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The Relationship Between Defense Expenditures and Economic Growth: A Granger Causality Approach

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Abstract

This paper examines the relationship between defense spending and economic growth in the United States of America between 1947 and 2016. Using quarterly data from the Federal Reserve of St. Louis Economic Data and the Granger Causality methodology, this study examines the potential two-way causality between defense spending and economic growth. The results suggest that over the longer time span of 6-7 years, Granger Causality was not seen between defense spending and economic growth. However, while analyzing incremental periods in smaller sections, there were differing findings about the nature of causality.

Introduction

This paper will take a look at the relationship between defense expenditure and economic growth. There has been extensive research conducted in economies in Europe, South America, and emerging BRIC countries, but there is a clear lack of causal research done on the United States (Dash & Sahoo 2016, Peacock & Wiseman 1961). There are multiple ways of determining a causal relationship between defense expenditure and economic growth including Vector Auto regression (VAR), Structural Vector Auto regression (SVAR), Granger Causality, and more. In this paper, Granger Causality will be the primary method to determine the two-way causality between defense expenditure and economic growth in the United States. Some studies in this field have often found that there is a two-way relationship between defense expenditure and economic growth, meaning that defense spending Granger causes economic growth and vice-versa. The time series analysis will take the years 1947 to 2016 as the range of the data sample. It is important to study the relationship between defense expenditure and economic growth in the United States because the United States has the largest defense expenditure in the world and surprisingly little empirical research has been conducted on this specific two-way relationship in the U.S. in recent years.

Literature Review

This paper will look at the relationship between the nature of defense spending on the economic well-being of the United States proxied by Defense Consumption Expenditures and Gross Investment, and Real GDP per Capita. It is a commonly held belief that defense spending

has a relationship to economic growth. This stems from Keynes' (1937) study on fiscal policy. Keynes found that short run economic growth was caused by the mobilization of resources, such as defense spending. However, it should be noted that there are other theories as well. Peacock & Wiseman (1961) looked into the Wagnerian theory suggesting that the opposite may be true. Under the Wagnerian theory, a period of economic growth would actually then spur the amount of capital generated as a nation, allowing for more capital to be spent on defense. This paper will look at the lagging and leading variables to determine the direction of the relationship between defense spending and short run economic growth.

Evidence of a positive relationship between Defense Spending and Economic Growth

This field of study originated in Benoit's (1973) paper observing the relationship between defense expenditure and economic growth in developing countries. Benoit found that there was a positive relationship between the two variables. The data showed that if a country had a high military burden, it had a rapid rate of growth. According to his analysis, there was less than a 1-in-1000 chance that these findings were accidental. He used Spearman correlation, and then confirmed his findings with regression analysis.

Dash et al (2016) focused their study on the relationship between defense spending and economic growth in the BRIC countries. Their study shows that in the BRIC countries, a 1% rise in GDP has been associated with a 0.54% rise in real defense expenditure per capita. Using panel data and Dynamic Ordinary Least Squares (DOLS), they showed that a 1% increase in economic growth is associated with a 0.86% increase in real defense expenditure. This study gave a percentage based look into the positive relationship between defense spending and economic growth.

Owyang et al (2013) discussed the differences in government spending multipliers during periods of slack in Canada and the United States. Using the local projection method and quarterly data from 1980 to 2010, they found that there was no evidence that multipliers are higher in the United States. However, using quarterly data from 1921 to 2010 for Canada, there was evidence that the government spending multipliers were greater during times when resources were idle and the economy was operating at less than full employment and equilibrium output.

Evidence of negative relationship between Defense Spending and Economic Growth

On the other hand, Deger and Smith (1983), found a negative relationship between the two variables in developing countries. This study comprised 44 Less Development Countries (LDCs). They note that when a developing country is increasing its defense spending, it diverts resources away from other possible avenues, such as investment. Also, they note that if the military demands a specific product, there is a possibility that there will be more firms attempting to generate that item, causing a surplus. Their study concluded that defense spending had a small positive effect on growth, but had a large negative effect on savings. Therefore, they concluded that the net effect of increased military spending on economic growth was negative.

