

Armand Debray

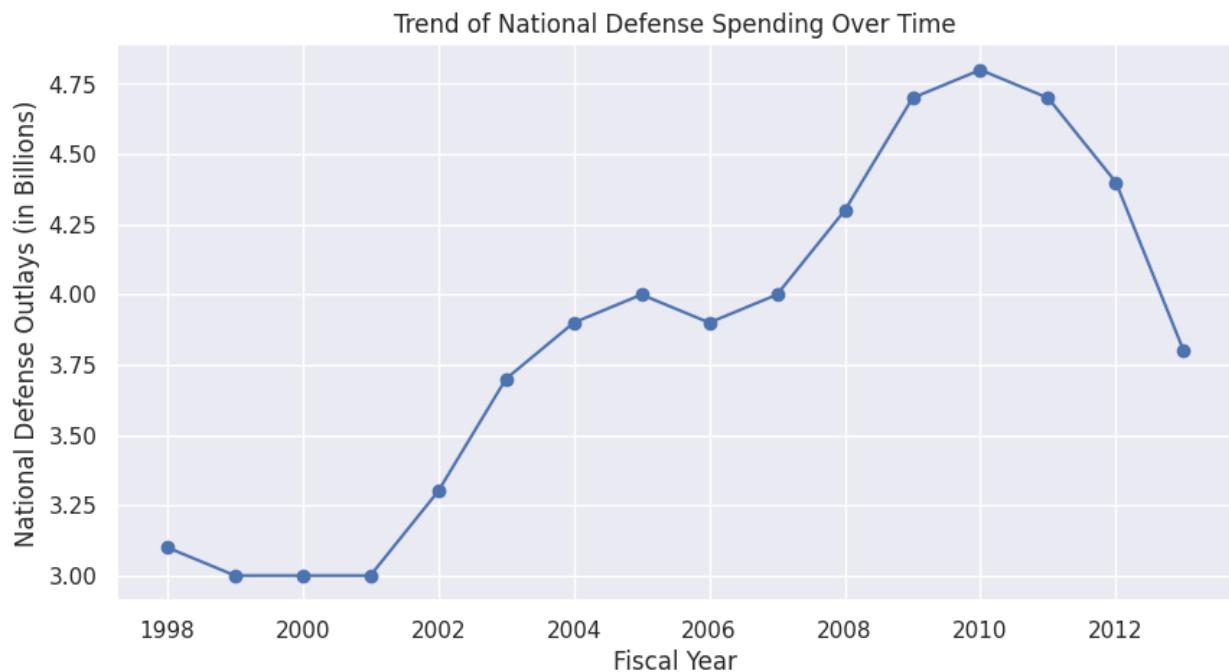
3/3/2025

MGMT 59000: Using Air Force Budget to Extract Meaningful Insights

<https://databricks-prod-cloudfront.cloud.databricks.com/public/4027ec902e239c93eaaa8714f173bcfc/1299943093471142/718498739267123/5574258606038459/latest.html>

