

Terrorism, very large scale

The President publishes the U.S. Government's primary unclassified probability estimate for very large scale (50,000+ fatalities [1]) terrorist CBRN attacks in the annual Budget, as part of his cost estimates for the Terrorism Risk Insurance Program [TRIA or TRIPRA] [2]. This has varied from 1.3% in CY 2008-09, to a generally flat 0.5-0.6% in CY 2010-16, to 0.25-0.4% in CY 2017-present, and is currently 0.29% per year [3], [4].

[1] The unusual structure of the Terrorism Risk Insurance Program (TRIP) effectively compresses the consequences of all of the scenarios for which the Government retains losses at the program cap of \$100 billion, such that best-estimate annual likelihood follows directly from annualized risk and the USG share of a \$100 billion loss event. (Very little of the overall distribution is captured in the \$42-100 band: nearly all the probability density in this USG-retained fraction is above the \$100 billion line.)

Threshold impacts. At that level, the covered losses consist almost entirely of workers' compensation (WC) insurance payments for deaths and permanent total disability (PTD) from CBRN attacks (CBRN only, e.g. fig. 4 p. 12 Willis [2014]; WC only, 100% take-up rate for WC and near zero for property, CBO [2015] p. 17, CBRN take-up rate range 3-10%, Dixon [2007] p. 17; dominance of fatality & PTD costs, Carroll [2005] tables pp. 80, 89, 91, charts pp. 82-83, 92-95). Industry modelled workers' compensation losses for large CBRN attack scenarios average \$0.679 million per fatality in 2005 (RMS [2005] p. 11) = \$1.80 million in 2022 (inflation adjustment from SSA [2022] for New York, <https://secure.ssa.gov/poms.nsf/lnx/0452150045#c35>). \$100 billion / \$1.8 million = 55,000+ fatalities.

[2] Treasury originally adapted its risk model from the insurance modeller AIR Worldwide, GAO (2014) page 17 (AIR is ISO's modeller), and further calibrated it to reflect the market's implicit risk judgements (Bush (2008)). Treasury has continued this approach since (the "market data" referenced by Obama (2009-16), Trump (2017-20), and Biden (2021-22)).

[3] Adjusted annual spending (a weighted average of ten year spending and outlays [3a], divided by remaining years of TRIA exposure [3b]) / the USG share of a \$100+ billion event [3c]. Additional detail, [4].

[3a] To correct for TRIA's 133% / 140% recoupment overfraction, a factor that Congressional budget scoring rules zero out but OMB's do not. The weighted average is 0.25 *Outlays* + 0.75 *Spending* for 133% [2007-14], 0.3 *Outlays* + 0.7 *Spending* for 140% [2015-present] = \$718 million (outlays and spending, Biden (2022)).

[3b] Six years in early 2022 when the FY 2023 Budget was made.

[3c] Currently 0.80 (the Government's fraction) times (\$100 billion minus the future-averaged (taking inflation into account) aggregate deductible [\$42.7 billion for CY 2022, Treasury (2021)]) = \$45.8 billion.

[4] Additional detail. **Frequency.** Annualized USG exposure \$118 million / year = (10-year outlays – spending) / (6 years' exposure) ÷ (1.40 TRIP recoupment factor [OMB scores it differently than the statute writers]). USG exposure per \$100+ billion loss event, \$40.342 billion = (\$100 billion – CY 2022-27 average GDP-inflated IMARA [Treasury (2021)]) × 80% USG copay. \$118 m / \$40,342 m = 0.0029 / year.

The changing formula in the 2015-19 TRIA 'regime' introduces a complication which doesn't affect the pre-2016 and present estimates, but requires averaging the Government's exposure to a maximal \$100+ billion event over the remaining years of that TRIA regime (the correction is minor and can be safely neglected, but I've incorporated it below).

Similar corrections are necessary for the FY 2021 and later budgets because the 2020-future aggregate retention also changes year to year; but (as a further complication) since it is unknown until the end of the previous year, the underlying variables have to be forecasted using the economic estimates (current-year dollar GDP projections, i.e. it is growth and inflation sensitive). The extra rows in the second table below include projected future years for the affected factor using the budget's economic assumptions for nominal GDP (main FY 2023 budget document table S-9), for the CY 2022 output numbers and intermediates. I applied the same calculations for the CY 2020 and 2021 estimates, but omitted them to save space: the intermediates and final numbers reflecting the non-displayed data are marked in yellow. Additional detail, note [4a] below.

Baseline estimated outlays. Heavy line indicates then-current TRIA regime sunset. Pink numbers are from the FY09 Treasury budget justification rather than the President's Budget. The column headers are the year relative to the fiscal year (FY) of the Budget: e.g. the first row comes from the President's proposed FY 2009 Budget which was prepared in January 2008 (CY 2008): -2 are the cost estimates for FY 2007, already past (the \$2-3 million is the administrative cost of the TRIA program), -1 are the cost estimates for the remainder of the FY in progress (FY 2008, October 2007 – September 2008), 0 is FY 2009, and so on.

