EMPIRICAL INVESTIGATION OF THE RELATIONSHIP BETWEEN GOVERNMENT SPENDING AND ECONOMIC GROWTH IN THE US AND CHINA

Morsheda Hassan, Wiley College, Marshall, Texas
morshedat@yahoo.com

Raja Nassar, Louisiana Tech University
Ran1@suddenlink.net

Chang Liu, Southern West University of Finance and Economics, China
changliu0826@yahoo.com

ABSTRACT

Of interest, is the debate over the effect of deficit financing on economic growth. There are those that argue for a negative effect and others for no effect or a positive effect. In fact, studies in the literature are mixed on the impact of deficit on growth. One theory claims that federal deficits are likely to increase growth of the gross domestic product (GDP) by increasing buying power. Another theory claims that federal deficits can reduce growth by affecting an increase in interest rate, which can lead to reduced investment. A third theory is that deficits have no effect on growth.

In this study, we investigate the relationship between government spending (whether deficit or surplus) and GDP growth in two different economies, namely the U.S. and China. In China there is surplus spending. On the other hand, deficit spending prevails in the U.S. Results show that in both countries government spending and GDP are co-integrated, indicating a long run equilibrium relationship between the two time series. Bivariate time series analysis indicated that there is a functional relationship between deficit spending and economic growth in the U.S. Deficit spending had a negative effect on economic growth. However, in China there was no effect of government spending on economic growth. In this case, economic growth seemed to be the determinant of government spending.

INTRODUCTION

The relationship between government spending and economic growth is of fundamental importance, especially in an economic downturn or recession. If the economy is down, revenue is down and government spending would likely result in a deficit. It is of interest then to determine if deficit spending would have an influence on economic growth. Economists hold three points of view on this issue, namely that deficit spending will have a negative effect, a positive effect, or no effect on growth. One theory claims that deficit spending will increase growth by increasing consumer buying power (Palley, 2011; Eisner, 1989; Domar, 1993). Another argument claims that it will decrease growth by increasing interest rate and thus reduce investment (Barth & Wells, 1999). A third claims that deficit spending has no effect on growth (Bernheim, 1989).

Government spending under a growing economy will usually lead to surplus spending. Of interest then is to determine if in this case there would be a relationship between surplus spending and growth. A growing economy according to Wagner's law (1892) leads to an increase in government spending. On the other hand, according to Keynesian economics, government spending leads to economic growth. These are then opposite views of the cause and effect between government spending and GDP growth. This is an important issue to investigate since it determines the economic measure a country should assume in promoting growth. If deficit spending reduces growth, then there would be a legitimate claim to fiscal austerity measures as is being proposed by some countries in Europe for a remedy to an economic downturn. On the other hand, austerity measures would be detrimental to the economy if spending is the right stimulus for growth.

From the arguments above, it is clear that empirical studies to determine the relationship between government spending and economic growth are of utmost importance. Of interest would be to determine the relationships between spending and growth under two scenarios: strong economic growth and slow growth or economic downturn.

In this study, we use time series data from the U.S. (exemplifying relatively slow growth or economic downturn) and China (exemplifying strong economic growth) to investigate the short and long term relationship between government spending, relative to revenue, and economic growth (as measured by the GDP) using time series and co-integration analyses.

RELEVANT LITERATURE

Budget deficits in recent years in the U.S. and other countries have caused concern about their possible effects on economic growth. Barth and Wells (1999) point out that budget deficit lowers national savings and has a negative effect on investment and net exports. Financing the debt by borrowing increases interest rate, which can lead in turn to a reduction in investment and an appreciation of the dollar. An appreciated dollar retards exports. Also, a reduction in investment leads to a reduction in economic growth. Barrow (1974) argued that private savings will increase when government sells bonds in order to finance the deficit. In this case, bond-financed deficits will have no effect on economic investment or export. In fact, empirical evidence showed that investment, export, and private saving declined over the period 1982 to 1994, a period of large and persistent deficits (Ball & Markiw, 1995). Eisner (1989) argued that government deficits has an effect on the economy in that they increase public debt and hence affect aggregate demand. Horrigan and Protopapadakis (1982) are of the belief that deficits and surpluses promote economic efficiency. As such, the question is how to determine the optimum size of deficits in order to enhance economic efficiency. Eisner (1989) and Domar (1993) argue that economic slowdown or an increase in unemployment calls for deficit spending in order to improve the economic situation.

