Worse than Baumol's Disease: the Implications of Labor Productivity, Contracting Out, and Unionization on Transit Operation Costs

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ABSTRACT

Unit costs measured as bus operating costs per vehicle mile have increased considerably above the inflation rate in recent decades in most transit agencies in the United States. This paper examines the impact of (lack of) productivity growth, union bargaining power, and contracting out on cost escalation. We draw from a 17-year (1997-2014) and a 415-bus transit agency panel with 5,780 observations by type of operation (directly operated by the agency or contracted out). We have three main findings: first, the unit cost increase in the transit sector is far worse than what economic theory predicts for industries with low productivity growth. Second, contracting out tends to reduce unit costs, and the results suggest that the costs savings from private operations can be only partly explained by lower wages in the private sector. Interestingly, we find that the cost savings from contracting out are larger when the transit agency also directly operates part of the total transit service. However, while overall unit costs are lower in contracted services, cost growth in large private bus operators is no different than cost growth in large public transit operators. Third, unique transit labor laws that lead to union bargaining power are a likely driver of the unit cost growth above inflation. Overall, these factors reflect inherent characteristics of the bus transit sector, such as the nature of low productivity growth and union legislative power related to the need for public subsidy. They drive increases in both transit fares and public subsidy at rates higher than inflation, and play an important role in the deterioration of transit agencies' financial sustainability.

Keywords: Public Transit, Baumol's cost disease, Contracting Out, Labor Unions, Cost escalation

1. INTRODUCTION

The cost of bus transit operations has risen rapidly across the United States (U.S.). As a result, most transit agencies struggle to balance budgets, leading to increasing concern about financial sustainability and capacity to provide more frequent and reliable service to meet increasing demand. In spite of higher ridership and fares, operating deficits grow because of cost increase greater than inflation, so the transit agencies struggle to find additional government support, which motivates an analysis of the drivers of transit cost escalation.

In particular, we examine three characteristics and potential drivers of unit cost: (i) Baumol's cost disease, which describes the implications of the inherent nature of low productivity growth; (ii) labor unions, which often hold substantial bargaining power for transit workers relative to management and significant influence on legislative bodies; and (iii) public operations of bus transit service which are not often near the feasible production frontier, which leads to consider contracting out to private providers as a potential alternative to achieve moderation of cost growth and facilitate service expansion.

The U.S. transit sector has seen costs soar over recent decades. The total operating expenditure measured in constant dollars in bus and rail transit service in the country increased from $25 to $38 billion between 1997 and 2014, a 49% increase. Over this period, service levels measured as vehicle revenue miles increased by only 16% (data from the National Transit Database [NTD] and Bureau of Economic Analysis [BEA]). In the same period, the total cost of transit increased from 0.21% to 0.24% of the gross domestic product (GDP). While government expenditure in transit is not nearly as high as in other areas such as education or health care, transportation has always struggled to find political support for its funding needs in the past. This need for political support for increasing subsidies makes transit particularly sensitive to union legislative influence.

Bus operating costs have also rapidly increased with a per vehicle revenue mile (VRM) and per passenger mile traveled (PMT) basis, since neither service supply nor ridership have increased nearly at the same pace as costs. In nominal terms, aggregate cost per VMT for all U.S. transit agencies has increased at a compounded annual rate of 3.5% from 1997 through 2014, compared to an annual inflation rate of 2.3% over the same period. Total costs per PMT have also increased above inflation, at a rate of 3.2%.

The increasing costs of transit operations have been partly funded with higher fare revenue, as a result of fare hikes and growing ridership, while the remaining funding needs have been met with growing government subsidies. Average fare revenue per PMT has increased at an annual rate of 2.1% for bus service from 1997 through 2014, roughly on par with the inflation rate. However, the increase in fare revenue has not been nearly enough to cover total cost growth, and in order to balance budgets, governments have provided additional operating budget support, as the average subsidy per PMT grew at annual rates of roughly 4.0%. Overall, 65% of the escalation of operating expenditures between 1997 and 2014 was covered with additional government

subsidy, and 35% was covered with additional fare revenue. While transit finance in the U.S. has deteriorated, Buehler and Pucher (*1*), for example, show success in the German public transit sector, which has been able to reduce unit costs, increase productivity and cut subsidies through organizational restructuring and contracting out most new service.

Understanding the factors that contribute to the escalation of transit operating costs and, as a result, to the growing needs for government support is important to inform public transportation policies. First, Baumol's cost disease offers a partial explanation from a productivity growth perspective for the cost problems of the transit sector. The theory predicts that industries with low productivity growth due to limited technology adoption and high labor intensity, such as transit, have an inherent disadvantage with respect to the rest of the economy and, as a result, higher cost growth rates. Second, institutional factors in the U.S. transit industry can also explain the large unit cost increase during recent decades, such as potential inefficiencies associated with public sector service delivery and unique transit labor protection laws and regulations, both of which can result in higher wages and less efficient organization of production.

