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THE IMPACT OF CAPITAL GRANTS ON MAINTENANCE IN THE LOCAL PUBLIC SECTOR

by Brian A. Cromwell

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Introduction

This paper examines whether state and federal grant policies induce local governments to substitute new investment for the maintenance of existing capital, resulting in excessive deterioration of public infrastructure. Using a new data set on the maintenance policies of local mass-transit providers, it shows that private owners of transit capital equipment devote significantly greater resources to maintenance than do public owners of similar capital. I measure the elasticity of maintenance with respect to capital subsidy rates using this public/private differential and using cross-state variation in capital subsidy policies. The results, which are corroborated in a companion analysis of scrappage in the public and private sectors, support the position that publicly owned capital deteriorates faster than similar private capital because of state and federal grant policies.

The condition of public infrastructure received much political and media attention in the early 1980s. This interest was sparked in part by Pat Choate and Susan Walter's book, America in Ruins, which gave striking examples of crumbling infrastructure, and by tragedies such as the 1983 collapse of the Interstate 95 bridge in Connecticut. Major studies by the Urban Institute and the Congressional Budget Office (1983) catalogued the existing state of public infrastructure and projected the need for new public investment.

Dilapidated infrastructure, however, does not necessarily point to government inefficiency. Equipment and structures have specified design lives, and crumbling capital could merely reflect the age of the existing capital stock. Leonard (1985), however, argues that federal grant policies, combined with budget rules and political pressures, induce local governments to systematically underfund maintenance. He identifies the resulting excessive deterioration of public infrastructure as the principal source of the recent "infrastructure crisis."

While the rate of depreciation of physical assets is assumed to be a constant technical parameter in most empirical studies of investment, a small body of literature argues that utilization and maintenance have important effects on the rate of capital deterioration. Drawing on this literature, and on models of bureaucratic behavior, this paper presents a model of maintenance and investment that more formally illustrates Leonard's arguments. While possible effects of bureaucratic behavior and political and budgetary pressures are briefly discussed, this paper focuses on the potentially large distortions that result from massive intergovernmental subsidies for capital purchases by local governments.

The impact of state and federal grant structure on the maintenance efforts of local governments is examined using data on the maintenance policies of both publicly and privately owned local mass-transit providers. The data were collected by the Urban Mass Transportation Administration (UMTA). Previous research into the maintenance efforts of local governments has been hampered by the lack of consist'ent measures of public capital and maintenance efforts. The UMTA data set, however, contains extensive information on vehicle fleets as well as expenditures and labor hours for vehicle maintenance. Furthermore, local transit-system heterogeneity provides useful natural experimental variation for comparing the maintenance policies of public versus private transit providers.

The results show that privately owned transit companies devote some 14 to 17 percent more labor hours to maintenance than do publicly owned and managed transit companies. This public/private differential, along with cross-state variation in grant policies, is used to measure the elasticity of maintenance with respect to capital subsidies. The point estimates suggest an elasticity of -0.16, meaning that a 10 percent increase in the subsidy rate for transit capital reduces vehicle maintenance by 1.6 percent. In a companion paper, Cromwell (1988), I examine the hazard rates for retirement and scrappage of public and private equipment and find evidence that federal capital grant policies lead to shorter equipment life in the local public sector.

The paper is organized as follows. Section I reviews previous studies of government efficiency and discusses the extension to analysis of depreciation and maintenance. Section II presents a model of public investment and maintenance that serves as a framework for the empirical analysis. Section III discusses the application of this analysis to the mass transit industry and discusses the data set used in the empirical work. Section IV presents empirical evidence concerning the maintenance policies of public versus private transit providers. Section V discusses variation in subsidy policies across states and presents an estimate of the elasticity of maintenance with respect to capital subsidies. Finally, Section VI presents conclusions and briefly discusses the scrappage results from the companion paper.

I. Public Sector Efficiency and Capital Maintenance

Public Sector Efficiency

Discussions of public good provision often assume that public bureaucrats are selfless persons who efficiently provide the level of goods desired by the public. The level of public goods demanded is assumed to be revealed through majority voting or some other political process. The public choice literature, however, holds that public officials and bureaucrats have objectives that diverge from maximizing public welfare. This literature explores whether government overproduces goods and services and whether government is cost-efficient in the level of services it does produce.

The overproduction debate stems from Niskanen's (1975) model of bureaucracy. Niskanen posits that a bureaucracy maximizes the level of service it provides (hence the size of its budget) subject to its production constraints and to the total amount of resources that its political superiors will provide. Since an agency negotiates with political leaders over a total budget as opposed to incremental units of service, and since the agency is often the sole provider of the service, it can use its monopoly power to establish a level of service greater than that desired by voters. Whether local governments adequately reflect the desires of the median voter, or whether the level of government services exceeds the wishes of the median voter as Niskanen's model predicts, remains controversial.[1]

While the service-maximizing model implies that bureaucrats minimize production costs per unit of service, work by Migue and Belanger (1974) and Orzechowski (1977) explicitly recognizes that bureaucrats desire higher wages, fringe benefits, and staff levels and will use their monopoly powers to obtain them. While these models imply that local government production is labor-intensive, De Allesi (1969) argues that budget-minded bureaus favor production methods that are capital-intensive, since these methods tend to concentrate a larger proportion of costs over a shorter time horizon. In either case, bureaucratic preference for capital or labor results in production decisions that are no longer cost-minimizing.

Empirical work usually compares public versus private provision of similar services and in general shows significant cost savings from privatization. Bennett and Johnson (1979) found a 32-percent saving in garbage collection costs in Fairfax, Virginia. Ahlbrandt (1973) documented a 50-percent saving in fire protection costs in Scottsdale, Arizona. Davies (1971) showed 13 percent lower costs in a privately operated airline in Australia compared with its public competitor. The technique of private versus public comparison is used in the empirical work that follows.

Capital Maintenance

This paper does not address the questions of whether government overproduces or is labor- or capital-intensive in production. Instead, I ask whether capital services used for production are provided in a cost-minimizing manner or, alternatively, whether government efficiently manages the stock of capital from which capital services flow.

Leonard (1985) argues that several institutional, political, and financial aspects of local governments may distort maintenance and capital procurement policies away from the cost-minimizing ones. First, capital budgeting procedures for local governments, if they exist, use inadequate measures of capital and depreciation. More important, maintenance is counted as an operating expense. Since the costs of deferred maintenance are not felt until later, Leonard argues that these budget procedures encourage public officials to underfund maintenance. This tendency is more pronounced when public officials and bureaucrats operate under short time horizons because of budgetary or political pressures. Finally, federal grant policies heavily subsidize the acquisition of new capital as opposed to maintenance of existing infrastructure, a policy that encourages local governments to neglect maintenance of current infrastructure in favor of purchasing new capital goods.