Ward and David (1992) conducted research on the United States from 1948 to 1996 examining the relationship between military expenditures and economic growth. Their study found that the military expenditures actually had a negative relationship with economic growth. This could be due to the fact that the amount of money spent on the military may have been more productively employed elsewhere. Both military and non-military government spending have lower "factor productivity" compared to the private sector, meaning that the private sector is

more efficient in the way it uses its resources. However, they do note that there are clear spin-off benefits generated by increased military spending.

Non-determinant evidence

Several studies have shown that there is no general consensus as to whether there is a causal relationship between defense spending and economic growth in either direction. Dakurah et al (2001) showed that in the survey of 62 developing countries, there are 20 countries that show a Granger Causality from defense spending to economic growth, implying that Keynesian economic theory is at work in the associated country. However, 17 countries showed exactly the opposite, with Granger Causality from economic growth to defense spending. This shows that Wagnerian theory was actually the prevalent economic theory. In addition to the unidirectional causality, there were also 7 countries with two-way causality, which means that economic growth causes a change in defense spending, but defense spending causes a change in economic growth as well.

Ozun & Erbaykal (2014) examined the causal relationship between defense spending and economic growth. They concluded that there were unilateral causal relationships in 7 NATO countries, while five countries were found to have no causal relationship at all. Turkey was the sole country in the data sample that showed a two-way causal relationship between defense spending and economic growth. Yildirim and Öcal (2006) looked at the conflict between Pakistan and India and the effects of the extra militarization and arms race conflict on economic growth. Their findings were that there was a Granger causal relationship between defense spending and economic growth in India, but not in Pakistan. To further look into the nature of

this relationship, they used a VAR analysis to conclude that this increased defense spending primarily spurred short run economic growth, but not long term economic growth.

Dudzeviciute et al (2016) took an in depth look at the different levels of economic development, and how that influenced the relationship between defense spending and economic growth. Their study focuses on five different levels of economic development. Low economic level, lower middle economic level, upper middle economic level, high economic level, and very high economic level comprise the categories. It is important to note that this data ranged from 2004 to 2013, so the financial crisis definitely played a role in the economic landscape of all of the countries in this study. Interestingly, the largest drops in GDP per capita came from the low economic level and the very high economic level groups. As far as interrelationship is concerned, all but the lower middle economic level showed a negative relationship between economic growth and defense spending. This implies that the higher the economic growth, the less is spent on defense spending.

United States defense expenditure

Harrison (2016) analyzes the fiscal year of 2017's defense budget. Out of the $905 billion budget, $523.9 billion is requested for the Department of Defense's base budget. This does not include things like military veterans' health insurance. There are some interesting data points discussed throughout this study. For instance, during the Korean war, the defense budget grew more than fivefold in three years. Also, before defense spending became heavily technological, there was a strong pattern of defense spending rising and falling with the amount of troops physically deployed. However, following Ronald Reagan's term as Commander in Chief, physical deployment of troops were not the main component of defense spending. This analysis

was not used for any hard data analysis in this study, but it was interesting to see what the United States Military budget is broken into.

Granger Causality

With respect to methodology, Granger (1969) looked at a two-variable case to establish a link between relationship and causality. He found that a feedback mechanism can be treated as two causal mechanisms joined. This work later led into what is known as a Granger Causality. Granger testing in Dudzeviciute et al (2016) shows that there is an absence of Granger Causality between defense spending and GDP per capita in high economic level countries, upper middle level countries, and low economic level countries. Based on this paper, we would expect to see that in the United States, increased defense spending would mean less economic growth. Dudzeviciute's study is limited in its decision to use only two variables, GDP per capita and defense spending.

