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EFFICIENCY ASPECTS OF GOVERNMENTAL COMPENSATION PAYMENTS: THE FEDERAL HIGHWAY PROGRAM

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Abstract

There is a well-developed literature of project evaluation based on the assumption that a project is "efficient" if losers could, potentially, be compensated by gainers. In sharp contrast, relatively little systematic work has been done to develop a corresponding economics of project evaluation under actual compensation criteria. This is largely because the amount of compensation that is actually paid is thought to influence mainly the income distributional consequences of public programs. In this paper, we develop a simple model of bureau behavior in which changes in compensation requirements induce public sector decision-makers to alter decisions about both the size and type of projects undertaken. We test some empirical predictions of the model using U.S. Department of Transportation data on highway construction. We find that the presence of compensation requirements had a significant impact on the level of total federal-aid highway construction by state. It appears that public agencies engaged in highway construction responded to the introduction of requirements that displacees be compensated as if those requirements represented increases in the costs of their highway activities. Even though payment of compensation may not have changed the real social costs of highway construction, but only their distributional impact, it appears to have had an impact on real output decisions.

EFFICIENCY ASPECTS OF GOVERNMENTAL COMPENSATION PAYMENTS: THE FEDERAL HIGHWAY PROGRAM

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In the welfare economics literature, the concept of hypothetical compensation permits the loss restrictive test of potential Pareto superiority to be used in place of the stricter test of actual Pareto superiority in the evaluation of public programs. There is, in fact, a well-developed literature of project evaluation based on the assumption that a project is "efficient" if losers could, potentially, be compensated by gainers. In sharp contrast, relatively little systematic work has been done to develop a corresponding economics of project evaluation under actual compensation criteria. This is largely because the amount of compensation that is actually paid will influence the income distributional consequences of public programs, and economists have sought to avoid making evaluations that require definite value judgments regarding alternative distributions of income.

Just as efficiency-oriented programs are almost certain to have unintended distributional consequences which may give some justification for compensation, so too compensation programs may affect the efficiency with which resources are used in the public sector. This is so because any attempt to provide compensation will inevitably alter the incentives that decision-makers face. For example, depending upon how compensation payments are financed, the magnitude of the payments will affect both the absolute and relative budgetary costs of projects as perceived by agencies and the private net benefits of projects perceived by specific

voters. It is likely that, if the levels of required compensation were changed, public sector decision-makers would be induced to alter decisions regarding both the size and the type of projects undertaken, since some projects involve more compensation relative to production costs than do other projects. Thus, by creating incentives to alter the use of real resources in the public sector, decisions concerning the use of alternative compensation rules possess a potential for affecting the level as well as the distribution of social income.

In this paper, the relationship between payment of actual compensation and the achievement of economic efficiency is examined both theoretically and empirically. At the theoretical level, the impact of various compensation arrangements on public decision-making is analyzed through the use of a simple model of bureaucratic behavior. The efficiency impacts of alternative compensation requirements are examined for cases in which government agencies choose to fund certain programs among public programs subject to budgetary restrictions. It is shown that the effects of such requirements depend upon the type of budget constraint faced by the agency and the manner in which compensation payments are financed. In the empirical section, estimates are made of the impact of compensation costs on the level and composition of federal-aid highway construction using U.S. Department of Transportation data.

1. COMPENSATION AND BUREAU BEHAVIOR

In order to predict the impact of compensation arrangements on the magnitude and composition of an agency's output, seeking to maximize some

benefit function subject to a budget constraint, it is necessary to develop an explicit model of bureau behavior. The following represents a first step in that direction.

Assume an agency characterized by the following:

(1) $(X_1 \ldots X_n)$--a vector of independent, perfectly divisible projects which the agency may undertake;

(2) $B = B(X_1 \ldots X_n)$--a well-behaved (convex, differentiable) function relating benefits derived by the agency to projects undertaken;

(3) Total direct construction costs for each project which are linear with respect to project scale;

(4) An exogenously determined budget constraint.

The implications of this characterization for a model of bureau behavior are straightforward. Assumptions (1) and (2) together allow the agency preferences for various project mixes to be represented in a manner which is formally identical to that utilized in the neoclassical consumer choice model. (1) and (3) imply that the agency faces constant direct costs for each additional unit of a given project in the same way that the consumer is conceived of as facing a fixed price for each additional unit of a good which he may wish to purchase. Thus, we can frame the project choice problem of an agency in a manner completely analogous to the standard model of consumer choice.