Apart from estimating the implications of these factors on the level of costs, we also seek to assess whether they also have an impact on cost growth. Can contracting out reduce unit cost escalation by encouraging more efficient practices and new technologies? Can modification of labor laws and regulation reduce transit cost growth rate?

This paper first presents a brief review of Baumol's cost disease and its application to transit, as well as the implications of contracting out and union political power on cost and efficiency. We then present the data and the econometric model used to assess the drivers of transit unit cost escalation. The following sections show the regression results, a discussion of the findings, and final remarks.

2. LITERATURE REVIEW

As our first focus of analysis, Baumol's cost disease is a theory that observes that some industries are characterized as being technologically progressive, while other stagnant industries have low productivity growth over time. The latter industries usually have a small role for technology and are labor intensive. The original framework by Baumol and Bowen (*2*) focused on the performing arts, showing that the unit cost of that industry must continually rise faster than the rate of inflation due to inherently low productivity growth.

In short, the theory claims that as wages increase in jobs with growing labor productivity, wages in jobs with stagnant productivity must also increase at the same pace, in order to continue to attract workers. As a result, wage growth rates are expected to equalize across industries, despite uneven growth rates in productivity. In the long term, unit costs in stagnant industries rise faster than productivity and, therefore, faster than costs in progressive industries. Baumol et al. (*3*) and Baumol (*4*) revisited the original paper, confirming not only the impact on performing arts, but also on other 'stagnant industries', such as healthcare and education.

Nordhaus (*5*) finds compelling evidence that, over long periods of time, technologically stagnant industries have increasing unit costs and declining outputs with respect to the rest of the economy, while their wage growth is similar to progressive industries. The author relies on aggregate industry level data to analyze the impact of Baumol's cost disease, with findings that strongly support the hypothesis of a cost disease caused by low productivity growth.

Hartwig (*6*), Colombier (*7*), and Bates and Santerre (*8*) proposed a novel method to assess Baumol's cost disease by estimating an econometric model with the differential between average wage growth and productivity growth –the so-called Baumol variable– as an independent variable and unit cost growth as a dependent variable. The authors applied this specification to healthcare data, concluding that the healthcare sector suffers from Baumol's cost disease. As Baumol's cost disease predicts, the higher differential between wage growth and productivity growth, the higher the unit cost increase, as in the following equation:

$$\Delta \ln(Unit\ Costs) = \lambda[\Delta \ln(Wages) - \Delta \ln (Productivity)] \quad (1)$$

A positive value for λ provides evidence of Baumol's cost disease. The explanatory variable in the right hand side of the model is called the Baumol variable. If λ is positive and the Baumol variable is also positive, this implies that the excess growth in wages over productivity drives the increase in unit costs.

A few authors have argued that Baumol's cost disease also affects the transit sector, such as Zureiqat (*9*), Evangelinos et al. (*10*), Gordon (*11*), and Morales Sarriera and Salvucci (*12*). The former explains that transit has limited potential for technological innovation, limited import substitutability (since operating labor must be hired locally), and is largely subsidized by the government, concluding that the implications of the disease also apply to transit. Gordon (*10*) entertains the possibility that contracting out is a partial solution for Baumol's cost disease by bringing down the costs of providing service and permitting quicker response to opportunities for service expansion. Evangelinos et al. (*11*) relies on a quantitative approach, calculating an efficient frontier using empirical data for transit agencies in Germany and in the U.S., and observing total factor productivity growth. The authors provide evidence of low productivity growth in the transit sector, especially in bus operations.

Morales Sarriera and Salvucci (*12*) performed an empirical analysis which found that labor productivity growth over the last two decades has been sluggish in the U.S. transit industry, close to zero for bus transit and lower than 1% per year for rail transit. Moreover, they found that the average compensation in the U.S. transit industry has been growing not only above the inflation rate, but also above the average compensation rate in the metropolitan areas in which they operate, outpacing the predicted rate of growth from a Baumol type analysis. The authors conclude that on top of the implications of Baumol's cost disease, other compounding factors must also affect cost escalation, such as institutional, political, or managerial factors.

With respect to these institutional factors, the potential to reduce costs and improve efficiency by contracting out has been the subject of a variety of papers. The findings are not

uniform and, in general terms, indicate that the success of private delivery of transit must be determined on a case by case basis. McCullough et al. (*13*) find that bus service operated under contract are often, but not always, less costly than directly operated service. The authors use a sample of U.S. transit agencies between 1989 and 1993, concluding that contracting should not be assumed as the appropriate strategy for every situation. More recently, Leland and Smirnova (*14*) find that "neither the type of government nor whether an agency contracts out has much impact on the efficiency and performance of urban bus services", using a factor analysis of multiple criteria to determine eight efficiency and performance factors for U.S. transit agencies, however none of the factors analyzed are directly related to unit costs. Using a similar sample, Iseki (*15*) performs a regression analysis and finds lower operating costs for partial and full-contracting agencies, which translates into savings of about 8% with respect to directly operated service.