Collins (1999) presents two points of view concerning the effect of deficits on the financial markets. The first claims that budget deficits cause interest rate to rise because of increased demand for loanable funds. A rise in interest rate could in turn reduce investment and economic growth. The second point of view , referred to as the Ricardian view, claims that a tax-induced budget deficit will have no effect on interest rate because it increases savings which offset the increase in demand for loanable funds. Collins presented coefficients of correlation (calculated over five year intervals between 1944 and 1994 in the U.S.) between deficits and stocks and bonds as well as data on deficits and investment and interest rates. Results were not consistent with the argument that deficits cause an increase in interest rate and a decrease in GDP growth, investment, and stock performance. Hutchison and Pyle (1984), Ford and Laxton (1995), and Tanzi and Fanizza (1995) provided empirical evidence indicating that higher deficits in industrial countries have increased interest rates. On the other hand, studies by Barro and Sali-I-Martin (1990) and Evans (1987) support the Ricardian view, namely that a tax induced budget deficit has no effect on interest rate.

Palley (2011) argues that deficit financed public investment is needed for economic growth and austerity measures slows growth. Taylor et. al. (2012) presented evidence to the effect that an increase in public spending in the U.S. had a positive effect on economic growth. The authors recommend an increase in public spending in order to stimulate growth which would eventually increase revenue. An alternative to this proposal is to use the Keynesian approach and inact a balance d increase in taxes and spending, with taxes coming from the rich and spending going to the middle class and poor. The assumption is that the middle class and poor have a higher propensity for spending than the rich. This increase in spending will help the economy grow. Liu et. al. (2008) using Granger causality analysis found that, for U.S. data between 1947 and 2002, public expenditure had a positive effect on GDP growth, which is in line with the Keynesian hypothesis. However, GDP growth did not have any effect on increasing the public expenditure.
From the above studies, it is clear that results are mixed on the effect of spending on economic growth. Hence, there is a need for further studies in this area in order to shed more light on this situation.

DATA COLLECTION

Data for the United States on government spending (GS) relative to revenue (spending – revenue) and GDP was in billions of dollars. Positive values for spending indicated deficit

spending and negative values non-deficit or surplus spending. The data were obtained from the on line source:
http://www.usgovernmentspending.com/downchart_gs.php?year=1900_2016&chart=G0-fed&units=p

For China. The GDP and government spending relative to revenue was in billions of Yuan and obtained from the on line source in China.

来源：国家统计局http://219.235.129.58/reportView.do?Url=/xmlFiles/e103f3e552a9477eb132917f956a3032.xml&id=7b50175ff30c45ddb0e78646864a1840&bgqDm=20060000

Data for the U.S. was over the years 1975-2011. In the case of China, data were available over the years 1975 – 2009.

Plots of the GDP and government spending relative to revenue over years are presented below:

FIGURE 1. PLOT OF GOVERNMENT SPENDING (SPENDING – REVENUE) GS, OVER YEARS IN THE U.S.

