Faculty Working Papers

COST FUNCTIONS FOR CORRECTIONAL INSTITUTIONS

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College of Commerce and Business Administration
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Summary:

The research reported here has been the estimation of cost functions for several types of California correctional institutions over the period 1948 to 1964 and for selected California jails in 1971-72. Prisons and jails are considered as multiple-product firms producing confinement, hotel-like amenities, and rehabilitation. Lacking a convincing measure of rehabilitative output, we netted out items clearly associated with that aspect of output and took average daily inmate population as the product measure. For the maximum security prisons there were significant economies of scale, tempered somewhat by the component of costs associated with a more violent inmate population. For medium security prisons we found long-run constant returns to scale in confinement. And lastly, for city and county jails it appears to be the case that there are constant returns to scale.

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I.

According to a recent joint report of the Bureau of the Census and the Law Enforcement Assistance Administration, expenditures by all governmental units on correctional institutions and programs amounted to almost $2.5 billion in fiscal 1972.[1,2] Yet despite the magnitude of the resources devoted to corrections, this activity has been subject to very little formal cost analysis.[3] This is not to say that individuals working in corrections or, for that matter, in the public sector in general have not been concerned with the costs of these activities. Nor has there been a paucity of descriptive studies on the costs of corrections. What has been lacking are detailed analytic cost studies of corrections, especially correctional institutions. It is to this latter and relatively unexplored area that this research is directed.

Granted that there has been a lack of analytic cost analysis of correctional institutions, of what use to decision-makers is such analysis? After all, most, if not all, correctional decision-makers have seen data on the cost per inmate in their systems and as far back as 1967 the President's Commission on Law Enforcement and Administration of Justice provided national data on costs per offender or inmate. While

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[1] Expenditure and Employment Data for the Criminal Justice System, 1974.

[2] The major expenditures were at the state and local level, $2.3 billion, and represented 23% of their expenditures on criminal justice and somewhat over 1.5% of their total expenditures for goods and services.

[3] A review of the recent ABA Correctional Economic Center, Economics of Crime and Corrections Bibliography, revealed only one analytical study of prison costs (unpublished as of this date).

undoubtedly some correctional authorities have found this type of cost information useful in decision-making and most have found it interesting, it is unlikely that such descriptive cost data has been of significant value in decision-making for the vast majority of correctional authorities. It is our contention that descriptive cost information, even if it is as specific as the cost per inmate-day at institution X, can be made relevant for the majority of correctional decision-makers only after they have been provided with a reasonable amount of information on the basic cost structure of the activities under their supervision. The emphasis here is on structure. There is no question that decision-makers in the public sector traditionally lack sufficiently detailed and accurate cost information for many decisions. However, our point is that even if more accurate and detailed data were available, its utility in decision-making would more often than not be constrained by a lack of knowledge concerning the underlying cost structure of many correctional activities.

A crucial question for most decision-makers in corrections is: How will the total cost of a correctional activity, e.g., incarceration, increase (decrease) with an increase (decrease) in the activity level? More detailed and accurate descriptive information on costs alone is unlikely to provide an answer to this question. While it is true, as we shall establish in a subsequent section of this report, that "better" data can provide more accurate decision-relevant cost figures, realizing this potential requires that the basic cost relationships of the various correctional activities have been specified. Certainly, the more comprehensive and accurate the initial data base, the more precise will be the initial cost structure specification. Nonetheless, the key element in decision-relevant cost data is a reasonable degree of knowledge concerning basic cost structure or more precisely the relationship between total costs and total activity levels. It is in this area, the relationship between total costs and total activity levels, that the application of economic cost concepts can have a significant impact on our understanding of correctional cost data.

We have taken a case study approach. Chosen for this purpose were five California State Correctional Institutions and 128 city and county jails within the State of California. All of the basic cost data for this study was obtained from published sources. The cost data on State Correctional Institutions was taken from the budgets of the California Department of Corrections reported in the California State Budget, 1948-1964, and the cost data for city and county jails from the California Bureau of Criminal Statistics, Jail Space Utilization Study.

Viewed from the governmental level, correctional activities or outputs are intermediate products or inputs in a government's production of crime control. Correction authorities, or specifically in the case of the state of California, the Department of Corrections, are a supplier of intermediate products, but unlike most such suppliers in the private sector, they supply their output to only a single buyer, the state government, in this example. Thus perhaps the private sector analogue most applicable to corrections is that of a vertically integrated firm or of a monopsonistic buyer from a monopolistic seller. This being the case, models of bilateral monopoly or of inter-firm decision-making would seem to be the relevant ones from which to begin. It may well be that by ignoring the structure of the market in which the California Department of Corrections operates we shall have biased our cost estimates. However, we have chosen to examine correctional institutions as if they were cost-minimizing businesses and have thus eschewed all questions of market structure.

In section II we explore the problems of defining the output of correctional institutions. Section III reports a short-run total cost function and an average cost function for two maximum security prisons in California. The following section suggests the form for long-run total cost functions in three medium security prisons. Section V reports regression results for a sample of county jails in California where the output definition problems ae not as severe as they are for prisons. In section VI we summarize our results.

II.

Cost functions relate output levels to costs, and thus before we can actually estimate such functions for correctional institutions we must deal with the problem of specifying the output of such institutions. Here the name is the message, and correctional institutions are supposed to correct or rehabilitate a subset of the population convicted of criminal behavior.[4] Although there is currently a great deal of debate concerning

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[4] It is a subset since not all convicted criminals are actually sent to such institutions.

cerning the degree of rehabilitation that takes place in correctional institutions, the facts concerning the precise level of rehabilitative output are as yet unknown, and at the present state of knowledge we can safely assume that one output of most correctional institutions is rehabilitation.[5] In addition to rehabilitation, correctional institutions produce the obvious output of confinement. This confinement takes a particular form and individuals are not confined on a part-time basis in their living quarters or on full-time basis in a commercial hotel but, rather, confinement takes place at one or several specially designed institutions. This confinement technology requires that correctional institutions produce in addition to confinement <u>per se</u> a certain level of hotel service and in most cases a specified level of personal goods and services, including medical care.[6] Thus, correctional institutions, as they are presently operated, produce multiple outputs of which confinement, hotel services, personal services, and rehabilitation are the most significant.

Actual measures of the various outputs must be specified. For all outputs except rehabilitation the measurement problem is tractable. It is true that there are significant quality differences in the confinement output, but in most cases this can be controlled by simply

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[5]Certainly for some local jails nad holding facilities the term correctional institution is misleading, and they neither intend nor accomplish a measurable amount of rehabilitation.