The TRIA runs by calendar year, so the total outlays and spending for e.g. the FY 2014 Budget, prepared in January 2013, represents the estimated risk from January 2013 to December 31, 2014 when the then-current 2007-14 TRIA program (and the Government's risk exposure with it) was scheduled to sunset.

Table 1. Outlays, Terrorism Risk Insurance Program, President's Budget.

CY made	FY	-2	-1	0	1	2	3	4	5	6	7	8	9	10 year outlays
2008	2009	2	152	426	727	1,019	1,262	1,449	1,600	1,500	1,200	900	600	10,835
2009	2010	2	109	366	684	999	1,281	1,502	1,468	1,215	905	611	385	9,525
2010	2011	2	104	236	326	385	430	380	259	161	107	103	79	2,570
2011	2012	2	108	241	335	390	359	237	149	91	60	69	55	2,094
2012	2013	2	105	245	341	316	215	131	84	56	38	57	48	1,636
2013	2014	2	108	253	267	183	110	71	47	32	22	48	43	1,184
2014	2015	2	113	179	135	78	50	34	23	16	12	43	13	696
2015	2016	1	88	230	345	415	464	499	432	292	180	143	111	3,199
2016	2017	1	88	233	350	421	469	411	278	171	111	100	83	2,715
2017	2018	2	48	133	204	247	229	161	103	72	54	53	49	1,353
2018	2019	3	46	127	195	192	135	85	58	42	33	38	37	988
2019	2020	2	37	104	126	91	57	39	28	22	19	24	24	571
2020	2021	3	31	94	160	206	238	262	283	300	282	223	160	2,239
2021	2022	3	21	66	115	151	175	191	203	190	80	12		1,204
2022	2023	3	22	67	114	148	171	186	177	137	94	66	52	1,234

Table 2. Program parameters, spending estimates, and net probability of \$100+ billion loss event.

year prepared	years remaining exposure	aggregate retention (\$m) [5]	USG fraction	USG share of \$100 bn insured loss in CY (\$m)	USG exposure (\$m) (one year) [6]	recoupment factor	10 year outlays (\$m)	10 year spending (\$m)	USG risk (\$m) (one year) [7]	one year probability [8]
2008	7	27,500	0.85	61,625	61,625	133%	10,835	3,850	798	1.294%
2009	6	27,500	0.85	61,625	61,625	133%	9,525	3,069	778	1.263%
2010	5	27,500	0.85	61,625	61,625	133%	2,570	1,260	317	0.514%
2011	4	27,500	0.85	61,625	61,625	133%	2,094	984	315	0.511%
2012	3	27,500	0.85	61,625	61,625	133%	1,636	780	331	0.537%
2013	2	27,500	0.85	61,625	61,625	133%	1,184	526	345	0.559%
2014	1	27,500	0.85	61,625	61,625	133%	696	300	398	0.646%
2015	6	29,500	0.85	59,925	53,912	140%	3,199	1,200	295	0.548%
2016	5	31,500	0.84	57,540	52,709	140%	2,715	1,183	324	0.615%
2017	4	33,500	0.83	55,195	51,502	140%	1,353	519	189	0.368%
2018	3	35,500	0.82	52,890	50,270	140%	988	332	173	0.344%
2019	2	37,500	0.81	50,625	48,961	140%	571	133	129	0.264%
2020	8	40,880	0.80	47,296	42,286	140%	2,239	394	115	0.272%
2021	7	41,706	0.80	46,635	43,171	140%	1,204	518	102	0.236%
2022	6	42,690	0.80	45,848	40,342	140%	1,234	497	118	0.292%
2023	5	45,008	0.80	43,994	39,241	140%				
2024	4	47,814	0.80	41,749	38,053	140%				
2025	3	51,279	0.80	38,977	36,821	140%				
2026	2	54,121	0.80	36,703	35,744	140%				
2027	1	56,520	0.80	34,784	34,784	140%				

