The Influence of Air Conditioning on the Growth of State Government Expenditures

Thomas A. Garrett and Natalia A. Kolesnikova

A key feature of the U.S. economy is the dramatic increase in expenditures by all levels of government beginning in the 20th century. At the national level, the U.S. government annually spent roughly $142 (in 2017 dollars) per capita from the 1790s to the 1910s compared to $11,500 per capita in 2017.[1] Expenditure growth outpaced the growth in income as well as population, with U.S. government expenditures accounting for 3.3 percent of gross domestic product (GDP) in 1930 compared to 20.5 percent of GDP in 2017. The behavior of state government expenditures parallels that of the U.S. government: total state government spending increased from $1,470 (in 2017 dollars) per capita in 1960 to nearly $6,980 per capita in 2017. Total state government expenditures increased from 5.8 percent of GDP in 1960 to roughly 12 percent of GDP in 2017.

The growth in government has attracted considerable academic research that has generated numerous theories to explain (or partially explain) government growth in the United States. All theories

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[1]U.S. government data (nominal values) are from the Office of Management and Budget. State government data (nominal values) are from the U.S. Census's *State Government Finances*, various years.

assume that a market for public sector output and expenditures exists (Mueller 2003).[2] The demand for government output and expenditures is determined by individual citizens or a collection of citizens organized into special interest groups. Essentially, demand-side theories argue that government has grown because citizens have demanded more government. These theories make use of the median-voter model (Downs 1957, 1961) to explain why citizens have had an increased demand for public goods (e.g., increased income) and a reduction in externalities (Baumol 1967; Ferris and West 1996; Mueller 2003), as well as a greater demand for more redistribution of income (Meltzer and Richard 1978, 1981, 1983).[3] In addition, citizen-based interest groups can increase government size by organizing members and applying political pressure more effectively than individuals (Olson 1965; Becker 1983; Ekelund and Tollison 2001).

Supply-side theories of government growth argue that government expenditures are determined by legislators and bureaucrats who face certain incentives, the inherent inefficiencies in the provision of government goods, and the structure of government (e.g., representative democracy versus democracy). Niskanen's (1971) theory of bureaucracy postulates that government bureaucrats maximize the size of their agencies' budgets in accordance with their own preferences, and are able to do so because of the unique monopoly position of the bureaucrat.[4] Fiscal illusion theory (Buchanan 1967) assumes that government, specifically legislators and the executive branch, can deceive voters as to the true size of government by using taxes and tax collection measures that are less obvious to citizens.[5] Finally, the idea that representative governments behave as monopolists was first suggested by Breton (1974) and extended further by Brennan and Buchanan's (1977, 1980) model of leviathan

[2]Also see Garrett and Rhine (2006) for a more thorough discussion of demand-side and supply-side theories of government growth.

[3]The median voter's demand for government is typically modeled as a function of income, the relative price of public goods to private goods, and tastes.

[4]Mueller (2003: chap. 16) provides a summary of 70 studies that examined the cost of public- versus private-sector provision of identical services. The majority of studies find that public provision is more costly.

[5]Examples include the federal withholding of income taxes and property tax collection through monthly mortgage payments

government where a monopoly government's sole objective is to maximize revenue.[6]

It is not unreasonable to argue that government growth is likely the result of both demand-side and supply-side factors. Thus, research along these lines to deepen our understanding of the market for government output and expenditures seems warranted. In this article, we argue that the introduction of air conditioning in states' capitol buildings was a permanent technology shock that may have contributed to the growth in state government output, and thus expenditures, by increasing the productivity (output per unit of labor input) of legislators, lobbyists, bureaucrats, and others involved in producing government output and expenditures. We also argue that the effects of air conditioning would have been most pronounced in warmer states.

The following quotations suggest that the hypotheses of this article merit more rigorous attention:

> The installation of air conditioning in the 1930s did more, I believe, than cool the Capitol, ... members were no longer in a hurry to flee Washington. The southerners especially had no place else to go that was half as comfortable [Martin 1960: 49].

> Six months of every year, the nation enjoyed a respite from the promulgation of more laws, the depredation of lobbyists, the hatching of new schemes for Federal expansion and, of course, the cost of maintaining a government running at full blast. Once air conditioning arrived, Congress had twice has much time to exercise its skill at regulating and plucking the population [Baker 1978: 6].