[6]It is interesting to note in this connection that even in centralized confinement centers all hotel services have not always been produced in the institution. A graphic example of this is the practice during the French Revolution of allowing prisoners to have their meals catered by private restaurants, at their own expense.

stratifying the analysis according to the security level of the institution.[7] Likewise there are quality differences in hotel and personal services, and while these present a more difficult measurement problem than confinement, solutions, albeit imperfect ones, can be found in this area. As for the output of rehabilitation, while there are simple theoretical measures (e.g., recidivism rates) empirically the measurement problem is extremely complex. Because of the empirical problems in measuring rehabilitation, most of the cost functions estimated in this study exclude rehabilitation. Rather we have made the extreme assumption that costs directed at rehabilitation do not show up in any of the output measures we shall use. There is no doubt that cost functions including rehabilitation output would be a desirable and useful tool for correctional decision-makers, and this is certainly an area for future research.

III.

The California Department of Corrections currently administers 12 major correctional institutions of which two--San Quentin State Prison and Folsom State Prison--are classified as maximum security prisons; three--Soledad or the Correctional Training Facility, the California Men's Colony, and Deuel Vocational Institution--are medium security prisons; and six--the California Institution for Men, the California Conservation Center, the Sierra Convervation Center, the

[7] In cases where escape ratios differ significantly between institutions of similar security levels or over time in the same institution the problem of measuring confinement may be made more difficult but certainly not impossible.

California Institution for Women, the California Rehabilitation Center, and the California Medical Facility--are either minimum security prisons or special purpose institutions.[8] Of these institutions, we have chosen the two maximum security prisons and the three medium security prisons for our cost function estimation.

These five institutions represent the subset of institutions for which, in our opinion, the conceptual problems were the least constraining.

Folsom State Prison and San Quentin State Prison were selected for the estimation of short-run functions because, over the time period covered in our data, the size of these prisons as measured by design capacity has been relatively constant. During the period under consideration, 1948 to 1964, the design capacity of Folsom State Prison ranged from 1894 to 1994 while the design capacity at San Quentin during the same period ranged from 2568 to 2667.[9] Given the narrow band of capacity variation in both institutions, it was our feeling that these institutions very closely approximated the traditional concept of a fixed plant size.

Since actual inmate populations at Folsom during the period ranged from 2141 to 2919 and from 3426 to 4793 at San Quentin, rated capacity is certainly not a measure of absolute prisoner capacity but rather an

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[8]A description of the institutions is available in a data appendix available on request from the authors.

[9]According to the Chief of Facilities planning for the Department of Corrections (Mr. Thomas L. Smithson), design capacity is an actual count of cells, wards and dormitories, allowing for single-celling.

indication of the physical size of the plant.[10] While a relatively fixed design capacity is not an exact counterpart of a fixed plant size in a private firm, it is a close enough approximation to make the concept of a short run cost function meaningful in this context.

However, there is one important aspect in which constant rated capacity differs from the traditional concept of a fixed plant size. When analyzing short run cost functions in private firms, it is usually assumed that the degree of utilization of the plant does not itself affect the nature of the output, i.e., that the quality of the output remains constant. The usual assumption is the steel produced when the mill is operating at 100 tons/month is the same as the steel that is produced at 500 tons/month. While it is true that even in these simple cases some quality deterioration takes place as the mill approaches physical capacity, for all practical purposes the steel is the same over a very large range of production levels. It is not at all clear that we may say the same for the output of a prison of a fixed design capacity as the inmate population varies, especially, as the inmate population exceeds the design capacity.

As was discussed above, one of the outputs of a prison is confinement and clearly the number of individuals confined per unit of time is a reasonable measure of this output level. Moreover, it is reasonable to assume that the quality of confinement _per se_ can be held constant

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[10] As Mr. Smithson expressed the proposition,
"Capacity figures are a physical count...and do not reflect administrative management practices that might reduce or increase available capacities."

over a large range of inmate populations within a prison of fixed design capacity. Leaving the question of rehabilitation output aside, prisons do produce outputs other than confinement. A prison produces hotel services, and can this be kept at a constant level as the inmate population varies? Certainly in extreme cases the hotel output of a fixed capacity prison is reduced or at least significantly modified as its confinement output (inmate population per unit of time) is increased. Even in the intermediate or less extreme cases one would expect some deterioration in the hotel output of a fixed capacity institution as the confinement output or number of inmates rises.

Assuming this relationship between confinement output and hotel services to be valid, of what relevance is it to our cost function estimation? Since hotel services are produced jointly with confinement— more precisely, for any individual one year's hotel service is provided with one year's confinement, if the quality of hotel service does not vary with the level of confinement activity, our output measure is sufficient for describing both activities. That is, if hotel services are constant we can write the cost function for a prison as

$$C = C(P \mid H = \overline{H},\ R = \overline{R}), \tag{1}$$

where C is the annual cost of providing all non-rehabilitative outputs (confinement and related hotel as well as personal goods and services), P is number of inmates confined in the institution during that year, H is hotel services held constant at quality level $\overline{H}$ (subject to the point made below) and R is rehabilitation held constant at $\overline{R}$. If, on the contrary, hotel services are changing as P changes, then our cost function is relating annual costs to the quality of confinement services and a mixture of a change in the quantity and quality of hotel services.[11]

As the data on rated capacity and inmate populations reported above indicates, something other than single-celling has been the norm at these institutions during the entire period. Thus, while single-celling may be the desired level of hotel service, it has not been the operational level and implicitly it appears to be an upper and not a lower bound on such services.[12] In dealing with the hotel service aspect of output, we have chosen to acknowledge that the quality of this input changes as the inmate population changes but have assumed that it is relevant to decision-makers only when the quality of such services approaches the correctional authorities' lower bound. In the case of Folsom and San Quentin we have taken the actual inmate figures to imply that this lower bound was not reached during the period 1948-64. Consequently, for inmate populations at these institutions within the historical bounds the interpretation of the cost function is clear. However, for populations greater than those historically experienced some care must be exercised in interpreting the estimated relationship. These short run cost functions, and in fact all such functions based on a prison of fixed capacity, are

[11] For simplicity we have deleted personal goods and services from this discussion but without doing much violence to practice we can assume, like confinement, they can be held constant as P increases.

[12] It is our understanding that the actual lower bound on hotel services in terms of space provided per inmate is substantially below those implied in most rated capacity figures.

only useful management tools up to the population level P at which the lower bound in terms of hotel services is reached. Simply put, short-run cost functions have definite upper bounds. They can be used for cost inferences only up to some P^* where P^* is defined as the inmate level at which hotel services fall below the corectional authorities' minimum permissible level. Even for inmate populations below P^*, the fact that hotel services are changing as P changes should always be kept in mind.