Another institutional characteristic that potentially affects transit costs is union bargaining power. Transit sector labor unions have been granted increased bargaining power for decades by federal and state regulations that add protection to the rights of transit employees (for example, Section 5333(b) of Title 49 U.S. Code, originally enacted by Section 13(c) of the Urban Mass Transit Act of 1964, and state binding arbitration requirements). To the best of our knowledge, no recent research has directly investigated the impact of union bargaining power on transit costs. Among the scarce literature on this topic, Schwarz-Miller and Talley (*16*) found that union drivers are paid a significant wage premium over nonunion drivers, and suggested that "special institutional features of the public transit industry have collectively conferred market power on unionized public transit workers." This power can lead to both higher wages and reduced flexibility to improve efficiency in service delivery.

3. DATA

The National Transit Database (NTD) is our main source of data, collected for the fiscal years 1997 to 2014, the period in which all variables of interest were available. We focus the analysis on bus transit service, and distinguish service that is directly operated by the agency from service that is operated by the private sector. Therefore, in the database, a single transit agency may be included with two different observations for a single year: for the service directly operated and for the service privately operated. From the NTD we are not able to identify the process in which bus service was awarded to private operators, for example, by competitive bidding or franchising. This presents an important limitation of NTD-based analyses about the effects of contracting-out, since the database does not differentiate between the specific forms of privatization.

We include all bus transit agencies that provide over 400,000 VRM per year in each unit of analysis. In 2014, these transit agencies were responsible for 98% of total bus miles in the U.S., and represented 66% of all bus transit agencies. The sample includes 415 transit agencies, of which 310 directly operate service, 53 contract out all transit service (full-contracting), and 26 contract out part of their bus service.

Overall, roughly 19% of bus miles in the country are provided by the private sector. Among the 39 largest bus transit agencies in the country (with annual VRM above 10 million), 6 contract out all their service (in Phoenix, urban and suburban, Honolulu, Las Vegas, Austin, Foothill (CA), and Las Vegas), and another 5 contract out at least 10% of their service (Denver, Houston, New Jersey, San Diego, and Orange County).

With the dataset, we calculate (i) unit costs, (ii) labor productivity, and (iii) average wages. First, regarding unit costs, we consider annual operating expenditure per annual VRM (miles traveled by vehicles while in revenue service). Operating expenditures include labor, fringe benefits, services, materials and supplies, utilities, casualties and liability costs, taxes, purchased transportation, and miscellaneous expenses, and excludes all capital expenses, depreciation and vehicle leasing and rental costs. We adjust operating expenditure to constant prices by deflating with the CPI (Consumer Price Index from the Bureau of Economic Analysis). We use VRM as the transit agency output because it is the decision variable and depends directly on its input choice (employees, vehicles, etc.). Vehicle revenue hours (VRH) is an alternative measure of output, however, it does not reflect the expansion of routes into areas with different levels of traffic congestion and speeds, and the data for VRH in the NTD is not entirely reliable, since some transit agencies assume a constant average speeds based on data for miles driven (which can vary widely per year or per agency). Finally, we do not intend to use this measure of unit cost as a proxy for efficiency, since efficiency integrates other dimensions from a productive, allocative, or technical standpoints, which are not in the scope of this analysis. Daraio et al. (*17*), for example focuses on measuring efficiency and effectiveness measures, and describe the use of techniques such as Data Envelopment Analysis and Stochastic Frontier Analysis for the transit sector.

Second, as a measure of labor productivity, we calculate the ratio of VRM to total full-time and part-time work hours of employees involved with operations, maintenance and administration. Therefore, the labor productivity unit is miles of service per labor hour. Third, we calculate average wage per hour in constant dollars (deflated using the CPI). As the NTD only requests directly operated service to report data on total work hours (or employee count), we cannot calculate labor productivity and average wages for private operated service. This measure is used to calculate the Baumol variable, therefore, it is inclusive of all wages and salaries (which according to economic theory should reflect the variation in labor productivity), but it is exclusive of fringe benefits and pensions.

Other NTD data that we used are: (i) total PMT (as a measure of size of the transit service), (ii) average vehicle speed in miles per hour (ratio of VRM to VRH), (iii) average passenger trip length in miles (ratio of PMT to total unlinked passenger trips), (iv) average vehicle occupancy (ratio of PMT to VRM), (v) population density in the service area, and (vi) total population in the service area. With respect to these variables, Avenali et al. (*18*) show that average speed is the most important predictor of unit costs among the explanatory variables in their model, and they find a weak association between unit costs and agency size.

Finally, we also introduce a binary variable to identify whether the transit agency is located in a state with right-to-work laws (where unionization is not compulsory), and another variable with the average state unionization rate of public sector employees (data from Union Membership and Coverage Database). Based on Cooper (*19*), we treat these variables as proxies for union bargaining power and union political power. Finally, we also collect data on state Gross Domestic Product (GDP) per capita from the Bureau of Economic Analysis, and the annual average U.S. retail price of diesel fuel from the Energy Information Administration, all in constant dollars. Table 1 shows summary statistics.

