Using the Armey Curve to Measure the Size of Government

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Introduction

The question of the size of the public sector in relation to the overall economy remains part of an ongoing economic and political debate unlikely to end anytime soon. Over the years, a number of economists have attempted to evaluate the effects–in the broadest sense–of a nation's government on its economic performance. Among the more prominent economists who have investigated this issue include Barro (1990) and Armey (1998); the latter is probably more known for his years serving in the U.S. House of Representatives. Other economists who conducted similar analyses include Rahn and Fox (1996) and Scully (1994).

This study uses the Armey curve to evaluate the relative size of government for the Mississippi economy. The Armey curve posits that a quadratic relationship exists between an area's government spending and its economic output. The Armey curve is similar to the other relations developed by the authors listed above–the so-called BARS curve takes its name from Barro, Armey, Rahn, and Scully. The Armey curve reflects the idea that with no government, a nation's economy will produce relatively little output. As the size and expenditures of government increase, the economy's output also increases, all else equal. At a particular level of government spending, the economy's output will be maximized, again holding all other factors constant. Beyond that maximizing level of expenditures, the nation's economic output will start to decline as government begins to "crowd out" the private sector by assuming more and more of its resources and functions. Essentially, the relationship depicted is one of diminishing marginal returns to government in the economy. Conceptually, the Armey curve is similar to the Laffer curve, which postulates that a tax

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rate exists that maximizes the amount of revenue the government obtains from taxation. The Armey curve has been most commonly applied to the economies of the U.S. and other nations, but Vedder and Gallaway (1998) include an analysis across all fifty states. Thus, with available data a researcher can apply the Armey curve to a region or an individual state economy.

Model

The Armey curve for Mississippi developed in this study takes the following form:

$$GDP_t = \beta_0 + \beta_1 EXP_t + \beta_2 EXP_t^2 + \beta_3 T + u_t \qquad \beta_2 < 0 \qquad (1)$$

where GDP_t = real gross domestic product in period t

EXP_t = real state government expenditures in period t

T = time trend

$u_t = \rho_1 u_{t-1} + \epsilon_t$

t = 1992, 1993, … 2015

The sign on the coefficient β_2 for an economy where the Armey curve applies is negative, which gives the line its parabolic shape. The time trend T is added in order to account for changes in the state's economy over time, such as increases in available resources. The final term included, u_t, is a first-order autoregressive [AR(1)] that is incorporated to address the issue of serial autocorrelation. The coefficient ρ_1 listed below Equation (1) represents the first-order serial autocorrelation coefficient. The term ϵ_t also listed below Equation (1) is the prediction error, the difference between the actual value of the dependent variable and the forecasted value.

Data used in this study include annual real GDP values for Mississippi obtained from the firm IHS Markit for the years 1992 to 2015. The values are reported by IHS Markit in 2009 dollars. The U.S. Bureau of the Census is the source of the expenditure data, which were obtained from the

agency's Annual Survey of State Government Finances for the years 1992 to 2015. The Consumer Price Index was used to convert this nominal data to 2009 dollars in order to be comparable to the real GDP data. The total annual expenditures for each state consist of direct expenditures and intergovernmental expenditures. Direct expenditures are categorized into funds for current operations, capital outlays, insurance benefits and repayments, assistance and subsidies, and interest on debt.

Results

The EViews 7.1 statistical software package was used to conduct ordinary least squares (OLS) analysis on the data set described above (IHS Global Inc. 2010). Table 1 below lists the results of the OLS analysis.

Table 1. Coefficient estimates from OLS regression.

Variable	Coefficient	Std. Error	*t*-Statistic
Intercept	-20245797866.27	43587892440.84	-0.464482
*EXP**	985112192402.68	489626418171.02	2.011967
EXP^2*	-2392447473006.27	1330142493951.20	-1.798640
*T***	659222981.67	231795454.38	2.843986
*u***	0.470510	0.188158	2.500609
R^2	0.956783		
F-statistic	99.62598		

*, ** = statistical significance at the 5%, 1% level

The *F*-statistic value indicates the overall significance of the regression. The value of the coefficient of determination exceeds 0.95, which signifies a relatively good fit of the model. The value of the Durbin-Watson statistic for the model with the AR(1) term included is approximately 1.64, which is within an acceptable range at the 0.01 percent level of significance. Each of the independent variables included in the OLS analysis is statistically significant at least at the 0.05 level. Most

notably, the coefficient of the square of the *EXP* variable has a negative sign, which along with the other information indicates the Armey curve fits the data for Mississippi.

The Armey curve, by construction, allows for the calculation of the level of government expenditures as a percentage that maximizes economic output. Setting Equation (1) equal to zero and differentiating with respect to *EXP* generates the following relation for finding the "optimal" level of government expenditures:

$$EXP^* = -\frac{\beta_1}{2(\beta_2)} \tag{2}$$

Using the results from the OLS analysis found in Table 1, *EXP** from Equation (2) can be calculated for Mississippi based on the 1992 to 2015 period. Solving Equation (2) finds *EXP** equals approximately 20.6 percent. Figure 1 below depicts the Armey curve derived for Mississippi from the data set used in this study, with the dotted line highlighting the approximate value of *EXP** at 20.6 percent. The curve indicates when state government expenditures equal about 20.6 percent of

