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Government funding gap impacts on commercial aviation safety: President Carter through Trump (1978-2020)

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Government funding gaps are common and have occurred throughout the years. Each funding gap will lead to the stoppage of government agencies. This paper studies the relationship between funding gaps and commercial aviation safety during 1978-2020. It showed that the funding gap has no statistically significant impact on commercial aviation safety in terms of accidents, however through the literature review it does affect aviation negatively through both safety and economy. The recommendations to avoid funding gap fallout include prioritizing crucial services such as aviation and national safety, and addressing matters which may compromise the security of the public during the budget process. Government agencies, including the FAA, should be mandated to develop contingency plans that would address such funding gaps, such as designating the emergency fund to keep the aviation safety function running during the shutdown and purchasing insurance against the government shutdown.

Keywords: Government Funding Gap, FAA, Commercial Aviation Safety

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Introduction

"A capitalist society needs a political system and a set of political values that can accommodate the clashes of opposed interests without blowing up, this is what a party system provides" (Mead, 2007, p. 309). The recent U.S. political history is restless, and there were numerous clashes between the Democrats and Republicans due their respective political agendas and interest. One of the grave fallouts is that it may lead to funding gaps forcing the government shutdown and furloughing of Federal employees. In the U.S., the Federal Aviation Administration (FAA) regulates aviation safety, operates the U.S. National Airspace System, do research and development on aerospace product and systems, and perform administrative programs like licensing and registering (FAA, 2016). The Department of Transportation (DOT), which oversees the FAA, often gets affected by the government shutdown directly, furloughing of non-essential employees, or indirectly due to inactivity of other Federal agencies (NAS Safety Review Team, 2023; *Putting U.S. Aviation at Risk: The Impact of the Shutdown*, 2019).

The Shutdown of U.S Federal government

The direct cause of the shutdown of the U.S. Federal government is due to the lack of appropriated funding (Brass, 2013). The lack of appropriated funding will occur if (1) there is not passage of regular appropriations bills by the October 1 deadline, known as the beginning of a new fiscal year, and (2) no agreement on stopgap funding for federal government operations through a continuing resolution (CR) (Rosar, 2004). Continuing resolutions are temporary spending bills that allow federal government operations to continue when Congress and the President have not approved final appropriations. Without final appropriations or a CR, there could be a lapse in funding, resulting in a government shutdown. CRs continue the level of funding from the prior year's appropriations or the previously approved CR from the current year. Full-year CRs provide appropriations for the remainder of the fiscal year and are functionally like final appropriations. A CR can include changes from the previous year's budget that could (1) alter the rate at which funds are utilized, (2) extend an expiring program authority, or (3) provide a specific dollar amount of funding to a program during the CR. The detailed process of the first case begins when Congress, especially the House of Representatives, exercises the responsibility of proposing an appropriation bill determining the government budget. The bill must be voted on by the House of Representatives and the Senate and finally signed by the President to become law (History, Art & Archives, U.S. House of Representatives, 2023). A list of government shutdowns and associated federal funding gaps in the study period (1978-2020) is given below (Burwell, 2013; Emma, 2020; Foran, 2019; Kaplan, 2018; Matthews, 2013; Stolberg & Kaplan, 2018; Sullivan & Holland, 2020). A summary of the US Federal government shutdown history is given below, there are numerous reasons resulting in the federal funding gaps for each administration. Among them, the longest Republican government shutdown was 35 days during President Donald Trump term, while the longest Democrat government shutdown was 25 days during President Bill Clinton term. None of the Presidents could escape the unfortunate government shutdown. History offers no certainties, but it does keeps reminding us James Hamilton's sage, "In framing a government which is to be administered by men over men, the great difficulty lies in this: you must first enable the Government to control the governed; and in the next place oblige it to control itself" (Madison, 1788, p. 360).

Table 1

Federal government shutdown history between 1978 and 2020

Year	Shutdown Period	Duration	President	Reason
1978	September 30 - October 18	18	Jimmy Carter	Nuclear-powered aircraft carrier.
1979	September 30 - October 12	11	Jimmy Carter	Higher pay, fewer abortions.
1981	November 20 - November 23	2	Ronald Reagan	Reagan vs Senate's decision of passing his bill with monetary cutdown.
1982	September 30 - October 2	1	Ronald Reagan	Congress delays in passing the budget after commencement of new term.
1982	December 17 - December 21	3	Ronald Reagan	Disagreement on spending of funds on public works. Raegan opposed the decision on spending, and wanted to spend on MX missile program
1983	November 10 - November 14	3	Ronald Reagan	Spending of $1B in education, falling short to defense spending about $11B (as per Reagan's request).
1984	September 30 - October 3	2	Ronald Reagan	Opposition to Reagan's crime-fighting package; instead, water project package was selected.
1984	October 3 - October 5	1	Ronald Reagan	A three-day extension to the previous shutdown issue.
1986	October 16 - October 18	1	Ronald Reagan	Disagreements over a provision to ban companies from creating subsidiaries to get around labor contracts.
1987	December 18 - December 20	1	Ronald Reagan	Disagreement on funding for the Nicaraguan "Contra" militants.
1990	October 5 - October 9	3	George H. W. Bush	Refusion on signing any CR into laws unless paired with a deficit reduction plan.