Prior to air conditioning, attempts to cool buildings or rooms, including those in states' capitols, were typically done with electric fans or swamp coolers (which worked on the principle of evaporation), neither of which reliably cooled rooms to comfortable levels (Arsenault 1984).[7] Air conditioning, however, effectively lowered

[6]Breton (1974) argues that the party in control of the legislature has an objective function that includes the probability of reelection, personal pecuniary gain, and the pursuit of personal ideals. While providing basic public goods, a monopoly government can obtain its objectives by bundling narrowly defined issues that benefit individual members of the government (see Tullock 1959).

[7]We discuss different types of air conditioning (e.g., window units versus central systems) later in the article.

both room temperatures and humidity levels, thus greatly improving working and living conditions. There is little doubt that the introduction of air conditioning transformed society during the 20th century by increasing the productive efficiency of businesses and households (Arsenault 1984; Cooper 1998; Solomon 2003). There is thus reason to presume that the public sector was also influenced by the transformative and productivity-enhancing effects of air conditioning.

Our theory of government growth is not an independent explanation for growth but rather a contributing explanation. That is, we take the supply-side and demand-side factors as given and reasonable and argue that the introduction and existence of air-conditioning has *enhanced* the supply-side and demand-side factors that have been hypothesized to influence state government growth—for example, lobbying in states' capitols by citizens and legislators became more pleasant and occurred all year without summer break. While we are agnostic about the precise effect of air conditioning on specific supply-side and demand-side factors that influence state government growth, it seems reasonable to suggest that air conditioning could have a direct effect on the productivity of all parties involved in producing government output just as it did for households and businesses.

The analysis proceeds in several steps. As a motivation for our empirical methodology, we first present a simple model of technological growth to demonstrate how the introduction and subsequent existence of air conditioning in a state capitol may have led to increased growth in state government output. A brief discussion is then provided to motivate the link between state government output and state government expenditures. We then discuss the panel data, identification strategy, and the empirical methodology that is used in order to test our hypothesis that the growth in state government expenditures was greater after the introduction of air conditioning in states' capitols. Finally, we present our empirical results, which support our hypothesis that the growth in state government expenditures was higher after the introduction of air conditioning in state capitols, and that this effect was more pronounced in the warmer southern states.

Conceptual Framework and Motivation

As the starting point for our conceptual framework, it is important to first examine how the introduction of air conditioning could have influenced the growth in the output of state governments.

As discussed shortly, there is a direct link between the growth in government output and the growth in government expenditures.

We assume that the introduction of air conditioning, both generally and in state capitols, acted as a one-time and permanent labor-augmenting technology shock.[8] Let the labor-augmenting technology be represented by the parameter A, where $A = 1$ before the labor-augmenting technology shock and $A > 1$ after the technology shock. We can write a representative production function for a state government's output (q) as

$$q = q(K, A \cdot L),$$

where K and L are capital and labor inputs, respectively.[9] Rewriting the above production function as a function of time to capture output growth as a result of air conditioning gives

$$q(t) = q(K(t), A \cdot L(t)). \tag{1}$$

Totally differentiating with respect to t yields

$$\frac{dq}{dt} = \frac{\partial q}{\partial K} \cdot \frac{\partial K}{\partial t} + \frac{\partial q}{\partial L} \cdot \frac{\partial L}{\partial t} \cdot A.$$

Dividing both sides by q gives

$$\frac{dq}{dt \cdot q} = \frac{\partial q}{\partial K \cdot q} \cdot \frac{\partial K}{\partial t} + \frac{\partial q}{\partial L \cdot q} \cdot \frac{\partial L}{\partial t} \cdot A,$$

or, equivalently,

$$\frac{dq}{dt \cdot q} = \frac{\partial q}{\partial K \cdot q} \cdot \frac{K}{K} \cdot \frac{\partial K}{\partial t} + \frac{\partial q}{\partial L \cdot q} \cdot \frac{L}{L} \cdot \frac{\partial L}{\partial t} \cdot A. \tag{2}$$

[8]We argue that air conditioning was a labor-augmenting shock since government output is predominantly determined by the actions of citizens and legislators. However, the impact of technological growth on output is similar regardless of how the technology is specified (e.g., capital augmenting or augmenting both inputs).

