



AIRLINE SAFETY | 8:20 PM | JUL 18, 2014

Should Travelers Avoid Flying Airlines That Have Had Crashes in the Past?

By NATE SILVER

The [downing of Malaysia Airlines Flight 17](#) in Ukraine on Thursday, following the disappearance of its Flight 370 in March, is the second mysterious incident involving the airline this year. The incidents don't appear to be related, but that isn't preventing people from [insisting that they'll never fly Malaysia Airlines again](#). Some of them will follow through — academic studies have found that high-profile crashes can [shift passenger demand away](#) from the airlines involved in the disasters.

Is this behavior rational? Should we really be less inclined to fly airlines that have had fatal crashes in the past — even when the crashes don't appear to be their fault? Or are crashes essentially random events that occur at about the same rate on all airlines over the long run? (The two fatal accidents involving Malaysia Airlines this year were the [first for the carrier since 1995](#).)

We can study this by looking at safety records for major commercial airlines over the past 30 years, as based on the [Aviation Safety Network's database](#). The method is relatively simple. I'll break the 30-year period down into two halves: first from 1985 to 1999, and then from 2000 to 2014. Then I'll look to see whether there was a correlation in crash rates from one half of the data set to the other. If we identify a correlation, that will imply that crash risk is persistent — predictable to some extent based on the airline.

I'll be making a couple of simplifying assumptions:

- First, I'll include all crashes regardless of their cause. The airline is clearly more culpable in cases such as the [1977 Tenerife disaster](#) than others like Flight 17. But the causes of many other disasters (such as Malaysia Flight 370) are controversial or poorly understood — I'm not going to try to assign blame.
- Next, I'll take crash rates on the basis of the number of [available seat kilometers](#) (ASKs), which is defined as the number of seats multiplied by the number of kilometers the airline flies.¹ ASK figures are taken as of December, 2012. This implicitly assumes that the number of ASKs has been constant for each airline since 1985, which is obviously not true — some airlines have grown while others have shrunk — but this is a necessary simplification until we can track down some older data. I do, however, exclude any airlines that were not operational as of Jan. 1, 1985,² and account for some major mergers (so Northwest's data is combined into Delta's, and so forth). I also include data for regional subsidiaries under the flagship carrier — so incidents for American Eagle are grouped with the data for American Airlines, for instance.
- I'll define crashes in three ways:
 - First, based on the rate of **incidents** as listed in the database, whether or not they resulted in a fatality.
 - Next, based on the rate of **fatal accidents**.³
 - Finally, by the rate of **fatalities** among passengers and crew on the airline.

Here's the data for 56 airlines that were in the [global top 100](#) as of December 2012 and which have operated continuously since Jan. 1, 1985. Airlines are sorted based on the rate of fatalities per ASK.

Incidents, Fatal Accidents And Fatalities

Per trillion available seat kilometers

*Includes regional subsidiaries

	1985-1999			2000-2014		
	INCIDENTS	FATAL INCIDENTS	FATALITIES	INCIDENTS	FATAL INCIDENTS	FATALITIES
Kenya Airways	9	0	0	10	10	1,388
China Airlines	19	8	843	3	2	267
Avianca	16	10	1,043	0	0	0
Pakistan International	29	11	881	38	8	175
Malaysia Airlines	4	1	42	4	3	885
Air India*	3	1	485	6	2	241
Ethiopian Airlines	56	15	438	14	5	258
EgyptAir	18	7	848	10	2	33
Gulf Air	4	0	0	13	4	628
Garuda Indonesia	21	8	343	9	4	48
Saudi Arabian	10	3	497	17	0	0
Japan Airlines	2	1	425	8	0	0
SWISS*	3	2	378	5	0	0
Vietnam Airlines	14	8	351	2	0	0
Korean Air	9	4	314	<1	0	0
South African	4	2	313	2	0	0
TAM	7	3	82	6	2	165
Xiamen Airlines	27	3	244	6	0	0
Aeroflot*	81	15	137	7	1	97
Philippine Airlines	22	12	230	6	3	3
Thai Airways	6	3	232	2	<1	1
Royal Air Maroc	22	13	221	13	0	0
SAS*	9	0	0	12	2	214
Air France	8	2	34	38	<1	149
Iberia	4	1	182	8	0	0
Aeromexico*	6	2	137	11	0	0
American*	5	1	25	4	<1	108
US Airways / America West*	8	4	117	6	1	12
Alaska Airlines*	7	0	0	7	1	121
COPA	7	2	108	6	0	0
Turkish Airlines	5	2	42	5	1	57
Alitalia	13	4	92	8	0	0
Delta / Northwest*	5	2	80	5	<1	10
United / Continental*	3	1	57	3	<1	20
SriLankan Airlines / AirLanka	9	4	55	16	0	0
Singapore Airlines	3	1	88	9	3	45
Condor	6	3	49	0	0	0
TACA	15	5	15	5	5	15
LAN Airlines	4	3	27	0	0	0
EI Al	4	4	15	4	0	0
Air New Zealand*	5	0	0	9	2	13
KLM*	5	<1	2	<1	0	0
Lufthansa*	2	<1	<1	1	0	0
All Nippon Airways	2	<1	<1	5	0	0
Austrian Airlines	4	0	0	4	0	0
Qantas*	<1	0	0	3	0	0
Aerolineas Argentinas	26	0	0	3	0	0
Southwest Airlines	<1	0	0	3	0	0
Hawaiian Airlines	0	0	0	3	0	0
British Airways*	2	0	0	3	0	0
Air Canada	1	0	0	1	0	0
Cathay Pacific*	0	0	0	1	0	0
Aer Lingus	1	0	0	6	0	0
Finnair	3	0	0	0	0	0
Virgin Atlantic	1	0	0	0	0	0
TAP - Air Portugal	0	0	0	0	0	0