1995	November 13 - November 19	5	Bill Clinton	Only Clinton opposed the proposed Appropriation bill for 1996 by Republican and House Speaker Newt Gingrich; the bill was supposed to reduce govt spending. Clinton opposed also because there was threat to a scheduled reduction on Medicare premium.
1995–1996	December 5, 1995 - January 6, 1996.	21	Bill Clinton	Extension to previous dispute on disagreement of proposed Appropriation Bill
2013	October 1 - October 17	16	Barack Obama	Disagreement between Republican and Democrats related to contents of 2014 appropriate Resolution Bill
2018	January 20 - January 22	1	Donald Trump	Disagreement on issue of immigration; Deferred Action for Childhood Arrivals (DACA) policy; Democrats demanded DACA, but Republican opposed.
2019	December 22, 2018 - January 25	35	Donald Trump	Disagreement on Trump-Mexico Wall
2020	October 1	1	Donald Trump	Dispute over farm aid
2020	December 22	1	Donald Trump	Covid-19 relief package

The Impact of Shutdown on Commercial Aviation and General Aviation

The partial government shutdown has affected the U.S. aviation industry because of lapsed federal funding. The FAA has faced the most significant impact, including other associations like Airports Council International and Air Line Pilots Association. The impact faced by the FAA has seen a reduction in the number of hiring new employees. Although there are 25,000 air traffic controllers exempt from furloughs, there was a suspension in training new controllers during the 2019 shutdown. A handful of employees from the Transportation Security Administration did not show up at work due to not getting paid. One of the major hubs – Miami International Airport, had to close one of its terminals on the weekend. Airlines like Southwest had to halt their new routes and operations because FAA inspectors were furloughed (Freight Waves Staff, 2019). The Federal Government shutdowns have impacted the Flight Standards certificate management activities. The impact extends to other activities, including the training equipment evaluation and approval of training program revisions, and it has affected the FAA Part 121 operations (FAA, 2019). The Office of Management and Budget (OMB) stated the General Aviation Manufacturers Association (GAMA) reported a delay of 156 aircraft deliveries with an estimated cost of $1.9 billion (2013).

The Impact of Shutdown on the FAA and the NTSB

During government shutdown in1995, about 7800 FAA employees were furloughed, but most of the FAA's personnel as part of the DOT employees were exempted and they returned to work on November 16th thanks to passage of the fiscal 1996 DOT appropriations bill, and the Federal government-wide furlough ended on November 20, 1995 (FAA, 1998). The 2013 shutdown led to about 15,500 of the approximately 46,000 FAA employees being furloughed and it lasted 16 days (Kraus, 2022). Multiple statements were released following the U.S. government shutdown in 2018 by Professional Aviation Safety Specialists (PASS), and their National President Michael Perrone who said, "Since President Trump has failed to reach an agreement with Congress--not once, but three times since September 30--to fund the federal government fully, Federal Aviation Administration (FAA) aviation safety inspectors were off the job"(PRNewswire-USNewswire, 2018) The PASS-related employees are responsible for the entire American aviation system's oversight, surveillance, and certification, and the responsibilities for PASS-related employees cover management of all general and commercial aviation, pilots, flight instructors, and repair stations all over the country and abroad (Professional Aviation Safety Specialists, 2019). The FAA has reduced FY2019 hiring air traffic controller target of 1431 to 907 after the 35-day government shutdown (NAS Safety Review Team, 2023).

For each day the government is non-functional, the aviation safety inspectors cannot oversee commercial and general aviation and perform their other responsibilities. The other effect of the government shutdowns is that the manufacturing inspectors cannot provide production approval and certification. Modernization of the National Airspace System (NAS) will be stopped. The aviation system in the U.S. serves 12 million jobs and provides United States Dollars (USD) 1.5 trillion through commercial aviation (FAA, 2020). The unavailability of safety inspectors during the government shutdowns poses a considerable risk to the aviation industry.