[9]We assume that there was no technological progress in air conditioning. Dropping this assumption would give us a parameter A that is a function of time, resulting in output growth being a function of technological growth in air conditioning over time. While technology may have improved the efficiency and cost of air-conditioning systems over time, it is unlikely there would have been significant improvements in the cooling ability of subsequent air-conditioning systems since initial air-conditioning systems already provided cool and low-humidity environments (Arsenault 1984).

Rewriting in familiar terms gives the following expression for output growth due to labor-augmenting technological progress:

$$\dot{q} = \dot{K} \cdot \varepsilon_{q,K} + \dot{L} \cdot \varepsilon_{q,L} \cdot A, \tag{3}$$

where $\varepsilon_{q,K}$ is the elasticity of output with respect to capital and $\varepsilon_{q,L}$ is the elasticity of output with respect to labor.[10] It should be clear from (3) that output growth, $\dot{q}$, is higher after the introduction of air conditioning ($A > 1$) than before the introduction of air conditioning ($A = 1$), regardless of whether the usage of inputs remains constant or increases over time.[11] Note that the technology shock essentially increases output by increasing the marginal product of labor, $(\partial q/\partial L) \cdot A$, in equation (2) even if the quantity of labor remains constant.

There is a clear link between government output and government expenditures; namely, that government expenditures reflect the total cost of producing total government output.[12] This cost not only includes the cost of inputs but also the cost of maintaining government programs (social programs, military, etc.). Thus, our line of reasoning is that air conditioning in a state's capitol was a positive

[10]Recall that the growth rate of any variable x per unit of time is $\dot{x} = (dx/x)/dt$.

[11]It is certainly possible that the introduction of air conditioning would have also increased labor supply and hours worked. Air conditioning in state capitols made the workplace more pleasant; thus, on the margin, employees would work more hours and consume fewer leisure hours. More hours worked would then have led to an increase in output. Unfortunately, we cannot isolate this effect with the available data.

[12]Measures of government output have included the number of bills, acts, or statutes (termed legislative output) enacted during a specified period of time, as well as legislative session length (Mayhew 1991; Howell et al. 2002; Clinton and Lapinski 2006). More legislative output will increase the total output of the respective public sector by increasing, for example, the scope and number of agencies, the number of new social programs, and, ultimately, expenditures on these programs, and so on. In our empirical models, we use government spending rather than the aforementioned government output measures due to the annual availability and consistency of expenditure data across states compared with state-specific data on bills, acts, or statutes (e.g., more bills or statutes passed in one state does not necessary imply that that state will have higher expenditures, because expenditures depend upon the purpose of the bills and statutes). We argue that government spending is a more comprehensive measure of (the dollar value of) government activity than bills, acts, statutes, or session length because spending not only captures the effects of the number of bills, acts, statutes, and session length, but also the demand-side and supply-side factors that occur outside of the legislative session.

technology shock that increased legislative output in a state capitol by "shifting up" the government production function, which resulted in an increase in the total output of the respective state government. This increase in total output then resulted in an increase in state government expenditures after the introduction of air conditioning.

We also argue that air conditioning enhanced the supply-side and demand-side factors that have been argued to also contribute to government growth. On the demand side, the presence of air conditioning in state capitols may have facilitated lobbying by consumer and business interests by making lobbying more comfortable, thus leading to additional legislative output and, following the explanation made earlier, ultimately an increase in government expenditures. On the supply side, theory and evidence suggest that governments are not cost minimizers. The additional total physical output due to air conditioning would therefore not be produced at the lowest cost. In other words, air conditioning would have further increased the cost inefficiencies of government, thus increasing state government expenditures even more.

It is worthwhile to summarize our conceptual framework and resulting hypothesis, as both serve as the basis for our empirical setup. Government output and expenditures were increasing before the introduction of air conditioning due to changes in input usage as well as supply-side and demand-side factors. The introduction of air conditioning was a one-time, permanent technology shock that increased output and expenditures by not only increasing the marginal product of labor, but also by enhancing the supply-side and demand-side factors that have been found to contribute to government growth. This implies that the average annual growth rate of state government expenditures was greater after the introduction of air conditioning. In the following section we discuss the empirical methodology used to test our hypothesis.