Bureaucrats may also derive utility from new investment. Weingast, et al. (1981) present a model of legislative behavior in which the geographic incidence of benefits and costs systematically biases public decisions toward larger-than-efficient projects. Capital projects give benefits directly to a small group, while their costs are widely distributed. Possible sources of utility from capital projects for public officials include kickbacks, political support, and contributions from direct project beneficiaries. Leonard (1985) emphasizes the political benefit that comes from being associated with large and visible investment projects, a "ribbon-cutting" effect. Such effects further encourage the substitution of investment for maintenance.

Treatment of Depreciation

In empirical investment studies, depreciation is commonly considered to take the form of "output decay," in which equipment productivity decreases at a constant exponential rate over time.[2] This assumption yields mathematical tractability and results in a constant replacement investment ratio. Feldstein and Rothschild (1974), however, argue that the conditions for a constant rate of depreciation are overly stringent and that shifts in tax policy change equipment life and scrappage rates, resulting in a nonconstant replacement-investment ratio. Feldstein's analysis of equipment life follows the standard treatment of Jorgenson, McCall, and Radnor (1967) in which the flow of capital services from a piece of equipment is assumed to be constant over time, but in which operating, maintenance, and reliability costs increase at a constant rate with equipment age. The optimization problem is to find the equipment life that minimizes the discounted stream of operating and replacement costs over time. Depreciation occurs in the form of "input decay," in which the input costs per unit of service increase with age while maintenance is just an operating expense, providing no future benefits.

An alternative approach assumes that depreciation takes the "output decay" form but depends on the level of maintenance and the rate of utilization. Maintenance retards the rate of decay of existing capital and increases the level of capital in future periods; it is therefore a type of investment. The decision-maker can preserve the existing stock of capital today or purchase new capital tomorrow. Depreciation is not a technical constant, but is determined through optimizing behavior. Nadiri and Rosen (1969) demonstrate the importance of the interaction between capital utilization and investment, while Bitros (1976) estimates the impact of maintenance on investment decisions. Schworm (1979) demonstrates how utilization and maintenance decisions are affected by tax policies. These studies argue that empirical analyses of investment that assume constant depreciation and replacement investment are misspecified. I use this approach to illustrate how public managers' maintenance decisions are potentially distorted, resulting in an inefficient rate of deterioration of capital assets.[3]

II. A Model of Investment and Maintenance

This section shows how state and federal grant policies potentially distort maintenance decisions from their optimal level. It begins with a simple input-choice model that addresses the question of how a firm or local government can efficiently provide a desired flow of capital services. The optimal maintenance level in this setting depends on relative prices and on the time preference rate. Capital grant policies, by altering the relative price of new capital, distort the maintenance decision.

Consider a local government that seeks to provide a desired flow of capital services k^*_t from $t = 1,...,\infty$ at minimum cost. The desired services k^*, are assumed proportional to a desired capital stock K^*_t. The cost of providing capital services in any period t is the sum of new investment and maintenance costs,

$$\text{(1)} \qquad \text{Cost}_t = q_t I_t + W^m_t M_t,$$

where q_t is the price of investment, I_t is investment, W^m_t is the price of maintenance, and M_t is maintenance.

The stock of capital in period t+l equals new investment plus the capital stock from period t left after depreciation.[4]

(2) $K_{t+1} = (1 - \delta_t)K_t + I_{t=1}$

The capital stock and investment in the initial period t=0 are assumed to be fixed at K_0 and $I_{,}$, respectively.

All capital depreciates at the same rate $6_{,}$. This rate, however, is affected by the level of maintenance per unit of capital and, as such, is not constant over time. Maintenance per unit of capital, m_t, reduces the rate of depreciation, but at a decreasing rate.

(3) $\delta_t = \delta\left(\frac{M_t}{K_t}\right), \quad \delta_m < 0, \quad \delta_{mm} > 0$

Assuming perfect certainty, the local government's problem is to minimize objective function (4) over a flow of maintenance and investment subject to $K_t = K^*_t$ and to conditions (2) and (3).

(4) $\text{Min} \sum_{t=0}^{\infty} \beta^t \left[W^m{}_t M_t + q_t I_t \right]$ where $\beta = \frac{1}{1+\theta}$

$M_t \quad t = 0,\ldots,\infty$

$I_t \quad t = 0,\ldots,\infty$

Future costs are discounted by a rate of time preference θ. For a surplus-maximizing community, this rate is its effective borrowing rate.

As discussed below, however, bureaucrats and public officials may discount future costs and benefits at a higher rate because of political or fiscal pressures. For private firms, θ is assumed to be the after-tax interest rate.[5]

The first-order conditions for this problem are

(5) M_t $\quad \beta_t W^m{}_t + \lambda_t \delta_m = 0$ and

$t = 0,\ldots,\infty$

(6) I_{t+1} $\quad \beta_{t+1} q_{t+1} - \lambda_t = 0.$

$t = 0,\ldots,\infty$

The first-order condition for M_t and I_{t+1} can be solved to illustrate the trade-off between maintenance of existing capital (this period) and investment in new capital (next period). The ratio of the prices equals the ratio at which maintenance in period t and investment in period t+1 create capital in period t+1.

(7)
$$\frac{W^m{}_t}{\beta q_{t+1}} = \frac{\dfrac{\partial K_{t+1}}{\partial M_t}}{\dfrac{\partial K_{t+1}}{\partial I_{t+1}}}$$

This equation can be solved for the optimal maintenance level as a function of the price of maintenance, the price of new investment, and the discount rate.

$$(8) \qquad M^*_t = M(W^m_t,\ q_{t+1},\ \theta)$$

Standard comparative static analysis of (7) yields

$$\frac{dM^*_t}{dW^m_t} = -\frac{\Omega_t}{\beta} < 0,$$

$$\frac{dM^*_t}{dq_{t+1}} = \frac{W^m_t \Omega_t}{\beta q_{t+1}} > 0,$$

and

$$\frac{dM^*_t}{d\theta} = -W^m_t \Omega_t < 0,$$

where

$$\Omega_t = \frac{K_t}{\delta_{mm} q_{t+1}} > 0 .$$

Maintenance is decreasing in the price of maintenance, increasing in the price of new investment, and decreasing in the discount rate.

