Is Public Expenditure Productive? Evidence from the Manufacturing Sector in U.S. Cities, 1880–1920

Melissa Yeoh and Dean Stansel

This article provides the first examination of the relationship between public expenditures and labor productivity that focuses on municipalities, rather than states or nations. We use data for 1880–1920, a period of rapid industrialization in which there were both high levels of public infrastructure spending and rapid growth of productivity. We use a simple Cobb-Douglas production function to model labor productivity in the manufacturing sector, letting total factor productivity depend on "productive" public expenditure by city governments—that is, on public spending that may raise the productivity of labor and encourage human capital accumulation.

Using a data set of 45 of the largest cities in the United States, we find no statistically significant relationship between productive public expenditure and labor productivity in the manufacturing sector during this period. These findings are robust to three different econometric approaches. We do, however, find a strongly positive and statistically significant relationship between private capital and labor productivity. Our results are consistent with those of much of the literature

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Melissa Yeoh is an Assistant Professor of Economics at Berry College, and Dean Stansel is an Associate Professor of Economics at Florida Gulf Coast University. They thank Noel Campbell, Garth Heutel, Brian McNamara, Mitch Mitchell, and Bob Mulligan for helpful comments on a previous version of this article and Amy Weisgarber for research assistance. Yeoh's work was supported by the Kirk Dornbush Summer Research Grant at Vanderbilt University. She thanks Jeremy Atack, Martha Bailey, Bill Collins, Tomas Cvrcek, Yanqin Fan, William Hutchinson, Bob Margo, Mototsugu Shintani, and John Warner for comments on earlier drafts.

examining this same relationship in states and nations and they have important implications for contemporary public policy issues.

An Overview

The decline in labor productivity in the United States during the 1970s created a challenging puzzle for economists to solve. Aschauer (1989) found that public capital had a strongly positive relationship with productivity in the United States, and argued that the productivity decline had been caused by a decline in public expenditure on infrastructure. Munnell (1990) and others found similar results. These initial findings were used by politicians and policymakers as evidence of the need for large increases in government spending on infrastructure. Some critics identified flaws in the econometric approach of this early work and, after correcting those flaws, found either a negative relationship or no statistically significant relationship between public capital and productivity. Peterson (1994) found that the marginal rate of return on public capital had declined substantially since 1950 and was substantially lower than that on private capital. He suggested that policies to increase private capital would contribute more to the growth of output than would the increases in public infrastructure recommended by Aschauer and others. The early literature on both sides of the debate is summarized in Munnell (1992) and Gramlich (1994). Few have been able to replicate the large effects found by Aschauer. Work in this area has slowed, but there remains no consensus (see, e.g., Kalyvitis and Vella 2011, and Lithgart and Suarez 2011). Moreover, virtually all of the existing literature has focused on national, regional, or state data and has analyzed contemporary time periods. While there is a substantial empirical literature investigating the relationship between local government spending and economic growth,[1] there appear to be none that examine the relationship with local labor productivity.[2]

[1]See, for example, Glaeser, Scheinkman, and Shleifer (1995), Holtz-Eakin and Schwartz (1995), Crihfield and Panggabean (1995), Dalenberg and Partridge (1995), De Mello (2002), Glaeser and Shapiro (2003), Denaux (2007), and Stansel (2009). The general consensus of this literature is that government spending, as a whole, has no significant relationship with growth, however a positive relationship was found for several specific categories of spending.

[2]Rauch (1994), Eberts (1986), Deno (1988), Eberts (1990), Duffy-Deno and Eberts (1991), and Boarnet (1998) all take a local approach and are closely related to the issue we examine, but none contain results using local labor productivity as their dependent variable.

One of Aschauer's (1989: 177) key findings was that "a 'core' infrastructure of streets, highways, airports, mass transit, sewers, water systems, etc. has [the] most explanatory power for productivity." Since the bulk of that infrastructure spending is done by local governments, we take a different approach than previous researchers and focus on local-level data and do so for a period of rapid industrialization, 1880–1920. During that time, there was a great deal of public expenditure on the construction of infrastructure and a rapid increase in the productivity of labor.[3] If public expenditure is positively associated with productivity, as some have claimed, then that relationship should be readily apparent in the data we have chosen.

The period between 1880 and 1920 saw tremendous growth in cities and wide variations in the labor productivity and public expenditure in areas across the United States.[4] The United States became a world leader in manufacturing during this period of rapid industrialization and much of the industrialization was correlated with city growth. Some cities recorded rapid population growth rates (for example, Detroit grew at an average of 73 percent per decade from 1880 to 1920), while other cities had slower population growth rates (such as Albany's average of 6 percent per decade).

Since manufacturing generated more than half of the total value of output in the United States by the late 19th century and was centered in the largest cities in the nation (Gallman 1960: 26), we focus our attention on whether public expenditure played any significant role in raising the labor productivity of manufacturing workers specifically. Labor productivity directly affected the profitability of manufacturing establishments and thus the overall economic growth of a city. Cities, in turn, were allocating large quantities of resources toward "public capital" such as roads, water supply systems, sanitation, education, and health. Furthermore, local governments were responsible for the bulk of government activity during this period, so focusing on city governments is most appropriate.[5]

[3]As Kendrick (1984: 389) documents, the productivity of labor over a similar period (1889–1919) was nearly double that of the previous four decades (1855–90). Total productivity was more than five times higher.

[4]In an empirical study on states, Mitchener and McLean (2003: 34–35) document "massive and persistent differences in productivity levels, and hence living standards" across the 48 U.S. states (excluding Alaska and Hawaii) from 1880 to 1960.

[5]In 1902, local governments accounted for 55 percent of all government revenue and 59 percent of all government outlays, compared to about 22 percent and 25 percent today (Menes 1999).