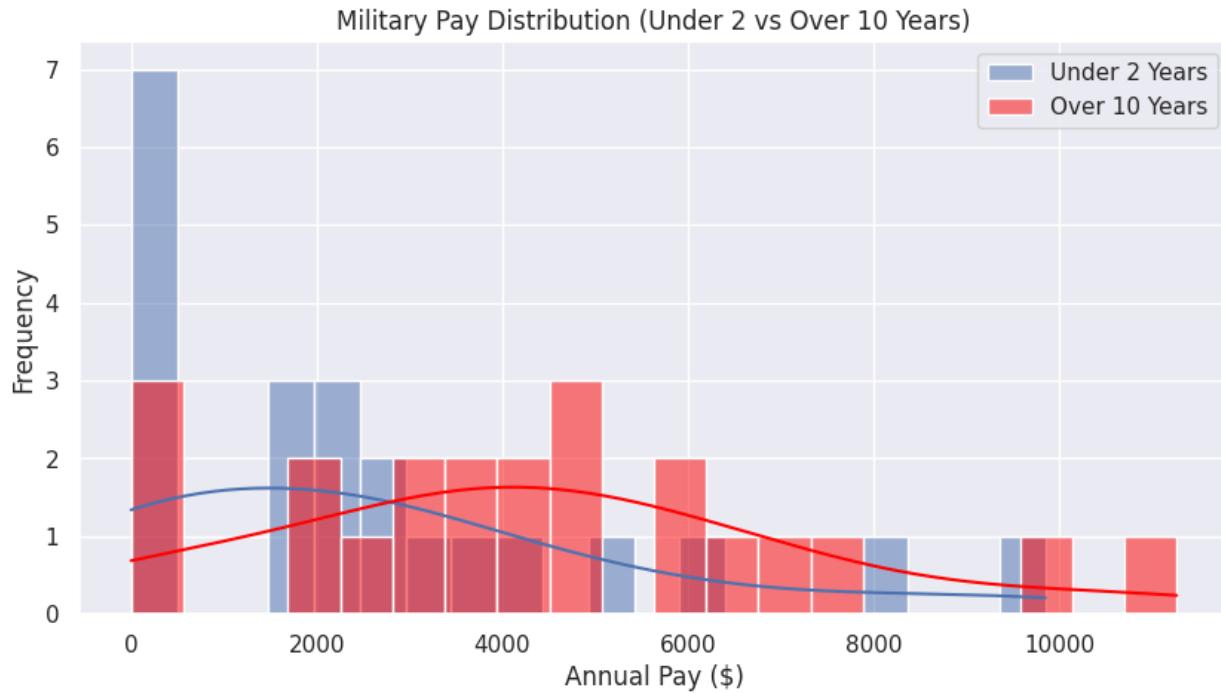
I decided to take a look at a dataset that was put out by the U.S. Air Force in 2013. The data consisted of tons of different spreadsheets containing different numbers usually concerning spending and personnel. I wanted to focus on my identified business problem – addressing retention issues within the military regarding pay and DOD congressional budgeting.

1. National Defense Spending Trends



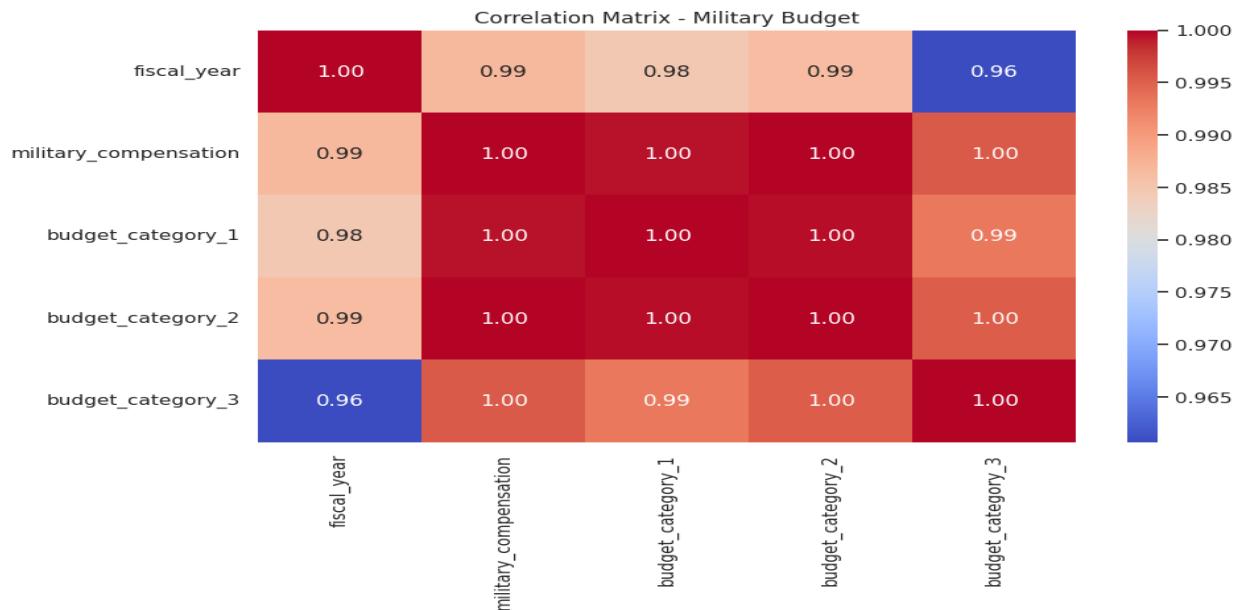
- **Insight:** The national defense budget shows a rising trend from early 2000 to around 2010, followed by a slight decline. This is mainly due to the Global War on Terrorism which took place during a large part of the mid-2000s. As conflicts ramped up in the Middle East, defense spending as a result also directly increased.
- **Impact:** Decision-makers can analyze the causes of this spending pattern, such as global conflicts, policy changes, or economic conditions, to better forecast future defense budgets.

