**Introduction**

Since 2005, The Congressional Budget Office (CBO) has been responsible for more than $500 billion dollars in defense spending alone. Each year highly scrutinized budget requests are processed by government accountants, refined, and settled on by congress. My goal for this research project was to model spending over a twenty-year period and try to determine what the following year’s spending would look like. The first cut I made to my project was to shorten the time frame, first to ten years and then to five. For this essay, I will use primarily the 2020 defense budget document, which contains an overview of the last five years and a forecast two years ahead. In this essay I will break down a five-year expenditure model for the United States Department of Defense.

**Methodology**

My methodology was to collect the data, plot it, then use polynomial regression modeling to predict the next year’s growth. I had varying levels of success with this. I got the linear modeling to work just fine however, so used that to set a baseline for the predictive part of the project. The data was collected from the Office of the Comptroller General, so there would be as little data bias as possible, although the budget release states that the numbers are estimates. Each year’s budget data is split into expenses for

* Army
* Navy
* Air Force
* Defense Wide

Each of these divided into 8 appropriation titles:

* Military Personnel
* Operation and Maintenance
* Procurement
* RDT&E (Research, Development, Test and Evaluation)
* Military Construction
* Family Housing
* Revolving Management Funds

Having collected data, and getting it stored in .csv files, I used the “ggplot” library to create plots of expenditures by departments, make a list of assumptions, and verify them against the predictive graphs.

The first graph to take a look at would be the Appropriation Title. This graph shows the total allotment granted to each subcategory, for the totality of the three major departments: Army, Navy, and Air Force. A simple graph of these subcategories across five years shows the growth of expenditures in total, then we can look at how those numbers are divided across the three major departments.

My initial assumptions were correct, that each branch showed growth in spending. The appropriation titles which showed the most spending was Operation and Maintenance, Procurement, and Military Personnel, whereas infrastructure costs were significantly less. The totals for each of these three branches are summed up in the black line and are mathematically correct give or take a few thousand dollars from rounded data. The last graph to display is for department totals, containing totals from Army, Navy, Air Force and Defense Wide spending. In these budgets, Defense Wife is an umbrella term for all minor DOD organizations. This graph suggests that on average the Air Force and navy cost about $25 million more yearly than the Army, Defense Wide being about $40 million less than that on average.

In 2017 when the Syrian conflict gained traction in US news media, there was talk of the US military getting involved. The US has remained uninvolved, but there was an increase in the defense budget to support overseas operations. This is apparent in all data shown.

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**First observations**

By way of data familiarization, an initial look at these graphs tells us a few things. Army spends less on procurement and research and development than the other two branches. Of the three major branches, the army is the one most focused on land warfare, meaning the least amount of high dollar equipment. The Air Force cannot fly without airplanes and the Navy cannot sail without ships. The Air Force paved the way for US Cyber warfare command, unmanned aerial vehicles, and precision guided weapons, and other high tech innovations. From 2019 onward, their research and development programs have totaled more than the Army and Navy combined. This is also partly due to Space Force, which falls under the department of the Air Force. Space Force was conceived in 2018 and signed into effect in 2019. The Navy leads expenses in procurement, using both ships and airplanes, as well as having ground missions.

To make this information useful, we must be able to visualize it in a way that helps us predict future spending patterns. This turned out to be tricky in R. and I had a great amount of difficulty getting anything to look presentable. I will use one department (Air Force) to explain how this could be accomplished, however.

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What we see here is an initial attempt to predict spending in four appropriation titles simply one year out. I had some difficulty getting this to graph but changing the values of the years helped. So, 2016 here equals year 0, 2021 equals year 6. This linear regression unfortunately did not have much to work with, and the lines generated have a rather unforgiving slope. This type of graphing would work better with ten or more years of data, but for this amount of data it seems too vaguely optimistic about the future, even just one or two years out. I had a choice here: add in five more years of data or try to represent the data in a polynomial regression. I went with the latter, so as to not have to rewrite my thesis.

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After spending much time on the coding and hitting too many roadblocks, I was able to get some data mapped in a curved line. The “Total” line had to be omitted, as it was making it hard to visualize the other lines. After saving a new .csv file with that column of data erased and plotting both the polynomial and plan line graph together, we can get a better idea of where spending may be the following year. This is where a predictive graph would have been especially helpful. I was not able to get the predictive function in geom\_smooth() or stat\_smooth() functions to work unfortunately, but when placed side-by-side with the line plot, the peaks and valleys are less random, and the simplest prediction to make is to follow the direction of the graph where it cuts of in 2021. For this above comparison in the Air Force budget, the only decrease would be in construction. Below we have the same comparison for the department of the Army. This model would suggest decreases in both construction and Operation and Maintenance.

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**Limitations**

The data used for this project was all fairly recent, being less than ten years old. This data is also heavily scrutinized by the budget offices of the department of defense, and very little is left unaccounted for. On the documents where it was collected however, there is a notice by each expense table stating that numbers may not add due to rounding. Disappointingly enough, this means the data is biased one way or another and there is really no way of knowing how. I also noticed that the figures for 2020 and 2021 have been rounded to the thousandth decimal, making this bias even greater. This poses a serious limitation on predictive graphing as well. Predictive graphing is also less accurate for less data points, and in each expenditure category there are only five. It is also worth mentioning that the US has had a steady inflation rate of 2.88% yearly on average since 2016. This is not accounted for in the data, and it certainly has an effect on purchasing power of the dollar.

**Conclusion**

This project definitely was more than bargained for, in terms of complexity. Although I was not able to accurately create a predictive graph with only five years data, I was able to better understand some macrotrends in government spending and visualize it effectively.

United States. Office of the Under Secretary of Defense (Comptroller). Defense Budget Overview: United States Department of Defense Fiscal Year 2021 Budget. Beach, John W Mr OSD COMPT. Revised May 13th, 2020. Washington D.C.: Government Publishing Office, May 13 2020.

United States. Office of the Under Secretary of Defense (Comptroller). Defense Budget Overview: United States Department of Defense Fiscal Year 2020 Budget Request. Beach, John W Mr OSD COMPT. First edition. Washington D.C.: Government Publishing Office, March 6th 2019.

United States. Office of the Under Secretary of Defense (Comptroller). Defense Budget Overview: United States Department of Defense Fiscal Year 2019 Budget Request. Elaine McCusker OSD COMPT. Revised February 13th 2018. Washington D.C.: Government Publishing Office, February 13th 2018.

United States. Office of the Under Secretary of Defense (Comptroller). Defense Budget Overview: United States Department of Defense Fiscal Year 2018 Budget Request. Norquist, David OSD COMPT. First edition. Washington D.C.: Government Publishing Office, May 15th 2017.

United States. Office of the Under Secretary of Defense (Comptroller). Defense Budget Overview: United States Department of Defense Fiscal Year 2017 Budget Request. Michael J McCord OSD COMPT. Revised February 2nd 2016. Washington D.C.: Government Publishing Office, February 2nd 2016.

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U.S. Military Spending/Defense Budget 1960-2021 World Bank. Retrieved 2021-12-06.