Some argue that public expenditure, particularly in education and health, increases human capital and thus raises labor productivity in cities that invested heavily in such areas (Glaeser, Scheinkman, and Shleifer 1995). However, not every type of public expenditure will raise labor productivity. Some types of public expenditure, such as spending on the maintenance of public buildings and the salaries of city employees in the legislative and judicial branches of government, will not raise labor productivity in manufacturing. For that reason, we focus on *productive* public expenditure.

Economic theory posits that productive public capital—such as roads, water supply systems, sewers, education, and health—lowers the cost of doing business and raises the marginal product of other forms of capital. As a result we should see businesses flourishing in cities that invested heavily in infrastructure. For example, public expenditure on roads, bridges, highways, and waterways lowers the cost of transportation and facilitates the movement of goods and labor throughout the United States.[6] Public expenditure on education, health, sanitation, and water supply systems may increase human capital accumulation by making the labor force (or the future labor force, in the case of school children) more literate and healthier.[7]

We can model the growth of a city using the augmented Solow growth model, assuming that the city is a small economy. This model suggests that physical and human capital accumulation should go a long way in explaining the differential income levels of cities. According to Barro (1997: 2) in his cross-country study of economic growth and convergence, "The concept of capital in the neoclassical model can be usefully broadened from physical goods to include human capital in the forms of education, experience, and health." The effects of physical capital accumulation (Romer 1986) and

[6]Moomaw and Williams (1991) found some evidence of a positive relationship between highway infrastructure and productivity in the 48 contiguous states. However, Jiwattanakulpaisarn et al. (2009) found no statistically significant relationship between investments in highways and employment in 100 counties in North Carolina.

[7]Menes (1999: 2) states, "The roads, sewers, schools, transportation, electricity, gas and water provided by local governments or by government franchisees were vital to the health, wealth, and happiness of residents."

human capital accumulation (Lucas 1988) on economic growth are modeled and documented in many studies, such as Barro's (1997) cross-country empirical study and Barro and Sala-i-Martin's (1991) study of income convergence in U.S. states.[8] Stansel (2005 and 2009) found similar results for the relationship between human capital and the growth of population and employment in U.S. metropolitan areas.

Holtz-Eakin and Schwartz (1995) and Rauch (1994, 1995) provide formal theoretical models of the relationship between public expenditure and productivity at the sub-national level that are closely related to the subject of this article. Those models come to opposite conclusions about that relationship. Holtz-Eakin and Schwartz's (1995) article develops a neoclassical growth model explicitly incorporating infrastructure investments and providing a tractable framework to empirically analyze the significance of public capital accumulation to productivity growth. Examining a panel of state data, they find no statistically significant relationship between public sector capital and the growth of productivity. Their results suggest that higher infrastructure outlays were not associated with a significant increase in productivity growth in U.S. states between 1971 and 1986.

Rauch (1994) develops a formal model to study the effect of municipal reform in the Progressive Era (from 1902 to 1931) on city governments' allocation of public expenditure and on city growth, using the rates of growth in manufacturing employment and value-added output as measures for city growth. He finds that city governments' expenditure on roads, sanitation, and the water supply system are statistically significant in explaining manufacturing employment growth in both panel and cross-sectional analyses. However, expenditures on roads and sanitation are not statistically significant in explaining growth in manufacturing's value-added output in the panel regression.[9]

[8]Black and Henderson (1999) provide a formal model of human capital accumulation and urban growth.

[9]Rauch (1995: 969) states, "Investment in new infrastructure is assumed to generate city growth by providing a complementary input that attracts investment of private capital in traded goods industries (manufacturing), creating jobs which in turn attract migrants from a surrounding agricultural hinterland."

Our dependent variable is based on the same data as those used by Rauch, but we use the *level* (rather than the growth) of the log of real dollar value added by manufactures *per worker* (rather than the total), that is, we use productivity not overall output growth. Our analysis differs from Rauch's in four important ways. First, we explicitly model labor *productivity* (not output growth) as a function of productive public expenditure. Second, we include education and health spending in our public expenditure measure so that it will capture those additional potential benefits to human capital and thereby productivity. Third, we examine an earlier time period, 1880–1920 (one that avoids the potentially contaminating effects of the Great Depression and that includes the last two decades of the 19th century, which saw large public investments in basic infrastructure). And, fourth, we do not examine the impact of municipal reform on cities' growth, which is the main emphasis of Rauch's analysis. We differ from Holtz-Eakin and Schwartz (1995) in that we examine public expenditure rather than the public capital stock, we examine cities rather than states, and we examine the period 1880–1920 instead of their more recent time period.

We build on the previous literature in this area by providing the first investigation of the effect of productive public expenditures on labor productivity in municipalities, which has important implications for contemporary public policy issues. In recent years, there have been efforts in the United States and elsewhere to improve economic conditions by substantially increasing government spending on infrastructure projects at the state and local level. Proponents of such efforts have argued that those projects will increase productivity. Our focus on a period of high public expenditure on physical infrastructure and rapid industrialization and growth provides an ideal setting for finding evidence that supports that hypothesis that public expenditure is productive.