In this paper, a Granger Causality analysis will be used to determine causality. Granger Causality is appropriate to use in a one to one relationship, and for a time series analysis it will be an appropriate test to use.

Hypothesis

The null hypothesis for this study (H_0) is that defense spending does not Granger Cause economic growth, nor does economic growth Granger Cause defense spending. This implies that the two are independent from one another. The alternative hypothesis (H_1) is that defense

spending Granger Causes economic growth, and that economic growth Granger Causes defense spending.

Data and Sample

The sample used in this study includes the time period from 1947 to 2016. Quarterly data are collected from the Federal Reserve Economic Data at the St. Louis Fed (FRED). FRED data contains the National Defense Consumption Expenditures and Gross Investment as well as the Real GDP per Capita.

Methodology

The purpose of this paper is to determine the degree of causality between defense expenditure and economic growth. This will be done through Granger Causality testing similar to that used in Dudzeviciute et al (2016). Granger testing is the process of using one series of data, analyzing its movements, then determining if it predicts the later movements of a different series of data. Therefore, this research will first see if defense spending Granger Causes economic growth, and then see if economic growth Granger Causes defense expenditure. It is important to note that the two are not mutually exclusive. As shown before in Ozun & Erbaykal (2014), Granger testing can show two-way causality between two variables. It is also important to note that it can show one-way causation, or no causation at all. Granger Causality requires two separate equations to determine causality as shown in multiple previous research studies (Farzanegan, 2014; Mosikari & Matlwa,2014). The regression equations below are used to determine Granger Causality in this paper.

$$Y_t = \beta_{1,0} + \sum_{i=1}^{p} \beta_{1,i} Y_{t-i} + \sum_{j=1}^{p} \beta_{1,p+j} X_{t-j} + \varepsilon_{1t}$$

$$X_t = \beta_{2,0} + \sum_{i=1}^{p} \beta_{2,i} Y_{t-i} + \sum_{j=1}^{p} \beta_{2,p+j} X_{t-j} + \varepsilon_{2t}$$

β parameters to be estimated, ϵ error, *p* is the number of lags used.

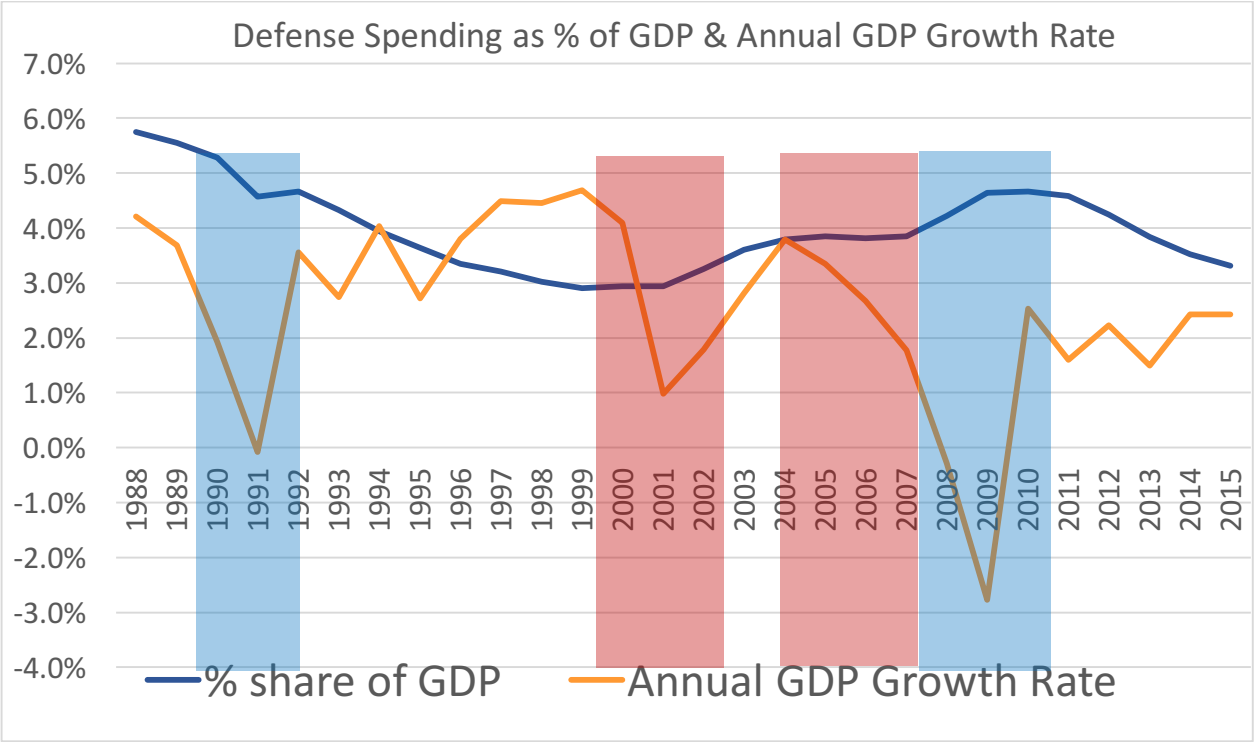
These regression equations show the effect of one variable on the other in terms of a lagged structure. A variable can be said to Granger Cause another when lagged values of "x" can assist in forecasting the current state of "y", as long as all other relevant information is given (Stern 2011). For purposes of this study, Y is the log of National Defense Consumption Expenditures and Gross Investment (defense spending) and X is the log of Real GDP per Capita (economic growth).