Data and Empirical Methodology

We use a panel dataset of U.S. states in order to test our hypothesis that the growth of state government expenditures was greater after the introduction of air conditioning in each state's capitol. In order to account for population growth that has occurred over time (which would affect the government expenditures via the supply and demand for government), our dependent variable is real per capita state government expenditure.[13] Our empirical approach is to examine whether the trend-rate of growth in state government expenditures, where the trend captures the behavior of expenditures due to all aforementioned supply and demand factors, was greater after the introduction of air conditioning, especially in warmer states.

Testing for differences in the trend-rate of growth in state expenditures before and after air conditioning requires identifying the point in time in which the "break" in the trend occurred. Our identification of this break in trend is the year in which air conditioning was installed in each state capitol. One issue we faced was how to define the existence of "air conditioning." Prior to the installation of central air-conditioning systems, some offices in state capitols had window air-conditioning units that cooled individual offices while leaving many other offices, conference rooms, and the legislative chambers uncooled. We consider the year when central air conditioning (e.g., HVAC) was introduced throughout the entire state capitol as the date in which air conditioning was introduced.

Much effort went into contacting state historians, legislative archivists, and even "old-timers" who had worked in the state capitol for decades, in order to determine when air conditioning was installed in each state capitol. We were able to obtain air-conditioning installation dates (years) for 21 states. The first year after each state installed air conditioning in its capitol building serves as the break in the trend for each state's expenditure growth that we test for in our empirical models.

As suggested earlier, it seems likely that the effect of air conditioning on state government expenditures would differ depending upon the relative difference in indoor air temperature due to air conditioning compared to indoor air temperature without air conditioning. That is, the relative increase in indoor comfort levels due to air conditioning would be greater in the states with warmer and more humid climates compared to the states with cooler and less humid climates. Thus, the hypothesized effects of air conditioning should be

[13]All state government expenditure data were obtained from the U.S. Census Bureau's *State Government Finances* (various years). State population data are from the Bureau of Economic Analysis. All data are in CPI base-year dollars (1983).

greater in warmer and more humid states. To explore this possibility, our empirical analysis considers the impact of air conditioning on state government expenditures in "warm" states compared to "cool" states.

We followed several steps in order to classify each of the 21 states in our sample as either a "warm" state or a "cool" state. The National Oceanic and Atmospheric Administration (NOAA) defines an uncomfortable and potentially dangerous heat-index level as that above 80 degrees Fahrenheit.[14] Thus, we classify a state as "warm" ("cool") if its average summertime heat index is above (below) 80. To calculate the summertime heat index for each state, we used the primary formula used by NOAA.[15] This formula requires data on air temperature and humidity levels. For each state, we therefore obtained the average air temperature and humidity levels over the months of June, July, and August in 2010 for each state's capital city.[16] We then calculated the heat index for each state's capital city and used the heat index benchmark of 80 to either classify the state as a warm state or a cool state.

Not surprisingly, it turned out that warm states had air conditioning installed sooner than many cool states. In order to be able to make a comparison between the effect of the introduction of air conditioning in warm and cool states, we omitted from our final sample those cool states that had air conditioning installed much later than any warm state. Our final sample includes all seven warm states for which we were able to obtain the dates of air conditioning installation and five cool states that had air conditioning installed during the same time period as warm states. Table 1 presents the 12 states in our panel of data, the year that air conditioning was installed in each state's capitol, and the classification of each state as "warm" or "cool." In these 12 states, air conditioning in the capitol buildings was installed between 1959 and 1969.[17] In order to ensure a sufficient

[14]See www.nws.noaa.gov/os/heat/heat_wave.shtml.

[15]See www.wpc.ncep.noaa.gov/html/heatindex_equation.shtml.

[16]Air temperature and humidity data are readily available from The Weather Underground at www.wunderground.com/history.

[17]The omitted cool states (Massachusetts, Michigan, Minnesota, Nevada, New Jersey, North Dakota, Vermont, Wisconsin, and Wyoming) had air conditioning installed in their capitol buildings as late as 1992.