The Theoretical Framework

We follow the lead of previous studies (e.g., Aschauer 1989, Holtz-Eakin 1994, and Morrison and Schwartz 1992) and specify an aggregate Cobb-Douglas production function for the manufacturing sector in city j, for year t, which takes the form:

$$(1)\quad Y_{j,t} = A_{j,t}\, K_{j,t}^{\alpha}\, L_{j,t}^{\beta},$$

where j indexes the city and t indexes the year. $Y_{j,t}$ is value added to manufacturing output, $K_{j,t}$ is the value of private capital, $L_{j,t}$ is the number of workers, and $A_{j,t}$ is the measure of total factor productivity. We assume that $\alpha + \beta = 1$, implying constant returns to scale. Dividing equation (1) by $L_{j,t}$ yields the following equation denominated in per worker units:

$$(2)\quad Y_{j,t}/L_{j,t} = A_{j,t}\,[K_{j,t}/L_{j,t}]^{\alpha},$$

where $Y_{j,t}/L_{j,t}$ is value added per worker and $K_{j,t}/L_{j,t}$ is the ratio of private capital to labor. Taking the natural logarithm of the above equation yields the following:

$$(3)\quad \ln[Y_{j,t}/L_{j,t}] = \ln[A_{j,t}] + \alpha\ln[K_{j,t}/L_{j,t}].$$

Since local estimates of the value of the public sector capital stock were not available for this time period, we follow Rauch (1994, 1995) in using productive public expenditure. To investigate the effect of cities' public expenditure on certain public goods like roads, water supply systems, sanitation, education, and health, we exclude all other public expenditure, and we let total factor productivity depend solely on productive public expenditure as follows:

$$(4)\quad \ln[A_{j,t}] = A_t + \gamma PUBLIC_{j,t} + c_j,$$

where A_t is the time effect common to all cities for a given year, c_j is the city-specific effect, and $PUBLIC_{j,t}$ is the productive public expenditure per capita in city j in year t. Note that we are not modeling the effect of public expenditure on private capital accumulation. The omission of this interaction between public expenditure and private capital accumulation simplifies the analysis and allows us to focus on analyzing the levels of public expenditure and labor productivity for a given level of private capital.

In equation (4) the variable A_t can be interpreted as the technology that is available to all cities in year t. These time effects can be consistently estimated with the use of dummy variables for each year in our sample (YEAR). These year dummy variables are important because we know that the technology available in the manufacturing sector changed significantly during the period 1880 to 1920. Therefore, cities chose different levels of public expenditure,

$PUBLIC_{j,t}$, which will affect their level of technical efficiency.[10] We expect to see lower labor productivity in cities that were slower in installing clean water supply systems and sewers or cities that invested lower expenditure per capita in the prevention and treatment of communicable diseases, medical work for school children, and food regulation and inspection because the residents of such cities may be less healthy, more prone to diseases, and less productive than their counterparts in cities that invested early in these public works.

Similar to the time effects, the city-specific effects c_j can be consistently estimated using dummy variables for each city (CITY) in the sample and omitting one city's dummy variable. These city dummy variables control for unobservable city-specific factors that do not change over time but could affect the level of technology in a specific city. These unobserved city-specific factors could also be correlated with the explanatory variables and in any given city may affect labor productivity in an unobservable way. Some examples of unobservable city effects are agglomeration externalities and knowledge spillovers for firms located in close proximity to one another within a city and the level of entrepreneurship in a city. Another unobservable city-specific effect could be corruption in the city governments and the presence of patronage politics that affects the level of public expenditure. Menes (1999) finds that patronage politics in a city results in higher than optimal provision of public goods and higher wages paid to city employees.

Finally, substituting equation (4) into equation (3) yields the following:

$$(5)\quad \ln[Y_{j,t}/L_{j,t}] = A_t + \gamma PUBLIC_{j,t} + \alpha \ln[K_{j,t}/L_{j,t}] + c_j + e_{j,t},$$

where $e_{j,t}$ is a random error term. Equation (5) is a standard two-way fixed effects model with both city and year dummies. We rename $\ln[Y_{j,t}/L_{j,t}]$ as LNVALUE, A_t as the dummy variable YEAR,

[10]For simplicity, following Glaeser et al. (1995) and others, we ignore the impact of the revenue source required to finance this higher spending (taxes or bonds). Since higher taxes would tend to reduce productivity, this implicitly biases upward our coefficients on public expenditure.

$\ln[K_{j,t}/L_{j,t}]$ as LNCAPITAL, and c_j as the dummy variable CITY to yield:

$$\text{(6)}\quad LNVALUE_{j,t} = \Sigma_t YEAR_t + \gamma PUBLIC_{j,t} + \alpha LNCAPITAL_{j,t} + \Sigma_j CITY_j + e_{j,t},$$

for t = 1880, 1890, 1900, 1910, 1920
for j = 45 cities listed as Albany . . . Worcester .[11]

Consequently, equation (6) gives us a theoretical framework in which to estimate how much, if at all, cities' public expenditure affected labor productivity in the manufacturing sector. The log-normal specification arises because we have assumed an aggregate Cobb-Douglas production function for the manufacturing sector and we take the natural logarithm of the production function in order to obtain a linear equation which we can then estimate using two-stage least squares (2SLS) regression. The interpretation of the slope coefficient γ for PUBLIC yields a percentage change in labor productivity given a dollar change in the level of public expenditure.

One potential problem with this estimation is the endogeneity of the explanatory variable PUBLIC, that is to say, public expenditure may be influenced by the same unobservable factors that influence labor productivity (i.e., the endogenous variable PUBLIC is correlated with the model's error term), thus rendering the 2SLS regression estimates biased and inconsistent (Bound, Jaeger, and Baker 1995: 443). For example, the demographics of the population or the preferences of the city governments can endogenously affect public expenditure. Taxation can also affect both public expenditure and labor productivity through its impact on private capital accumulation (Rauch 1995: 968–69). There may be other omitted variables that also determine labor productivity and may influence public expenditure.