The starting point for actual cost function estimation, at a single prison, is the type of data presented in Table 1. This table shows total non-rehabilitative expenditures (FTC) and inmate populations (ADIPF) at Folsom State Prison from 1948 to 1964.[13] It should be emphasized again that, while the data in Table 1 is quite straightforward, assembling consistent historical data in this form is a non-trivial task even in a system with as long a history of data collection as California's.[14]

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[13]Terminating our data base at 1964 does not indicate a disinterest in more recent experience. In fact we were quite anxious to include more recent data in our sample but comparable and detailed cost data by institution was simply not available for more recent years. Since switching to a "Program" approach, California has stopped publishing detailed budgets for each institution. Unfortunately, collecting unpublished institutional data for more recent years proved to be too time consuming an undertaining for this study. A "Program" approach certainly emphasizes the similarity between the Department of Corrections and a private firm. It is unfortunate, however, that for the purposes of this and perhaps other cost studies, one of the procedural aspects of the California "Program" approach involves the publication of less data on operations at the plant or prison level.

[14]The actual historical budget data used in this construction had never been collected as a series and rehabilitation expenditures have never been systematically separated.

TABLE 1

Cost and Inmate Data

Folsom State Prison

YEAR	FTC	ADIPF
1948	$1,995,532	2,535
1949	2,037,461	2,750
1950	2,218,270	2,738
1951	2,407,471	2,415
1952	2,434,532	2,212
1953	2,693,584	2,500
1954	2,712,909	2,622
1955	2,732,171	2,436
1956	2,812,894	2,141
1957	3,100,055	2,460
1958	3,255,748	2,868
1959	3,410,436	2,450
1960	3,784,565	2,783
1961	3,815,040	2,919
1962	3,858,202	2,634
1963	3,923,725	2,526
1964	4,266,637	2,557

Source: State of California, The Governor's Budget, 1950-1967.

Notes: FTC = nominal total costs at Folsom,
ADIPF = average daily inmate population at Folsom.

The expenditure data listed in the Table are not actually the total cost of plant operation at various output levels. Missing from the expenditure data are most of the capital charges associated with the operation of this fixed capacity facility, specifically a measure of the actual annual cost or annual opportunity cost to the State of California of owning much of the in-place capital, such as the buildings and major equipment items at Folsom. For example, if instead of owning the physical plant at Folsom the state had a long-term lease on the facility then the expenditures listed in Table 1 would have been significantly higher than the actual expenditure listed in the table. Assuming that lease did not include any maintenance, then the hypothetical lease payments might roughly approximate the capital charges missing from the actual data in Table 1. The point is actually quite simple: public enterprises such as prisons do not, in their annual budgets, have imputed to them the costs of actually using much of their in-place capital and thus, total recorded expenditures consistently understate actual total costs of operation. For the purposes of short-run cost analysis this underestimation is not crucial. While the omission of capital charges understates the actual cost per inmate, it has very little effect on the magnitude of a change in total costs due to change in the inmate population.

While cost figures derived from actual budget data are not total cost figures, neither are they a pure measure of variable costs. Unless all fixed costs are entirely omitted from the budget data the expenditure data does not represent pure variable costs. Judging from the budget details and actual estimation results, it is unlikely that all fixed costs have been deleted. To the extent that cost functions estimated from this data include an element of fixed costs, it once again does not impinge on their relevance in answering the important short run question of how total costs vary with changes in the inmate population.

The cost data in Table 1 span a period of 17 years, and thus the effect of price level changes must be accounted for. Our procedure for accomplishing this involved segregating the cost data into three major categories: (1) Salaries and Wages (FTS), (2) Purchases of Goods and Services (FTOE), (3) and Minor Equipment Purchases (FTK). After segregating the cost data, each category was deflated by the appropriate deflator. All price deflators were obtained from U.S. Department of Commerce publications and the details of the deflation procedure are presented in Appendix B. Table 2 gives the constant dollar or deflated costs by category and Table 3 is the constant dollar version of Table 1. In both Tables 2 and 3 the letter R preceding the symbols defined above simply denotes a deflated series, e.g., RFTC is total non-rehabilitative expenditures at Folsom State Prison in 1967 dollars. Thus, Table 3 contains the basic data actually used in estimating a short run total cost function for Folsom State Prison.

For the Folsom cost function the following two functional forms were employed:

$$RFTC = \beta_0 + \beta_1 ADIPF + \mu_1 \tag{2}$$

$$RFTC = \alpha_0 + \alpha_1 ADIPF + \alpha_3 (ADIPF)^2 + \mu_2 \tag{3}$$

The error terms, μ_1 and μ_2, are assumed to have a mean of zero and a constant variance. β_0 and α_0 in equations (2) and (3) represent constant

TABLE 2

Deflated[a] Cost Data

Folsom State Prison

YEAR	RFTS	RFTOE	RFTK
1948	1,690,270	862,463	96,173
1949	1,743,818	1,212,907	59,882
1950	1,715,260	1,361,316	96,346
1951	1,849,176	1,318,699	60,410
1952	1,849,230	1,199,431	57,343
1953	1,999,341	1,281,118	57,802
1954	2,018, 750	1,198,763	53,162
1955	2,026,762	1,095,293	44,282
1956	2,048,787	998,747	49,888
1957	2,070,887	1,124,384	51,836
1958	2,044,410	1,179,828	31,510
1959	2,152,715	1,103,100	49,750
1960	2,293,602	1,183,231	64,420
1961	2,206,049	1,206,842	40,812
1962	2,232,572	1,133,434	38,150
1963	2,257,986	1,025,726	67,294
1964	2,253,661	1,068,099	55,653

Source: State of California, The Governor's Budget, 1950-1967.

Notes: RFTS = real salarie and wages,
RFTOE = real purchases of goods and services,
RFTK = real minor equipment purchases.

[a]The deflators are explained in the text and more formally in the appendix available on request.

TABLE 3

Deflated[a] Total Cost and Inmate Data

Folsom State Prison

YEAR	RFTC	ADIPF
1948	3,085,333	2,535
1949	3,016,607	2,750
1950	3,172,922	2,738
1951	3,228,285	2,415
1952	3,196,004	2,212
1953	3,338,261	2,500
1954	3,270,675	2,622
1955	3,166,337	2,436
1956	3,097,422	2,141
1957	3,247,107	2,460
1958	3,255,748	2,868
1959	3,305,565	2,450
1960	3,541,253	2,783
1961	3,453,703	2,919
1962	3,404,156	2,634
1963	3,351,006	2,526
1964	3,377,413	2,557

Source: State of California, The Governor's Budget, 1950-1967.

Notes: RFTC = real total cost,
ADIPF = average dialy inmate population.