Table 1: Descriptive Statistics (1997-2014 for 5780 observations)

Variable	Average	Median	Min.	Max.
VRM (millions)	5.1	1.7	0.4	104
PMT (millions)	56.0	12	1.0	1,950
Crowding (passengers per vehicle-mile)	7.9	6.9	1.6	24.1
Speed (vehicle-miles per vehicle-hour)	14.5	13.7	8.9	30.3
Trip Length (passenger miles per trip)	5.9	4.0	1.4	45.0
Operating Cost per Vehicle Revenue Mile	$6.92	$6.39	$2.75	$17.06
Unionization Rate[1]	40.6%	48.8%	2.7%	72.4%
Private (% of contracted out service)	20.6%	-	-	-
Full Contracting (% of full to total contracted out service)	16.4%	-	-	-
Right-to-work (% of operations in right-to-work states)	37.5%	-	-	-

[1] In the public sector, statewide, average by observation.

4. MODEL

We estimate three panel regression models to analyze the implications of Baumol's cost disease, contracting out, and unionization. A panel approach allows us to control for unobservable agency-specific characteristics, to disentangle the variance of the data within and across agencies and, therefore, to explore the drivers of unit cost. In particular, we employ a random effects model, which according to Bell and Jones (*20*) is the best approach to model cross-classified panel data. Bell and Jones (*20*) argue that a fixed effects approach for such database would remove time-invariant variables from the estimation, losing an important share of the information. This is critical for estimating the impact of binary variables such as contracting or right-to-work, which are time-invariant. In addition, the random effects model assumes that co-variates are uncorrelated with unobservable characteristics, which in this database can be represented by the effect of unobservable management decisions or efficiency.

The first model uses the unit costs as the dependent variable, and the second and the third models both use unit cost growth rates as the dependent variable (the full sample in the second model and the sub sample of directly operated service in the third model).

The first panel regression equation we estimate is given by:

$$\ln(c_{it}) = \alpha_0 + \alpha_i + \beta_1 Private_{it} + \beta_2 Full\ Contracting_{it} + \beta_3 RightToWork_{it} + \beta_4 \ln(Union_{it}) + \beta_t T_t + \sum \delta_j \ln(z_{it}^j) + \varepsilon_{it} \quad (2)$$

The dependent variable $\ln(c_{it})$ is the inflation-adjusted annual operating cost per vehicle revenue mile at time t for a combination of a transit agency, mode, and type of delivery *i*, $Private_{it}$ is a binary variable equal to one if operations are contracted out, $Full\ Contracting_{it}$ is a binary variable equal to one if all operations are contracted out by the transit agency, $RightToWork_{it}$ is a binary variable equal to one if the agency operates in a state with right-to-work laws, $\ln(Union_{it})$ is the log of the unionization rate (in percentage points) of public sector employees in the state in which the agency operates, T_t is a time trend, z_{it} represents a vector of control variables, α_i are transit agency/mode specific effects, and ε_{it} are random errors. Finally, β, δ, and α are parameters to be estimated.

The control variables in the equation are (i) state GDP per capita (in order to measure income levels), (ii) average speed (as a proxy for both stop spacing and traffic congestion), (iii) average trip length (as a proxy for urban vs suburban service characteristics), (iv) average vehicle occupancy (as a proxy for crowding), (v) PMT, (vi) total population in the service area, (vii) population density in the service area, (viii) diesel fuel prices (included in the bus transit specification), (ix) a binary variable equal to one for the years of the economic crisis in 2008 and 2009. Finally, we also include (x) an interaction term between private and right-to-work binary variables.

The second panel regression model we estimate is:

$$\Delta\ln(c_{it}) = \alpha_0 + \alpha_i + \beta_1 Private_{it} + \beta_2 Private_{it} * Medium_{it} + \beta_3 Private_{it} * Large_{it} + \beta_4 Full\ Contracting_{it} + \beta_5 RTW_{it} + \beta_6 \ln(Union_{it}) + \beta_t T_t + \sum \delta_j \Delta\ln(z_{it}^j) + \varepsilon_{it} \quad (3)$$

Compared to the first model, we use unit costs growth rates in percentage points as the dependent variable. The set of covariates representing privatization and unionization are similar to those in equation 2, as this model seeks to estimate their impact on unit cost growth rather than levels. The only difference is that now we also estimate the impact of contracting out by the size of the private transit operations. For that, we treat as medium size the operations with PMT above the median of all contracted out bus service (roughly 10 million annual PMT), and as large the operations with PMT above the 75th percentile (roughly 40 million annual PMT).

To maintain consistency across models, as well as for the dependent variable, control variables are also transformed in growth rates using log differences. With respect to equation 2, we do not include population and population density as these variables hardly vary or are not updated annually, therefore they are not meaningful when measuring growth rates.