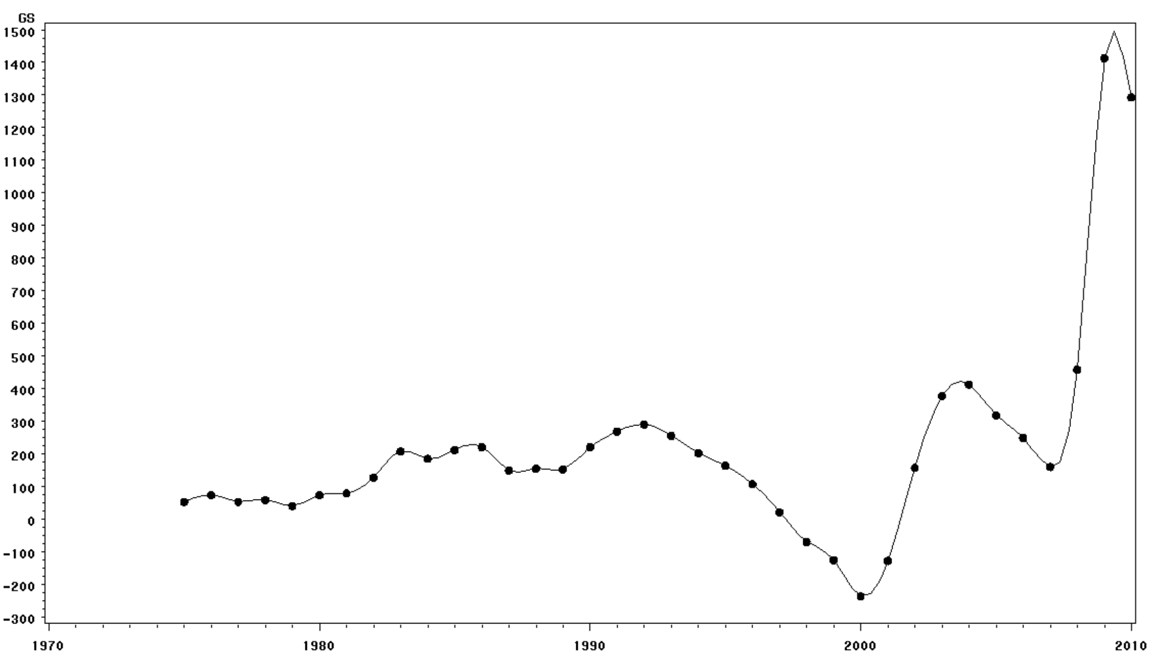


FIGURE 2. PLOT OF GDP OVER YEARS IN THE U.S.