[a]The deflators are explained in the text and more formally in the appendix available on request.

terms or, in this context, cost elements not associated with the level of output measured in terms of inmate population. Given Eq. 2 as the relevant cost function, the marginal cost of an additional prisoner is β_1. On the other hand, if Eq. 3 turns out to be the best approximation to the actual cost function, then the incremental or marginal cost will be $(\alpha_1 + 2\alpha_3 \text{ADIPF})$.

OLS techniques indicated that Eq. 2 or the simple linear cost function is the better approximation. The results are given in Table 4. Our actual estimated version of Eq. (2) is

$$\text{RFTC} = 2{,}499{,}932 + 296\ \text{ADIPF}, \tag{2A}$$

with an R^2 or multiple correlation coefficient of .20. Both parameters were statistically significant. From 2A we can infer that adding an additional inmate to Folsom costs approximately $296 in 1967 dollars. The explanatory power of the regression is not very large, and one must, therefore, draw conclusions gingerly. It appears to be the case that for confinement and hotel services there were significant aeconomies ot sclae at Folsom. In fact, in the Folsom case the incremental cost of adding a prisoner was only about 25% of the average cost per inmate during the period.[15]

Not entirely satisfied with the explanatory power of the relationship in Eq. 2A, we investigated several causes of cost variation not

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[15] It should be noted and kept in mind when evaluating these results that all during the period under consideration Folsom was operating above its rated capacity and certainly within a very narrow range of output relative to its potential output variation.

TABLE 4

Estimated of Total Cost Functions
for Folsom State Prison, 1948-1964

DEPENDENT VARIABLE	CONSTANT	ADIPF	ADF2	FMA	FVC	DVM2	T	R^2 ($\bar{R}^2$)
RFTC	2547580	207 (102)**					20177 (4305)	.69 (.65)
RFTC	644213	1765 (3218)	-.29 (.63)					.20 (.09)
RFTC	2499932	296 (157)						.20 (.15)
RFTC	1849466	268 (124)			2154884 (679248)			.53 (.46)
RFTC	-373117	1156 (2581)**	-.18 (.50)	47687 (57998)	-805730 (1586774)	81239 (98058)	25985 (14956)	(.73) (.57)

All estimates are OLS and additional regression results are available upon request.

**Standard error

Source: State of California, The Governor's Budget, 1950-1967.

Variables: RFTC = Deflated Folsom total costs,

ADIPF = average daily inmate population at Folsom,

ADF2 = $(\text{ADIPF})^2$,

FMA = median age of inmate population at Folsom,

FVC = percent of total inmate population at Folsom committed for violent crimes (homicide, assault, robbery, and sex offenses),

DVM2 = dummy variable for capacity change at Folsom,

T = time trend indicator with 1948 = 1, 1949 = 2, ...

measured by our single output variable, ADIPF. Included in this investigation were additional factors such as the median age of Folsom inmates, a variable for the capacity change at Folsom, the percentage of total inmates committed for commission of violent crimes (FVC), and finally a time trend variable (T). These regressions are also reported in Table 4.

First, by including a variable measuring the violence history of inmates (FVC)[16] the estimated cost function becomes:

$$RFTC = 1,849,466 + 268\ ADIPF + 2,154,884\ FVC \qquad (2B)$$

and the R^2 jumps to 0.53, a significant increase in explanatory power over Eq. (2A). From 2B it appears as if the composition of the inmate population is quite important in determining the absolute cost of operating a prison. Consistent with our intuition the more violent the prison population the higher are its total costs. One would expect that the costs of more guards, of isolating prisoners, and the like would vary directly with the violence record of the inmates.

However, the most interesting aspect of 2B is that the marginal cost is extremely close to the estimate provided by the simple model in Eq. 2A. Thus, while we can explain more of the variation in total costs by including a violence index in the equation, the estimated magnitude of the key parameter in the system (the coefficient of ADIPF) is not significantly changed by this procedure.

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[21]This index was constructed by taking the annual percent of total inmates who had been sentenced for the violent crimes of robbery, homocide, assault, and sex crimes.

Our next respecification of the model involved the use of a simple time trend. In this case the estimated equation is

$$RFTC = 2{,}547{,}580 + 207\ ADIPF + 20177\ T \qquad (2C)$$

where T is the time trend. This equation had an R^2 of 0.69. The interpretation of a positive coefficient on T is that there is a secular increase in the cost of operating a fixed capacity prison.[17] Since the simple correlation between T and FVC is 0.88, part of what we are measuring in the time variable is probably the secular increase in the percentage of inmates with a violent history. Nonetheless given that the explanatory power of this specification exceeds that of 2B, there are obviously factors other than the increase in FVC over time that cause the secular increase in the operating costs of Folsom.

Unfortunately, data limitations prevented us from exploring this area in more detail, but it is clear from these two simple extensions that very simple modifications of the elementary linear model in 2A greatly increase the explanatory power of the estimated relationship. Nonetheless, in all of the cases presented here the estimates of the marginal cost of confinement and hotel services are very close in magnitude, and our comments regarding the interpretation of the incremental cost estimate in Eq. 2A remain valid in these more complex specifications.

In analyzing the Folsom cost data, we took a very direct approach and estimated a short run total cost function. Our results were extremely

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[17]Recall that we are working with constant dollar costs and this secular increase is not merely a simple inflation factor.

interesting and suggested that for institutions like Folsom State Prison, operating at relatively high levels of output (inmate populations considerably in excess of design capacity), the incremental cost of adding an additional inmate was substantially below the average cost, which in this context is often referred to as the cost per inmate. Moreover, at these high output levels, our regression results suggested that the total cost function is best approximated by a relationship involving a constant marginal cost. Thus at high output levels, the incremental cost of adding an inmate to the existing population is approximately constant over a rather large range of population changes. Intuitively, adding an additional inmate or, for that matter, an additional 50 inmates, increases total costs by approximately the same amount at population levels 10% above design capacity as it does at levels 50% to 60% above design capacity.

Another, and complementary method of analyzing prison cost data, is to estimate short-run average cost functions. This procedure allows us to work with a cost figure that is already familiar to many correctional decision-makers, the cost per inmate. In this approach to cost function estimation, instead of analyzing the relationship of total costs to total output, as we did in the case of Folsom, we analyze the relationship between cost per inmate (average cost) and total output.