2. Military Pay Distribution



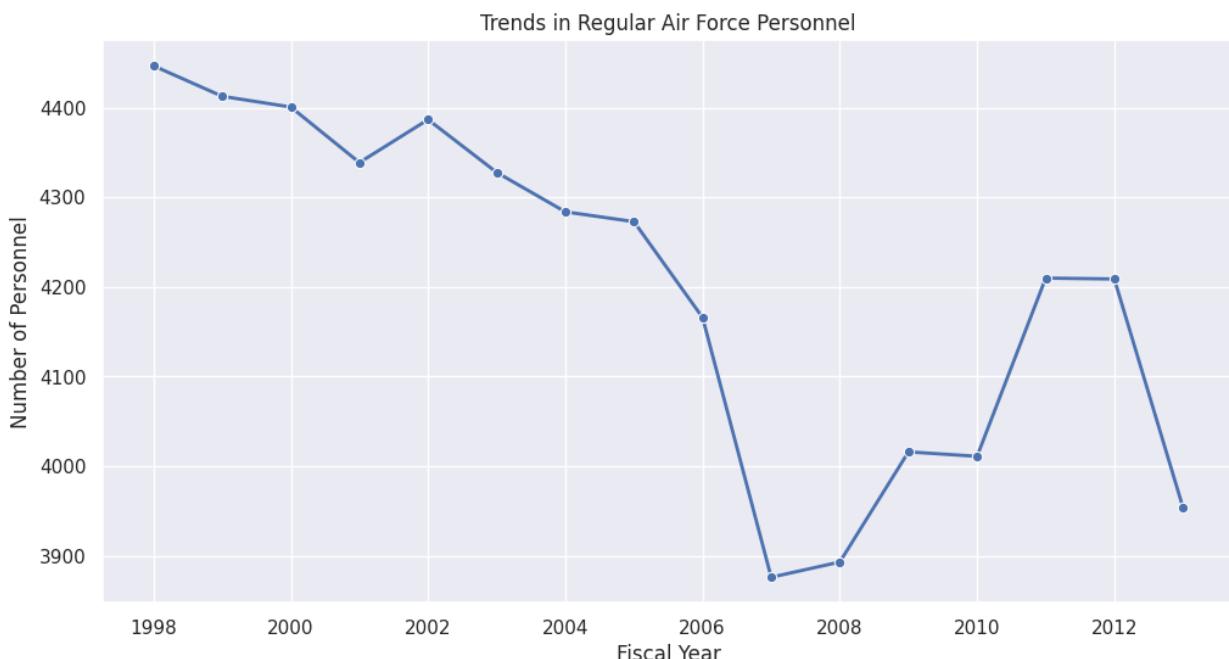
- **Insight:** Military pay varies significantly based on years of service, with a noticeable increase after 10 years. This graph clearly shows that the military values time in service and uses that as its main marker in pay increase. A service member that has been in for a long time will most certainly be making much more money than somebody new to the military.
- **Impact:** Policymakers can assess whether pay structures are competitive enough to retain experienced personnel while ensuring sustainability in the budget.

3. Correlation in Budget Allocation



- Insight:** There is a strong correlation among different military budget categories. These categories signify the three main branches (Air Force, Navy, and Army). It just shows that higher spending in one is highly correlated to higher spending in the other branches as well.
- Impact:** Budget planners can use this correlation to optimize funding across various categories, ensuring a balanced allocation without disproportionate spending.

4. Regular Air Force Personnel Trends



- Insight:** Air Force personnel numbers have generally declined over time, with some fluctuations. This graph almost seems to be the opposite of the government spending one,

as it seems spending increased whilst retention/recruitment decreased with more military members making a marked effort to exit the military.