All calculations have been analyzed using Eviews econometric software.

Time Series Analysis of Defense Spending and Economic Growth

Investigating the years 1947-2016, there are significant trends to identify concerning both defense spending and economic growth.

Exhibit 1

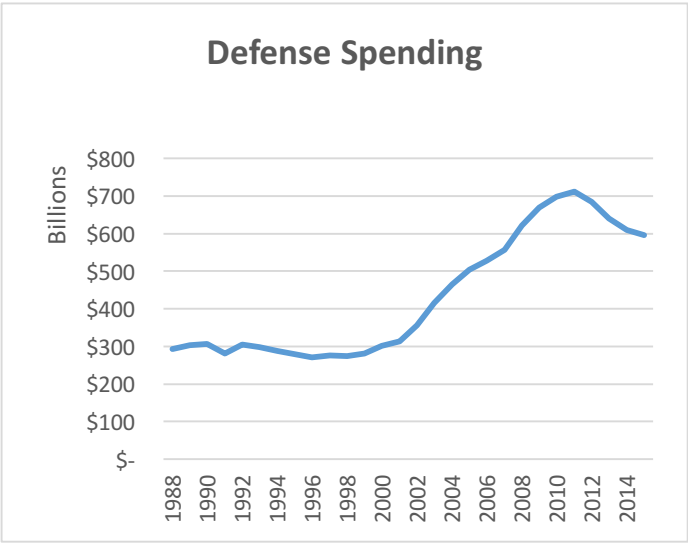


As seen in Exhibit 1, from 1988 to 1999, defense expenditure as a total percentage of GDP fell from 5.7% to just below 3%. Following 1999, defense expenditure as a total percentage of GDP then rose until 2010 to 4.7%, from which point it fell to 3.3% in 2015. In the same exhibit, we can see the rise and fall of the annual GDP growth rate. While defense expenditure as a proportion of GDP moved along a relatively smooth path, annual GDP growth rate had very volatile changes. First, from 1988 to 1990, the annual GDP growth rate fell from 4.2% to -.07%, then immediately rebounded to 4.7% the following year. Another large drop is seen from 2000 to mid-2001, which could possibly be explained by the Dot-com bubble bursting in March, 2000.