Another problem is that current expenditures (our independent variable of interest) depend on per capita income because cities with

[11]Our sample consists of 45 of the largest U.S. cities: Albany, Atlanta, Baltimore, Boston, Buffalo, Cambridge, Chicago, Cincinnati, Cleveland, Columbus, Dayton, Detroit, Fall River, Grand Rapids, Hartford, Indianapolis, Jersey City, Kansas City, Louisville, Lowell, Memphis, Milwaukee, Minneapolis, Nashville, New Haven, New Orleans, New York, Newark, Omaha, Paterson, Philadelphia, Pittsburgh, Providence, Reading, Richmond, Rochester, San Francisco, Scranton, St. Louis, St. Paul, Syracuse, Toledo, Trenton, Wilmington, and Worcester.

higher levels of average income may raise more tax revenues and thus provide more public goods and this may result in reverse causality linking the dependent variable (LNVALUE) to the explanatory variable (PUBLIC).

We deal with this problem of endogeneity in three econometric specifications: first, we use an instrumental variable (IV) in a 2SLS estimation; second, we use the initial-year values for the public expenditures and all other covariates to explain the subsequent 10-year growth rate of labor productivity (the dependent variable); and third, we use the lagged public expenditures as an explanatory variable. In our first method, we use ethnic fragmentation (ETHNIC) as an instrument for public expenditure because there is existing literature that suggests that ethnic fragmentation within a city makes it difficult for a city to agree on public spending due to the heterogeneous preferences of different ethnic groups over the types of public goods to produce with tax revenues. Thus, certain public goods such as education, roads, and sewers supplied by U.S. cities are inversely related to ethnic fragmentation in those cities (Alesina, Baqir, and Easterly 1999: 1243). The key finding in Alesina et al. (1999: 1274) is that ethnically fragmented cities devote lower shares of spending to core public goods like education and roads.

For our instrumental variable, we use Alesina et al.'s (1999: 1254–55) index of ethnic fragmentation (ETHNIC), which "measures the probability that two randomly drawn people from a city . . . belong to different ethnic groups." Thus, our measure of ethnic fragmentation is as follows:

$$(7)\quad \text{ETHNIC} = 1 - \textstyle\sum_i (Race_i)^2,$$

where $Race_i$ indicates the proportion of the population listed by the Census as race i and i = {Native White, Foreign White, African-American, and Other (includes Chinese, Japanese, and American Indians)}. ETHNIC is a probability that ranges from 0 (if perfect homogeneity or only a single race lives in a city) to a maximum of 0.75 (if perfectly fragmented into four equally sized racial groups). Our measure of ethnic fragmentation (ETHNIC) differs slightly from Alesina et al.'s because we use only four racial groups compared to their five racial groups, because we grouped Chinese, Japanese, and American Indians as "Other." The modern Census classification for "Asian and Pacific Islander" and "Other" (which largely identifies the Hispanic population in the United States) is unavailable during the period from 1880 to 1920. The main difference in our ETHNIC index from Alesina et al.'s is that we separated the White classification into Native White and Foreign White.

In the 2SLS IV estimation, we use the fitted values (PUBLIC_HAT) from the first-stage regression of PUBLIC on ETHNIC in the second stage regression of LNVALUE on PUBLIC_HAT. The idea here is that the instrumented estimate (PUBLIC_HAT) delivers exogenous variation in the explanatory variable and allows for a clean identification of the effect of PUBLIC on LNVALUE.[12] Good instruments should be correlated to the endogenous variable but should be exogenous or excludable from the second stage of the 2SLS regression so as not to influence the outcome directly. The evidence in Alesina et al. (1999) supports our choice of ethnic fragmentation as an instrumental variable for productive public expenditure.

The 2SLS regression is specified as follows. In the first stage, we estimate $PUBLIC\_HAT_{j,t}$:

$$(8)\quad PUBLIC_{j,t} = \alpha + \beta_1 ETHNIC_{j,t} + \beta_2 LNCAPITAL_{j,t} + \beta_3 LNPOP_{j,t} + \beta_4 LNLAND_{j,t} + \beta_5 LNWAGE_{j,t} + \beta_6 YEAR_t + \beta_7 CITY_j.$$

In the second stage, we use the instrumented estimate $PUBLIC\_HAT_{j,t}$ as a regressor:

$$(9)\quad LNVALUE_{j,t} = \alpha + \beta_1 PUBLIC\_HAT_{j,t} + \beta_2 LNCAPITAL_{j,t} + \beta_3 LNPOP_{j,t} + \beta_4 LNLAND_{j,t} + \beta_5 LNWAGE_{j,t} + \beta_6 YEAR_t + \beta_7 CITY_j.$$

In our estimates of equations (8), (9), (10), and (11), we included other covariates such as the natural log of city's population, the natural log of the city's size (in acres), and the natural log of real wage to control for the effects of these covariates on public expenditures per capita and on the natural log of value added per worker. We control for cities' population (LNPOP) because presumably cities with higher populations would provide more public goods. We also control for land area in acres (LNLAND) to account for boundary changes like the annexation of Brooklyn and Allegheny, respectively, by New York City in 1898 and Pittsburgh in 1907. Ideally we should be able to control for the level of income per capita by city (as this

[12]See Bound, Jaeger, and Baker (1995) and Angrist and Krueger (2001) for an introduction to IV estimation.

will affect the level of public expenditure because cities with a wealthier tax base may be able to provide more public goods), but these data do not exist in the time period under study. A good proxy for personal income per capita by city is the average real manufacturing wage obtained from the *Census of Manufactures* by city and deflated by the national CPI into real 1890 constant dollars. Since wages are usually assumed to follow a log-normal distribution, we include the log of cities' real average manufacturing wages (LNWAGE) as a control in our regression analysis. We also include city-specific (CITY) and time-specific fixed effects (YEAR).

