers) or eliminated (for negative values) from the state prison system to reach the point where the marginal costs of incarcerating an additional prisoner equal its marginal benefits. For an analogous table that includes murder, see table 12 in the text.

Table F3 computes the changes in incarceration needed to reach optimality under the assumption that either incarceration is ineffectual at reducing murder or the social cost of murder is essentially zero. While it may seem odd that increases in incarceration should reduce other crimes but not murder, note that none of the estimated effects of incarceration on murder depicted in table 1 is statistically significant, and most of them have suggested lower elasticities for murder than for other crimes. Still, it seems unlikely that murders would not go down if incarceration increased, even if the estimates in table 12 using the same elasticity for all index I crimes may overstate the true level of murder reduction.

The second possible assumption—that the social cost of murder is very low—is again an exaggeration, but it serves as a corrective to the very high estimates of the social cost of murder that we use in the table 12 calculations. Since a not inconsiderable number of murder victims are criminals, the social cost of their murder may be considerably lower than the social cost of the murder of an innocent citizen. By computing incarceration optimality both with an exaggerated effectiveness of the benefits of prisons in reducing the social costs of murder and without any regard for this effectiveness, we hopefully bracket the true effect.

Table F3 reveals that if one adopted a low estimate of the cost per crime (CPC), then under any combinations of elasticity and cost per added prisoner (MC)—with only one exception—we are above the optimal level of incarceration right now. The one exception is that if prisons are cheap (as shown in panel a of table F3) and highly effective ($\eta = -0.4$), then further increases in incarceration would be called for in this calculus. Expressed differently, if the true CPC is low, then current incarceration policy could only be optimal if the crime elasticity exceeds -0.3 and prisons are very cheap.

At the other end of the spectrum, now consider the case where costs per crime are high (shown in column d, table F3). In this case, most combinations of elasticity and MC point towards the need for greater levels of incarceration to reach optimality. If the high costs-of-crime estimates are correct, then the only way that current policy could be optimal would be if the

elasticity is less than -0.05 (if MC is $25,797), slightly above -0.05 (if MC = $35,000), slightly below -0.10 (if MC is $55,000), and close to -0.15 for the most expensive incarceration cost estimates.

My own view for a state with operating costs at the mean is that the social cost of incarceration at the margin would be at least $55,000, and the high cost of crime might be reasonable. With murder included in the analysis (as in table 12), optimality would be reached with an intermediate elasticity close to -0.075. With murder dropped from the calculus (as in table F3), those assumptions and an elasticity of -0.075 would lead us to predict that our prison population should be cut back by perhaps hundreds of thousands. An intermediate assessment that entails some reduction in the social costs of murder from increased incarceration might suggest a need to reduce the prison population by 100,000.