The most striking point in this data though is the enormous drop from mid-2007 to mid-2009 following the financial crisis. Already falling annual GDP growth rates plummeted from just below 2% to almost -3%. This shows only the second time in this time period annual GDP growth rate was negative, and the only time it was more than 0.1% negative.

In accordance with the large drops in annual GDP growth rate, there are differences in the political atmosphere as well. During the drop from 1989 to 1991, there was a Democratically controlled Senate, as well as a Democratically controlled House of Representatives, shown by blue shading. At the time of the Dot-com bubble burst, there was a Republican controlled Senate, and a Republican controlled House of Representatives, shown by red shading. Out of all significant drops during this time period, the Financial Crisis was the largest. At this time, there was a split Senate, and a Democratically controlled House of Representatives. This information is interesting to see, because Congress is responsible for passing the laws associated with a majority of fiscal decisions, as well as taxation plans. It is important to note that there were large drops in annual GDP growth rate regardless of whether or not it was a Republican or Democratically controlled Congress.

Exhibit 2



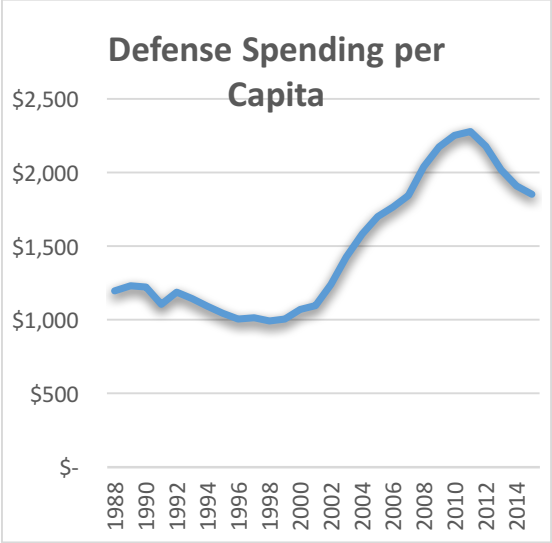
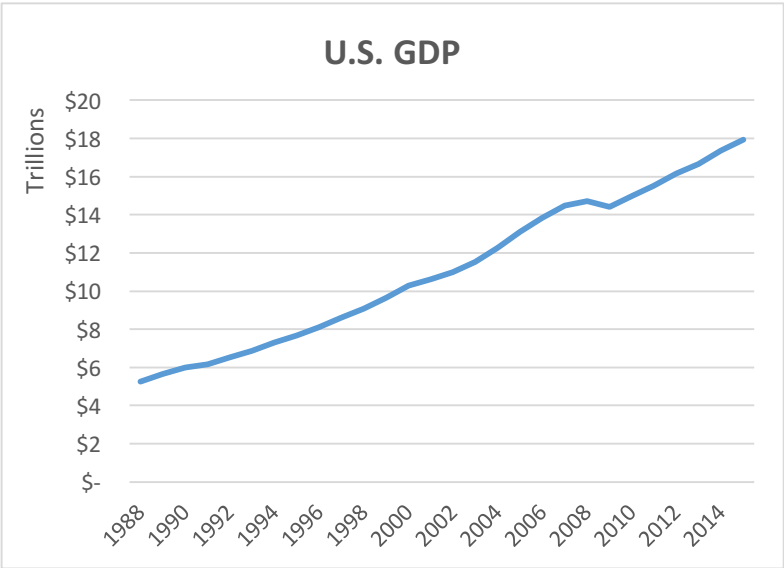


Exhibit 2 shows both the defense expenditure per capita and defense expenditure in total USD. Starting with defense expenditure, from 1988 to 2014 it has risen 103% from $293 billion to $596 billion. However, defense expenditure peaked in this time period in 2011 at $711 billion dollars. Looking at defense expenditure per capita, there is an almost identical graph due to the fact that the large amount of capital spent on defense expenditure dwarfs the relatively small amount of change in people. From 1988 to 2015, defense expenditure per capita has increased 55% from $1,196 to $1,854. Again it peaked in 2011 at $2,279.