The sample used in this Case Study for the analysis of short-run average cost functions is drawn from San Quentin's post-war expenditure and output data. In Table 5 we have presented the same data for San Quentin as was presented for Folsom. Transforming the total cost data into cost per inmate (AVDSQTC) format, we get the cost series shown in

TABLE 5

Deflated Cost[a] and Inmate Data
San Quentin State Prison

YEAR	RSQTC	ADIPSQ
1948	$5,083,855	3988
1949	4,631,915	4023
1950	4,960,539	3750
1951	5,074,511	3636
1952	5,133,211	3781
1953	5,253,772	3737
1954	5,161,086	3935
1955	5,114,222	3480
1956	4,994,232	3426
1957	4,974,927	4130
1958	5,069,511	4742
1959	4,885,032	4326
1960	5,361,720	4793
1961	5,179,408	4565
1962	5,070,898	3794
1963	5,251,443	4265
1964	5,211,327	3850

Source: State of California, The Governor's Budget, 1950-1967.

Notes: RSQTC = Real total costs at San Quentin,
ADIPSQ = average daily inmate population.

[a]The method of deflation is exactly that use on the Folsom cost data.

Table 6 and this series serves as our basic input for estimating San Quentin's short-run average cost function.

If we refer back to Eq. 2, we see that this simple linear form of the total cost function implies, in the case of San Quentin, the following form for the average cost function:

$$\text{AVDSQTC} = \gamma_0 + \gamma_1\text{RADSQ} \tag{3}$$

where γ_0 is a constant term and RADSQ = 1/ADIPSQ. Thus, if San Quentin's total cost at high output levels is also best approximated by the functional form in Eq. 2, then its average cost function will be of the form shown in Eq. 3. In this case the cost per inmate (AVDSQTC) will change by $-\gamma_1[1/(\text{ADIPSQ})^2]$. As long as γ_1 is positive, the cost per inmate will decrease as the inmate population increases and the magnitude of this decrease will be related to the inmate population and in fact will be smaller, the larger the inmate population.[18] The magnitude of γ_1 will determine the magnitude of the decrease in average cost at any inmate level.

Estimating Eq. 3 using the San Quentin data, we obtained the following average cost function:

$$\text{AVDSQTC} = 59 + \underset{(11.5)}{4{,}844{,}719}\ \text{RADSQ} \qquad \text{(t-ratios)} \tag{3A}$$

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$$\frac{d\ \text{AVDSQTC}}{d\ \text{ADIPSQ}} = -\delta_1[1/(\text{ADIPSQ})^2]$$

$$\frac{d\left(\frac{d\ \text{AVDSQTC}}{d\ \text{ADIPSQ}}\right)}{d\ \text{ADIPSQ}} = 2\delta_1[1/(\text{ADIPSQ})^3]$$

TABLE 6

Deflated Average Cost[a] and Inmate Data

San Quentin State Prison

YEAR	AVDSQTC	ADIPSQ
1948	1275	3988
1949	1151	4023
1950	1323	2750
1951	1396	3636
1952	1358	3781
1953	1405	3737
1954	1312	3935
1955	1470	3480
1956	1458	3426
1957	1205	4130
1958	1069	4742
1959	1129	4326
1960	1119	4793
1961	1135	4565
1962	1337	3794
1963	1231	4265
1964	1354	3850

Source: State of California, The Governor's Budget, 1950-1967.

Notes: AVDSQTC = Average total costs at San Quentin,
ADIPSQ = average dialy inmate population at San Quentin.

[a]See the text.

Details are given in Table 7. This relationship has an R^2 of .90 and the estimate of the coefficient δ_1 is statistically significant. We can reject the hypothesis that $\gamma_1 < 0$, and thus, based on Eq. 3A, we can conclude that at San Quentin, as at Folsom, cost per inmate decreases as the inmate population increases. In terms of magnitude, Eq. 3 implies that at an inmate level of 3500, the decrease is 40¢ per inmate and a at level of 4500, it is only 23¢ per inmate. Nonetheless, these calculations are merely illustrative. The important point is the behavior of the cost per inmate as the inmate population increases, and the fact that at San Quentin as at Folsom, the short-run marginal cost of confinement and of hotel services is substantially below the cost per inmate (average cost).

However, unlike our results on the total cost function for Folsom, in the San Quentin estimations it is more difficult to establish one functional form as having superior explanatory power. As the results in Table 7 show, while Eq. 3A has no less explanatory power than other forms of the average cost function, the adjusted R^2's are too close in magnitude for us to use this measure to establish (3A) as the best approximation. Nevertheless it is true that the estimated coefficients on terms ADIPSQ and $(\text{ADIPSQ})^2$ tend to be less significant in the sense that their standard errors are much larger in relation to the coefficients than is the case with RADSQ. Thus in equations involving terms RADSQ, ADIPSQ and $(\text{ADIPSQ})^2$, only the coefficient on RADSQ passes the traditional t-test for significance. Although Eq. 3A appears to be an adequate approximation of San Quentin's average cost function, at least over the range of population experienced during the period, all

TABLE 7

Estimate Cost Functions for San Quentin State Prison (1948-1964)

DEPENDENT VARIABLE	CONSTANT	RADSQ2	ADIPSQ	ADSQ2	SQVC	SQMA	LADSQ	R^2 ($\bar{R}^2$)
AVDSQTC	59	4844719 (421324)**						.90 (.89)
AVDSQTC	-1776	8557277 (4186712)	.22 (.25)					.90 (.88)
AVDSQTC	-902	7432285 (2823925)		.00002 (.00002)				.90 (.88)
AVDSQTC	-956	7462883 (2930122)		.00002 (.00002)	98 (491)			.90 (.87)
AVDSQTC	-1701	8658719 (2956452)		.00003 (.00002)	-589 (684)	21 (15)		.92 (.89)
LAVSQ	15						-.95 (.09)	.89 (.88)

All estimates are OLS.

**Standard error

Source: State of California, The Governor's Budget, 1950-1967.

Variables: AVDSQTC = RSQTC/ADIPSQ, Deflated cost per inmate at San Quentin,

LAVSQ = natural logarithm of deflated cost per inmate at San Quentin,

RADSQ2 = 1/ADIPSQ,

ADIPSQ = average daily inmate population at San Quentin,

ADSQ2 = $(\text{ADIPSQ})^2$,

SQVC = percent of total inmate population at San Quentin committed for violent crimes (homicide, robbery, assault, and sex offenses),

SQMA = median age of inmate population at San Quentin each year,

LADSQ = natural logarithm of average daily inmate population at San Quentin.

of the estimated cost functions in Table 7 evidence decreasing average costs up to an inmate population far larger than those in the sample. In other words, whichever of the cost equations selected, there are decreasing costs per inmate up to populations of at least 5200 inmates. Equivalently, all cost functions for San Quentin presented in Table 7 show marginal cost below average cost up to an output (inmate population) significantly larger than the highest output experienced at San Quentin during the post-war period.