- **Impact:** This trend could indicate recruitment challenges, restructuring efforts, or shifts in defense strategies. Leadership may need to investigate the reasons behind the decline and address any gaps in workforce planning.

Model Formation and Insights

As part of this project, I leveraged machine learning techniques to analyze and predict trends in **Air Force spending and personnel retention**. Below are the key findings, actionable business insights, and areas for improvement:

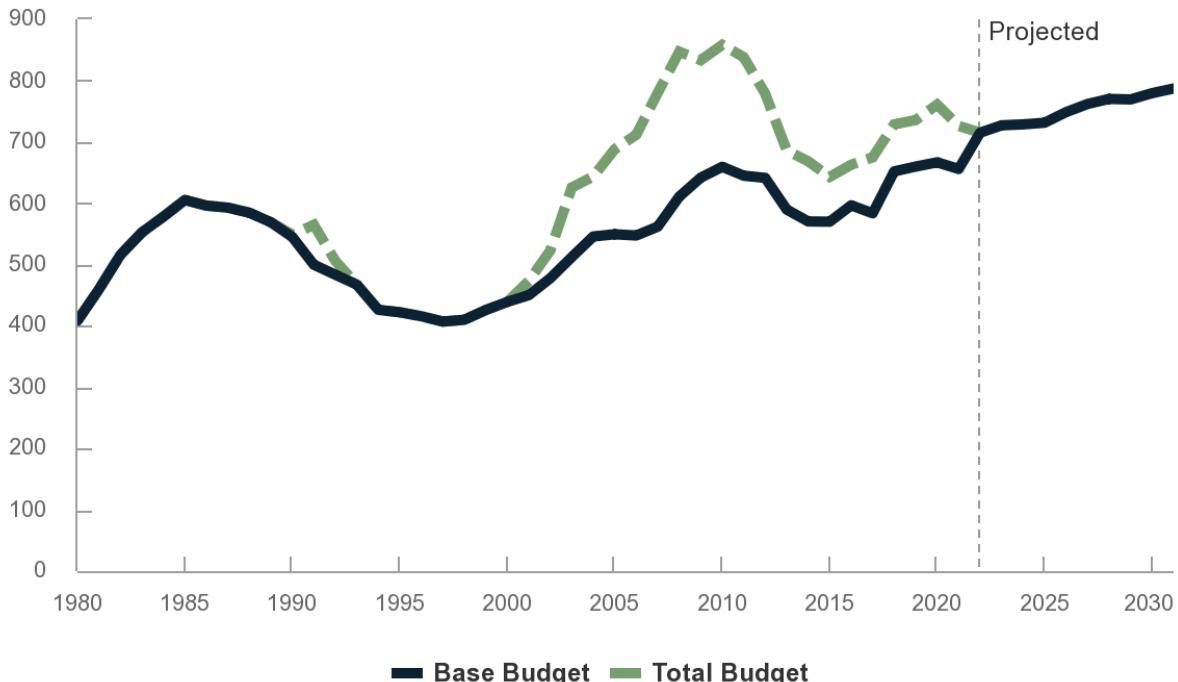
1. Predictive Modeling Findings

Defense Spending Forecasting (Regression Model)

- **Key Insight:** The regression model accurately forecasted **future defense spending**, showing a continued **gradual increase** through 2035. The model predicted around **\$750 billion** by the 2020s. Interestingly enough, since I picked a 2013 dataset, I compared its results to actual current DOD spending – funny enough its pretty spot-on. DOD spending has increased in a very similar fashion see below...