Exhibit 3



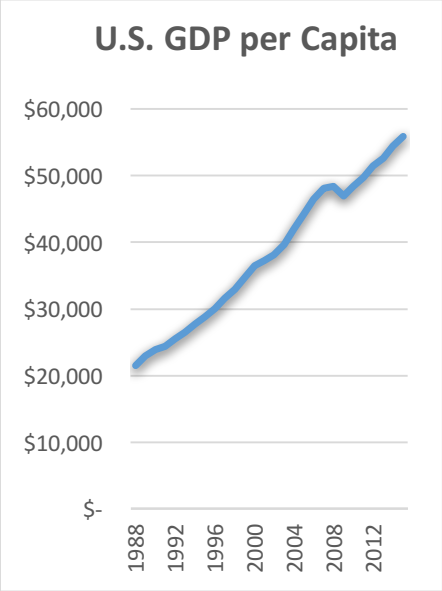
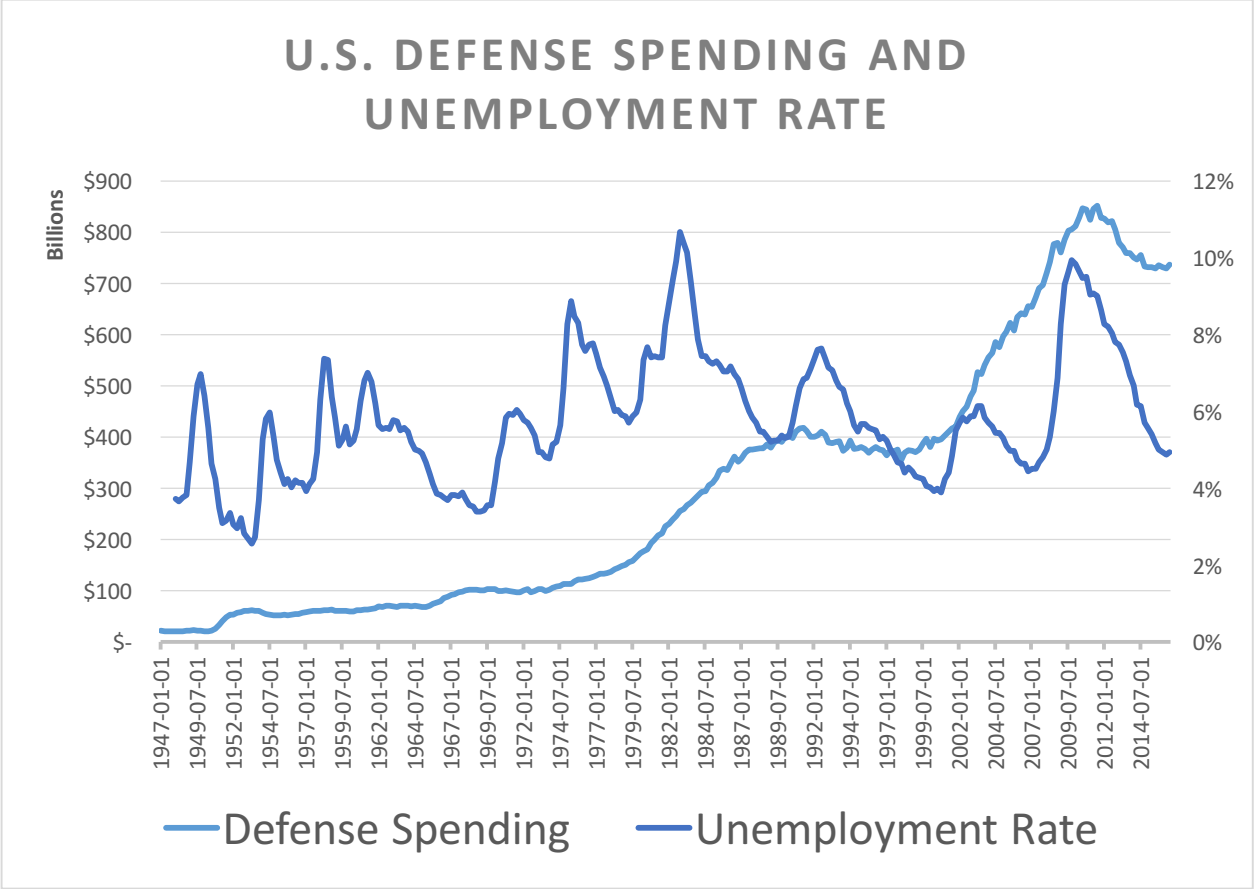