If it is assumed for simplicity that the agency choice set is limited to two projects, X_1 and X_2, then in the absence of any costs other than direct costs one would have:

$$B = B(X_1, X_2); \tag{1}$$

$$TC = k_1X_1 + k_2X_2; \tag{2}$$

$$TC \leq \bar{K} \text{ (budget constraint).} \tag{3}$$

But it is likely that in addition to the direct costs incurred to purchase the factors and resources necessary for production, other "indirect" or external costs would be imposed on at least some individuals or institutions adversely affected by the reallocation of resources implied by the agency activity. In some cases such individual losses would correspond to real social losses, while in others they would merely represent a pure income transfer between losers and gainers. As we will see later, the distinction between these two forms of loss is important in evaluating the normative aspects of compensation. However, for purposes of positive analysis, insofar as behavioral predictions of agency response are concerned, the distinction is not important. For the moment it is sufficient to point to the likely existence of such negative spillovers, at least for some groups, and make the additional assumption, if only for simplicity, that these external damages will also vary in a linear manner with respect to output; thus,

$$E_1 = c_1X_1 \text{ (external damages imposed on some groups caused by production of } X_1) \tag{4}$$

$$E_2 = c_2x_2 \text{ (external damages imposed on some groups caused by production of } X_2).$$

It is the existence of such damages that causes demands for compensation payments to be made. The level of compensation that actually emerges in response to such demands depends, of course, upon a number of factors not explicitly incorporated in the above model. The question of what the payment level would be in the case of any given government activity is itself an important one; however, it will not be addressed here. Thus, for purposes of the present analysis, we consider the level of required compensation as exogenously given to the agency (for example, by a legislative body), varying from zero to full compensation, with full compensation defined to be the payment of all damages sustained by those adversely affected. The compensation rule is formally defined as:

$$C_1 = a_1(c_1x_1)$$

$$C_2 = a_2(c_2x_2) \tag{5}$$

$0 \leq a_i \leq 1$, where a_i = fraction of losses paid as compensation.

Suppose the agency were not held liable for the negative spillover effects generated by its activities. In that instance, from the agency's point of view, $a_1 = a_2 = 0$ and the relevant budget constraint would be:

$$TC = k_1x_1 + k_2x_2 \leq \bar{K} \tag{6}$$

with the constrained optimization problem defined as:

$$\max B(x_1x_2) \text{ subject to } k_1x_1 + k_2x_2 \leq \bar{K}. \tag{7}$$

The solution to this problem can, of course, be depicted quite easily in graphical form as in Figure 1, with the equilibrium allocation of agency resources to X_1 and X_2 given by X_1^* and X_2^*.

The impact of compensation requirements on agency behavior can be observed by contrasting the above situation with one which would emerge if the agency were required to compensate from a fixed budget those hurt

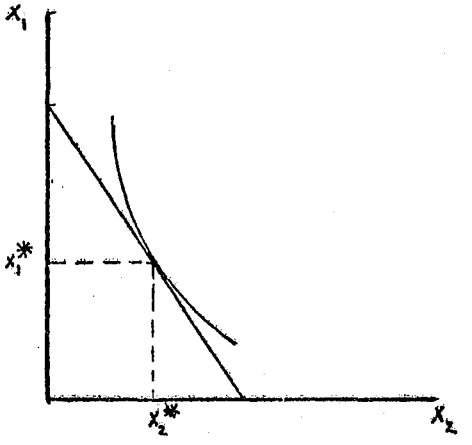

Figure 1

by its activities. In this instance, a_1 and a_2 would not in general equal zero, and the budget constraint would be:

$$(k_1 + a_1c_1)x_1 + (k_2 + a_2c_2)x_2 \leq \bar{K} \qquad (8)$$

with the constrained optimization problem modified accordingly. Comparing (8) and (6), it is clear that the presence of compensation requirements will affect the agency budget constraint in one of two possible ways.

If $\frac{a_1c_1}{k_1} = \frac{a_2c_2}{k_2}$, that is, if the ratios of compensation payments to construction costs associated with each project are the same, then the requirement that compensation be paid will be tantamount to a parallel downward shift in the budget constraint as depicted in Figure 2, leaving unchanged the relative costs to the agency of undertaking X_1 versus X_2.