In 2013, most of the workforce were furloughed at the National Transportation Safety Board (NTSB), delaying investigations of 59 aircraft accidents, and the NTSB investigated only two aviation accidents during this period the United States Office of Management and Budget (OMB) reports. The previous accident investigations were therefore delayed from their expected completion dates. The shutdown also led NTSB to reschedule two important public investigative hearings (OMB, 2013).

Methods

As the literature review shows, government shutdowns have negative impact on operation and safety inspection of the FAA. This study examines how much the impacts of governments shutdown on commercial aviation safety in a quantity. The researchers pose the following questions:

1. Does the duration of funding gap days have a statistically significant impact on commercial aviation safety (annual commercial aviation accident number)?

2. Does the percentage of legislation enacted has a statistically significant impact on commercial aviation safety (annual commercial aviation accident number)?

3. Does the amount of annual FAA spending has a statistically significant impact on commercial aviation safety (annual commercial aviation accident number)?

Data Sample

The data collection of this research was a daunting task. The researcher originally filed Freedom of Information Act (FOIA) request to the FAA to retrieve the information including FAA spending, FAA aviation safety spending, FAA aviation safety branch (AVS) employee number, FAA total employee number on November-08-2022. And the request was never returned, and the researcher also made similar attempt to email the National Transportation Library, and nobody replied to the email as well. Thus, the researchers have to select the current independent variables.

The accident rate is computed from the number of commercial aviation accidents divided by annual departures in the United States. The number of commercial aviation accidents were collected from the NTSB and the NTSB Annual Review of Aircraft Accident Data provided by Hunt Library at Embry-Riddle Aeronautical University (ERAU, 2023; NTSB, 2021). The annual departure numbers of commercial aviation were collected from the World Bank (2023).

A brief explanation of all the variables used in the study is given below.

Table 2

Overview of variables used in the study.

Variable	Description	Source
AccidentCount	Annual number of the U.S. commercial aviation accidents.	FAA, NTSB
FG	Funding gap days + 1 (to remove zero days)	Infogram, and Washington Post (Matthews, 2013)
PctLawEnacted	Percentage of law enacted=annual number of legislation became law/average annual number of bills introduced in each session	US Congress bills by final status dataset (GovTrack, 2024)

Variable	Description	Source
FAASpending	Annual FAA spending adjusted for inflation baseline as 1978	For FAA spending between 2005-2020, collected from the FAA Budget Estimates between 2007-2022 (FAA, 2024); For FAA spending between 2002-2004, collected from Avionics News (Dickstein, 2005); For FAA spending between 1999-2001, collected from Administrator factor book 2001-2003(FAA William J. Hughes Technical Center, 2024); For FAA spending between 1978-1998, calculated from Aviation: Direct federal Spending,1918-1998 by John Fischer and Robert Kirk Congressional Research Service (1999).
Departures	Annual commercial aviation departures	World Bank (2023)

As the above table shows, the dependent variable in the study is AccidentCount, and FG, PctLawEnacted, FAASpending and Departures are all independent variables in the study. To be clear, all the accident number list here are US Air Carriers Operating Under 14 CFR 121, Scheduled and Nonscheduled Service. PctLawEnacted are involved with all the laws, and it is a good metric to reflect how harmonious of legislative branch and the White House, which is strongly correlated with government shutdown. Departures represents the total (international and domestic) scheduled traffic carried by the air carriers registered in the U.S., and it may be subject to the changes in the classification of air traffic in the past (World Bank, 2023). Last, President Carter took office in 1977, but our collected data period started in 1978, because 1978 is the year Airline Deregulation Act signed into law and took effect (Adrangi et al., 1997; Belobaba et al., 2016).

Table 3

Variable summary statistics.

	AccidentCount	FG	PctLawEnacted	FAASpending	Departures
Mean	30.88	4.28	0.04	3853037.83	7762146.19
Standard Deviation	10.30	6.39	0.02	802408.45	1851799.08

Minimum	11	1	0.014458542	2078226.472	4572100
Maximum	56	26	0.09327895	5100318.739	10099031
Observations	43	43	43	43	43

It is noteworthy that the variance of dependent variable AccidentCount is square of standard deviation, which is around 106, and the Shapiro-Wilk normality test reports p-value of 0.02366, suggesting it is not normally distributed. However, after logarithmic transformation: ln(AccidentCount), the same test reports p-value of 0.3983, and suggesting it is normally distributed. Additionally, all the independent variables are transformed in natural logarithmic way.