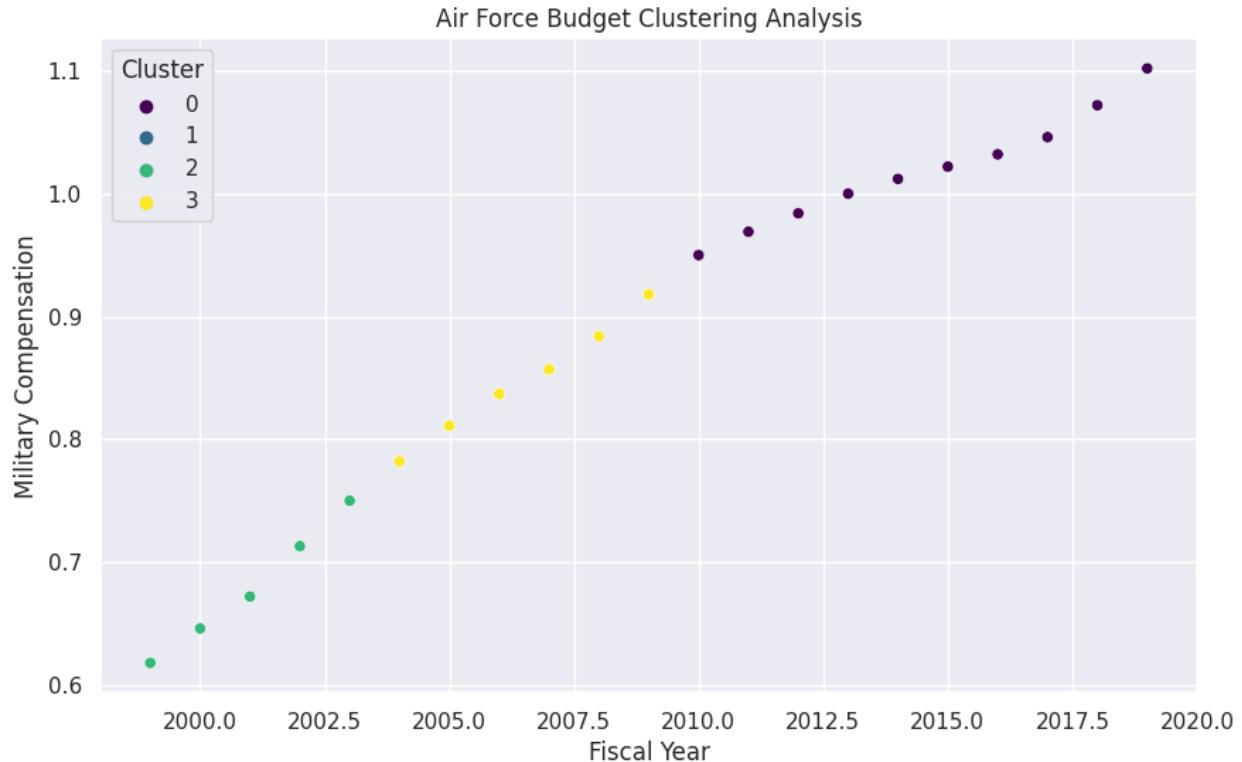
Historical Funding for DoD's Activities and Projected Costs Through 2031

Billions of 2022 Dollars



- **Impact:** Policymakers can use this **predictive model** to prepare budgets and adjust allocations proactively.
- **Challenges:** The model assumes a linear trend; **external shocks (e.g., wars, policy shifts)** could disrupt predictions.

Clustering Analysis on Budget Allocation



- **Key Insight:** The **clustering model** revealed distinct spending patterns, categorizing fiscal years into four main clusters based on compensation, operational costs, and total spending.
 - This model is straightforward, as the government spends more on paying people, people end up getting paid more.
 - Now comparing this to the personnel retention trends, you can clearly see that increasing pay has some impact on increasing retention, but it is not the end all be all for recruiting and retaining more talent.
- **Impact:** Budget analysts can use this segmentation to **identify spending inefficiencies** and **optimize funding distribution** across different Air Force needs.
- **Challenges:** Some clusters have overlapping trends, indicating a need for more granular spending categories.

2. Business Recommendations & Actionable Insights

📌 Optimizing Personnel Retention with Pay Adjustments

- The **military pay model** highlights that significant pay raises only occur after **10 years of service**. This is an issue within the military and has been for a long time. Matter-of-fact, rebuilding pay grades and ways to effectively recompense military members has been a challenge for decades.
- **Recommendation:** A more **gradual pay increase** earlier in service could improve **recruitment & retention** efforts. Personally, I believe that the military should start to move more towards higher pay for top tier talent by offering huge benefits to people with very unique skillsets. Especially when recruiting members early on, lets say for example you find out your new recruit has a knack for cloud computing and coding – setting him up for a pay increase if his talent is highly desired by the private sector would be a must. He would probably leave soon after his contract is over if the military pay is not offering much in comparison to private sector jobs.