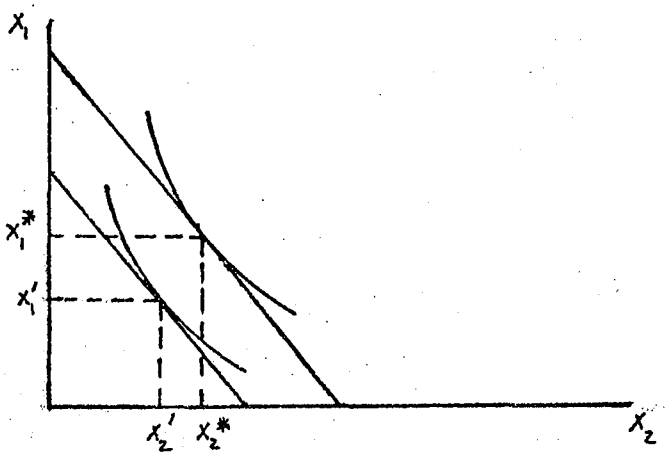

Figure 2

In terms of the impact on total agency output, the result is not surprising; the presence of compensation requirements would cause both projects to be produced at a smaller scale. In terms of project mix, however, the effect would be ambiguous. Even if compensation payments were the same for all projects, the project mix would still change if the "budget elasticities of demand" for different projects were unequal. This would be so if the ratios of benefits to budgetary costs were unequal for different projects. In this case, it would be rational to reduce the scale of those projects with relatively low ratios of benefits to budgetary costs more than the projects with higher benefit-cost ratios.

A more general and interesting case would arise in the situation where $\frac{a_1 c_1}{k_1} \neq \frac{a_2 c_2}{k_2}$, that is, where the ratios of required compensation payments to construction costs for each project were unequal. For the extreme case where $\frac{a_1 c_1}{k_1} = 0$ and $\frac{a_2 c_2}{k_2} \geq 0$, the effect of a change in compensation requirements would be equivalent to an increase in the relative cost of producing project X_2, depicted graphically in Figure 3.

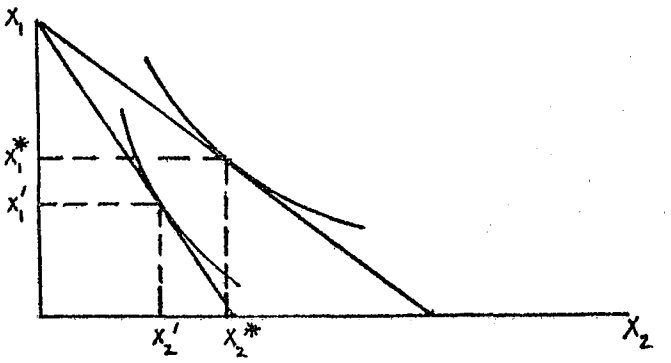

Figure 3

An immediately observable result in this case is that the scale of the project requiring the greater amount of compensation (hereafter referred to as the "compensation-intensive" project) will diminish in absolute terms. However, the effect of compensation on the composition of projects undertaken is a good deal more complicated to determine. On the one hand, since compensation would cause the relative budgetary cost of project X_2 to increase, the substitution effect would induce the agency to produce relatively more of project X_1. On the other hand, since compensation would reduce the "purchasing power" of the budget as a whole, the agency would be induced by produce less of project X_1 as well as X_2. Depending on the strength of these two offsetting effects, the total change in X_1 could go either way. Thus, on theoretical grounds alone, it is impossible to predict whether the relative share in agency activity of the compensation-intensive project, X_2, would decrease, remain the same, or increase, if the payment of compensation were required. This is a question that can only be resolved empirically.

The above can be modified quite readily to accomodate the case where it is not required that compensation be paid out of a fixed budget, but some budget adjustments are made instead. This situation can perhaps be

illustrated by the following simple numerical example. Consider an agency in precompensation equilibrium at X_1^* and X_2^* with $\bar{K}$ = \$100 and $k_1X_1^*$ = \$50, $k_2X_2^*$ = \$50; in addition assume that total external damages, E_1 and E_2 are equal to 0 and \$20, respectively. Suppose that a requirement to compensate losers in full is now introduced.

In the absence of any budget adjustment this will cause the construction budget constraint to shift from $\bar{K}$ to $\bar{K}'$ as in Figure 4.