TABLE 1
Air Conditioning in the State Capitols

State	First Full Year of A/C	Cool or Warm State	Contact/Source
Arizona	1961	Warm	Alice Duckworth, Museum Outreach Coordinator Arizona Capitol Museum
Arkansas	1969	Warm	Dr. David Ware, Capitol Historian
Colorado	1959	Cool	Colorado State Archives, Capitol Virtual Tour
Idaho	1968	Cool	Ric Johnston, State of Idaho Division of Public Works
Kansas	1959	Warm	K. Vance Kelley, Treanor Architects
New Mexico	1967	Cool	Rick Hendricks, Ph.D., State Historian
Ohio	1964	Cool	Chris Matheney, Historic Site Manager, Ohio Statehouse
South Carolina	1961	Warm	www.scstatehouse.gov/studentpage/Explore/history.shtml
Tennessee	1959	Warm	Jim Hoobler, Senior Curator, Tennessee State Museum
Texas	1959	Warm	Julie Fields, Public Information Coordinator, Texas Preservation Board
Utah	1963	Cool	State Building Board and Jensen Construction
Virginia	1965	Warm	Jim Woolton, Executive Director, Capitol Square Preservation Council

Note: See text for a description of how "cool" and "warm" states were classified as such. More detailed contact and source information are available from the authors.

number of year-observations before and after the introduction of air conditioning, our panel includes the years 1950–75.[18]

Our empirical objective is to test whether the trend growth in state expenditures is larger after the introduction of air conditioning, and whether the difference in expenditure growth as a result of air conditioning varies between warm states and cool states. To meet this objective, we first created binary variables that denote whether a state is warm or cool, as well as a variable that denotes the presence of air conditioning in each state's capitol. We construct the variable *Cool* that has a value of '1' if state *i* has been classified as cool, and has a value of '0' if state *i* has been classified as warm. Similarly, we construct another binary variable *Warm* that has a value of '1' if state *i* has been classified as warm, and has a value of '0' if state *i* has been classified as cool. The variable *PostAC* has a value of '1' for all years in which air conditioning was present in each state's capitol, and has a value '0' otherwise. We also create a linear time trend variable (*Trend*) to capture the growth in state government expenditures, where $Trend_t = t$ for years (observations) $t = 1, 2, \ldots 26$.

The variables we use in our empirical models are as follows. The variable $WarmTrend_{it}$ is constructed as $Warm_{it} \cdot Trend_t$, and this variable captures the time trend for all states classified as warm. Similarly, the variable $CoolTrend_{it}$ is constructed as $Cool_{it} \cdot Trend_t$, and this variable captures the time trend for all states classified as cool. These two variables are then interacted with the variable *PostAC* to arrive at the variables $WarmTrendPostAC_{it}$ and $CoolTrendPostAC_{it}$. With these variables in hand, we can specify our regression equation as

$$(4) \quad G_{it} = a_0 + a_1 \cdot WarmTrend_{it} + a_2 WarmTrendPostAC_{it} + a_3 \cdot CoolTrend_{it} + a_4 \cdot CoolTrendPostAC_{it} + a_5 \cdot Inc_{it} + \delta_i + \theta_{D60} + \theta_{D70} + \delta_i \cdot \theta_{D60} + \delta_i \cdot \theta_{D70} + \varepsilon_{it},$$

[18]In addition to ensuring a sufficient number of years pre– and post–air conditioning, we chose to end our sample in 1975 to (1) avoid potential confounding effects from the national and state fiscal crises of the late 1970s, and (2) to best capture the effects of air conditioning that are likely to be seen soon after the introduction of air conditioning rather than later years due to dilution of the potential effect over time. Similar results are obtained using alternative end-dates around 1975. These results are available from the authors.

where i denotes each state ($i = 1, 2 \ldots 12$) and t denotes each year ($t = 1, 2, \ldots 26$) in our sample of panel data. The dependent variable, G, is total state government expenditures. We first specify this variable as the natural log of real per capita expenditures so that the trend coefficients reflect the average annual growth rate of expenditures. As an alternative measure, we also estimate this regression with the dependent variable measured as the level of real per capita state expenditures. Fixed state-effects (δ_i) are included to account for cross-state heterogeneity, as well as allowing the initial level of government growth to differ by state. Fixed decade-effects (θ_{D60} and θ_{D70}) are included to account for decade-specific shifts in government expenditures. We also interact these decade-effects with each state's fixed-effect to account for state-specific decade-effects, such as crisis episodes (Higgs 1987; Bologna and Young 2016), changes in the federal/state relationship (Sobel and Crowley 2014) that have been shown to be state specific and have differing effects on state government expenditures, and other technological changes (e.g., the introduction of computers) that may have occurred. Finally, we include per capita state personal income (Inc_{it}) to control for the demand-side effect of income growth on government expenditures. Our key trend variables thus capture the behavior of government expenditures due to all possible aforementioned reasons except income growth.