Table 4

Correlation table between model independent variables.

	ln(FG)	ln(PctLawEnacted)	ln(FAASpending)	ln(Departures)
ln(FG)	1			
ln(PctLawEnacted)	0.25162446	1		
ln(FAASpending)	0.3095795	0.2142257	1	
ln(Departures)	-0.07542839	0.05473939	-0.83528562	1

We calculate correlation matrix of the independent variables and variance inflation factors (VIF) for all independent variables for testing multicollinearity. VIF ranges from 1.31 to 5.01. Using a commonly applied rule of 10 (for VIF), this suggests that the independent variables of the current study are not multicollinear (O' Brien, 2007).

Models

In this study, we plan to use three linear regression models to analyze the data: log-log linear regression model (1), zero-truncated Poisson regression model (2), and zero-truncated negative binomial regression model (3). Log-log linear regression model is that both dependent variable and independent variables are transformed by natural logarithmic transformation whose results are easy to interpret results and the data are normally distributed for meeting linear regression assumption (Weisberg, 2014; Wooldridge, 2013). Zero-truncated counted models are designed to analyze data doesn't have zero count in observation (Nava, 2014).

The log-log linear regression model is given by:

$$ln(AccidentCount) = \beta_0 + \beta_1 ln(FG) + \beta_2 ln(PctLawEnacted) + \beta_3 ln(FAASpending) + \beta_4 ln(Departures) \quad (1)$$

The zero-truncated Poisson regression model (ZTP) is given as:

$$p(AccidentCount|FG, PctLawEnacted, FAASpending, Departures) \quad (2)$$

$$= \frac{p}{1 - p(0)}$$

$$= \left(\frac{\lambda^{y} Exp(-\lambda)}{AccidentCount!\,(1 - \exp(-\lambda))}\right), AccidentCount$$

$$= 0,1,2$$

where:

$$\lambda = E(AccidentCount|FG, PctLawEnacted, FAASpending, Departures) = Exp(\beta_0 + \beta_1 FG + \beta_2 \text{PctLawEnacted} + \beta_3 \text{FAASpending} + \beta_4 \text{Departures})$$

The zero-truncated negative binomial regression model (ZTNB) is given by

$$p(AccidentCount|FG, PctLawEnacted, FAASpending, Departures) \quad (3)$$

$$= \left(\frac{r}{r+\mu}\right)^{r} \frac{\left(\frac{\Gamma(r + AccidentCount)}{\Gamma(r)\Gamma(AccidentCount + 1)}\right)\left(\frac{\mu}{r+\mu}\right)^{AccidentCount}}{1 - \left(\frac{\mu}{r+\mu}\right)^{AccidentCount}}, AccidentCount$$

$$= 0,1,2,3 \ldots,$$

The letter r is called dispersion parameter allowing the estimation of the mean and variance independently of each other to deal with the situations of overdispersion.

where:

$$\mu = E(AccidentCount|FG, PctLawEnacted, FAASpending, Departures)$$

$$= Exp(\beta_0 + \beta_1 FG + \beta_2 \text{PctLawEnacted} + \beta_3 \text{FAASpending} + \beta_4 Departures)$$

also:

$$Var(AccidentCount) = \mu + \frac{\mu^2}{r}$$

A measure of goodness of fit for the Poisson regression model is obtained by computing the deviance statistic of the base model against the full model. In this study, base model is the ZTNB, and full model is the ZTP. H0: the base model has a better fit, against the alternative Ha: the full model has a better fit. Under H1, the deviance has a chi-squared distribution where the degrees of freedom are equal to the number of

predictors in the full model. If the deviance is greater than the p-value, the alternative hypothesis is accepted, meaning that the full model fits the data best.

$$Deviance = -2\ (lnL(ZTNB) - lnL(ZTP)) \quad (4)$$

$$P\left(\mathrm{X}^2(4)\right) > Deviance \quad (5)$$

Results

All the models were computed in the R Studio and two zero truncated models are computed using VGAM: Vector Generalized Linear and Additive Models packages (Yee, 2015). The results of the model output are shown in table 5 through table 7 adapted from R output.