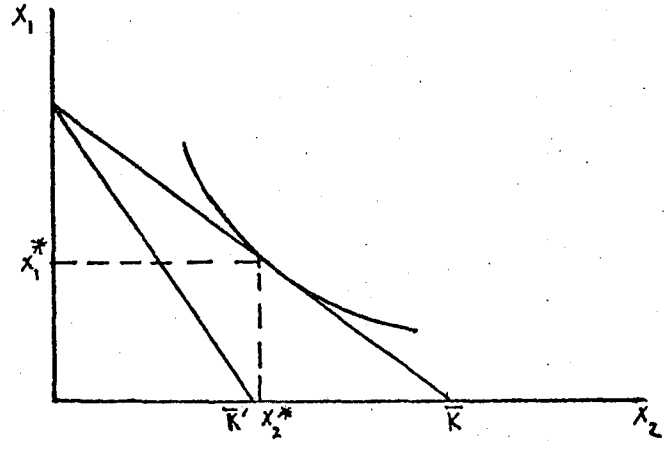

Figure 4

There are two methods by which one might attempt to adjust the budget so as to offset the impact of the compensation requirement. One approach would be to adopt a matching grant formula, whereby each dollar paid out in compensation payments by the agency would be exactly offset by the higher level budget authority. This form of budget adjustment would be tantamount to an upward rotation of $\bar{K}'$ to $\bar{K}$--in effect returning to the original budget constraint without compensation--and would, as a result, permit compensation to be made to the losers without altering either the magnitude or composition of agency output. Alternatively, the budget authority might choose to provide the agency with a lump sum grant

to permit it to produce at the precompensation equilibrium output and pay full compensation--i.e., in terms of our example, it might choose to increase the agency budget from $100 to $120, leaving the agency free to decide how to spend the additional increment. As indicated in Figure 5, such a formula would effectively alter the agency budget constraint from $\bar{K}'$ to $\bar{K}''$ with the agency attaining a new equilibrium at X_1^{**} and X_2^{**}.

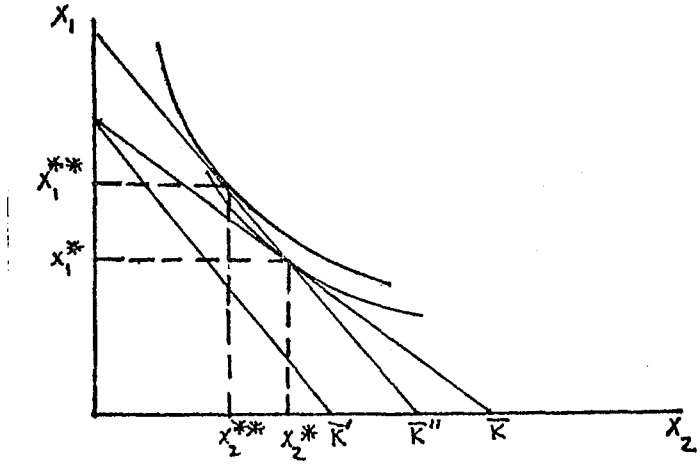

Figure 5

From Figure 5, it is obvious that the compensation requirement, even though offset by a budget adjustment, will not be neutral with respect to project mix and scale. Indeed, in this instance, to the extent that the "income effect" of the compensation requirement is offset by a lump sum budget change, the effect will be quite unambiguous--the introduction of the compensation payment will cause the agency to provide less of the compensation-intensive activity and more of those activities requiring relatively less compensation.

While it is a relatively straightforward exercise to predict the impact of requiring that compensation be paid, it is a good deal more complicated to assess the normative implications of these results. This is so because, in addition to the factors discussed above, the impact of compensation on allocative efficiency will depend on: (1) whether the agency budget prior to payment of compensation is itself of a size compatible with achieving allocative efficiency; and (2) whether the nature of the losses for which compensation was required are real or pecuniary.

Consider first the case in which, prior to the introduction of compensation, the agency budget was of super-efficient size in the sense that, if the agency were required to account fully for all social costs, the marginal social benefit of an additional budget dollar would be less than the marginal social cost. If the individual losses occasioning compensation represented real social costs, it is clear that under such circumstances efficiency would be increased if the agency were required to pay compensation strictly out of its own budget, without provision for any offsetting budget adjustments. Since, by assumption, the budget would be too large if compensation were not paid, the income effect of a compensation requirement for real external costs would increase efficiency by restricting the construction budget in the direction of a more optimal size. Moreover, by causing the relative budgetary costs of projects to more accurately reflect their relative social costs, the substitution effect of such a requirement would induce the agency to select an efficient mix of projects. If the individual losses occasioning compensation represented pure income transfers, however, the efficiency impact of requiring compensation would be ambiguous. On the one hand, the income

effect of such a requirement would tend to offset the loss in efficiency resulting from the excessive size of the budget prior to compensation ("excessive" in efficiency terms). On the other hand, the substitution effect of such a requirement would cause the budgetary costs of projects to less accurately reflect their relative social costs, and therefore induce the agency to select a less efficient mix of projects unless appropriately offsetting matching grant adjustments to the agency budget were made.