Our second method to address the endogeneity issue is to use initial-year values for the public expenditure data (and all other explanatory variables) and subsequent growth (following the initial year) for the dependent variable.[13] Higher productivity growth from 1880 to 1890, for example, cannot have an impact on the level of public expenditure in 1880. So we examine in a panel regression the relationship between public expenditure in the first year of each decade (1880, 1890, 1900, and 1910) and the growth of labor productivity over the subsequent decade (1880–90, 1890–1900, 1900–10, and 1910–20), summarized in equation (10).

$$(10)\quad LNVALUE_{j,t+10} - LNVALUE_{j,t} = \sum_t YEAR_t + \gamma PUBLIC_{j,t} + \alpha_1 LNCAPITAL_{j,t} + \alpha_2 LNPOP_{j,t} + \alpha_3 LNLAND_{j,t} + \alpha_4 LNWAGE_{j,t} + \sum_j CITY_j + e_{j,t},$$

for t = 1880, 1890, 1900, 1910
for j = 45 cities listed as Albany . . . Worcester.

Finally, our third method to address the potentially endogenous relationship between public expenditure and productivity is to use lagged values for public expenditure. Productivity in 1890, for example, cannot have an impact on public expenditure in 1880. Due to limited availability of data, we must employ a 10-year lag. However, that may be unrealistically long. Public expenditures in the current year certainly have a bigger impact on productivity in future years than in the current year, but the ideal lag may be less than 10 years. Equation (11) provides the precise specification.

[13]There is precedent for this in the literature. For example, Barro (1991) and Glaeser et al. (1995) both use 1960 government expenditure data as an explanatory variable for 1960–90 economic growth.

TABLE 1
DESCRIPTIVE STATISTICS

Variable	N	Mean	Std. Dev.	Min	Max
Ln Value Added	219	7.05	0.35	6.07	8.01
Public Expenditure	219	5.61	2.55	0.28	15.39
Ethnic Fragmentation	219	0.43	0.07	0.15	0.57
Ln Private Capital	219	7.50	0.48	6.12	8.61
Ln City Population	219	12.13	0.96	10.53	15.54
Ln City Size (acres)	219	9.67	0.88	8.05	12.25
Ln Real Wage	219	6.14	0.21	5.29	6.64

NOTE: Year and city dummies are excluded from this table.

$$(11)\quad LNVALUE_{j,t} = \sum_t YEAR_t + \gamma PUBLIC_{j,t-10} + \alpha_1 LNCAPITAL_{j,t} + \alpha_2 LNPOP_{j,t} + \alpha_3 LNLAND_{j,t} + \alpha_4 LNWAGE_{j,t} + \sum_j CITY_j + e_{j,t},$$

for t = 1890, 1900, 1910, 1920
for j = 45 cities listed as Albany . . . Worcester.

Data Sources and Construction of Variables

We assemble a panel dataset for 45 of the largest cities in the United States that spans 40 years by hand-collecting data from the decennial censuses of 1880 to 1920, with 219 observations for cities' value added by manufacture, value of private capital in manufacturing, public expenditure, ethnic fragmentation, average number of wage earners, city size in acres, and city population.[14] See Table 1 for the summary statistics of the variables used in the regression analysis and Table 2 for the correlation matrix. We restrict our attention to

[14]We are missing observations for Grand Rapids, Memphis, Omaha, and Trenton in 1880. We also dropped two observations that were substantial outliers (Wilmington in 1880 and Reading in 1920, which were not representative of the usual trend of annual public capital spending) and thus would distort the coefficient estimates. In 1880, Wilmington spent 581 percent and 176 percent more on roads and education, respectively, in real terms compared with the average of 1890 to 1920. Similarly, in 1920 Reading spent 64 percent more on sewers, in real terms compared with the average between 1880 and 1910. Reading's spending on education cannot be consistently compared due to accounting irregularities (zero dollars recorded for 1880 and 1890 and $4,500 current dollars in 1910).

TABLE 2
Correlation Matrix

	Ln Value Added	Public Expenditure	Ethnic Fragmentation	Ln Private Capital	Ln City Population	Ln City Size (acres)	Ln Real Wage
Ln Value Added	1						
Public Expenditure	0.369	1					
Ethnic Fragmentation	−0.158	0.018	1				
Ln Private Capital	0.850	0.389	−0.139	1			
Ln City Population	0.524	0.300	0.137	0.422	1		
Ln City Size (acres)	0.297	0.194	0.200	0.226	0.762	1	
Ln Real Wage	0.814	0.382	−0.178	0.729	0.453	0.283	1

the 1880–1920 period for two reasons. This was a period of rapid industrialization in which there were both high levels of public infrastructure spending and rapid growth of productivity. Comparable data were not available for the years before 1880,[15] and incorporating additional data beyond 1920 would include data contaminated by the effects of the Great Depression.

Data on the value added by manufacture are published every five years in the *Census of Manufactures* and are available by city and by industry. The value added per worker is the difference in the value of total output less the cost of raw materials, divided by the average number of wage earners employed during the year. These wage earners, up through the working foreman level, are typically production workers, although there is no way to distinguish them from other nonproduction wage earners. The figures for value added per worker by city are deflated by the national Consumer Price Index (CPI) and converted into the natural log of value added per worker in 1890 constant dollars (LNVALUE).[16] Similar to other Census data, these value-added data are subject to some reporting error, but the method of enumeration is consistent throughout the time period of study. The source for these value-added data are the *Census of Manufactures* for the years 1879, 1889, 1899, 1909, and 1919, but these data are also published in the decennial censuses. Cities' value added by manufacture for the first three census years (1880, 1890, and 1900) also included "hand and neighborhood industries" but the latter two years (1910 and 1920) only measure "factory" establishments.

In other studies, such as Mitchener and McLean (1999 and 2003), labor productivity is measured by the average manufacturing wage. However, a problem in using wages as a measure of labor productivity arises if public expenditure is regarded as an amenity by city residents, then we can expect to see public expenditure be partly capitalized into wages (but this may also reflect higher taxes within

[15]See U.S. Department of Commerce (2008) for a discussion of the history of the Census Bureau's collection of data on U.S. governments.