Table 5

Results of the log-log linear regression model

	Estimate	Standard Error	t value	Pr(>|t|)	
(Intercept)	-3.059012	3.491598	-0.876	0.386477	
ln(FG)	-0.04761	0.045911	-1.037	0.306292	
ln(PctLawEnacted)	0.002413	0.105124	0.023	0.98181	
ln(FAASpending)	-0.987769	0.434553	-2.273	0.028761	*
ln(Departures)	1.353653	0.363722	3.722	0.000639	***
Residual standard error	0.2864 on 38 degrees of freedom				
Multiple R-squared	0.3407				
Adjusted R-squared	0.2713				
F-statistic:	4.91 on 4 and 38 degrees of freedom				
p-value	0.002728				

Note. Significant codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Table 6

Results of zero-truncated Poisson regression model

	Estimate	Standard Error	z value	Pr(>|z|)	
(Intercept)	2.993	0.2124	14.092	<2E-16	***
FG	-0.005859	0.004657	-1.258	0.2084	
PctLawEnacted	0.3584	1.65	0.217	0.828	

FAASpending	-1.609E-07	7.637E-08	-2.108	0.0351	*
Departures	1.359E-07	3.151E-08	4.315	0.000016	***
Name of linear predictor	loglink(lambda)				
Log-likelihood	-166.9144 on 38 degrees of freedom				
Number of Fisher scoring iterations	4				

Note. Significant codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1. No Hauck-Donner effect found in any of the estimates.

Table 7

Results of zero-truncated negative binomial regression model

	Estimate	Standard Error	z value	Pr(>|z|)	
(Intercept):1	2.965	0.3316	8.943	<2e-16	***
(Intercept):2	3.007	0.3601	8.351	<2e-16	***
FG	-0.005331	0.007406	-0.72	0.47168	
PctLawEnacted	0.1143	2.628	0.044	0.96529	
FAASpending	-1.551E-07	1.181E-07	-1.313	0.18902	
Departures	1.377E-07	4.878E-08	2.823	0.00476	**
Names of linear predictors	loglink(munb), loglink(size)				
Log-likelihood	-153.1688 on 80 degrees of freedom				
Number of Fisher scoring iterations	5				

Note. Significant codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1. Warning: Hauck-Donner effect detected in the following estimate(s): (Intercept):2

The Hauck-Donner effect indicated that ZTNB has some internal problems causing estimated (unconstrained) parameter is close to the boundary of the parameter space (Hauck Jr & Donner, 1977). The deviance difference is 27.4912, and its statistic p-value of 1.581333e-05. Hence, the zero-truncated Poisson regression model (ZTP) is selected as the optimal model in the study.

Refer to table 6, there are three statistically significant variables: Intercept, FAASpending and Departures. The model predicts: *Ceteris paribus*, commercial aviation accident count will

change by a factor of 0.9999998391 ($e^{-1.609*10\hat{}-7}$) for every one percent increase in the FAA annual spending (FAASpending); and it also predicts: *Ceteris paribus*, commercial aviation accident count will change by a factor 1.0000001359 ($e^{1.359*10^{-7}}$) for every one percent of annual departure increases. It is extremely minimal impact. And both the duration of funding gap and percentage of law enacted have no effect on commercial aviation accident. And there are also other factors affect commercial aviation safety not captured in this study.

Limitation

As shown in the methods section, this study is not absent from bias and error. For instance, it is worthwhile to look at accidents involving commercial cargo traffic, and/or incident count. And more importantly, due to the complex nature of each government shutdown and funding gap, the study could evolve into a mix-methods research, which will require participation of government staff interview or survey. However, it is difficult to obtain the data through FOIA, and it is more difficult to get opinions from the government insiders and relevant stakeholders due to the sensitive nature of this topic.

Conclusion

The quantitative result suggests that the increase the FAA spending may decrease commercial aviation accident rate with little practical significance, and the annual departure number positively correlate with commercial aviation accident rate with little practical significance as well. They are both making sense intuitively. And surprisingly, the funding gap has no effect on commercial aviation accidents. We believe it stems from the fact that aviation accidents are rare events and future research should find a better indicators of safety performance metrics on the commercial aviation. Based on the literature, the funding gap have negatively impacted aviation in terms of economy and safety. The lawmakers should make sure that they prioritize crucial services such as aviation and national safety, and other functions which may compromise the welfare of the public. National Airspace System (NAS) Review Team consists of former FAA Administrator Michael Huerta, former NASA Administrator Charles Bolden, former NTSB Chairman Robert Sumwalt, and other experienced aviation leaders (2023) recommended exempt the FAA from the operation effects of government shutdown. The materialization of this recommendation remains a quixotic ambition based on today's political quagmire, so we recommend that government agencies, including the FAA, should be mandated to come up with some contingency plans that would address the future funding gaps, such as designating stash funds to keep the operations related to aviation safety running during the shutdown or purchase insurance for the agency. Future research should include the more safety performance metrics, and how they get affected by the government shutdown, and moreover the future study should aim at the prevention of government shutdown and mitigation strategies for government shutdown impact on aviation safety.

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