Consider, second, the case in which, prior to compensation, the agency budget was of efficient size in the sense that, if the agency were required to fully account for all social costs, the social benefit of an additional budget dollar would equal the marginal social cost. If the individual losses occasioning compensation represented real social costs and the agency were required to pay compensation strictly out of its own budget, efficiency would be increased. It would, therefore, through its budgetary costs, fully account for all social costs. This would not be the case, by assumption, if compensation were not required to be paid. If the individual losses occasioning compensation represented pure income transfers, requiring that compensation be paid without provision for any offsetting budget, adjustments would not be efficient. Since, by assumption, all relevant social costs would already be included in budgetary costs, the size of budget would be efficient in the absence of compensation, and therefore, the income effect of such a requirement would restrict the construction budget below the optimal size. Moreover, for reasons discussed above, the substitution effect of such a requirement

would induce the agency to select an inefficient mix of projects. In this latter case, if it were required that compensation be paid, it would be appropriate to provide a budget adjustment which would offset both the inefficient income and substitution effects of compensation. This would be accomplished through the provision of a matching grant. Alternatively, the undesirable income effect of required compensation could be offset through provision of a lump sum grant. In this case, however, the inefficiencies caused by compensation-induced substitution between projects would remain.

Finally, consider the case in which, prior to compensation, the agency budget was inefficiently small in the sense that, if the agency were required to fully account for all social costs, the social benefit of an additional budget dollar would exceed the marginal cost. If the losses occasioning compensation were real social costs, the efficiency impact of requiring that compensation be paid, without provision of an offsetting budget adjustment, would be ambiguous. Since, by assumption, the budget was too small in the absence of compensation, the income effect of such a requirement would lessen efficiency by reducing the budget to a still less optimal size. By causing the relative budgetary costs to more accurately reflect relative social costs, however, the substitution effect of such a requirement would induce the agency to select a more efficient project mix. So in this case, it would be appropriate to provide a budget adjustment which would preserve the desirable substitution effect, but offset the undesirable income effect. Ideally, this would be accomplished through provision of a lump sum grant. Alternatively, the undesirable income effect of required compensation could be offset

through provision of a matching grant; however, in this case, the desirable impact of the substitution effect would be offset. If, on the other hand, the losses occasioning compensation were income transfers, to require that compensation be paid out of a fixed budget would not be efficient, since both the income and the substitution effect of such a requirement would be inefficient. Thus, in this case it would be appropriate to provide a budget adjustment which would offset such effects and be accomplished through the provision of a matching grant to cover all compensatory income transfers. A lump sum grant would be a less desirable alternative for reasons already discussed, although it would be preferable to no adjustment at all.

In summary, the analysis indicates that, from a normative, efficiency standpoint, the impacts of a requirement that compensation be paid is a complex issue and difficult to assess on theoretical grounds alone. However, certain positive predictions about agency behavior have been derived which can be empirically tested. Specifically, we have argued that the introduction of compensation requirement would either (1) cause all projects to be undertaken at reduced scale if they were equally compensation-intensive; or (2) cause the most compensation-intensive project to be reduced in scale, if (a) agencies view as costs only those items explicitly included in the agency budget; and (b) compensation is required to be paid out of a fixed budget. In the following sections, we test these predictions using empirical evidence from the federal-aid highway program.

2. IMPACT OF COMPENSATION REQUIREMENTS ON FEDERAL-AID HIGHWAY CONSTRUCTION

Federal-aid highway construction represents an excellent example of a government program which is presumably undertaken in the greater public interest, but which also imposes costs (in addition to direct construction costs) on certain groups. While at least 22 different types of such "non-construction" costs have been identified by Downs (1970, ch. 8), perhaps the most visible and politically controversial have been the losses borne by individuals and families displaced from their homes and neighborhoods.