These results can be used to predict relative maintenance levels for two types of service providers: a profit-maximizing firm and a community-surplus-maximizing local government. Table 1 outlines differences between these two models in discount rates, investment prices, and maintenance wages.

Table 1
Private Versus Local Public Sector:
Discount Rates, Investment Prices, and Maintenance Wages

	PRIVATE SECTOR	LOCAL PUBLIC SECTOR
Discount Rate	$(1 - \tau)r$	r_m
Effective Investment Price	$(1 - c - \tau z)q$	$(1 - G^c{}_f - G^c{}_s)q$
Effective Maintenance Wage	$(1 - \tau)W^m$	$(1 - G^o{}_f - G^o{}_s)W^m$

Source: author's calculations.

Since profit-maximizing firms can deduct interest payments from taxable income, their effective discount rate is the after-tax interest rate $(1 - \tau)r$. The discount rate for a surplus-maximizing local government would be its effective municipal borrowing rate r_m. There are good reasons to suspect, however, that the rate at which public decision-makers discount future costs and benefits exceeds r_m. Cohen and Noll (1984) demonstrate that legislators maximizing the probability of reelection seek to defer costs. Furthermore, local budget procedures often ignore future costs and benefits.

Leonard (1985) argues that capital budgets, if they exist, use inadequate measures of capital and depreciation while officials are often legally constrained to meet balanced operating budgets year to year. This discounting of future costs is enhanced in times of fiscal pressures. Section IV examines differences in maintenance outcomes due to such effects by comparing transit systems run by city governments with those operated by independent authorities or managed by private consultants.

The effective price of investment for a private firm is the investment price q minus the present value of any investment tax credit and deductions for depreciation, $(1 - c - \tau z)q$, where c is the investment tax credit and τz is the per-dollar present value of depreciation deductions. Local governments, on the other hand, often receive substantial matching federal subsidies for new capital goods. In mass transit, for example, the federal government pays up to 80 percent of the cost of new investment. Furthermore, many states also subsidize the local share.

My survey of state policies identified five states that pay the entire remaining 20 percent, resulting in an effective capital price of zero.[6] Ten other states also contributed between 10 and 20 percent subsidies for transit capital. The effective price of new capital for a surplus-maximizing local government is thus $(1 - G^c_f - G^c_s)q$, where G^c_f and G^c_s are the matching federal and state grant rates for capital expenses, respectively. The price of maintenance faced by local governments in most cases is the nominal price W^m_t. In certain instances, however, local governments are subsidized at the margin for operating expenses and the effective price of maintenance is $(1 - G^o_f - G^o_s)W^m_t$, where G^o_f and G^o_s are the marginal subsidies for operating expenses from the federal and state governments, respectively. Since firms can deduct maintenance expenses from taxable income, the effective maintenance price for the private sector is $(1 - \tau)W^m_t$.

If the present value of the investment tax credit and depreciation deductions equals the value of being able to write off investment immediately -- that is, if $(1-\tau) = (1 - c - \tau z)$ -- the ratio of prices facing the private firm is undistorted. Similarly, for the public sector, if the marginal subsidy for operating expenses equals the marginal subsidy for capital -- that is, if $(1 - G^c_f - G^c_s) = (1 - G^o_f - G^o_s)$ -- relative prices are undistorted. Massive subsidies for capital in the local public sector, however, imply a large distortion in relative prices and suggest that their maintenance efforts will be lower than in the private sector.

Judgments about the relative efficiency of these providers depend on assumptions as to the appropriate social discount rate and about the relative strengths of the distortions mentioned above. If one assumes, however, that the distortions faced by a private firm between maintenance and investment are small compared to those in the public sector and that the after-tax interest rate is a reasonable approximation of the social discount rate, then maintenance efforts of private firms represent a natural benchmark with which to evaluate the maintenance policies of local governments.

III. Depreciation Comparison for Local Mass Transit

The local mass-transit industry is the focus of the empirical analysis for several reasons. First, the production processes of transit providers are relatively homogeneous and their inputs (labor hours and vehicle miles) are measurable, facilitating comparisons of cost-efficiency across transit providers. Second, the flow of transit capital services, assumed here to be annual vehicle miles, is also relatively homogeneous and easily measured. Combined with data on expenses and labor hours for maintenance, this permits comparison of maintenance per unit of capital.

Finally, transit service is provided by a heterogeneous set of institutions--including city governments, regional authorities, public agencies managed by private concerns, and wholly private operators. These providers receive revenues from a wide variety of sources, including fares, federal operating assistance, state and federal capital grants, local general revenues, and local dedicated taxes. This heterogeneity enables me to control for variations in operating conditions and to measure the impact of subsidies and institutional settings on maintenance policies.

Data

The data source for this work is the Section 15 Reporting System administered by the Urban Mass Transportation Administration (UMTA). Section 15 of the Urban Mass Transportation Act (UMT Act) establishes a uniform accounting system for public mass-transportation finances and operations. All applicants and direct beneficiaries of federal assistance under Section 9 of the UMT Act are subject to this system and are required to file annual reports with UMTA.[7]

Section 15 data for fiscal year (FY) 1979 through FY 1984 are available for some 435 transit systems and include detailed information on revenue sources, expenses, employees, and hours and miles of service provided.[8] These data provide an unprecedented view of a cross-section of local government entities that perform similar activities. The revenue data are broken into revenues from both transit operations and public subsidies, including information on federal, state, and local contributions for operations and capital procurement. Dedicated state and local revenues are identified.

The expense data are broken down into wages, fringe benefits, materials, and services for the areas of administration, operations, and maintenance. Data on labor hours for types of employees are provided as well. Using the expense and employee data, average salary rates can be constructed for the different types of employees. Vehicle inventories for each system are broken down by model, year of manufacture, and mileage, providing an unusually detailed cross-section of data on publicly owned physical assets. Finally, operating statistics include data on passengers, vehicle miles, and vehicle hours. The detailed data on maintenance employee hours, maintenance expenses, vehicle miles, and vehicle inventories are of particular interest for this work.

Federal Transit Policies

The federal government plays an important role in financing the local public mass-transportation industry. The largest component of federal transit aid is the Section 3 discretionary grant program, which provides up to 75 percent of approved capital expenditures by local transit authorities. A majority of these grants go to large transit systems with rail systems for major construction projects and expansions. The principal federal grant program for properties that operate only bus lines, however, is the Section 9 formula grant program, which distributes funds to urbanized areas for use in transit operating and capital expenditures.