Since data limitations do not allow us to calculate labor productivity and average wages in privately operated transit operations, we then estimate a third model that includes only directly operated service in order to include the Baumol variable as a regressor::

$$\Delta \ln(c_{it}) = \alpha_0 + \alpha_i + \beta_1[\Delta \ln(w_{it}) - \Delta \ln(y_{it})] + \beta_2 RightToWork_{it} + \beta_3 \ln(Union_{it}) + \beta_t T_t + \sum \delta_j \Delta \ln(z_{it}^j) + \varepsilon_{it} \quad (4)$$

The above equation uses the Baumol variable, which is the percentage differential between the inflation adjusted wage growth rate $\Delta \ln(w_{it})$ and the labor productivity growth rate $\Delta \ln(y_{it})$ for every transit agency in each year. Instead of the economy-wide Baumol variable as used by Hartwig (*6*), we calculate the Baumol variable for each transit agency (by mode and type of operation), aiming to assess the extent of the implications of Baumol's cost disease within the transit sector itself. In other words, whether agencies with wage growth above their own rate of labor productivity growth face higher unit cost growth rates relative to their peers.

For each model we show three specifications, one with the full list of independent variables, and another two with a reduced number of independent variables guided by variance inflation factors (VIF) in order to avoid multicollinearity. We use a rule of thumb for VIF less than 10 (excluding variables with a higher VIF), since many of the variables are ratios that combine similar numerators and denominators. Moreover, we estimate robust standard errors. Finally, the estimations only include transit agencies with at least 5 years of data in the sample in order to reduce imbalance, and also excludes observations with variation over 15% or more in service levels, in order to reduce the noise introduced by substantial service changes within a fiscal year.

5. RESULTS

Error! Reference source not found. reports the estimation results for Equation 2 with a random effects panel data regression and the level of unit costs as the dependent variable. The table shows three specifications. The third specification avoids any type of multicollinearity between control variables. Specifications 2 and 3 also allow a direct interpretation of average coefficients without interaction terms.

The results show that private operators tend to have lower unit costs (on average 16.4% lower than directly operated service, given by the coefficient associated with the variable *Private* in specification 3). This negative effect on unit cost is highly significant across specifications. The first two include a binary variable when there is full contracting (when the entirety of bus operations is contracted out), and since the parameter is positive and statistically significant, this shows that the cost reduction from private service provision is lower in such case. In other words, it appears that contracting out is more effective in reducing costs when part of the service is still offered by the public sector, possibly because this can provide an in-house benchmark for cost and efficiency, creating in total some quasi competitive pressures to moderate cost growth. It may as well create as a credible alternative to contracting if there are a small number of private providers and little competition for the market.

TABLE 2 Random Effects Model with the Log of Unit Costs as Dependent Variable, Full Sample, 1997-2014

Independent Variables	Specification (1)	Specification (2)	Specification (3)

	Para-meter	Std. Err.	Sig.	Para-meter	Std. Err.	Sig.	Para-meter	Std. Err.	Sig.
Private	-0.542	(0.09)	**	-0.336	(0.07)	**	-0.164	(0.03)	**
Private*Right-to-Work	0.197	(0.05)	**	0.169	(0.05)	**	-	-	-
Private*All Contracted	0.337	(0.09)	**	0.160	(0.07)	*	-	-	-
Right-to-Work	-0.056	(0.02)	*	-0.171	(0.03)	**	-0.133	(0.03)	**
ln(Unionization %)	0.071	(0.02)	**	-	-	-	-	-	-
ln(PMT)	-0.095	(0.02)	**	-	-	-	-	-	-
ln(Speed)	-0.351	(0.08)	**	-0.411	(0.05)	**	-0.414	(0.05)	*
ln(Trip Length)	-0.173	(0.10)	.	-	-	-	-	-	-
ln(Crowding)	0.211	(0.02)	**	0.057	(0.02)	**	0.057	(0.02)	**
ln(Trip Length)*ln(Speed)	0.029	(0.04)	.	-	-	-	-	-	-
ln(Population)	0.156	(0.02)	**	-	-	-	-	-	-
ln(Pop. Density)	0.068	(0.02)	**	-	-	-	-	-	-
ln(State GDPpc)	0.281	(0.04)	**	-	-	-	-	-	-
ln(Diesel Price)	0.063	(0.01)	**	-	-	-	-	-	-
Crisis (2008-2009)	0.020	(0.00)	**	0.028	(0.00)	.	0.027	(0.00)	**
Trend	0.011	(0.00)	**	0.016	(0.00)	**	0.016	(0.00)	**
Constant	-1.811	(0.56)	**	2.768	(0.14)	**	2.762	(0.14)	**
Observations	5779			5780			5780		
Transit Systems	415			415			415		
R-sq Between	0.46			0.38			0.40		
R-sq Overall	0.48			0.41			0.41		
Wald	1650		**	1008		**	984		**

Significance: * 95%, ** 99%, and "."non-statistically significant.
"-"parameters not estimated for that specification.