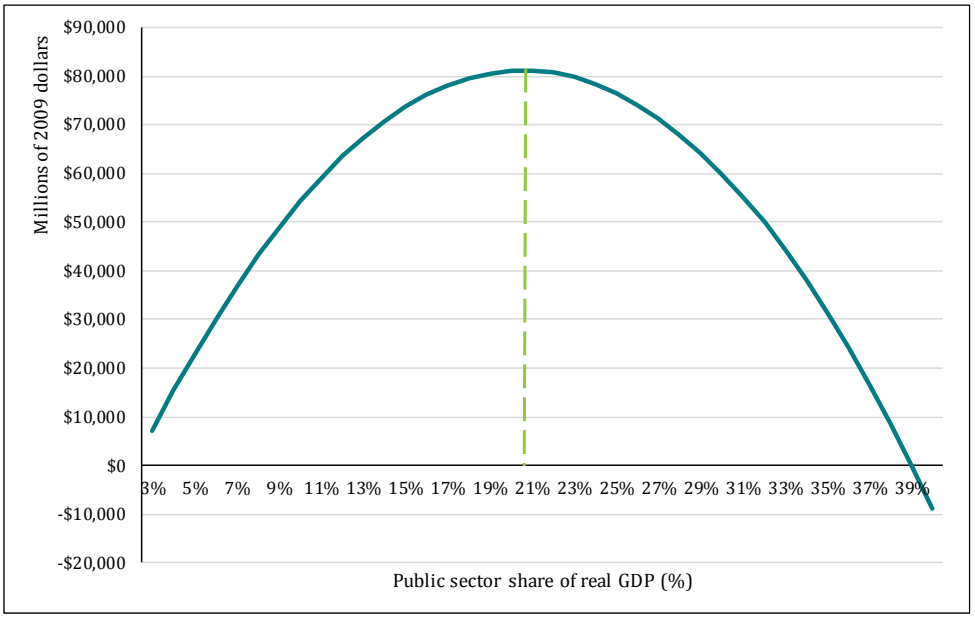

Figure 1. Armey curve for Mississippi constructed from OLS results.

real GDP, Mississippi real GDP is maximized at a value of just over $81 billion, as expressed in 2009 dollars. Notably, Figure 1 indicates real GDP for Mississippi falls to a value of zero when government expenditures are between 2.0 and 3.0 percent of real GDP. Similarly, Figure 1 also indicates the value of real GDP for Mississippi falls to zero when government expenditures are just over 39.0 percent of real GDP. Thus, the Armey curve in Figure 1 delineates the range of government spending (as a share of the total economy) over which real GDP is positive: approximately 3.0 percent to 40.0 percent. Outside of this range, state government either does not produce enough output or commands too many resources for the state's economy to generate positive real GDP.

Discussion

How do government expenditures in Mississippi compare to the "optimal" level defined above? In the data from 1992 to 2015, the average value of government expenditures as a share of real GDP is 18.5 percent, just over 2.0 percentage point below the *EXP** share of 20.6 percent calculated previously. However, the value of 18.5 percent captures over twenty years of data. If more recent years are compared, such as the last five years of the data (2011 to 2015), the average value of government expenditures as a share of real GDP is about 19.9 percent–less than 1.0 percentage point below the *EXP** value of 20.6 percent. Thus, based on the findings of the Armey curve analysis government expenditures in Mississippi are quite close to the level that maximizes real output of the state's economy.

How does the preceding result for Mississippi compare to those of other studies? Barro (1990) finds the maximum growth rate in real GDP for the U.S. occurs when the expenditure ratio is just over 25.0 percent, albeit with a relatively large standard error. A somewhat different but related investigation by Scully (1994) finds that the combination of federal, state, and local taxes

should not exceed 23.0 percent of gross national product in order to maximize economic growth. He observes 1949 was the last year taxes were not above this threshold. In the analysis by Vedder and Gallaway (1998) using data from 1947 to 1997, the authors find the Armey curve for the U.S. reached a peak when federal spending as a share of real GDP was approximately 17.5 percent. They note the last year federal spending did not exceed that level was 1965. In a more recent study De Witte and Moesen (2010) use nonparametric techniques to determine the optimal size of government in the long run in the U.S. equals just over 32.0 percent of real GDP growth and that the U.S. average tax burden exceeds this level by 3.1 percentage point. Thus, as this brief review indicates, findings regarding Armey curve-type analysis can vary considerably depending on the techniques and metrics employed. However, these studies also suggest the result for an individual state such as Mississippi appears reasonable.

As with most models, the Armey curve includes a number of caveats. One is the model assumes a goal of maximizing economic growth in the form of changes to GDP when other objectives may be desirable. Another is the Armey curve does not speak to the composition of government expenditures; in other words, the model provides no information on *how* a government should spend its revenues to achieve maximum economic growth. Finally, the Armey curve developed for Mississippi addresses only state-level government expenditures. Obviously combining this spending with federal government expenditures and local government expenditures could significantly alter the economic outcome.

Conclusions

In summary, the Armey curve provides a broad measure of the relative size of the government for a given area. It provides no specific analysis of tax structure or spending as it considers government as a whole. Nevertheless, the Armey curve remains a useful means of viewing the size of

government in relation to the economy. In this study of the Armey curve for Mississippi, the findings indicate government for the state is not beyond the size associated with the largest economic output; in fact, the most recent level of expenditures appears quite close to this size. This study does not address how the "optimal" level of public sector expenditures for Mississippi compares to other states. However, based on the fact that government in Mississippi is a relatively larger share of the state's real GDP than in other states–government is the single largest component of real GDP in Mississippi–the level of expenditures at which real GDP is maximized is likely higher than in most states.

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