Exhibit 3 shows both the United States' GDP and GDP per capita. Similar to Exhibit 2, these graphs look nearly identical. U.S. GDP increased from $5.2 trillion to $17.9 trillion from 1988 to 2015, a 242% rise. GDP per capita has risen 160% from $21,483 to $55,836 during the same time period. Although Exhibit 2 shows a more warped graph, both GDP per capita and GDP have seen close to a linear relationship in accordance with the time period, excluding a bump and fall from 2006 to 2008.

Exhibit 4



Although unemployment is not used as a variable in this study, Exhibit 4 shows the unemployment rate as along with defense spending from 1947 to 2016. There is an enormous increase in defense spending during this time period. However, unemployment rates seem to be varying throughout the time series. This graph enables us to see unemployment and defense spending throughout the entire time series analyzed in this study.

Granger Causality Testing

A Granger Causality approach is being used in this study to determine causal relationships between defense spending and economic growth. First, the entire sample period is

analyzed, going up to 28 lags, or 7 years. Second, the data will be analyzed in specific sub-sample periods to determine if the findings change depending on the time period studied. All data are collected through the Federal Reserve Economic Data, and consist of quarterly data from 1947 to 2016. In order to linearize the data series, this study analyzes the log of both defense spending and economic growth in the Granger Causality testing. The results are presented in Tables 1 and 2 below.

Table 1

Long term Granger Causality Testing

Lags	Null Hypothesis	Observations	F-Statistic	Probability	Test Results
	GDP per Capita does not Granger Cause Defense Spending		3.2429	0.0128	**Reject**
4	Defense Spending does not Granger Cause GDP per Capita	275	2.8386	0.0248	**Reject**
	GDP per Capita does not Granger Cause Defense Spending		2.60189	0.0095	**Reject**
8	Defense Spending does not Granger Cause GDP per Capita	271	2.66268	0.008	**Reject**
	GDP per Capita does not Granger Cause Defense Spending		1.97354	0.0273	**Reject**
12	Defense Spending does not Granger Cause GDP per Capita	267	1.95763	0.0288	**Reject**
	GDP per Capita does not Granger Cause Defense Spending		1.53343	0.0893	**Reject**
16	Defense Spending does not Granger Cause GDP per Capita	263	1.92686	0.0191	**Reject**
	GDP per Capita does not Granger Cause Defense Spending		1.86361	0.0162	**Reject**
20	Defense Spending does not Granger Cause GDP per Capita	259	1.75276	0.0274	**Reject**
	GDP per Capita does not Granger Cause Defense Spending		1.63623	0.0362	**Reject**
24	Defense Spending does not Granger Cause GDP per Capita	255	1.84353	0.0124	**Reject**
	GDP per Capita does not Granger Cause Defense Spending		1.33798	0.1306	**Fail to Reject**
28	Defense Spending does not Granger Cause GDP per Capita	251	1.49923	0.0599	**Reject**

As shown above, between 1947 and 2016, the null hypothesis that GDP per capita does not Granger Cause defense spending, and that defense spending does not Granger Cause GDP

per capita can be rejected up to 24 lags, or 6 years. This means that there is statistically significant evidence that one of these variables can be used to predict the level of the other up to six years. It is important to note that in the 28 lag structure, or 7 years, that the null hypothesis that GDP per capita does not Granger Cause defense spending can be rejected. As shown, the 8 lag structure tests provide high F-statistics which correlates with a 1% confidence interval. The 4, 12, 16, 20, and 24 lag structure tests all are within 10% confidence, with every test excluding "GDP per Capita does not Granger Cause Defense Spending" in the 16 lag structure within a 5% confidence level.