Because UMTA seeks to wean local properties away from operating assistance, the Surface Transportation Act of 1982 capped the level of funds available for operating assistance for FY 1983 and beyond to some 90 percent of the FY 1982 level, or to 50 percent of a property's operating deficit, whichever was lower. The overwhelming majority of public transit properties are constrained by the cap and receive no operating assistance on the margin. The Section 9 capital funds are principally used for vehicle replacement and pay up to 80 percent of the cost of a new vehicle.

Federal control over maintenance principally consists of setting an upper limit for deterioration of federally purchased equipment. UMTA requires local transit properties to operate buses purchased with federal funds for at least 12 years or 500,000 miles.[9] Failure to do so results in a penalty in federal assistance for new capital purchases. This 12-year limit, however, is below the potential operating life of 15 to 20 years for standard bus models. UMTA also requires that the number of spare vehicles available at periods of maximum service be no higher than 20 percent, thus putting an upper limit on the fleet size. This guideline, however, is not as rigorously enforced as the 12-year vehicle life guideline.[10]

My discussions with .transit professionals have yielded ample anecdotal evidence that, in spite of UMTA regulations, inadequate maintenance can lead to rapid depreciation of bus equipment. In St. Louis, the Bi-State Transportation Agency attempted to trade in a set of AM General buses after nine years claiming that they were "lemons." UMTA disagreed and forced Bi-State to make needed repairs to keep them operating or to buy out the UMTA share. In 1983 the New York Metropolitan Transit Authority convinced UMTA that the recurring problems with their recently purchased Grumman advanced-design buses were due to the manufacturer's design. New York was allowed to replace these buses with federal assistance. The Grummans, however, were resold to some smaller transit agencies such as Pioneer Valley Transit in Springfield, MA, who report having no problems with them.

These anecdotes suggest that maintenance practices can lead to rapid deterioration of equipment in the public sector. It is important, however, to distinguish between variations in maintenance and depreciation attributable to unavoidable operating conditions, and variations due to capital grant policies or bureaucratic behavior that are potential sources

of government inefficiency. The empirical work that follows attempts to identify these separate effects.

IV. Public Versus Private Maintenance Efforts

The variation in institutional settings for transit providers allows for natural experiments on vehicle maintenance policies. In my first set of tests, I examine the impact of three distinct types of providers: transit systems run by city governments, transit systems managed by private management companies, and wholly private transit companies. The control group of transit systems are those run by independent transit districts or regional authorities.

Transit systems managed by city governments are of interest, because their immediate superiors are elected officials and because they compete with other city services for the same revenues. They may have higher rates of time-preference and are perhaps subject to a greater "ribbon-cutting" effect than the control group. This suggests that maintenance efforts will be lower for city providers.[11]

Transit systemsmanaged by private consultants provide a second natural test of the model. These consultants, such as American Transit Enterprises (ATE) of Cincinnati, Ohio, provide top management and technical and professional backup service to public transit systems for a fixed fee. While decisions on the level of service are made by the public superiors, operation and maintenance decisions are made by the managers under standard company policies which they claim reflect professionally accepted practices. Discussions with ATE suggest that this results in greater planning and reduced political pressure. Because manager promotion is based on professional considerations, decision-makers are less likely to be subject to political pressures than the control group. While ATE may not be able to systematically disregard its client's wishes, ATE has a reputation for good maintenance; thus, a public property's selection of ATE could signal tastes for a professionally run and well-maintained system. Furthermore, the use of a private management firm allows public officials to avoid responsibility for adverse maintenance outcomes by claiming that their hands are tied.

Finally, the maintenance policies of privately owned transit systems are of interest as a natural benchmark to evaluate the policies of public properties for reasons discussed in section II. Public transit properties receive enormous capital subsidies on the margin, while marginal operating subsidies are uncommon. The model therefore predicts that private maintenance efforts will exceed those of public systems.

My initial empirical work examines a cross-section of Section 15 data for FY 1984 from 122 transit properties. The sample consists of single-mode bus operators -- properties that provide only fixed-route bus service as opposed to rail or demand-response service -- that operated at least five revenue vehicles. Included in this sample are 27 properties operated by city governments, 18 properties managed by ATE, and 22 privately owned properties. These private properties consist of 12 in the New York metropolitan area with the rest scattered across the country.[12]

Their inclusion in the Section 15 data results from contracting with a public recipient of Section 9 funds to provide transit services. As these contracts often provide for the leasing of public vehicles, care is taken in the following analysis to distinguish between mileage on leased vehicles versus those owned by the private operators.

Table 2 reports sample means for maintenance expenses and maintenance employees, scaled by annual vehicle miles. In general, the average levels of both expenses and labor hours follow the predicted patterns. The private systems on average spend 45 percent more on maintenance per mile and devote 29 percent more labor hours to maintenance than do the public systems. Within the public sector, city governments spend 8 percent less than transit authorities, while ATE-managed properties spend 9 percent more. The pattern for labor hours is slightly different, with city governments devoting 5 percent more than average and ATE-managed properties devoting 7 percent more.

The means shown in table 2, while consistent with the predicted results regarding the private and ATE-managed operators, do not control for systematic differences due to wages, operating conditions, and fleet composition. In particular, the average age of vehicles in private systems is substantially higher than that for public fleets, with 38.4 percent of the private fleets being more than 12 years old compared to 22.0 percent of the public fleets. The distribution of vehicles weighted by miles is similar, with 26.7 and 11.2 percent of the mileage being run on vehicles

Table 2
Vehicle Maintenance Expenses and Labor Hours*

	PRIVATE	PUBLIC Public Total	City Owned	Transit Auth.	ATE-Managed
Expenses per mile ($1.00)	0.77 (0.12)	0.53 (0.02)	0.49 (0.03)	0.53 (0.03)	0.58 (0.04)
Labor hours per 1,000 miles	37.8 (3.6)	29.3 (1.4)	30.9 (3.3)	27.9 (1.6)	31.4 (1.7)
Labor hours per 1,000 miles (Adjusted)	38.9 (3.7)	30.8 (1.4)	33.4 (3.3)	28.9 (1.6)	33.4 (2.0)
Percent expense contracted out	2.8 (1.1)	4.6 (0.7)	6.9 (1.9)	3.8 (0.7)	4.8 (1.9)
Percent expense for labor	67.8 (3.5)	63.2 (1.6)	60.5 (2.7)	64.1 (2.4)	66.0 (2.7)
Percent of fleet > 12 years old	38.4	22.0	15.9	25.4	12.9
Percent mileage on vehicles > 12 years old	26.7	11.2	8.9	12.8	4.7
NOTE: Number of Observations	22	100	27	55	18

* 1984 cross-section sample means (standard errors).