The estimations also reveal that unit costs in right-to-work states are lower than in states where union membership is compulsory (coefficient associated with *RTW* in specifications 1 and 2), and in states with lower union membership rates in the public sector. This reflects the impact of labor union power in negotiating wages, fringe benefits, and work rules. From the second specification, in which the impact of the proxy right-to-work is assessed independently from unionization rates, we find that costs may be on average 17% lower in states with right-to-work laws.

An interaction term between the variables private operations and right-to-work shows that the two are not independent, and that the expected cost savings from contracting out is lower in right-to-work states. One interpretation of this finding is that part of the costs savings from contracting out are due to reduced labor union power (and therefore lower average wages and benefits) for workers in the private sector compared to workers in the public sector. Conversely, another interpretation is that once cost savings from private sector operations are realized, reducing overall union bargaining power does not have an additional impact on cost savings, which indicates

that the political power of unions in private sector situations is not as relevant. While these are potential explanations, the relationship between wage rates, private sector operations, and union political power cannot be directly assessed with this model.

Most control variables are statistically significant. Unit costs are higher in transit agencies that operate in higher income states, potentially reflecting higher wages due to cost of living. Unit costs are also higher in areas that are more populated and also more densely populated, after controlling for all other characteristics, which may also reflect higher labor costs in urban areas vis-à-vis rural areas. Costs are higher in transit systems with higher vehicle occupancy (considered a proxy for crowding), in systems with smaller average trip lengths (a characteristic of more urban transit relative to suburban), and in systems with lower average speed (expected with shorter stop spacing and higher traffic congestion). While these three variables are interrelated, for example, transit systems with larger average passenger trip length are expected to have higher average vehicle speed, the coefficients all indicate that unit costs tend to be larger in more urban and dense spaces. An interaction term of the variables trip length with speed tested if there is a compounding effect between both, but is not statistically significant.

Moreover, on average larger bus transit systems (in terms of PMT) have slightly lower unit costs (as indicated by the coefficient -0.095 in specification 1), which can be interpreted as an indication of a small but statistically significant returns to the scale of operations. It is important to note that this coefficient was not significant in the auxiliary model we ran without the control variables for crowding, speed or trip length.

Finally, the trend shows that there is an increase in unit costs that cannot be explained by the variation of other variables in the model. The unexplained portion of unit cost escalation is equal to 1.1% per year in the first specification, and 1.6% in the other two specifications with fewer control variables. Since the dependent variable unit cost is inflation adjusted, this trend reveals cost growth above the inflation rate.

The R-squared statistics for the regressions in TABLE 2 are between 0.41 and 0.48, which indicates that there are other characteristics of the transit agencies (potentially political, managerial, or operational) that contribute to the determination of unit costs that cannot be explained by the independent variables used in the model. Regardless, the high significance of most of the included variables show that they are important determinants of unit costs.

In the regression results shown in

TABLE ***3*** we use unit cost growth rates (in percentage points) as the dependent variable with the same sample of private and public transit operators. In this model, we find that the impact of contracting out on unit cost escalation depends on the size of the service provided by the private operator. First, we find that for small transit operations, contracting out tends to reduce the rate of cost escalation compared to bus service directly operated by the transit agency (about 2.9 percentage points per year compared to public operations, after adding the coefficients for private and for the interaction of private and small transit operators). However, the magnitude of this effect is not significant for large sized private operations.

Specification 1 shows that transit agencies that contract out all bus service also face relatively higher cost escalation than agencies that contract out only part of their service, following a similar rationale as the model explaining the level of unit cost. The parameter that measures this relationship is equal to 1.46 percentage points.

Specification 2 does not account for the differential between full and partial contracting, and does not include some control variables in order to avoid potential multicollinearity; however, the results about the size of private bus operations and cost escalation remains the same. By adding the coefficient for private operations with the interaction term for size with private operations, the only statistically significant result is lower cost growth trends for small size contracting. For large size contracting, the total average effect on cost growth is not significantly different from zero. Specification 3 only accounts for the overall impact of private operations, regardless of contract size, compared to directly operated service. The resulting coefficient is equal to -0.629 percentage points and is statistically significant, which is driven by the average impact of small size contracting.

TABLE ***3*** also reveals that on average transit agencies in states with right-to-work laws have about 0.5 percentage points lower unit cost growth rates, indicating the long-run impact of the bargaining power of labor unions. The table generally shows similar results for the significance of the coefficients of the same control variables in TABLE 2, for example crowding, speed, among others. The variable crisis is not significant in any of the specification, as the effect of GDP growth rates already controls for the effect of changing economic conditions.

The constant represents the average rate of growth unexplained by other variables in the model (equal to 1.7 percentage points in specification 1), and the trend variable reflecting the changes in the rate of growth between 1997 and 2014 is not statistically significant in specifications 2 and 3. The R-squares are lower than that in the first model, showing that unit cost growth rate is more difficult to predict than levels. One potential reason is the higher and more ad hoc variability in annual growth rates, i.e., while the levels of costs tend to be relatively constant over time, growth rates may change significantly from one year to another, driven by changes in local prices and in the labor market. Nevertheless, the explanatory variables show high statistical significance in predicting rates of change."