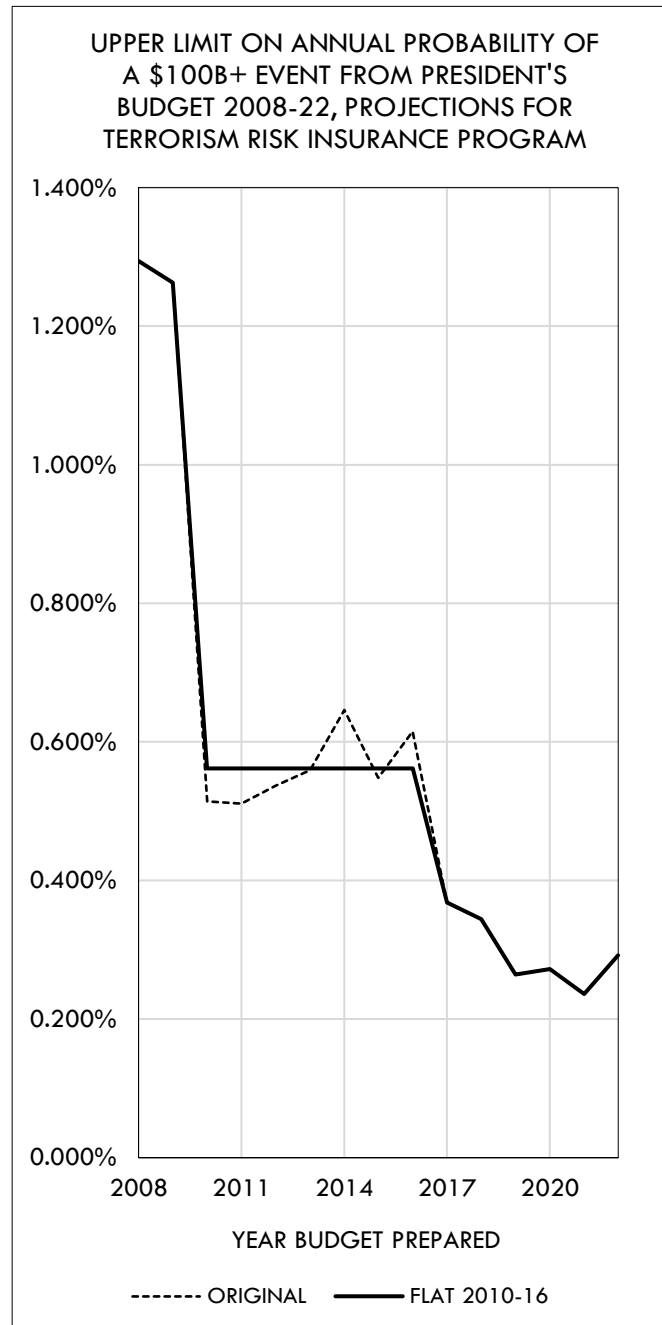
[5] CY 2023-27 based on CY2021-future industry direct earned premium (DEP) GDP-adjusted from CY 2020 (last DEP year published by Treasury for IMARA, Treasury [2021]) from projected nominal GDP (November 2021 OMB economic assumptions table S-9, President's Budget p. 141). DEP in TRIP-eligible insurance lines track nominal GDP (Treasury [2016] page 23).

Note: The same projections, applied for the 2020-prepared (FY21) and 2021-prepared (FY22) Budget estimates using those Budgets' GDP projections in the same way, are reflected in the 2020 and 2021 probability estimates in the final column, but other than the final intermediates where their influence enters and the final numbers (both marked in yellow) they are omitted to save space.

[6] USG exposure = USG share of \$100+ billion insured loss, averaged over remaining years of exposure. The \$100 billion is total per year; I'm also treating it as per event, because the very low probability of one event – TRIA has been in place since 2002, but has never been triggered (e.g. the Boston Marathon bombing, SNRA p. 320 *Assumptions* last paragraph) – and insurance modelers' probabilistic representation of terrorist events make multiple very large events in one year very unlikely in these models.

[7] USG risk = Recoupment-adjusted average annual USG exposure (Outlays – [(Outlays – Spending) / (recoupment factor) × {years remaining exposure}])).

[8] Probabilities in yellow incorporate non-displayed data to save space, see [5] above.



The dashed line is the actual data. The solid line reflects my belief (with no evidence other than intuition, from years of staring at these numbers) that the variation between 2010 and 2016 reflects arithmetic and program-related differences, rather than a change in the underlying threat assumptions. The small increase from 2011 to 2014 reflects a larger portion of the total outlay and spending estimates falling within the ten-year budget window that the President reports these numbers to, as the expiration of the then-current TRIA program approached. The clear variation after that appears to primarily reflect changes in the U.S. Government's perceived terrorism risk picture, which is what I'm using these numbers to capture.

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Single line formula

Formula:

$$\text{- Annual likelihood} = ([(R_f - 1) \times (\text{Outlays})] + [\text{Spending}]) / (R_f \times [\text{Years}] \times f_x \times [\$100 \text{ billion} - AD])$$

Where

- R_f = the TRIA recoupment overfraction (133% CY 2007-2014, 140% CY 2015-present).
- Outlays = Ten year outlays, Terrorism Risk Insurance Program.
- Spending = Ten year net USG spending, Terrorism Risk Insurance Program.
- Years = Years remaining in then-current TRIA regime (i.e. years of remaining USG exposure).
- f_x = USG fraction above the aggregate deductible (85% CY 2007-14, 80% CY 2020 – present, reducing by 1% per year from CY 2015 to CY 2019).
- AD = TRIA aggregate deductible. \$27.5 billion CY 2007-14, increasing by \$2 billion each year to CY 2020, Treasury published IMARA (\$42.7 billion in CY 2022, <https://www.govinfo.gov/content/pkg/FR-2021-12-23/pdf/2021-27795.pdf>) CY 2020 – present; or, at a second level of complexity, the average of the inflation-projected values of this factor through the end of the current TRIA program (currently through December 2027).