Source: author's calculations.

older than 12 years for the private and public systems, respectively. The older fleet in the private systems is consistent with privately owned capital deteriorating slower than publicly owned capital as a result of greater maintenance efforts. It is also consistent with the view, however, that increased maintenance efforts by the private systems merely reflect the fact that they operate older fleets. In the empirical analysis that follows, I attempt to control for the age composition of the vehicle fleet.

For regression analysis, I increased the sample size to 387 observations by pooling the 1984 cross-section with 1983 and 1982 cross-sections of 125 and 140 properties, respectively. Only 76 properties appeared in all three cross-sections. The turnover resulted from properties that added demand-response vehicles to their service, and thus dropped out of the single-mode sample, as well as turnover in properties appearing in the Section 15 data. To control for the effects of wages, operating conditions, and fleet composition on maintenance, I estimate a log-linear approximation of (8) scaled by capital services using ordinary least squares regression (OLS).

$$(9) \quad LNMAINT = B_0 + B_1 LNSIZE + B_2 LNWAGE + B_3 CITY + B_4 ATE + B_5 PRIVATE + B_6 NY + \sum B_i X_i + e$$

The log of maintenance labor hours per 1,000 vehicle miles, LNMAINT, is regressed on the log of size, the log of wage, dummy variables for type of provider, and a set of variables X_i that control for technical and operating conditions and fleet composition. The reported OLS standard errors are corrected for correlation of errors across time periods using a covariance matrix constructed from the residuals of the cross-section OLS regressions. While the OLS results for the cross-sections are not reported here in full, they yield results substantively identical to the pooled regressions, though with higher standard errors.

A unique feature of this data set is its inclusion of a direct measure of maintenance effort: vehicle maintenance labor hours. This allows analysis of actual maintenance conducted as opposed to expenditures which are affected by variations in local price levels. Many transit systems, however, contract out for a portion of their maintenance. To control for this, I gross up the labor hours by the percent of maintenance expenses contracted out, making the assumption that the labor component of contracted maintenance equals that done in-house. Use of the adjusted measure, shown in table 2, does not affect the analysis.

A more significant potential problem with the use of the labor hours measure is the implicit assumption that total maintenance effort is in fixed proportion to labor hours. As shown in table 2, labor expenses, on average, account for some 60 to 68 percent of total maintenance expenses for various types of providers, with public transit authorities devoting 64.1 percent of maintenance expenses for labor as opposed to 66.0 percent for ATE-managed systems and 67.8 percent for private systems. While this suggests little variation in the composition of maintenance efforts across types of properties, it should be noted that the standard deviations of maintenance composition are large, suggesting either reporting difficulties or some substitution between labor and capital in maintenance efforts. At present, however, I have no indication that such difficulties bias a comparison of maintenance efforts between types of providers and believe that the benefits of directly measuring the major maintenance input outweigh any disadvantages.

Table 3 reports the means and standard deviations of independent variables used to control for wages, operating conditions, and fleet composition(1984 cross-section values only). For a measure of wages, I use the average hourly salary and fringe benefits paid to maintenance employees (WAGE).[13] While I do not have measures of equipment prices q, measures of discount rates θ, or preferences for new investment, I assume that the means of these variables shift only with respect to type of provider. I therefore employ dummy variables for city government (CITY), the ATE managed properties (ATE) and the privately owned properties (PRIVATE) to pick up these effects. Since more than half of the private observations come from the New York metropolitan region, a dummy variable (NY) is included to pick up any fixed effect associated with this area.

The variables measuring technical and operating conditions include systemwide annual mileage (SIZE), average speed (SPEED), the percentage of

Table 3
Operating Conditions, Wages, and Fleet Composition*

VARIABLE	DESCRIPTION	PRIVATE	PUBLIC
SIZE	Total annual mileage, 1,000	2,392 (2,187)	3,501 (10,217)
WAGE	Hourly wage and fringe, $	12.57 (4.91)	11.75 (3.86)
SPEED	Average speed, MPH	14.8 (6.6)	13.6 (2.0)
SPARES	% spare vehicles during peak operation	19.4 (11.8)	29.7 (12.6)
MILES	Average annual miles per vehicle	35.2 (14.6)	37.5 (8.6)
AGE	Average vehicle age, weighted by annual mileage	6.8 (3.6)	5.5 (2.3)
LEASED	% of miles on leased vehicles	32.4 (40.9)	14.4 (34.1)
CRASH	Collisions per 1,000 miles	0.049 (0.031)	0.038 (0.022)
DENSITY	Population density	4,173.0 (1,632.0)	2,559.7 (1,140.8)
CRIME	Property crimes per 1,000 persons	13.3 (17.6)	13.6 (16.4)
GMC84	% of miles on GMC buses, 1977-1984 models	20.5 (29.6)	19.3 (31.5)
GMC76	% of miles on GMC buses, 1971-1976 models	16.1 (16.8)	16.4 (27.6)
GMC70	% of miles on GMC buses, pre-1971 models	14.8 (14.6)	4.8 (9.4)
CRUISER	% of miles on MCI buses, intercity-type bus model	4.3 (12.3)	0.0 (0.2)
AMGENERAL	% of miles on American Motors mid-1970s bus model	0.0 (0.0)	3.5 (12.6)

Table 3 (cont.)
Operating Conditions, Wages, and Fleet Composition*

VARIABLE	DESCRIPTION	PRIVATE	PUBLIC
SMALL	% of miles on vehicles seating under 25	7.1 (23.4)	6.2 (20.7)
MIDSIZE	% of miles on vehicles seating 25-35	12.2 (31.1)	26.6 (41.7)

* 1984 cross-section sample means (standard deviations).

Source: author's calculations.

spare vehicles at the time of peak operation (SPARES), and average annual miles per vehicle (MILES). The percentage of miles run on leased vehicles' (LEASED) is included since private firms, and some public properties, often lease vehicles from public agencies. The rate of vehicle collisions (CRASH), population density (DENSITY), and property crime rate (CRIME) are included to measure congestion and hazardous operating conditions.

While the above variables can be thought of as exogenous to the maintenance decision, a set of potentially endogenous variables measuring fleet composition was also constructed. The most important of these variables is the average age of the vehicle fleet weighted by annual mileage (AGE). This measures the age of the capital stock in use. Measures of the manufacturer, vintage, and type of vehicle are included to control for variation in the type and quality of equipment.