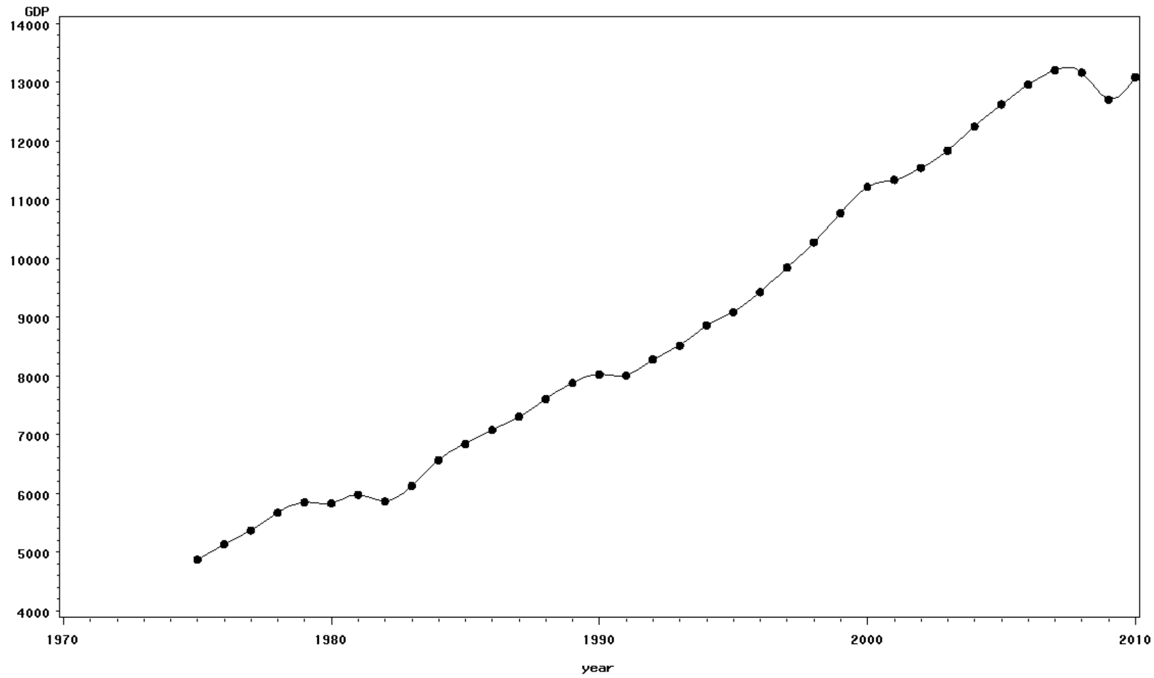


FIGURE 3. PLOT OF GOVERNMENT SPENDING (SPENDING – REVENUE), GS, OVER YEARS IN CHINA

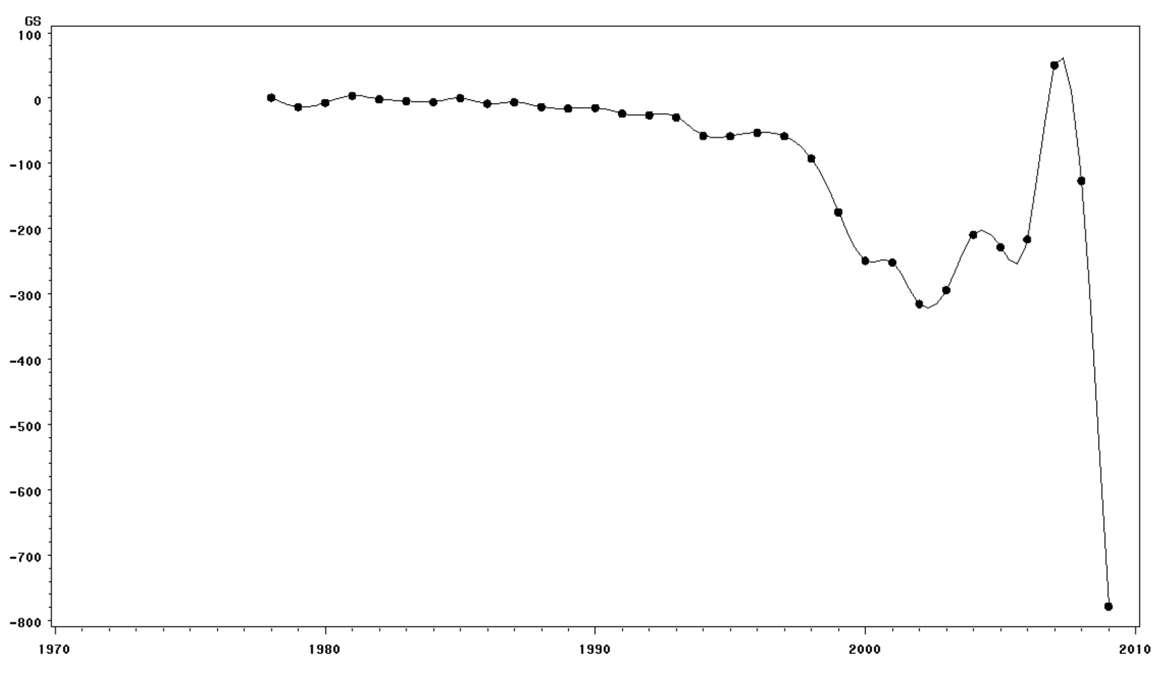
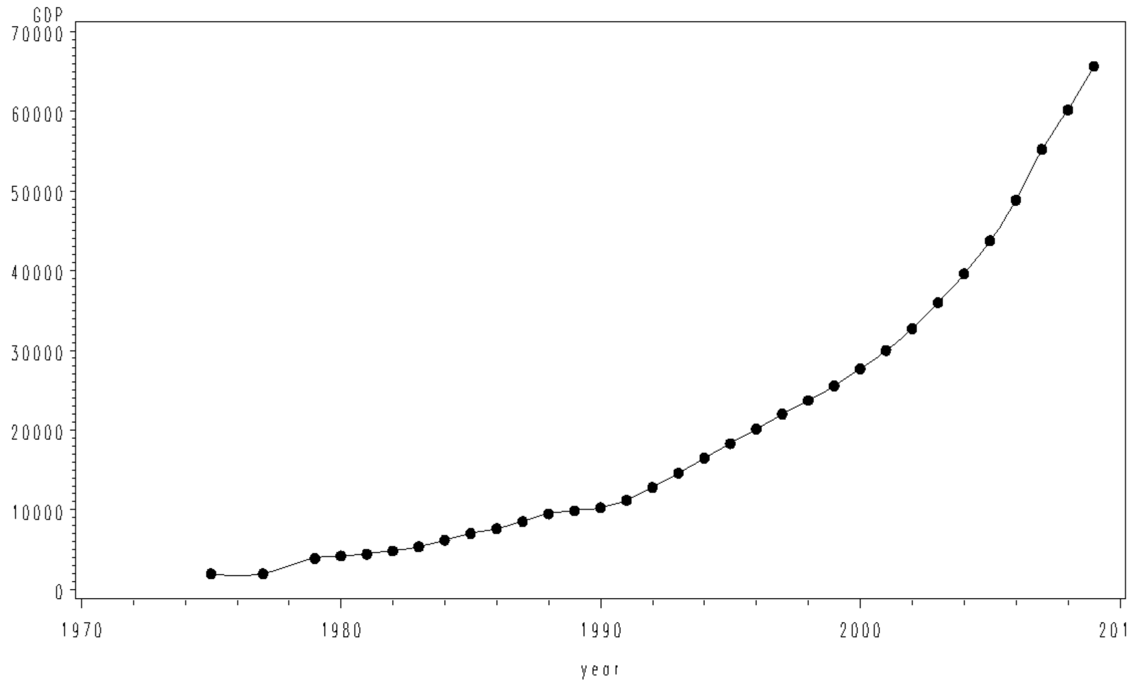


FIGURE 4. PLOT OF GDP OVER YEARS IN CHINA



METHODOLOGY

The SAS software was used in the data analysis. The Johansen co-integration analysis was performed in order to determine if co integration exists between government spending relative to revenue, GS, (spending-revenue) and economic growth as measured by the GDP. Also, time series transfer function analysis was used to build an empirical model relating GDP to government spending.