Table 2

Sub-Period Granger Causality Testing

Time period	Null Hypothesis	Observations	F-Statistic	Probability	Test Results
	GDP per Capita does not Granger Cause Defense Spending		1.93094	0.1542	Fail to Reject
1947Q1 - 1955Q4	Defense Spending does not Granger Cause GDP per Capita	28	1.33179	0.322	Fail to Reject
	GDP per Capita does not Granger Cause Defense Spending		1.22257	0.3263	Fail to Reject
1956Q1 - 1970Q4	Defense Spending does not Granger Cause GDP per Capita	48	2.39483	0.0347	Reject
	GDP per Capita does not Granger Cause Defense Spending		1.50854	0.1915	Fail to Reject
1971Q1 - 1984Q4	Defense Spending does not Granger Cause GDP per Capita	48	1.24087	0.3157	Fail to Reject
	GDP per Capita does not Granger Cause Defense Spending		2.21462	0.049	Reject
1985Q1 - 2000Q4	Defense Spending does not Granger Cause GDP per Capita	48	1.40972	0.231	Fail to Reject
	GDP per Capita does not Granger Cause Defense Spending		1.5611	0.1654	Fail to Reject
2001Q1 - 2016Q3	Defense Spending does not Granger Cause GDP per Capita	51	3.48501	0.0037	Reject

In the sub-sample testing, there are some interesting changes. During the time periods from 1947 – 1955 and 1971 – 1984 there was no statistically significant evidence to support the claim that either of the null hypotheses can be rejected. However, there are some indications of significance in the other time periods. In both the time periods of 1956 – 1970 and 2001 – 2016 there is statistically significant evidence for rejecting the null hypothesis that defense spending does not Granger Cause GDP per capita. This implies that during these periods, defense spending can help predict a pattern in the future value of GDP per capita. Finally, between 1985 – 2000, the null hypothesis that GDP per capita does not Granger Cause defense spending can be rejected. In contrast to the previous time periods, during this sample period, GDP per capita can be used to assist in predicting a pattern in future defense spending.

Conclusions

In this paper, Granger Causality testing has been used to analyze the relationship between defense spending and economic growth in the United States between 1947 to 2016.

Examining the entire sample period, there was definite statistically significant data that rejected both null hypotheses. During the whole sample GDP per capita Granger Causes defense spending and defense spending Granger Causes GDP per capita up to six years. This implies a two-way causal relationship between the two variables. This is consistent with both Keynesian and Wagnerian Macroeconomic theories. This two-way causal relationship is consistent with the 7 countries in the Dakurah et al (2001) study. However, when broken down into shorter time spans, this changes. Different time series lengths saw significantly different results. It would be very interesting to further research why the shorter time series varied from the entire sample period. It would be beneficial to further see the short run implications to better allocate funding,

especially in times of economic recession. The ability to spur short run growth in these times is critical. Also, on a long run scale, it would show if defense spending is the correct avenue to allocate capital to. Perhaps long run economic growth would be better spurred by investment in health care or infrastructure. Implications of this causal nature shows that it is beneficial to research this topic further.

There are definite limitations to this paper's findings. Only defense spending and economic growth have been used to determine the relationship between one another. Other outside variables were not considered in this study except to deflate the series. There are a number of economic factors that play into economic growth, and using a bivariate approach limits this. Using a Vector Auto Regression would be able to incorporate other outside variables, such as employment, consumption and income.

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