While age and vintage of equipment affect the level of subsistence maintenance needed to keep the equipment running, good preventive maintenance over time permits the operation of an older fleet. Variables measuring age of equipment are therefore potentially endogenous and could bias regression estimates. The standard econometric solution for this problem is to instrument for the potentially endogenous variable with variables correlated with this variable, but uncorrelated with the error term. Unfortunately, I am aware of no obvious valid instruments and instead report both reduced-form regressions excluding the fleet composition variables, and larger regressions containing these potentially endogenous variables. Results for the larger regressions should be interpreted with caution due to the potential bias.

Table 4 reports four regression equations. Regression (1) is a reduced-form specification containing the set of operating variables but excluding the New York (NY) dummy variable and the age and fleet composition variables. The estimated coefficient for PRIVATE, 0.237, has a standard error of 0.064. It is highly significant, suggesting that private operators conduct substantially more maintenance. Inclusion of the NY dummy variable in (2), however, reduces the estimated coefficient of PRIVATE to 0.165 with a standard error of 0.076. This still represents a 17 percent higher level of maintenance for privately owned systems than for public systems. The estimated coefficients (standard errors) for the 1982, 1983, and 1984 cross-section regressions are 0.138 (0.905), 0.220 (0.108), and 0.151 (0.118), respectively.

The large positive coefficient of NY can be interpreted in part to reflect the extreme operating conditions in the New York City area caused by heavy congestion and poor roads. Because half of the observations for private operators occur in the New York area, it is not surprising that the NY dummy variable substantially reduces the private coefficient.

The estimated coefficient for the ATE dummy is positive and significant in both (1) and (2), indicating that ATE-managed properties

Table 4
Ordinary Least Squares Regression, 1982-1984 Pooled Cross-Section*

	(1)	(2)	(3)	(4)
Constant	5.200 (0.579)	5.441 (0.592)	5.397 (0.594)	5.187 (0.577)
LNSIZE	0.141 (0.021)	0.140 (0.021)	0.138 (0.021)	0.139 (0.021)
LNWAGE	-0.441 (0.060)	-0.454 (0.060)	-0.456 (0.059)	-0.435 (0.057)
CITY (Dummy Var.)	0.023 (0.056)	0.011 (0.056)	0.010 (0.055)	-0.007 (0.052)
ATE (Dummy Var.)	0.120 (0.063)	0.117 (0.062)	0.118 (0.061)	0.137 (0.058)
PRIVATE (Dummy Var.)	0.237 (0.064)	0.165 (0.076)	0.168 (0.076)	0.141 (0.075)
NY (Dummy Var.)	--- ---	0.175 (0.103)	0.175 (0.102)	0.178 (0.097)
LEASED	0.0003 (0.0006)	0.0006 (0.0006)	0.0006 (0.0006)	0.0004 (0.0006)
LNSPEED	-0.663 (0.096)	-0.636 (0.095)	-0.631 (0.095)	-0.691 (0.091)
SPARES	0.0035 (0.0014)	0.0037 (0.0014)	0.0038 (0.0014)	0.0045 (0.0014)
LNMILES	-0.247 (0.062)	-0.239 (0.061)	-0.237 (0.060)	-0.222 (0.058)
CRASH	0.966 (0.889)	0.905 (0.876)	0.954 (0.864)	0.688 (0.824)
LNDENSE	0.077 (0.057)	0.033 (0.062)	0.034 (0.062)	0.066 (0.060)
LNCRIME	-0.0100 (0.0540)	0.0005 (0.0538)	0.0004 (0.0531)	0.0042 (0.0522)
AGE			0.0100 (0.0166)	-0.0223 (0.0202)

Table 4 (cont.)
Ordinary Least Squares Regression,
1982-1984 Pooled Cross-Section*

	(1)	(2)	(3)	(4)
AGE*AGE	---	---	-0.0006	0.0018
	---	---	(0.0009)	(0.0012)
GMC84	---	---	---	0.0010
	---	---	---	(0.0007)
GMC76	---	---	---	0.0011
	---	---	---	(0.0008)
GMC70	---	---	---	-0.0004
	---	---	---	(0.0002)
CRUISER	---	---	---	0.0073
	---	---	---	(0.0026)
AMGENERAL	---	---	---	0.0020
	---	---	---	(0.0013)
COMPACT	---	---	---	-0.0014
	---	---	---	(0.0009)
MIDSIZE	---	---	---	0.0013
	---	---	---	(0.0006)
Number of Obs.	387	387	387	387
Deg. of Freedom	374	373	371	364
Sum of Sq. Res.	40.609	40.139	40.089	37.656
R-Squared	0.430	0.436	0.437	0.471

NOTE: Dependent variable = log of maint. hours per 1,000 miles.
Mean of dependent variable = 3.400 .

* OLS standard errors corrected for correlation of errors across periods.

Source: author's calculations.

conduct some 12 percent more maintenance than other public systems. This result holds in all of the regressions that follow. The sign of the CITY dummy, however, is positive and insignificant, in contrast to the prediction of the model. The estimated elasticity of maintenance labor hours with respect to the maintenance wage ranges from -0.44 to -0.46 in the regression results and is significant in all cases.

Other variables in (1) and (2) include LEASED, to control for leased equipment, and CRASH, LNDENSE, and CRIME to control for adverse conditions associated with operation in the New York area. The coefficient for LEASED is positive but insignificant. The operating condition variables have the expected positive signs in most cases but are insignificant.

Variables controlling for system characteristics appear to be important determinants of maintenance efforts. Maintenance is increasing with the size of operation, with an estimated elasticity of 0.141, suggesting diseconomies of scale in that a doubling of size raises maintenance hours 14 percent. Maintenance decreases with the average speed of operation, possibly due to less wear and tear of highway miles versus stop-and-go operation in congested areas. Finally, two variables measuring equipment utilization, SPARES and LNMILES, enter with positive and negative estimated coefficients, respectively. All of the estimated coefficients for these variables are statistically significant.

Regression (3) controls for the age-distribution of the fleet entering AGE and AGE-squared to account for any nonlinearities associated with maintenance of aging equipment. The estimated coefficients for these variables are of opposite sign, suggesting an age-maintenance profile in which maintenance efforts first increase, then decrease with the age of equipment, but are insignificant. The coefficient for PRIVATE rises slightly to 0.168 and remains statistically significant.