Prior to 1968, virtually no attempt was made either to minimize the losses suffered by the displaced persons or to provide compensation to them. The first federal highway relocation law, enacted in 1962, merely requested states to provide relocation information to displacees. It did not require that compensation be paid in money or that relocation housing actually be made available to them. Even in cases where it was known that relocation resources were insufficient, neither federal nor state highway officials were obligated to curtail their displacement activities or to provide compensation to those adversely affected.

This situation was significantly altered by passage of the Highway Relocation Assistance Act of 1968 (hereafter the 1968 Act), which required that state agencies provide specific assurances to persons displaced by federal highway projects. These would include safe, sanitary, and decent replacement housing to be available (1) at rents or prices within their financial means; (2) in areas not generally less desirable than those from

which they were displaced with respect to public utilities and public and commercial facilities; and (3) in areas reasonably accessible to their places of employment (Berzon, 1971). The Act also required that cash compensation (described in Table 1) be paid to displacees.

These provisions were superseded in 1971 by those contained in the Uniform Relocation Assistance and Real Property Acquisition Policies Act (hereafter the Uniform Relocation Act) which established uniform relocation requirements for all federal programs. Although similar in intent, the Uniform Relocation Act provided greater protection to displacees than the 1968 Act in two crucial respects. First, if it was found that suitable replacement housing was not available, the Secretary of the Department of Transportation was empowered to "take such action as is necessary or appropriate to provide such housing" with funds authorized for the highway project. Second, the Uniform Relocation Act provided more generous cash compensations to displacees than those required by the 1968 Act. These are described in Table 2.

Budget Adjustments in Response to Compensation Requirements

The analysis in Section 1 revealed the crucial role played by budget adjustments in determining the impact of increased compensation requirements on agency behavior. In this regard, an assessment of the budgetary impact of compensation requirements is complicated by the intergovernmental means of financing highway construction. That is, it is necessary to determine the impact of compensation requirements on the budget of the Federal Highway Administration as well as the impact of such requirements on the budgets of the various state agencies.

Table 1

Cash Assistance Available to Highway Displacees Under Terms of the Highway Relocation Assistance Act of 1968

Type of Payment	Amount and Duration
Moving and Related Expenses	Actual expenses up to $200 plus a $100 dislocation payment.
Relocation Payment to Renters	Difference between pre- and post-dislocation rents for 2 years up to a total of $1500.
Expenses Incidental to Transfer of Property	Actual amount.
Replacement Housing for Owners	Difference between condemnation payment and price of substitute home up to $5000.
Payment to Owners of Businesses and Farms	Payment equal to average net earnings of business or farm or $5000, whichever is less.

Source: U.S. Congress, House of Representatives, Committee on Public Works, 1970. Hearings on H.R. 14898 and S.1, p. 63.

Table 2

Cash Assistance Under Terms of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970

Type of Payment	Amount and Duration
Moving and Related Expenses	Actual "reasonable" expenses.
Relocation Payments to Renters	Difference between pre- and post-dislocation rents for 4 years up to a total of $4000.
Expenses Incidental to Transfer of Property	Actual amount.
Replacement Housing for Owners	Difference between condemnation payment and price of substitute home up to $15,000.

Source: Uniform Relocation Assistance and Land Acquisition Policies Act of 1970.

At the federal level, both the 1968 Act and later the Uniform Relocation Act required that the Federal Highway Administration reimburse the states in full for relocation payments made during the first one to one and one-half years after the introduction of compensation requirements. Following this transition period, both acts required partial federal reimbursement to the states with the federal share of compensation outlays equal to the federal share of all other project costs. There is no evidence that budget adjustments of the matching grant type were provided to offset fully the increased compensation expenditures necessitated by such requirements. However, it does appear that a partial adjustment of the lump sum type was provided.

This adjustment took the form of the Right of Way Revolving Fund, established in 1969, which provided for funds in addition to those appropriated for federal-aid highway construction to be used "to acquire rights of way for future highway construction on any Federal-Aid System" as well as for payments for the moving and relocation of persons and businesses. The partial nature of this adjustment is easily demonstrated by two features of the fund. First, amounts allocated to the fund could also be used for purposes other than payments of compensation to displacees. Second, even if it is assumed that all of the Right of Way Fund was used for payment of compensation, the amounts spent in each year would have offset roughly just three-fifths of the federal share of compensation outlays between 1971 and 1973, as illustrated in Table 3.