The interpretation of the coefficients of interest in equation (4) is as follows. When the dependent is specified as the natural log of real per capita expenditures, the coefficient α_2 reflects the growth in government expenditures for warm states after the introduction of air conditioning *relative* to the growth in government expenditures for warm states prior to the introduction of air conditioning (α_1). Similarly, the coefficient α_4 reflects the growth in government expenditures for cool states after the introduction of air conditioning *relative* to the growth in government expenditures for cool states prior to the introduction of air conditioning (α_3). When the dependent variable is specified as the level of real per capita expenditures, α_2 and α_4 reflect the marginal difference in per capita spending after air conditioning relative to spending before air conditioning in warm and cool states, respectively. As stated earlier, the goal of our empirical framework is not to determine the significant factors that explain the growth in the state government expenditures, but rather to see if there is a break in the trend (where the trend reflects the behavior of government expenditures due to all possible aforementioned reasons, except income) after the introduction of air conditioning.

It is worthwhile to briefly discuss our expected empirical results based upon the previous conceptual framework. Regarding warm state capitols, it seems reasonable that air conditioning would have likely resulted in a significant marginal improvement in comfort levels, and thus productivity and expenditures. If air conditioning increased the growth in government spending in warm state capitols, we expect to find that α_2 is positive and statistically significant. However, with respect to cool states, the marginal improvement in comfort levels as a result of air conditioning may not have had a significant impact on subsequent expenditure growth. More importantly, however, if air conditioning had a greater impact on expenditures growth in warm states than it did in cool states, we should find that α_2 is significantly larger than α_4.

Empirical Results

This section presents the empirical results from equation (4) as well as the results from the above-mentioned hypothesis tests. In addition, we present empirical results from growth regressions that consider various components of state government spending.

The Growth Rate of State Government Expenditures before and after Air Conditioning

The empirical estimates for equation (4) with the dependent variable specified as the natural log of real per capita expenditures (so the trend coefficients reflect the average annual growth rate of expenditures) are shown in the first column of Table 2. We find that, not surprisingly, expenditure growth in both warm and cool states was increasing before the introduction of air conditioning, where warm states had an average growth rate of 4.6 percent and cool states had an average growth rate of 4.1 percent. Per our hypothesis, we wish to examine whether the growth in expenditures was higher after the introduction of air conditioning in the capitols. For warm states, we find that the relative annual expenditure growth in warm states after the introduction of air conditioning was

TABLE 2
Air Conditioning and State-Government Expenditures: Growth Regressions

Variable	Total Spending: (1) Dependent Variable: Ln Per Capita Total State Expenditures	Spending Component: (2) Dependent Variable: Ln Per Capita State Education Expenditures	(3) Dependent Variable: Ln Per Capita State Health Expenditures	(4) Dependent Variable: Ln Per Capita State Welfare Expenditures	(5) Dependent Variable: Ln Per Capita State Transfer Expenditures
Constant (α_0)	5.4660**	3.2511**	3.1085**	1.5326**	3.5349**
	(0.0894)	(0.1594)	(0.1562)	(0.1515)	(0.1103)
WarmTrend (α_1)	0.0459**	0.0382**	0.0472**	0.0091*	0.0289**
	(0.0021)	(0.0039)	(0.0032)	(0.0041)	(0.0020)
WarmTrendPostAC (α_2)	0.0029**	0.0105**	0.0064**	−0.0014	0.0103**
	(0.0007)	(0.0014)	(0.0014)	(0.0014)	(0.0011)
CoolTrend (α_3)	0.0412**	0.0461**	0.0358**	−0.0051	0.0351**
	(0.0020)	(0.0034)	(0.0030)	(0.0035)	(0.0018)
CoolTrendPostAC (α_4)	−0.0009	0.0060**	0.0072**	0.0055**	−0.0004*
	(0.0067)	(0.0010)	(0.0014)	(0.0010)	(0.0009)
Ln(PC Income) (α_5)	0.1838**	0.6592**	0.1142	0.7100**	0.4954**
	(0.0545)	(0.0978)	(0.0957)	(0.0916)	(0.0662)