As our results indicate Eq. 3A is adequate for analyzing San Quentin's cost function over the range actually experienced during the post-war period; however, considering another functional form does provide additional insight. For example, instead of using Eq. 3A as an approximation to the short run average cost function, let us approximate it using the estimated cost function (3B).

$$\text{AVDSQTC} = -902 + 7432285\ \text{RADSQ} + .00002\ \text{ADSQ2} \qquad \text{(3B)}$$

where $\text{ADSQ2} = (\text{ADIPSQ})^2$. It is straightforward to establish that Eq. 3B implies that cost per inmate (AVDSQTC) declines until the inmate population reaches approximately 5700 and increases thereafter.[19] Thus Eq. (3B) implies that average cost is greater than marginal cost up to 5700

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$$\frac{d\text{AVDSQTC}}{d\text{ADIPSQ}} = 0 \text{ and } \frac{d\left(\frac{d\text{AVDSQTC}}{d\text{ADIPSQ}}\right)}{d\text{ADIPSQ}} > 0,$$

at ADIPSQ ≈ 5700 in Eq. 3B.

inmates and less than marginal cost thereafter. Translated into the terminology of corrections: the existing cost per inmate figure will, at an institution like San Quentin, overestimate the incremental cost of an additional inmate up to 5200 inmates and thereafter the existing cost per inmate figure will underestimate it. Since these estimated cost functions lack precision at inmate levels substantially above the sample bound, this discussion must be interpreted with care. What a cost function like Eq. 3B indicates, is that while our experience in institutions like San Quentin suggests that cost per inmate substantially overestimates incremental costs, there is a strong possibility that at very high inmate populations (relative to design capacity) cost per inmate would actually underestimate incremental costs. The concept of a U-shaped short run average cost curve for a prison conforms very closely to the traditional assumption about the shape of such curves for private firms and is an area that deserves additional attention. Unfortunately, our data base had too restricted an output range to explore this phenomenon adequately.

The impact of our findings on San Quentin's cost structure is that they support our previous work on Folsom. That is, existing cost per inmate tends seriously to overestimate the impact on short run total costs of increasing inmate populations. Multiplying existing cost per inmate data times a small projected increase in inmate population will significantly overestimate the cost of this projected increase. Moreover, the data is consistent with the hypothesis that prisons such as Folsom and San Quentin are underutilized in terms of confinement output,[20] total confinement costs might be minimized by using one large facility more intensely. However, with this prescription one needs to recall that prisons produce a joint output and that maximizing efficiency with regard to only one of those outputs might be detrimental to the others. It may well be that minimizing confinement costs pushes hotel services and rehabilitation below the acceptable lower bound. In any case, decision-makers should be aware that the data from Folsom and San Quentin imply that at present utilization rates, the short-run cost per inmate substantially overstate the incremental confinement costs.

IV.

Unlike the design capacity of both Folsom and San Quentin, the design capacity of DVI, CMC and CTF have varied considerably over the post-war period.[21] DVI had a design capacity of 540 in 1948 and 1523 in 1964. CMC started operation in 1954 with a design capacity of 600 and in 1964 had a design capacity of 3762; finally, CTF or Soledad had a design capacity of 600 in 1948 and 3239 in 1964. Thus, these medium security prisons have not had a fixed plant size over the post-war period and represent an excellent example for estimating long run cost functions. For the correctional decision-maker such functions help answer the

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[20] If there were economices of scale in confinement one would minimize long run total confinement costs by operating a plant at an output lower than the output level at which average cost is minimized. However if there are such scale economies, how do we explain the existence of two maximum security prisons? Another explanation in terms of risk aversion is provided below in our discussion of overcapacity in jails.

[21] The data appendix gives details of capacity variation.

question: How do total costs vary with changes in inmate populations when all factors including the institutions' size are variable?

This is a crucial question and it is unfortunate that data restrictions prevent us from exploring the area in sufficient detail in this study. First, the lack of capital cost data seriously restricts our ability to estimate pure long run cost functions. While the lack of such data was not a serious drawback in short-run cost function estimation, it is a major obstacle in long-run cost function estimation. At present, for state institutions, we have only the most informal evidence. Based on an informal review of some capital appropriations information, it appears that capital costs are proportional to output. However, at this point, proportionality is only a conjecture and requires a detailed and formal investigation to establish whether the data are actually consistent with this hypothesis.

In addition to the capital cost problem, there appear to be many more problems with the interpretation of the basic budget data than was the case with Folsom and San Quentin. Extracting a consistent series for non-rehabilitation total costs posed a more difficult problem in these cases. Given the data problems in this part of the study, we prefer to view these estimated long run cost functions more as an illustration than as a rigorous estimation of an actual long run cost function.

Our estimates of long run total operating cost functions for DVI, CMC and CTF which have the highest explanatory power were,

$$RDVITC = 304{,}334 + 1{,}773\ DVIAPIP, \tag{4}$$

$$RCMCTC = -53{,}437 + 1517\ CMCADIP, \text{ and} \qquad (5)$$

$$RCTFTC = 909{,}307 + 885\ CTFADIP - .009(CTFAIP)^2 \qquad (6)$$

where RDVITC, RCMCTC and RCTFTC are deflated total operating costs at DVI, CMC and CTF respectively and DVIADIP, CMCADIP and CTFADIP are average daily inmate populations at DVI, CMC and CTF respectively. The R^2's for Eqs. (4), (5) and (6) are .74, .97 and .80 respectively. Table 8 reports these results.

It is interesting to note that in two cases (DVI and CMC) a simple linear cost function is the best approximation and in those cases the incremental or marginal costs ($1773 and $1517) are very close to costs per inmate figures or average costs.[22] This suggests that in the long run, at least, operating costs are nearly proportional to output. That is, when an institution's size is variable, doubling output will approximately double operating costs. In this case, the results for CTF are somewhat of an anomaly. For CTF the best fitting estimation is nonlinear and is characterized by marginal cost substantially below average cost. In fact, marginal costs are actually declining in this case. The CTF results suggests a non-proportional relationship between total operating costs and inmate populations and one in which doubling inmate populations will actually less than double long run operating costs.

At this point, our results on estimating long run cost functions for state prisons are far too inclusive for us to conclude that, in fact,

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[22] The negative term on Eq. 5 does suggest a nonlinearity at ouptut ranges outside the sample.

TABLE 8

Estimated Long-Run Cost Function for Medium Security Correctional Institutions, 1948-1964

DEPENDENT VARIABLE	CONSTANT	CTFADIP	$(CTFADIP)^2$	DVIADIP	$(DVIADIP)^2$	CMCADIP	$(CMCADIP)^2$	R^2
RCTFTC	2865834	-17 (12)**						.12
RCTFTC	909308	885 (130)	-.009 (.001)					.80
RDVITC	304334			1773 (274)				.74
RDVITC	108405			-149 (2116)	1 (1)			.75
RCMCTC***	-63626					1548 (70)		.97
RCMCTC***	-53437					1517 (241)	.009 (.066)	.97

All estimates are OLS.