TABLE 3 Random Effects Model with Unit Cost Growth (percentage points) as Dependent Variable, Full Sample, 1997-2014

Independent Variables	Specification (1)			Specification (2)			Specification (3)		
	Para-meter	Std. Err.	Sig.	Para-meter	Std. Err.	Sig.	Para-meter	Std. Err.	Sig.
Private	-0.891	(0.75)	.	0.869	(0.65)	.	-0.629	(0.24)	**
Private*Small	-1.986	(0.73)	**	-2.586	(0.75)	**	-	-	-
Private*Medium	-0.676	(0.57)	.	-1.133	(0.56)	*	-	-	-
Private*Large	0.572	(0.57)	.	-0.067	(0.58)	.	-	-	-
Private*All Contracted	1.462	(1.46)	**	-	-	.	-	-	-
Right-to-Work	-0.478	(0.15)	**	-0.493	(0.14)	**	-0.494	(0.15)	**
Δln(Unionization %)	-0.007	(0.14)	.	-	-	.	-	-	-
Δln(PMT)	-15.10	(3.78)	**	-	-	.	-	-	-
Δln(Speed)	-13.12	(2.62)	**	-18.58	(2.74)	**	-1.105	(0.37)	**
Δln(Trip Length)	-6.759	(1.09)	**	-	-	.	-	-	-
Δln(Crowding)	22.061	(3.45)	**	2.51	(0.80)	**	2.786	(0.81)	**
Δln(Trip Length)* Δln(Speed)	-34.83	(21.7)	.	-	-	.	-	-	-
Δln(State GDPpc)	0.826	(3.47)	.	-	-	.	-	-	-
Δln(Diesel Price)	3.617	(0.65)	**	3.954	(0.65)	**	4.015	0.648	**
Crisis (2008)	0.425	(0.33)	.	0.202	(0.32)	.	0.171	(0.33)	.
Trend	-0.043	(0.02)	*	-0.014	(0.02)	.	-0.014	(0.02)	.
Constant	1.703	(0.58)	**	1.291	(0.19)	**	4.190	(0.65)	**
Observations	5249			5251			5251		
Transit Systems	396			396			396		
R-sq Between	0.13			0.13			0.07		
R-sq Overall	0.10			0.05			0.04		
Wald	252		**	151		**	95		**

Significance: * 95%, ** 99%, and "."non-statistically significant.
"-"parameters not estimated for that specification.

In order to capture the impact of productivity growth and Baumol's cost disease, TABLE 4 shows the results of the model that incorporates the Baumol variable. The estimations include only directly operated service due to labor data availability. The coefficient for the Baumol variable—the gap between productivity growth and wage growth is positive and significant, ranging between 0.53 and 0.55 in the three specifications.

This is evidence that part of the unit cost escalation is because labor productivity does not increase at the same pace as wages, as it is the case in most agencies. With no productivity growth (typical in bus operations), a 2% increase in wages above inflation causes an increase of unit costs of roughly 1.1%. Another implication is that a 1% increase in labor productivity could bring down unit costs by roughly 0.55% if wages increased at the same pace as inflation.

TABLE 4 Random Effects Model with Unit Cost Growth (percentage points) as Dependent Variable, Directly Operated Service, 1997-2014

Independent Variables	Specification (1)			Specification (1)			Specification (3)		
	Para-meter	Std. Err.	Sig.	Para-meter	Std. Err.	Sig.	Para-meter	Std. Err.	Sig.
Baumol Variable	0.533	(0.02)	**	0.555	(0.02)	**	0.557	(0.02)	**
Right-to-Work	-0.330	(0.11)	**	-0.298	(0.10)	**	-	-	-
ln(Unionization %)	-0.125	(0.10)	.	-	-	-	-	-	-
ln(PMT)	-11.660	(2.85)	**	-	-	-	-	-	-
ln(Speed)	-3.295	(1.61)	*	-6.292	(1.81)	**	-6.359	(1.83)	**
ln(Trip Length)	-2.731	(0.78)	**	-	-	-	-	-	-
ln(Speed)*ln(TripLenght)	-43.027	(16.30)	**	-	-	-	-	-	-
ln(Crowding)	14.468	(14.47)	**	1.799	(0.59)	**	1.665	(0.58)	**
ln(State GDPpc)	4.486	(2.70)	.	7.535	(2.82)	**	-	-	-
Diesel Price Growth (%)	6.729	(0.60)	**	-	-	-	-	-	-
Crisis	0.295	(0.30)	.	-	-	-	-1.393	(0.28)	**
Trend	-0.031	(0.01)	*	0.007	(0.01)	.	-0.011	(0.01)	.
Constant	1.706	(0.41)	**	1.042	(0.16)	**	1.089	(0.14)	**
Observations	4071			4073			4073		
Transit Systems	300			300			300		
R-sq Between	0.35			0.36			0.34		
R-sq Overall	0.34			0.28			0.28		
Wald	1359		**	978		**	936		**

Significance: * 95%, ** 99%, and "."non-statistically significant.
"-"parameters not estimated for that specification.