(Continued)

TABLE 2 *(Continued)*
Air Conditioning and State-Government Expenditures: Growth Regressions

Variable	Total Spending: (1) Dependent Variable Ln Per Capita Total State Expenditures	Spending Component: (2) Dependent Variable Ln Per Capita State Education Expenditures	(3) Dependent Variable Ln Per Capita State Health Expenditures	(4) Dependent Variable Ln Per Capita State Welfare Expenditures	(5) Dependent Variable Ln Per Capita State Transfer Expenditures
State Dummies	Yes	Yes	Yes	Yes	Yes
Decade Dummies	Yes	Yes	Yes	Yes	Yes
State*Decade Dummies	Yes	Yes	Yes	Yes	Yes
Difference in warm state growth versus cold state growth after AC ($\alpha_2 - \alpha_4$)	0.0020	0.0045	−0.0008	−0.0069	0.0099
T-test for H_o: $\alpha_2 \leq \alpha_4$	3.916**	2.910**	−0.469	−4.764	6.795**

Notes: See Table 1 for air conditioning dates. All coefficients reflect per capita expenditures. The coefficients α_2 and α_4 are interpreted as the marginal difference in per capita expenditures relative to α_1 and α_3, respectively. The sample period is 1950 to 1975 for each of 12 states (N = 312). Standard errors (in parentheses) are corrected for groupwise heteroscedasticity and cross-group correlations. ** denotes statistical significance at 5 percent and * denotes statistical significance at 10 percent. The T-test for coefficient inequality is a one-tailed test with the decision rule: reject H_o: if $t > t_{\alpha,df}$.

0.29 percentage points larger than annual expenditure growth before the introduction of air conditioning. For cool states, we find no statistically significant change after the introduction of air conditioning. Per the bottom of column (1), this difference in expenditure growth for warm states after air conditioning is found to be statistically larger (0.20 percentage points) than expenditure growth in cool states after air conditioning. In sum, the results in column (1) support our conceptual hypothesis as well as the notion that the introduction of air conditioning in cool states may not have resulted in significant marginal improvement in comfort levels to influence productivity and expenditures.

Having shown that the growth in state government expenditures in warm states was higher after the introduction of air conditioning, we now examine whether the growth rate of various components of state government spending were similarly affected by the introduction of air conditioning. Doing so not only provides additional support for our hypothesis but provides insight into the underlying drivers of the previous results for total state government expenditures. We consider four components of state government spending in the subsequent analysis: education spending, health spending, welfare spending, and transfer payments to local governments. Equation (4) is estimated for each component of state government spending, where the dependent variables are now the natural logarithm of each of the four components of state government expenditures. The results from these regressions are shown in column (2) through column (5) of Table 2.

The results are similar to our findings for total state government expenditures. There was positive growth in per capita expenditures in each component of state government expenditures in both cool states and warm states before introduction of air conditioning. After the introduction of air conditioning in warm states, the spending growth rate for each component except welfare was higher. In addition, the increase in the growth rates of education spending and transfer payment spending in warm states after air conditioning are greater than the increase in spending on these categories in cool states after the introduction of air conditioning, as evident from the *t*-tests shown at the bottom of Table 2. There was no statistically significant difference between increases in spending on health and welfare between warm and cold states.

State Government Expenditures before and after Air Conditioning

Here we repeat the previous analyses but use the *level* of real per capita expenditures instead of the natural logarithm. These results are presented in Table 3. First considering total state government expenditures, the results in column (1) show that per capita expenditures have increased after the introduction of air conditioning in both warm and cool states. Specifically, per capita expenditures increased by $5.13 per capita in warm states after the introduction of air conditioning and by $1.42 dollars in cool states after the introduction of air conditioning. As shown in the bottom of column (1), the difference in the relative effects ($3.71) for warm state and cool states is statistically significant. Considering the four components to total spending in column (2) through column (5), we find that per capita spending on all the components has increased after introduction of air conditioning in both warm and cool states. The effect of air conditioning was greater in warm states than in cool states for per capita expenditures on education, health care, and transfer payments, with significant differences of $1.83, $0.23, and $1.74, respectively.