[16]The national CPI—constructed by the Bureau of Labor Statistics—is available in the *Historical Statistics of the United States, Colonial Times to 1970* (Series E135–166). We use a national CPI to make price adjustments because during 1880–1920, the commodities and labor markets in the United States were pretty well integrated due to the completion of the transcontinental railway (Walton and Rockoff 2002: 363).

a city). The correlation will be negative because people will desire to live in a city with lots of public goods, thereby bidding the wages down. This capitalization of public expenditure into wages is the reason we are using value added per worker in manufacturing as the measure of labor productivity.

The changes in the level of value added by manufacture or labor productivity (LNVALUE) are correlated with public expenditure by city governments. In this article, we use the public capital definition set out by Corsetti and Roubini (1996: 2) as "government spending [that] affects the productivity of the final goods sector or the human capital accumulation sector." Data on city governments' spending were collected from the U.S. Census volumes on *Valuation, Taxation and Public Indebtedness* (1880) and *Wealth, Debt and Taxation* (1890) and from volumes of *Statistics of Cities* and *Financial Statistics of Cities* for all cities with populations of 30,000 or more (for 1904) and 100,000 or more (for 1909 and 1919). Similar to Rauch (1995) our measure of public expenditure per capita (PUBLIC) is the per capita sum of city governments' spending on roads, sanitation, and water supply systems, but we also include education and health spending. We think it is important to consider these education and health expenditures, which are not included in Rauch (1995), because they are components of public expenditure that may increase human capital accumulation. The expenditures on sewers and water supply systems have major health implications and thus would also have an effect on human capital accumulation.

Different types of public expenditure surely affect city residents' health, education, and labor productivity in different ways, but we are unable to properly account for these different effects. Using separate variables for each individual category of spending is problematic because of inconsistencies in reporting by local governments. For example, some cities' irregular accounting methods recorded zero expenditure on water supply systems and schools for some years (the water works may be contracted out to a private operator and the school expenditure could be listed under general expenses instead of under education). Because of those inconsistencies, we take a simple sum of cities' public expenditure on the five components (roads, water supply systems, sanitation, education, and health) and divide by the population of each city to obtain public expenditure per capita (PUBLIC). We use city population as the denominator because these public goods are largely nonexcludable and used by the entire population in each city. PUBLIC is also deflated by the national CPI and converted into real public expenditure in 1890 constant dollars. We believe the use of per capita expenditures is superior to the percentage of total expenditure measure that Rauch uses because it more accurately reflects the quantity of resources being devoted to public capital. An even better measure would be expenditures as a percentage of personal income, but the personal income data are not available by city for this time period.

The *Census of Manufactures* also reports the aggregate value of private capital stock, in current dollars, by city and by industry. These capital figures "show the total amount of capital, both owned and borrowed, on the last day of the business year reported."[17] There may be some measurement error in this variable because of the ambiguity of the census questions and the general difficulties of accounting for the value of capital goods. Private capital is a necessary variable to include in our regression analyses because it is an essential input in the manufacturing sector.

In order to construct the index of ethnic fragmentation (ETHNIC), we collected data from the U.S. Census volume on *Census of the Population* for the number of people within each city who are Native White, Foreign White, African-American, and Other (includes Chinese, Japanese, and American Indian) according to the racial classification used by the U.S. Census. Recall that the index is defined as follows:

$$\text{ETHNIC} = 1 - \Sigma_i \, (Race_i)^2,$$

where $Race_i$ indicates the proportion of the population listed by the Census as race i and i = {Native White, Foreign White, African-American, and Other (which includes Chinese, Japanese and American Indians)}. In our data set, the ETHNIC index ranges from a minimum of 0.15 in Reading, Pennsylvania, in 1880, to a maximum of 0.57 in Memphis for the year 1890. Southern cities—such as New Orleans, Memphis, Richmond, and Atlanta—show high levels of ethnic fragmentation because of their larger proportions of African-American residents. These Southern cities record ethnic fragmentation index numbers between 0.42 and 0.57, whereas cities in the Northeast (except Reading) record ethnic fragmentation index

[17]The quote is excerpted from the "Explanation of Terms" from the *Census of Manufactures* (1920: 15–18).

numbers between 0.28 and 0.50. These Northeast cities are fragmented between Native Whites and Foreign Whites.

Empirical Results

We use both panel and cross-sectional analyses to investigate the relationship between cities' productive public expenditure and labor productivity in the manufacturing sector. Table 3 provides the 2SLS estimates of equations (8) and (9) with robust standard errors. As panel A indicates for the first stage, in columns (3)–(6) (including all the regressions where the control variables are included), we see that ethnic fragmentation has the expected negative sign and is statistically significant in explaining differences in public expenditure. This provides evidence that ethnic fragmentation is indeed a good instrument for public expenditure. It is also economically significant because a 0.10 increase in the ethnic fragmentation index results in $2.15 (in column (6) specifically) decrease in real public expenditure per capita, which is about 38 percent of the mean public expenditure per capita. Panel B illustrates that the instrumented estimate PUBLIC_HAT has no statistically significant relationship with labor productivity when private capital and the other control variables are included (columns (10)–(12)).[18] However, private capital (LNCAPITAL) is highly significant, both economically and statistically, because a 1 percent increase in LNCAPITAL is associated with a 40.8 percent increase in labor productivity. The YEAR dummies are all negative in relation to the excluded 1920 dummy and are mostly statistically significant at the 1 percent significance level in explaining labor productivity because the available technology in later years plays a crucial role in increasing labor productivity.