CO-INTEGRATION

Co-integration between two time series implies that the two variables are in a long-run equilibrium relationship. This means that in the long run, the two series do not diverge over time. Any divergence is usually short term and eventually the two series come back together. Furthermore, two series that are co-integrated may or may not be correlated. Table 1 presents the co-integration analysis results for GDP and GS using the Johansen co-integration test (Johansen, 1988).

In the U.S., government spending relative to revenue (GS) and log GDP (lGDP) seem to be co-integrated since the trace value is larger than the critical value when the rank is 0, but less than when the rank is 1. This says that there is a long-term linear relationship between the two variables. Also, based on the transfer function time series analysis below, the two series are also cross correlated.

For China, government spending relative to revenue and LGDP are also co-integrated with r = 1, implying, as for the U.S., a long-term linear relationship between the two variables. It is interesting to note, however, that for China the two time series are not cross correlated indicating that there is no short term relationship between the two. As a result, there was no functional relationship between spending and growth as indicated by the transfer function analysis.

TABLE 1. JOHANSEN CO INTEGRATION RANK TEST FOR GOVERNMENT SPENDING (GS) AND GDP GROWTH

Variables	H_0: rank = r	H_a: rank > r	Trace	Critical Value
U.S.				
GS LGDP	0	0	54.13	12.21
	1	1	0.00	4.14
China				
GS LGDP	0	0	83.86	12.21
	1	1	0.41	4.14

BIVARIATE TIME SERIES MODELING USING THE TRANSFER FUNCTION APPROACH

The transfer function analysis is the state of the art modeling approach to determine the functional relationship between two series, the input or independent series and the output or dependent series. We are interested in determining if government spending relative to revenue (GS) does have an effect on GDP. Hence, the input series is GS and the output series is GDP or in this case its log transform. This approach is especially relevant when there is no feed- back between the output and input series as determined by the cross-correlation function. If the cross-correlation between two stationary series is significant for only zero or positive lags, then there is no feed- back between the output and input series (Wei, 2006). This was the case for the series considered in this study. Indeed the cross correlation between GS and log GDP for the US series was significant only for lag zero.

The analysis is based on the fact that the two series are stationary. For the U.S. data, both series were not stationary. Their first difference was stationary as determined by the Dickey-Fuller unit root test and the dampening patterns of the autocorrelation function (ACF) and the partial autocorrelation function (PACF). Likewise, GS and LGDP were not stationary for the China data. However, GS(1) and LGDP(1) were found to be stationary. Therefore, the analysis that follows is based on the first difference, GS(1), and LGDP(1).

A transfer function model between two series, y and x, is expressed in general as

$$y_t = v(B)x_t + e_t \quad (1)$$

Where e_t is a noise series that is independent of x_t.
Here, $v(B) = \sum v_j B^j$, where B is the backshift operator, $Bx = x_{t-1}$.
The function v(B) is determined from the cross correlation between x and y.

The steps involved in the identification of the transfer function model are (Wei, 2006):

1. Prewhiten the input series.

Identify an autoregressive integrated moving average (ARIMA) model $\phi_x(B)x_t = \Theta_x(B)\,\alpha_t$ and use it to whiten the input series by calculating the white noise series in Eq. (2) below.

$$\alpha_t = (\phi_x(B) / \Theta_x(B))x_t \quad (2)$$

In general, $\phi_x(B)$ and $\Theta_x(B)$ are expressed as

$$\phi_x(B) = (1-\phi_1 B-\phi_2 B^2-\ldots- \phi_p B^p)x_t$$

$$\Theta_x(B) = (1-\Theta_1 B-\Theta_2 B^2-\ldots-\Theta_q B^q)\,\alpha_t$$

2. Compute the filtered output series

$$\beta_t = (\phi_x(B) / \Theta_x(B))\,y_t \quad (3)$$

3. Calculate the sample cross correlation between α_t and β_t

$(\rho_{\alpha\beta}(k))$ so as to determine v_k, where

$$v_k = \rho_{\alpha\beta}(k)\,(\sigma_\beta/\sigma_\alpha) \quad (4)$$

4. Identify v(B)

Match the pattern of v_k with the known theoretical patterns of v(B) in order to identify v(B).