The binary variable right-to-work is statistically significant, and confirms that unit costs tend to grow at lower rates in states where unions tend to have less political power. On the other hand, the other proxy for union power (percentage of unionized public sector employees) does not have the same strong explanatory power.

Regarding other control variables in the model, the signs of associated parameters follow the same trend as the results in the prior models. The binary variable representing the financial crisis in 2008 is only significant in the specification that does not control for state GDP per capita growth, which already captures changes in economic growth. Finally, The R-squared in TABLE 4 are higher than the R-squared in the estimations without the Baumol variable in

TABLE ***3***, which shows that the Baumol variable helps explain a substantial portion of cost escalation, in spite of the smaller sample size in the model in TABLE 4 (only direct operations).

6. CONCLUSIONS

The U.S. bus transit sector has seen unit costs (operating expenditures per vehicle revenue mile) soar in the last two decades. Unit costs have grown at a much faster pace than inflation and as a result, transit agencies have struggled to balance budgets. This paper focused on three main characteristics associated with cost escalation: Baumol's cost disease (related to low productivity growth), contracting out (the potential of competition for the market to drive costs down), and union political power (the effect of strong bargaining power).

The findings reveal that all three have a direct impact on transit unit costs. First, one of the main drivers of the soaring unit costs is lower labor productivity growth compared to wage growth above the inflation rate. Baumol's cost disease predicts this result but the effect in transit is even more pronounced because of the faster-than-the-average growth of transit wages (*12*). Comparing our results to those in the literature, the magnitude of the Baumol variable coefficient for transit (roughly 0.55) is larger than that found by Colombier (*7*) for the health care sector (between 0.16 and 0.20). However, our estimation strategy is different, since we use a Baumol variable that compares the differential between productivity growth and wage growth for each transit agency within the transit sector itself, while previous research has used a Baumol variable for the economy overall.

Second, contracting out tends to reduce the level of unit costs in bus transit operations, and these cost savings tend to be higher when part of the transit service continues to be operated by the transit agency. A potential explanation is that the agency becomes a direct benchmark for the contractor, with information about costs and potential efficiency and vice versa, the contractor provides a benchmark to consider improvements for in-house production. In addition, the credible option of public sector direct provision of service can reduce the market power of a limited pool of competing providers.

An interpretation of the results indicates that only part of the cost reductions associated with contracting out are derived from lower wages, since workers in the private sector are often not under the same union agreements as workers in the public sector. Potential efficiency gains associated with competition for the market and the delivery of the service may also be responsible for part of the cost savings. However, further research is required to support the direct causation between these variables.

Large contracted transit operations tend to experience the same pace of unit cost escalation as service directly operated by the agency. Two main reasons may contribute to this: (i) lack of competition for the market once a company is established and operating a large amount of fixed route services, and (ii) poor contract design with no incentives for operators to continuously seek costs saving opportunities. In some cases, contracting out bundles of bus transit service may strengthen the level of competition between private operators, as analyzed in Avenali et al. (*21*). In addition, although the benefits of contracting out can reduce the level of costs, private transit

operators should be expected to be as susceptible as directly operated transit service to the implications of low productivity growth and Baumol's cost disease. A limitation of the findings related to contracting out is that the NTD data does not report the process in which the service was awarded to the private sector or how competitive it was; therefore, in situations with more competition for the market the effect on level and cost growth may be more relevant.

Finally, transit agencies in states without right-to-work laws (which is an indication of union political power), tend to have higher unit costs. In addition, the results show that such transit agencies also tend to have higher rates of cost escalation. This evidence supports the hypothesis that strong union bargaining power tends to lead to higher wages and benefits, higher wage and benefit growth, and also reduced flexibility to improve efficiency in service delivery.

The main mitigation strategy to reduce the soaring costs of transit operations appears to be stimulating productivity, which can reduce the impact of Baumol's cost disease. This can be achieved by, for example, adopting automation, updating of vehicle fleets to reduce maintenance costs, or using more efficient maintenance practices, scheduling and routing tools. Nevertheless, it must be recognized that transit has inherently low productivity growth because: (i) the sector is labor intensive, as employment costs can make up over two-thirds of operational costs, and (ii) the sector is not technologically dynamic, that is, innovation and technology has not substantially changed the way that transit is supplied and has not leveraged significant operational efficiencies that reduce the labor required for a given level of service. Therefore, policymakers must understand that the escalation of transit cost is partially explained by these inherent characteristics of the sector, and that its survival depends on increasing operation revenues above the inflation rate through higher subsidies or higher fare revenue.

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