Our second approach to address the potentially endogenous relationship between public expenditure and productivity is to regress

[18]We also estimated equation (5) by cross-sectional regressions for each year. The cross-sectional regression allows the constant and slope coefficients to change for each year. The different signs, sizes of the coefficients, and significance levels make it harder to formulate an overall interpretation for the entire time period under study, but we found that public expenditure per capita is not statistically significant with respect to labor productivity in each of the years studied. For brevity, those results are not included herein.

initial year values for public expenditure and the other explanatory variables on subsequent growth of the dependent variable as proposed in equation (10). Those results are provided in Table 4.

As column (3) indicates, we find no statistically significant relationship between productive public expenditure and the subsequent 10-year growth of labor productivity.[19] The fact that we are measuring the growth of productivity rather than the level helps explain why we find a negative and statistically significant coefficient on private capital. According to economic theory, cities with higher levels of private capital will have higher productivity. So, cities with higher levels of capital in the initial year would be expected to already have higher levels of productivity. If they have reached the point of diminishing marginal returns to capital, we would indeed expect to see lower growth of productivity in the subsequent years, compared to productivity growth in cities with lower levels of capital.

Finally, our third method for addressing endogeneity is to use lagged values for the potentially endogenous explanatory variable, so we regress productivity on public expenditure from 10 years earlier as proposed in equation (11). None of the other explanatory variables are lagged. As Table 5 illustrates, once the other covariates are included, productive public expenditures have no statistically significant relationship with the productivity of manufacturing labor 10 years later. This result mirrors our instrumental variables results in Table 3. While we find a small statistically significant positive coefficient without control variables in column (1), as we add other covariates the coefficient on LAGGED PUBLIC loses statistical significance and becomes smaller and changes to a negative sign. As with both of our other sets of results, the most prominent finding is the strong statistical significance of private capital.

Our results from these three separate estimation techniques find no evidence of a statistically significant relationship between public expenditure and labor productivity in the manufacturing sector during the period 1880–1920. These results confirm the theoretical model and empirical findings of Holtz-Eakin and Schwartz (1995),

[19]Running the regressions as four separate cross-sections, instead of as a panel, yields similar results. All coefficients on public expenditure are statistically insignificant as in Table 4. The one difference is that the coefficient in the regression for 1880–90 productivity growth has a positive sign. For brevity, those results are not included herein.

TABLE 3
Two-Stage Least Squares Regression Results

	(1)	(2)	(3)	(4)	(5)
		First-stage dependent variable: PUBLIC			
ETHNIC	0.621	3.333*	−20.56***	−21.46***	−21.12***
	(2.344)	(1.881)	(6.196)	(6.148)	(6.077)
PUBLIC_HAT					
LNCAPITAL				1.669**	1.475**
				(0.644)	(0.684)
LNPOP					0.993
					(0.703)
LNLAND					0.130
					(0.497)
LNWAGE					
1880 DUMMY		−1.988***	−0.744	1.137	2.070*
		(0.472)	(0.522)	(0.915)	(1.109)
1890 DUMMY		−1.239***	0.0975	1.177*	1.783**
		(0.361)	(0.425)	(0.602)	(0.725)
1900 DUMMY		2.122***	2.832***	3.352***	3.759***
		(0.360)	(0.342)	(0.407)	(0.490)
1910 DUMMY		0.318	0.969**	0.997**	1.203***
		(0.431)	(0.446)	(0.436)	(0.450)
CONSTANT	5.347***	4.292***	11.24***	−1.620	−13.30
	(1.003)	(0.784)	(1.948)	(5.159)	(8.418)
CITY DUMMIES?	No	No	Yes	Yes	Yes
Observations	219	219	219	219	219
R-squared	0.000	0.298	0.619	0.629	0.633

Note: Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.

who document an insignificant relationship between public expenditure and productivity growth in states from 1971 to 1986. Rauch (1994) was examining manufacturing employment growth in cities rather than productivity, so our results are not directly comparable. However, our findings are somewhat at odds with his finding of a positive relationship with some categories of public expenditures for the period 1902–1931. Finally, our results are similar to the empirical findings of Glaeser et al. (1995). Their results indicated that with the exception of sanitation spending, public expenditures had no relationship with the income and population growth rates of cities in

TABLE 3 *(cont.)*
Two-Stage Least Squares Regression Results

(6)	(7)	(8)	(9)	(10)	(11)	(12)
Second-stage dependent variable: LNVALUE						
−21.50***						
(6.056)						
	−1.239**	0.0110	−0.0092	0.00319	−0.00067	−0.0090
	(0.581)	(0.0598)	(0.0218)	(0.0169)	(0.0175)	(0.0158)
1.591**				0.471***	0.449***	0.408***
(0.668)				(0.0652)	(0.0646)	(0.0698)
1.004					0.0763	0.0799
(0.698)					(0.0581)	(0.0512)
0.190					0.0610*	0.0345
(0.509)					(0.0348)	(0.0315)
−0.940						0.433***
(1.637)						(0.126)
1.860		−0.832***	−0.860***	−0.319***	−0.242**	−0.128
(1.203)		(0.124)	(0.0533)	(0.0737)	(0.0939)	(0.0833)
1.793**		−0.454***	−0.471***	−0.167***	−0.109*	−0.0991*
(0.723)		(0.0781)	(0.0378)	(0.0418)	(0.0558)	(0.0506)
3.731***		−0.347**	−0.297***	−0.186***	−0.135**	−0.0911
(0.499)		(0.138)	(0.0625)	(0.0547)	(0.0617)	(0.0585)
1.186***		−0.206***	−0.193***	−0.197***	−0.172***	−0.155***
(0.455)		(0.0507)	(0.0352)	(0.0248)	(0.0278)	(0.0291)
−8.858	14.00***	7.343***	7.392***	3.621***	2.337***	0.180
(11.57)	(3.263)	(0.338)	(0.117)	(0.498)	(0.802)	(0.813)
Yes	No	No	Yes	Yes	Yes	Yes
219	219	219	219	219	219	219
0.634	0.025	0.633	0.879	0.924	0.927	0.933

the period between 1960 and 1990. Our results also generally confirm their findings for the relationship between urban growth and racial composition and segregation. More recently, using a similar approach but examining metro areas instead of cities, Stansel (2009) also found no significant relationship between local government spending and economic growth over 1960–90. As discussed previously, the general consensus in this local growth literature is that government spending, as a whole, has no significant relationship with growth, however a positive relationship is sometimes found for specific categories of spending.