Once v(B) is identified, express e_t in Eq. (1) as $e_t = y_t - v(B)\,x_t$ (5)

and identify the appropriate model for Eq. (5) to determine the final model in Eq. (1).

ANALYSIS FOR THE U.S.

The model that was identified for the U.S. using the transfer function analysis above gave the following functional relationship between LGDP(1) and GS(1):

$$(1 - 0.23164\ B)\ LGDP\ (1)_t\ =\ .02357\ \ -0.000051\ GS(1)_t \qquad (6)$$

The model satisfied the diagnostic checking, namely:

1. There was no cross correlation between the noise series and the independent or input series (GS), which indicates that the error was independent of the input series

2. Both the autocorrelation function, ACF, and the partial autocorrelation function, PACF, for noise in the model showed no pattern. Also a formal chi-squared test confirmed that the noise was white noise

As a result, the transfer function model in Eq. (6) is an adequate model relating the first difference of the log of GDP to the first difference of GS.

From the model in Eq. (6), it is seen that GS(1) has a negative effect on LGDP(1).

FORECASTING

In using the model for forecasting, one may replace in Eq. (6) $GS(1)_t$ by $GS_t - GS_{t-1}$ and

$LGDP(1)_t$ by $LGDP_t - LGDP_{t-1}$.

This gives:

$$(1 - 0.23164\ B)\ (LGDP_t - LGDP_{t-1})\ = 0.02357 - 0.000051\ (\ GS_t - GS_{t-1}) \qquad (7)$$

Expanding Eq. (7) gives:

$$LGDP_t - LGDP_{t-1} - 0.23164(LGDP_{t-1} - LGDP_{t-2}) = 0.02357 - 0.000051\ (\ GS_t - GS_{t-1})$$

or

$$LGDP_t\ \ = LGDP_{t-1} + 0.23164(LGDP_{t-1} - LGDP_{t-2}) + 0.02357 - 0.000051\ (\ GS_t - GS_{t-1}) \qquad (8)$$

In order to obtain the forecast for $LGDP_t$ at time t, one needs to predict the value for GS_t
This can be obtained from the following time series model developed from the observed values of the time series GS.

$$GS\ (1)_t =\ \ 0.19294\ GS(1)_{t-1}\ \ \textbf{OR} \qquad (9)$$
$$GS_t = 1.19294\ GS_{t-1}\ \ - 0.19294\ GS_{t-2}$$

ANALYSIS FOR CHINA

Of interest is the fact that the cross correlation was close to zero and therefore not significant (Chi-square = 0.12 and p close to 1.0) and there was no functional relationship between LGDP(1) and GS(1). In this case, the independent variable GS had no effect on LGDP as the dependent variable. There is evidence from the Granger causation test that LGDP Granger causes GS (p = 0.0082), but GS does not Granger cause LGDP (p = 0.9579). This result is in accord with the fact that GS has no effect on LGDP. Also, it supports Wagner's law in the sense that strong economic growth leads to increased government activities and spending. Spending in China is not deficit spending because of the strong economic growth. It is reasonable then to assume that the strong economy contributed to non-deficit spending.

CONCLUSION

Results of the bivariate time series analysis are interesting in that they show that under different economies, U.S. and China, government spending and log GDP were co-integrated. This means that both time series variables are in a long-run equilibrium relationship. The two series do not diverge over time. Any divergence is usually short term and eventually the two series come back together. It is not surprising to find that spending and economic growth go hand in hand and have a long-run equilibrium. This long-run relationship may be due to direct cause and effect or may be due to a third variable or group of variables that were not observed. Likewise, a functional relationship, as represented by Eq. (8) for the U.S. data, may not be due to direct cause and effect.

Of interest is the finding that deficit spending had a significant negative effect on growth as determined by the time series bivariate model. China, on the other hand, shows strong economic growth and non-deficit spending. Under these conditions, the bivariate time series analysis failed to show any significant effect of non-deficit spending on economic growth. In this regard, the Granger test showed also that non-deficit spending had no causal effect on growth. On the other hand, economic growth Granger caused government spending. The fact that deficit spending had a negative effect on growth in the U.S. could be attributed to the fact that the money spent may not have been enough nor allocated properly in order to stimulate growth. More studies are needed in this regard, using more data and control variables, in order to shed more light on this spending and growth dilemma.

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