Both the 1968 Act and the Uniform Relocation Act provided for partial reimbursement to the states for compensation outlays. Under this

Table 3

Ratio of Right of Way Revolving Fund to Federal Compensation Outlays: 1971-1974

Year	Amount Spent From Right of Way Revolving Fund (Millions)	Federal Compensation Outlays (Millions)	Ratio of Right of Way Revolving Fund to Federal Compensation Outlays
1971	16.6	37.3	.45
1972	24.9	34.3	.72
1973	23.0	36.1	.64
TOTAL	63.9	107.7	.59

Source: Highway Statistics, 1971, 1972, and 1973, Tables FE-10, FR-1, and FR-2.

formula, each state would receive 90 cents for each dollar of compensation paid in connection with the federal interstate system and 50 cents for each dollar of compensation paid in connection with other federal-aid systems. Thus, from the perspective of the states, partial budget adjustments of the matching grant type were provided.

Thus, budget adjustments were not made to fully offset the impact of increased compensation requirements, either at the federal or the state level. Based on the analysis in Section 1, we would expect to observe a reduction in output of the more compensation-intensive components of the federal-aid highway program. In the next section, we test this prediction using cross section data.

3. REGRESSION RESULTS

Our theory suggests that a compensation requirement will have an impact on the geographical distribution of construction activity. First, since the above-mentioned compensation requirements apply only to federally-assisted highway projects, we would expect, ceteris paribus, that highway agencies in the more compensation-intensive states would find federally-assisted highway programs relatively less attractive compared to state-funded programs than those agencies in the less compensation-intensive states. Second, we would expect, ceteris paribus, that decision-makers at the federal level tend to favor and approve highway projects in states with lower compensation costs relative to construction and acquisition costs. Thus, we expect the level of required compensation to have a negative impact on the amount of federal-aid highway construction undertaken in any given state.

In order to test this hypothesis, we estimated a number of regressions with cross section data for the year 1972. In this section, we discuss the variables used in each of the regressions. We then turn to the empirical findings.

The Variables

Dependent variables. We experimented with two proxy variables for highway construction.

(a) Real capital outlays. The first dependent variable used was real capital outlays for federal highway construction, constructed by deflating capital outlays by state by an unpublished cross section index

of construction costs. We regard this variable (which includes (1) land acquisition and right of way costs; (2) preliminary and construction engineering costs; (3) roadway and structural construction costs, and (4) costs of installing traffic service facilities) as a reasonably good proxy for public investment expenditure on highways in constant dollars.

(b) Miles of federal highway completed. In addition to real capital outlays, we also used miles of federal-aid highways completed in 1972 by state. This variable is an estimate of the actual physical additions made to the federal-aid system, and thus offers an opportunity to explore the impact of compensation on the number of miles of federal-aid systems actually put in place.

Independent variables. Four independent variables were included in the real capital outlay regressions. Five independent variables were included in the miles completed regressions.

(a) Fuel consumption. Friedlaender's (1968) study of highway investment demand suggests that auto and truck fuel consumption is an important determinant of the level of highway construction. Two versions of the regression model were run, one using data on the level of fuel consumption, the other using data on changes in fuel consumption. The regressions in which the level of fuel consumption was included performed better than those containing data on changes in fuel consumption both in terms of the performance of the individual variables and the overall fit of the regression equations. So the fuel consumption variable is the level of fuel consumption, by state.

(b) Stock of highways in place. To the extent that highway construction can be viewed as representing additions to an existing "inventory" of

transport facilities, it seems plausible to include the existing stock of highways in place at the start of the year as an independent variable. As a proxy for this variable we used observations on the traveled way of the federal-aid system in 1971, representing the mileage of existing routes plus the officially designated routes completed and open to traffic.

(c) Federal subsidies. It is plausible that the amount of federal-aid construction undertaken by the individual states would be sensitive to the amount of federal subsidy received. Thus, we included data on the amount of federal funds received by each state in relation to state contributions to the highway trust fund as a proxy for net federal subsidies received.

(d) Construction costs. For those regressions in which the dependent variable is represented by number of miles completed, we experimented with including as an independent variable an unpublished cross section index of construction costs computed by the Federal Highway Administration. In general, equations containing this variable performed better than those in which construction costs were omitted. Thus, for the miles completed regressions, we report the results for those specifications that include constructions costs as a variable.