TABLE 4
Regression Results for Ten-Year Growth Rates in LNVALUE

	(1)	(2)	(3)
	Dependent variable: DLNVALUE		
PUBLIC	−0.00964*	−0.00768	−0.0125
	(0.00582)	(0.00632)	(0.00911)
LNCAPITAL	−0.120***	−0.187***	−0.265**
	(0.0445)	(0.0658)	(0.125)
LNPOP	0.0404**	0.0388**	0.218**
	(0.0198)	(0.0190)	(0.0992)
LNLAND	−0.0109	−0.0204	−0.0956
	(0.0214)	(0.0232)	(0.0726)
LNWAGE	−0.192**	−0.0248	−0.333
	(0.0964)	(0.101)	(0.247)
1890 DUMMY		−0.150***	−0.0988
		(0.0388)	(0.0915)
1900 DUMMY		−0.0934	−0.0327
		(0.0586)	(0.120)
1910 DUMMY		0.0194	0.0754
		(0.0772)	(0.164)
CONSTANT	1.948***	1.571***	2.565
	(0.487)	(0.596)	(2.039)
CITY DUMMIES?	No	No	Yes
Observations	174	174	174
R-squared	0.245	0.356	0.515

Note: Robust standard errors in parentheses.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$.

One possible explanation for the consistent finding of an insignificant relationship is that the potential benefit of local government spending may be outweighed by the cost of the taxes necessary to finance that spending. (Unlike the federal government, local governments generally lack the ability to run a budget deficit.) Taxes remove money from the private sector, in which the profit motive tends to ensure its efficient usage, and transfer it to the political sector, in which electoral motives play a strong role. As a result, when local government spending and taxes rise, there

TABLE 5
Regression Results with Lagged Public Expenditures

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Dependent variable: LN VALUE						
LAGGED PUBLIC	0.0317***	0.003	−0.00158	−0.0017	−0.00533	−0.000637	−0.00429
	−0.00578	−0.00561	−0.0052	−0.00519	−0.00479	−0.00447	−0.00434
LNCAPITAL		0.585***	0.526***	0.524***	0.420***	0.394***	0.448***
		−0.0519	−0.0556	−0.0564	−0.0596	−0.0882	−0.0882
LNPOP			0.0787***	0.102***	0.0748***	0.0645***	0.217***
			−0.0149	−0.0286	−0.0223	−0.0218	−0.0743
LNLAND				−0.0295	−0.0269	−0.022	−0.000298
				−0.0261	−0.0235	−0.0226	−0.034
LNWAGE					0.645***	0.584***	0.221
					−0.131	−0.126	−0.16
1890 DUMMY						−0.110**	−0.00901
						−0.0537	−0.0527
1900 DUMMY						−0.122***	−0.0736**
						−0.041	−0.0356
1910 DUMMY						−0.162***	−0.136***
						−0.0325	−0.0313
CONSTANT	6.984***	2.655***	2.172***	2.180***	−0.69	0.0337	−0.114
	−0.0395	−0.38	−0.376	−0.38	−0.662	−0.734	−0.809
CITY DUMMIES?	No	No	No	No	No	No	Yes
Observations	174	174	174	174	174	174	174
R-squared	0.104	0.569	0.627	0.63	0.704	0.749	0.911

Note: Robust standard errors in parentheses.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$.

is a reduction in the efficiency of the usage of resources. All else equal, areas that utilize resources more efficiently will tend to have more prosperous economies. As Stansel (2011) illustrates for metropolitan areas and Poulson and Kaplan (2008) illustrate for states, higher tax burdens do tend to be associated with slower economic growth.[20]

Conclusion

This article provides the first examination of the relationship between public expenditures and labor productivity that focuses on municipalities, rather than states or nations. Despite examining the issue in a context very conducive to finding a positive relationship between public expenditure and productivity (during a period of rapid expansion of both), this article finds no evidence of such a relationship. Once other factors are controlled for, higher levels of productive public expenditure by city governments have no statistically significant impact on labor productivity in the manufacturing sector for 1880–1920. These findings are robust to three different econometric approaches. They are consistent with the findings of much of the other literature in this area, and they have distinct implications for contemporary public policy issues.

There have been efforts in many countries in recent years to dramatically increase public spending as a way to improve economic conditions. In the United States, for example, federal government spending increased by more than $1 trillion dollars between fiscal year 2007 (the peak of the previous expansion) and fiscal year 2012, an increase of 40 percent in just four years. Much of that new spending has focused on infrastructure projects at the state and local level, with the argument often being made that those projects will boost productivity. Our results, and the similar results of others, cast doubt on the ability of that fiscal expansion to achieve its intended effect. These results may be particularly relevant for rapidly growing middle-income countries.[21] For local governments in particular, keeping their tax burden low—especially relative to their neighbors—may be a more effective strategy for economic revival.

[20]Reed (2008) provides an excellent summary of the voluminous literature in this area, focusing on the states.

[21]We are grateful to an anonymous referee for making this point.

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