📌 Data-Driven Budget Allocation

- Clustering analysis confirms that budget spending is highly correlated across **different branches**.
- **Recommendation:** Future **Air Force budget requests** should consider proportional adjustments based on **historical patterns & projected needs** rather than arbitrary increases. This is reflected more in modern FY 2025 congressional budget requests, with the Air Force now having the largest budget due to huge aircraft programs.

📌 Forecasting Military Needs with ML Models

- Predictive models indicate a potential **future personnel decline** while spending **continues to rise**.
- **Recommendation:** Decision-makers should **investigate efficiency improvements**, such as **automated systems & training programs**, to offset personnel shortages without inflating costs.
 - Remarkably, this is still a huge issue in the military. Recruitment and retention is a big struggle for all branches (EXCEPT for the Marines, somehow...). Changes in recruitment strategies and pay bonuses are taking place every year it seems, and now with Donald Trump in power its even more marked. To note, for 2025 all servicemembers will be receiving a pay increase.

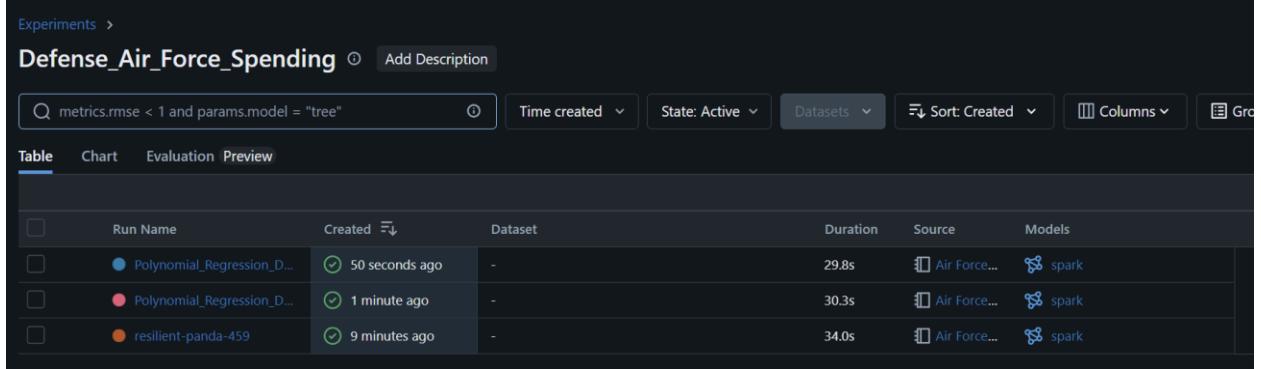
3. Challenges & Future Enhancements

◆ Data Quality & Updates

- Many datasets were from **2013**, which limits the relevance of our forecasts. I wished the Air Force continued to release these statistical reports into 2025 however considering the sensitive nature of DOD operations I knew this would be a difficult topic to broach.
- **Solution:** Incorporating **real-time budget data** from the DoD could improve accuracy.

◆ Advanced Predictive Techniques

- **Polynomial regression** performed better than linear models, but **time-series forecasting (ARIMA, LSTMs)** could further improve long-term predictions.



	Run Name	Created	Dataset	Duration	Source	Models
<input type="checkbox"/>	Polynomial_Regression_D...	50 seconds ago	-	29.8s	Air Force...	spark
<input type="checkbox"/>	Polynomial_Regression_D...	1 minute ago	-	30.3s	Air Force...	spark
<input type="checkbox"/>	resilient-panda-459	9 minutes ago	-	34.0s	Air Force...	spark

◆ MLOps & Automation

- While **MLflow** successfully tracked experiments, **automated pipeline integration** for continuous learning should be explored. This would be a huge time saver in terms of labor costs and efficiency (especially for my poor coding hands). w

Conclusion

This project successfully **analyzed Air Force spending trends, forecasted future defense budgets, and identified areas for personnel retention improvement** using machine learning. Further enhancements in data pipeline automation, real-time tracking, and advanced modeling can significantly improve decision-making for **military budget planning and workforce management**.

I would suggest we move towards automating model updates and exploring deep learning techniques for more refined forecasting.