Conclusion

Previous research has found that the introduction of air conditioning led to a substantial increase in the productivity of households and businesses, especially those located in warmer climates. In this paper we argued that a contributing reason for the growth in state government expenditures that occurred during the latter half of the 20th century was due in part to the introduction of air conditioning in state capitols. Our conceptual framework of state government production demonstrated that the introduction of air conditioning in state capitols was a positive technology shock that would have increased the productivity of all demand-side and supply-side groups involved in producing public sector output. By collecting and assembling a unique data set containing the various dates when air conditioning was installed in state capitols, we tested our hypothesis using a quasi-experimental empirical framework.

Our empirical work supports our hypothesis. We find that the annual rate of growth in expenditures for warmer states was significantly higher after the introduction of air conditioning in these state

TABLE 3
Air Conditioning and State-Government Expenditures: Levels Regressions

	Total Spending	Spending Component			
	(1) Dependent Variable	(2) Dependent Variable	(3) Dependent Variable	(4) Dependent Variable	(5) Dependent Variable
Variable	Per Capita Total State Expenditures	Per Capita State Education Expenditures	Per Capita State Health Expenditures	Per Capita State Welfare Expenditures	Per Capita State Transfer Expenditures
Constant (α_0)	157.972**	−91.566**	19.086**	−46.671**	−9.842
	(28.729)	(17.612)	(2.668)	(7.001)	(10.324)
WarmTrend (α_1)	21.499**	5.284**	1.316**	0.255	3.224**
	(1.374)	(0.821)	(0.134)	(0.318)	(0.386)
WarmTrendPostAC (α_2)	5.127**	3.583**	0.532**	−0.561**	2.479**
	(0.525)	(0.333)	(0.062)	(0.101)	(0.256)
CoolTrend (α_3)	27.100**	8.719**	1.242**	−0.494	6.311**
	(1.656)	(0.840)	(0.142)	(0.315)	(0.463)
CoolTrendPostAC (α_4)	1.421**	2.896**	0.300**	0.375**	0.744**
	(0.511)	(0.280)	(0.053)	(0.079)	(0.171)
PC Income (α_5)	25.236**	28.183**	1.626**	10.656**	15.190**
	(5.523)	(3.409)	(0.509)	(1.180)	(1.882)

(Continued)

TABLE 3 *(Continued)*
AIR CONDITIONING AND STATE-GOVERNMENT EXPENDITURES: LEVELS REGRESSIONS

	Total Spending	Spending Component			
	(1) Dependent Variable	(2) Dependent Variable	(3) Dependent Variable	(4) Dependent Variable	(5) Dependent Variable
Variable	Per Capita Total State Expenditures	Per Capita State Education Expenditures	Per Capita State Health Expenditures	Per Capita State Welfare Expenditures	Per Capita State Transfer Expenditures
State Dummies	Yes	Yes	Yes	Yes	Yes
Decade Dummies	Yes	Yes	Yes	Yes	Yes
State*Decade Dummies	Yes	Yes	Yes	Yes	Yes
Difference in warm state change versus cold state change after AC ($\alpha_2 - \alpha_4$)	3.706	0.687	0.232	−0.936	1.735
T-test for H_o: $\alpha_2 \leq \alpha_4$	5.479**	1.828**	3.718**	−8.506	5.729**

NOTES: See Table 1 for air conditioning dates. All coefficients reflect per capita expenditures. The coefficients α_2 and α_4 are interpreted as the marginal difference in per capita expenditures relative to α_1 and α_3, respectively. The sample period is 1950 to 1975 for each of 12 states (N = 312). Standard errors (in parentheses) are corrected for groupwise heteroscedasticity and cross-group correlations. ** denotes statistical significance at 5 percent and * denotes statistical significance at 10 percent. The *T*-test for coefficient inequality is a one-tailed test with the decision rule: reject H_o: if $t > t_{\alpha,\mathrm{df}}$.

capitols than was the annual growth of expenditures in cooler states. In addition, we also find that the growth rates for each of several components of government spending—education, health care, transfer to local governments—were significantly higher in warmer states after the introduction of air conditioning compared with cooler states. Similar results were obtained with per capita expenditures. Both our conceptual framework and empirical results not only contribute to the literature on government growth, but they also provide a contribution to the literature on the productivity effects of air conditioning.

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