Regression (4) includes the fleet composition variables discussed previously. GMC84 accounts for the percentage of miles run on the advanced-design buses manufactured between 1977-1984, while GMC76 and GMC70 control for the workhorse new-look buses manufactured between 1971-1976 and pre-1970, respectively. The coefficients for GMC84 and GMC76 enter with positive but statistically insignificant coefficients, while the GMC70 coefficient enters with a negative and statistically significant coefficient of -0.0004, suggesting that buses of this vintage on average require some 4 percent less maintenance. The composition variables also control for mileage on small (COMPACT) and midsized vehicles (MIDSIZE) as well as mileage on intercity-type buses (CRUISER) and a mid-1970s model manufactured by American Motors (AMGENERAL) that is reported to have had significant maintenance problems. The coefficients for MIDSIZE and CRUISER are positive and significant, suggesting that controlling for operating conditions, these type of vehicles require greater levels of maintenance. The coefficient on AMGENERAL is estimated at 0.0020 with a t-statistic of 1.56, suggesting that these vehicles require 20 percent more maintenance on average. Finally, the results suggest that COMPACT vehicles require less maintenance than average.

Inclusion of the fleet composition variables results in a flipping of the signs for AGE and AGE-squared, suggesting an age profile in which maintenance first decreases, then increases with age. These results are consistent with reported experience in the transit industry. The coefficient for PRIVATE in regression (4) declines to 0.141 with a t-statistic of 1.88.

The results of these regressions suggest that private owners of transit capital devote some 14 to 17 percent greater resources to maintenance than do public owners of similar equipment. This result survives controlling for wages and operating conditions as well as the age distribution and composition of the fleet, suggesting that private maintenance efforts exceed the subsistence level needed to keep the fleet in operation.

V. Cross-State Variation in Capital Subsidy Policies

While the analysis in section IV suggests that an important differential exists between the maintenance efforts of private versus public owners of capital, the zero/one nature of the experiment does not provide enough variation to estimate the impact of grant policies with any degree of confidence. Models of bureaucratic behavior or political pressures could also explain the public/private differential. To identify the price effects of capital subsidies, therefore, I will use variations in grant policies across states.

The federal Section 9 grant program subsidizes new capital purchases by public mass-transit providers at a rate of 80 percent. This rate is constant across properties and effectively is a marginal subsidy for all public vehicle purchases. Certain states, however, contribute up to 100 percent of the local share, that is, the 20 percent not paid for with federal funds. To identify those states which contributed capital funds at the margin, I conducted a telephone survey of Departments of Transportation (DOTs) in the 29 states represented in the sample. The information received was cross-checked with a survey conducted by the American Association of State Highway and Transportation Officials (1986). Table 5 presents survey results that categorize states by size of capital subsidy. Half of the state DOTs contacted report that they provide no direct subsidy for capital, while seven states subsidize capital at a rate of 10 percent, or half of the local share, two states subsidize capital at a rate between

Table 5
State Capital Subsidy Policies

ZERO SUBSIDY	10 PERCENT SUBSIDY	10 - 20 PERCENT SUBSIDY	20 PERCENT SUBSIDY
Arkansas	Florida	Pennsylvania	Alaska
Colorado	Georgia	Virginia	Connecticut
Delaware	Maine		Illinois
Indiana	Nevada		Michigan
Louisiana	North Carolina		New York
Mississippi	Ohio		
Missouri	Tennessee		
Rhode Island			
Texas			
Washington			
Wisconsin			
South Dakota			
California			
Montana			
Arizona			

Source: telephone survey by author.

10 and 20 percent, and five states pick up the full local share, subsidizing new capital purchases at a rate of 20 percent.

Through this survey I also identified a few instances where operating expenditures are subsidized on the margin. While most states give transit operating subsidies on the basis of a formula unrelated to expenses or deficit, Wisconsin, Pennsylvania, Connecticut, and Illinois (for downstate communities) cover a significant share of operating expenses at the margin. Furthermore, small transit systems in North Carolina and Georgia are subsidized on the margin by 50 percent through the Section 9 federal funds controlled by the state governor.

To conduct empirical analysis, I constructed a capital subsidy variable CAPSUB that equals the relative subsidy for capital faced by the local government.

$$\text{CAPSUB} = \frac{\left(1 - G^{c}{}_{f} - G^{c}{}_{s}\right)}{\left(1 - G^{o}{}_{f} - G^{o}{}_{s}\right)} \tag{10}$$

For a local transit system receiving a 20 percent subsidy from the state as well as a 80 percent subsidy from the federal government, the effective price of capital is zero. The controlling factor in purchasing new capital in such cases are UMTA regulations regarding fleet size and minimum vehicle life. Public properties are permitted a spare vehicle ratio of only 20 percent at times of peak operation and are required to make buses last at least 12 years.

To construct CAPSUB for private operators requires an estimate of the after-tax price of capital. This can be defined as the price of investment minus any investment tax credit or gains from depreciation. CAPSUB for a private firm thus equals $(1 - c - \tau z)/(1 - \tau)$. For this estimate I used a value of 0.10 for the investment tax credit c, calculated the per-dollar present value of depreciation allowances τz for buses as 0.41 using the ACRS tax rules, and used the corporate tax rate of 0.46 for τ.

Table 6 reports results from the pooled reduced-form maintenance regressions that exclude the age and fleet composition variables but include CAPSUB. In regression (1), which excludes both the PRIVATE and NY dummy variables, the estimated coefficient for CAPSUB is 0.251 with a standard error of 0.114. When the NY variable is included, the CAPSUB variable is estimated at 0.158 with a standard error of 0.088. This estimate suggests that a 100 percent subsidization of capital purchase results in a 16 percent reduction in vehicle maintenance. This is the best estimate available, because when the PRIVATE dummy variable is entered in (3), the CAPSUB variable no longer has the power to distinguish a price effect. The estimated coefficients of PRIVATE, NY, and CAPSUB are all

Table 6

Ordinary Least Squares Regression with Capital Subsidy Variable, 1982-1984 Pooled Cross-Section*