**Standard error.

***1954-1964

Source: State of California, The Governor's Budget, 1950-1967.

Variables: RCTFTC = Deflated total cost at the Correctional Training Facility (Soledad),

CTFADIP = average daily inmate population at CTF,

RDVITC = deflated total cost at Deuel Vocational Institute,

DVIADIP = average daily inmate population at DVI,

RCMCTC = deflated total cost at California Men's Colony (San Luis Obispo),

CMCADIP = average daily inmate population at CMC.

long run operating costs are proportional to inmate populations. In part, because of the inconclusive nature of our results in this area, we decided to investigate long run cost functions using another sample, city and county jails in the State of California.

V.

Up to this point we have reported on our investigation of empirical cost functions based on time-series data. The cost function estimations reported were for specific institutions and were based on the historical cost data for those institutions. However there was a second part of our investigation that involved the estimation of cost functions using cross section data. In this experiment we used the cost and output data generated by the California Bureau of Criminal Statistics' Jail Space Utilization Study to estimate a cost function for city and county jails in California. In other words, we used data collected on specific jails at one point in time (1971-72) to estimate a cost relationship that would explain the cost structure of city and county jails in general.[23] Using this cross section approach enabled us to shed some additional light on estimating long run cost functions and to investigate a number of interesting areas precluded by data restrictions in the time-series analysis.

The first question we investigated using this data source was the relationship of capital costs to inmate population. As in the case of

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[23] A list of the jails covered in this survey is available in the data appendix, available on request.

state institutions, city and county institutions do not include capital costs in their operating budgets, and the results in the survey did not provide a direct measure of such costs. However some respondents to the survey (35) did give the original construction costs of their physical plant, and the year in which the construction was actually completed. We felt that by using this data we might implicitly obtain one major capital cost relationship by using the revealed or estimated relationship between investment in plant and equipment and output. In order to investigate the relationship between investment and output we first transformed the construction cost data into a constant dollar series by using the Department of Commerce deflator for government construction. Then, assuming that confinement technology was constant over the period covered, we estimated the following investment functions:[24]

$$X_{40} = 1{,}066{,}514 + 2180(X_{18}) \tag{7}$$

$$X_{40} = 1{,}321{,}703 - 1746(X_{18}) + 1942(X_{18}^2) \tag{8}$$

where X_{40} is deflated costs of physical plant and X_{18} is the rated capacity of the institution. Also, see Table 9. In neither case was the explanatory power of the relationship overwhelming ($R^2 = 0.12$ in Eq. 7, and 0.14 in Eq. 8). Adjusted for the difference in the number of variables, the explanatory power ($\bar{R}^2$) of Eq. 7 is trivially better than Eq. 8. The coefficient estimate in Eq. 7 is significantly better than the estimates in Eq. 8 and in this sense the simple lienar form is superior to the form involving X_{18}^2.

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[24] A full list of variables is given in the data appendix.

TABLE 9

Investment Functions for California Jails

DEPENDENT VARIABLE	CONSTANT	X18	$(X18)^2$	R^2	$\bar{R}^2$	N
X40	1066514 (701654)*	2180 (1022)		.12	.094	35
X40	1321703 (763991)	-1746 (4639)	1942 (2238)	.14	.086	35

All estimates are OLS.

*Standard Error

Source: California Department of Justice, Bureau of Criminal Statistics, Jail Space Utilization Study, 1974.

Variables: X40 = Deflated costs of physical plant for jails,

X18 = rated capacity of the jail.

We next attempted to use the cross section data for estimating a long run operating cost function. The cost function that was estimated using the Jail Space Utilization data was a long run function because across the sample of 128 institutions, all factors were variable. In concrete terms, the rated capacity of institutions included in the survey, although not in any actual estimation, ranges from a low of 6 to a high of 3251. Thus, in no meaningful sense was the plant size constant, or for that matter was any other input constant, across the sample. Again, because no explicit capital charges were included in the budget figures, the best that we could do was to estimate a long run total operating cost function.

Estimating a long run cost function using cross section data is not without difficulties. There is the obvious problem of assuming that all of the jails in the sample actually produced the same output. To some extent we have adjusted for this by considering attributes of the output and of the institutions themselves in several of the estimates that appear in Table 10. Considering the attributes of the output was of particular importance here because of the impossibility, in many instances, of obtaining non-rehabilitation total costs. Thus, we were forced in most estimations to use total costs unadjusted for rehabilitation and attempted to net out the non-confinement costs in the estimation itself. It is worth noting at this point that in terms of programs we usually associate with rehabilitation, only paid counseling proved to be strongly associated with variations in total cost.

Perhaps a more serious problem in estimating a long run cost function, whether it is on cross section or time series data, is the assumption that, at least on the average, decision-makers in charge of a confinement operation actually minimize total costs at any output level. When investigating a cost function for an institution whose size has been constant for some time, this assumption seems ultimately plausible; especially if the plant manager is most interested in rehabilitation. For the case in which the manager is very interested in rehabilitation, cost minimization of confinement enables him to devote a maximum amount of his limited resources to rehabilitation. Since we were concentrating on cost functions for confinement in the fixed plant cases, our assumption appears very reasonable in the analysis of Folsom and San Quentin. However, once we leave the area of fixed capacity institutions, the proposition of cost minimization at any output level is less straightforward. It may be quite plausible to assume that a manager of fixed size plant minimizes costs for any output level, but this does not imply that decision-makers considering the size or scale of plant have enough information (in some cases the proper incentive) to pick the optimum size institution for any output level. If lack of information causes decisions regarding scale of institution to be biased in the sense that decision-makers consistently choose too small or too large a facility, in terms of cost minimization, then estimated long run cost functions will not be the analogue of the economists' long run cost function and may be of only limited direct use to correctional decision-makers. The main utility of such estimations may be to point out the bias in past decisions.

Still another problem of estimation using this particular cross section data is the transient nature of the inmate population in many city and county facilities. While some of this distortion has been accounted for in several of the estimations where the type of facility has been explicitly introduced, we doubt all of this bias has been removed. With a large transient population, facilities may tend to be built with a design capacity that exceeds their expected output or population. In fact, if decision-makers feel that there must always be "room at the inn" their plants will always be too large for cost minimization with respect to average daily populations. Excess capacity will be built into the system as insurance, and the plants may be minimum cost in terms of the maximum inmate population that the decision-maker feels he must be able to accommodate on extremely short notice. Such risk aversion will certainly bias the estimated function upward relative to a minimum total cost function on expected values. However, if there is a reasonable amount of consensus concerning the degree of excess capacity, the estimates based on this data, while they may not conform precisely to the cost function of simple economic theory, will still be of interest to correctional decision-makers at the city and county level. Given the desired degree of excess capacity, the estimated function will give the operational relationship between operating cost variation and average inmate population in systems with large transient populations.