(e) Compensation variables. The variables used to represent compensation were relocation payments made to highway displacees by state. We experimented with a number of alternative specifications of the compensation variable. In one version of the real capital outlay regressions, the impact of compensation requirements is captured by total outlays for relocation assistance. In the second version, the impact of compensation is captured

by the ratio of relocation payments to total capital outlays. In the case of the miles completed regressions, the impact of compensation is captured by total outlays for relocation assistance in one version, and relocation payments per mile completed in the second version.

The Findings

Table 4 shows the impact of compensation requirements on real capital outlays for federal highway construction by state. Under both specifications, the coefficient of the compensation variable is negative and, in the case of the ratio of compensation payments to total capital outlay, is statistically significant. At the mean of the sample, the elasticity of output with respect to the ratio of compensation to capital outlays equals -.012. That is to say, a 100 percent increase in the ratio of compensation to construction costs would lead to a reduction in real capital outlays for highways of rougly 1.2 percent. From this information, it is also possible to estimate the sensitivity of highway investment to changes in total compensation outlay. At the mean of the sample, in order for the ratio of compensation to construction costs to increase by 100 percent, it would be necessary to increase total compensation outlays by $850,000 holding capital outlays fixed. This in turn would lead to a reduction in real capital outlays of roughly 1.2 percent or 1.9 million dollars. Thus, this would imply a reduction in real highway construction outlays of 2.2 dollars per each dollar of compensation paid.

In Table 5, we present results of the regression in which miles completed was used as the dependent variable. Again, under all alternative

Table 4

Real Capital Outlays for Federal-Aid Highways
by State, 1972 (Millions of Dollars)

Variable	Model	
	I	II
Constant (millions of real dollars)	170.0 (.75)	246.2 (1.12)
Fuel Consumption (thousands of gallons)	54.9 (6.8)	56.2 (10.6)
Stock of Highway Miles in Place Lagged One Year (thousands of miles)	1.7 (1.8)	1.5 (1.77)
Federal Subsidy	46.8 (.54)	130.8 (1.44)
Index of Construction Costs	...	...
Total Compensation Outlays (millions of dollars)	-2.65 (.21)	...
Compensation Outlays Per Million Dollars of Capital Outlay	...	- 3,286.8 (2.16)
R^2	.80	.82

Note: Absolute value of the t-statistics are in parentheses. Ellipses denote that the variable did not enter the particular model.

Table 5

Miles of Federal-Aid Highway Completed
by State, 1972 (Thousands of Miles)

Variable	Model	
	I	II
Constant (thousands of miles)	204.471 (2.45)	214.3 (2.6)
Fuel Consumption (thousands of gallons)	23.7 (1.5)	5.77 (.59)
Stock of Highway Miles in Place Lagged One Year (thousands of miles)	.008 (4.7)	.010 (6.0)
Federal Subsidy	.409 (2.7)	.367 (2.6)
Index of Construction Costs	-215.5 (3.1)	-176.0 (2.7)
Total Compensation Outlays (millions of dollars)	- 52.8 (2.4)	...
Compensation Outlays Per Mile Completed	...	-1215.8 (3.5)
R^2	.65	.69

See note to Table 4.

specifications, the coefficient of the compensation variable is negative and in both cases is statistically significant. The coefficient of total compensation outlays implies a reduction in federal-aid miles completed roughly 53 miles per million dollars of compensation paid. At the mean of the sample, this translates into an elasticity of miles completed with respect to compensation of roughly -.02. In other words, a 100 percent increase in compensation would reduce the number of miles completed by 2 percent.

4. SUMMARY AND CONCLUSIONS

In Section 1 of this paper, we developed a simple model of bureau behavior which suggested that bureaus would respond to the introduction of more stringent compensation requirements by altering both the level and the composition of their output. We believe that the regression results presented in Section 3 provide empirical confirmation of the basic hypotheses in Section 1.

Specifically, we have provided evidence which strongly suggests that the presence of compensation requirements had a negative impact on the level of total federal-aid highway construction by state in 1972. Compensation requirements induced a shift in the geographical composition of federal-aid programs toward states in which compensation outlays were relatively low.

It appears that public agencies engaged in highway construction have responded to the introduction of requirements that displacees be compensated as if those requirements represented increases in the costs of their highway activities. Of course, many of the losses suffered by displacees, particularly those associated with higher housing costs, do not represent real

social costs, but rather redistributions of income between, say, tenants and landlords, or between homeowners along the right of way and the general public. Even though the existence of compensation payments may not have changed the real social costs of highway construction, but only their distributional impact, it nevertheless appears to have had an impact on real output decisions.

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