	(1)	(2)	(3)
Constant	5.106	5.428	5.457
	(0.585)	(0.596)	(0.588)
LNSIZE	0.138	0.138	0.142
	(0.022)	(0.021)	(0.021)
LNWAGE	-0.439	-0.455	-0.456
	(0.061)	(0.060)	(0.060)
CITY	0.011	0.0003	0.020
(Dummy Var.)	(0.057)	(0.0554)	(0.056)
ATE	0.116	0.113	0.114
(Dummy Var.)	(0.064)	(0.062)	(0.061)
PRIVATE	---	---	0.384
(Dummy Var.)	---	---	(0.251)
NY	---	0.210	0.158
(Dummy Var.)	---	(0.100)	(0.103)
CAPSUB	0.251	0.158	-0.263
	(0.114)	(0.088)	(0.289)
LEASED	0.0006	0.0008	0.0003
	(0.0006)	(0.0006)	(0.0007)
LNSPEED	-0.660	-0.628	-0.635
	(0.098)	(0.096)	(0.095)
SPARES	0.0034	0.0037	0.0036
	(0.0015)	(0.0014)	(0.0014)
LNMILES	-0.247	-0.238	-0.243
	(0.062)	(0.061)	(0.060)
CRASH	1.110	0.985	0.838
	(0.900)	(0.881)	(0.871)
LNDENSE	0.090	0.032	0.033
	(0.057)	(0.063)	(0.062)
LNCRIME	-0.017	-0.002	0.007
	(0.055)	(0.054)	(0.054)

Table 6 (cont.)
Ordinary Least Squares Regression with Capital Subsidy Variable, 1982-1984 Pooled Cross-Section*

	(1)	(2)	(3)
Number of Obs.	387	387	387
Deg. of Freedom	374	373	372
Sum of Sq. Res.	41.110	40.371	40.010
R-Squared	0.422	0.433	0.438

NOTE: Dependent variable = log of maint. hours per 1,000 miles.
Mean of dependent variable = 3.400 .

* OLS standard errors corrected for correlation of errors across periods.

Source: author's calculations.

insignificant with the sign of CAPSUB reversing. It appears, however, that the PRIVATE variable dominates the CAPSUB variable when both are placed in the regression equation. Since the estimated coefficient of CAPSUB is insignificant in the unrestricted regression (3), the hypothesis that the correct regression specification excludes CAPSUB cannot be rejected. The t-statistic of the PRIVATE variable in (3), however, is 1.53, and the hypothesis that the correct regression specification excludes PRIVATE can be rejected at the 80 percent confidence level, though not at the 95 percent level. This suggests that there are influences other than price effects that lead private operators to devote higher levels of maintenance than public operators and supports the view that bureaucratic and political factors reduce maintenance efforts in the public sector.

VI. Conclusion

This paper examines whether state and federal grant policies induce local governments to substitute new investment for the maintenance of existing capital. An empirical analysis of the maintenance practices of local mass-transit providers shows that privately owned transit companies devote some 14 to 17 percent more labor hours to maintenance than do publicly owned and managed transit companies. This result is robust under several specifications controlling for wages, operating conditions, system characteristics, and fleet composition.

Noting that the federal government subsidizes new transit capital purchases in the public sector at a matching rate of 80 percent, the private/public differential and cross-state variation in grant policies are used to measure the elasticity of maintenance with respect to capital subsidies. The point estimates suggest an elasticity of -0.16, that is, a 10 percent increase in the subsidy rate for transit capital reduces vehicle maintenance by 1.6 percent. The results are unable to distinguish, however, between a price effect from capital subsidies versus a fixed effect associated with private operation. Non-nested hypothesis tests suggest that the fixed effect dominates and that influences other than price effects lead private operators to devote higher levels of maintenance than public operators. This supports the view that bureaucratic and political factors reduce maintenance efforts in the public sector.

While the results in this paper establish that private owners of transit capital devote significantly greater resources to maintenance than do public owners of similar capital, they do not necessarily demonstrate that public capital deteriorates at a faster rate than privately owned capital. The higher levels of maintenance labor hours could be attributed to more capital-intensive maintenance practices. Furthermore, an implicit assumption that maintenance is qualitatively similar between the two sectors could be false. If one sector fixes equipment upon failure, as opposed to conducting preventive maintenance, differences in overall maintenance levels could result. A companion paper (Cromwell, 1988), however, directly examines the scrappage and retirement rates of private versus public equipment to determine whether the higher maintenance in the private sector is reflected in longer equipment life.

Using a panel of fleet data, I examine the hazard rates for retirement and scrappage of public and private equipment. A significant upward shift is seen in the scrappage rate for public vehicles at the 13-year point. This shift is important because federal regulations require vehicles purchased with federal funds to remain active for at least 12 years before replacement. The fact that this response does not also occur in the private sector strongly suggests that it is caused by the drop in price of replacement at the 13-year mark for public vehicles as opposed to any underlying technical process of deterioration. It is strong evidence that federal capital-grant policies lead to shorter equipment life in the local public sector and corroborates the evidence in this paper that

public properties substitute new investment for the maintenance of existing capital.

Endnotes

1. For a review of this debate, see Dudley and MontMarquette (1984).

2. For a review of the literature, see Jorgenson (1971).

3. Decisions about utilization rates represent an important extension of this analysis not presented here.

4. A variant of this model not presented here incorporates the fact that local governments can issue debt for new capital purchases, but finance maintenance from current revenues. This condition affects the analysis when a local government is constrained in its ability to achieve some overall desired level of debt. Gordon and Slemrod (1985), however, argue that communities do not face such binding limits. One potential limit on borrowing would be statutory limits set by the state specifying that the outstanding debt in a municipality cannot exceed some percent of the assessed property value of the community. Separate limits, however, are set for school bonds and for debt of special districts, so that creating special districts allows more debt to be issued. In addition, they argue, some forms of debt are normally entirely exempt from these limits, and states often provide a mechanism to relax a binding restriction on debt issues.

5. This assumption avoids the complexities associated with the financial structure of the firm discussed in Stiglitz (1973) and King (1975).

6. In the zero price case, local governments are constrained by federal regulations regarding minimum vehicle life and maximum size of fleet. See section III.

7. See UMTA (1983).

8. Figure cited is as of the 1983 report year.

9. See UMTA (1985).

10. See Touche Ross (1986).

11. The provision of transit services by city governments as opposed to regional agencies is assumed to reflect the geographic area of service provision and state policies toward the creation of independent districts as opposed to tastes for maintenance. Thus, the provision of service by city government is assumed to be exogenous to the maintenance problem.

12. Privately owned companies were identified using UMTA (1986). The survival of these private companies over a time when most were failing

and being bought out by public agencies reflects local demand conditions for transit (as in the New York area) and policy decisions by local authorities not to get into the transit business, in addition to the probability that they were well-run properties. I assume that these historical conditions are independent of current maintenance policies.

13. Transit properties are assumed to be price-takers in the labor market.

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