Having explored some of the problems in this part of the study, we are now in a position to present some of the major results of our estimation:[25]

$$X_{26} = 199{,}750 + 2881\ X_{20} \quad (8)$$

$$X_{21} = 339{,}427 + 1862X_{20} + .37\ X_{20}^2 \quad (9)$$

$$X_{26} = 195{,}349 + 3501\ X_{20} - 1.14\ X_{20}^2 + .00048\ X_{20}^3 \quad (10)$$

where X_{26} = total annual operating costs of the jail, and X_{20} is the average daily population of the jail. The adjusted R^2's for the equations are 0.78, 0.79, and 0.80 respectively. Again, as in the case of long run functions for state prisons, the appropriate functional form is not immediately obvious.

From inspecting the details of the estimation in Table 10, we notice that the least significant coefficients in the estimations are the coefficients on X_{20}^2 and X_{20}^3 in Eq. 10, and of these, the coefficient X_{20}^2 has the highest standard error relative to the coeffficient estimate. If we cannot reject the hypothesis that the coefficient on X_{20}^2 in Eq. 10 is in fact zero, then all equations evidence non-decreasing marginal costs. Moreover the increase in marginal cost in both Eqs. 9 and 10 would be quite small. For example, in Eq. 9 the increase in marginal cost per inmate is .75 or $75 per 100 inmates. Given that the mean of X_{20} is 240, this variation in marginal cost is not very significant, and it appears that we can accept the simple linear form in Eq. 8 as an operational approximation to the long run cost function.

Now if we take this analysis one step further and introduce a quality of hotel service variable our results become even more interesting.

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[25] Only 63 of the 128 institutions listed in the <u>Jail Space Utilization Study</u>, reported sufficient data for this estimation.

TABLE 10

Estimated Total Operating Cost Functions for

California City and County Jails, 1971-72

U.	DEPENDENT VARIABLE	CONSTANT	X20	$(X20)^2$	$(X20)^3$	(X18)	X42	R^2	$\bar{R}^2$	N
.	X26	199750 (106804)*	2881 (196)					.78	.78	63
.	X26	339427 (121003)	1862 (495)	.37 (.16)				.80	.79	63
.	X26	195349 (139932)	3501 (9778)	-1.74 (1.10)	.00048 (.00026)			.81	.80	63
.	X26	142489 (216711)	1972 (835)			910 (.815)		.78	.77	60
.	X43	186185 (103402)	2861 (190)					.79	.79	63
.	X43	322976 (117036)	1863 (479)	.36 (.16)				.80	.79	63
.	X26	-130 (271730)	1627 (508)				25809 (11603)	.68	.61	12
.	X26	85105 (286747)	3516 (2024)			-1687 (1750)	24740 (11201)	.72	.62	12
.	X43	.4488 (1.020)	.0033 (.0016)				.0428 (.0392)	.53		9
.	X1	1.0561 (.0745)	-.0001 (.0001)	4.90 (.93)	(1/X20)			.32		72

1 estimates are OLS.

tandard error.

urce: California Department of Justice, Bureau of Criminal Statistics, Jail Space Utilization Study, 1974.

riables: See the data appendix for a complete list.

X26 = Total operating costs,

X43 = toptal operating costs minus capital outlays,
X1 = average cost of food per inmate day,
X20 = average estimated daily inmate population,
X18 = total rated capacity,

Using square footage per inmate at rated capacity, we obtain the following estimated cost function:

$$X_{26} = -130 + 1627\ X_{20} + 25{,}809\ X_{42} \qquad (11)$$

where X_{42} is the square footage measure. This relationship suggests that if you hold service level constant, then we have a proportional relationship between output and operating costs when the jail size is allowed to vary. That is, double the inmate population, keeping hotel services constant, and you will double the operating costs. Only 12 jails provided sufficient information for this estimation and thus while the results are suggestive, they are by no means definitive.[26,27]

VI.

We may now summarize our findings. It is worth re-iterating that our measure of output is simply prisoners confined for each of the three types of correctional institutions which we have studied. We have not found it possible explicitly to keep the quality of the hotel and personal services constant, save in an imperfect way for jails. To the extent that those services are inversely related to the number of prisoners confined in a fixed-capacity institution, our results underestimate the total cost of the correctional industry.

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[26] In another small sample result, using average daily cost data supplied in the survey, we found a very small increase in average confinement costs as inmate population increases. See Table 10, eqns. 9 and 10.

[27] We have only reviewed selected results from our investigation of California jails. The interested reader is referred to the additional results in the data appendix.

Additionally, we have tried to avoid the knotty problem of rehabilitated output by deducting all those items in the Department of Corrections' budgets which were clearly identifiable as rehabilitation-related. In whichever direction that rehabilitation and confinement are related, our estimated functions may be biased, according as to how accurately we have netted out rehabilitation costs and our output measure does not confound confined and reformed prisoners.

For the two maximum security prisons--San Quentin and Folsom--we found significant economies of scale in confinement regardless of whether we estimated total or average cost functions. For both prisons we also found a significant and slightly increasing marginal cost associated with confining a more violent inmate population.

For the three medium security prisons--the Correctional Training Facility (Soledad), the Deuel Vocational Institute, and the California Men's Colony (San Luis O'bispo)--we were able to estimate long-run cost functions since capacity changed significantly in all three institutions over the sample period, 1948-1964. For Deuel and the CHC we discovered constant returns to scale in confinement with long-run marginal and average costs approximately equal at levels of $1500-$1700. There was evidence for long-run economies of scale in confinement only at the CTF.

Lastly, we used the extensive survey of the California Bureau of Criminal Statistics' Jail Space Utilization Study of 1971-72 to estimate cost functions for city and county jails. It was necessary to produce separate estimates for capital and operating costs. Our regressions suggest a simple linear relationship between the capacity of a jail and the real costs of physical plant, but the relationship is not statistically powerful. For the estimates of long-run operating costs, we could not reject the hypothesis of non-decreasing long-run marginal costs. The best fit was for constant returns to scale with a very low marginal operating cost of less than a dollar. By introducing a service quality variable, we found still stronger evidence of long-run constant returns to scale for city and county jails.

These conclusions have clear public policy implications for those concerned with crime and the treatment of criminals. We stress that these estimates are a beginning and that much further research is needed in the economics of correctional institutions.

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