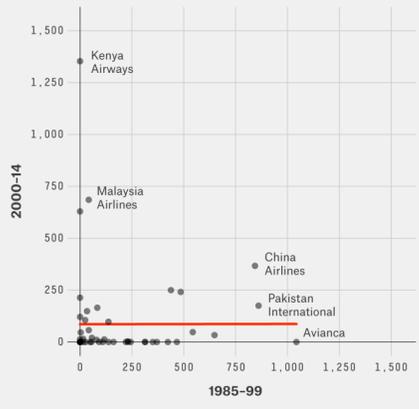
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As you should see, the number of fatalities is not very consistent from the first half of the data set to the next. Avianca, the national airline of Colombia, had a series of major crashes from 1983 through 1990. But it has had almost no problems since then — no fatal accidents since 1990, and no incidents of any kind since 1999. By contrast, Kenya Airways was fatality-free until 2000 but has had two major accidents since then and ranks as the worst airline since 2000 based on the number of fatalities per ASK.

One or two other carriers, such as Taiwan's China Airlines (not be confused with Beijing's Air China*), have had problems in both halves of the data set. But these cases are more the exception than the rule. Overall, there is no correlation in the rate of fatalities from one period to the next.

Fatalities by Airline Are Highly Unpredictable

Fatalities adjusted for seats available and distance traveled (deaths per 1 trillion seat kilometers)



FIVETHIRTYEIGHT SOURCE: FLIGHT SAFETY FOUNDATION

Accidents that produce a massive number of fatalities are rare compared to fatal accidents of any kind, however. And fatal accidents represent only about one-quarter of all incidents listed in the database. So it may be better to compare airlines on the basis of their number of incidents, whether or not they resulted in a fatality, which has the effect of increasing the sample

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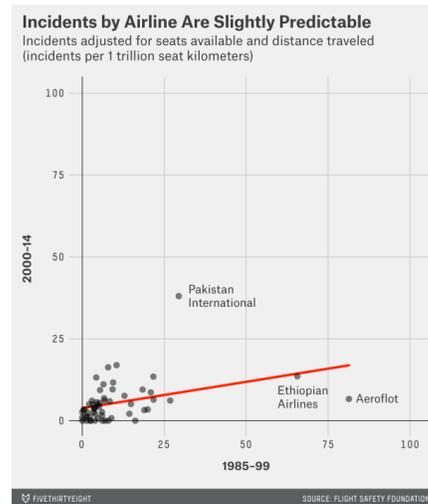
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size. These near-misses can still produce non-fatal injuries. They may also provide useful evidence about the overall hazard associated with flying a given airline, in the same way that the [number of smaller earthquakes](#) in a region over a period of time can be used to predict the likelihood of a catastrophic one.⁵



Viewed this way, there is a modest correlation from one period to the next.⁶ There are also a few major outliers in the chart: two are [Pakistan International Airlines](#) and [Ethiopian Airlines](#), which have had a persistently high rate of incidents. A third outlier, Russia's Aeroflot, had an [extraordinarily high number of reported incidents in the 1990s](#) — many of them attempted hijackings around the time of the breakup of the Soviet Union — but only an average number in recent years. There is still a positive correlation even if those three airlines are excluded, however, which rates as modestly statistically significant⁷ — some airlines are slightly safer to fly than others.

Our preliminary answer, then, is that an airline's track record tells you something about its probability of future crashes — although not a lot, and only if looked at in the right way. In particular, you should look toward an airline's rate of dangerous incidents of any kind rather than its number of fatalities or fatal accidents. These near-misses are more consistent from period to period — and could result in a deadly crash the next time around.

But there's a better rule to follow. If you're insistent on minimizing your crash risk, you should avoid airlines from developing countries.

Let's combine our three measures of crash rates — incidents, fatal accidents and fatalities — into a single measure which I'll call the airline's safety score. I calculate it as follows:

- For each category, subtract an airline's crash rate from the average for all airlines since 1985. This gives safer airlines positive scores and less safe airlines negative scores.
- Multiply the result by the square root of the number of seat kilometers flown. This gives more credit to an airline that has achieved a strong safety record over a larger sample of flights.
- **Standardize** the score in each category to calculate how many standard deviations an airline is above or below the mean. Then average the scores from the three categories together. This is the safety score.

Positive scores indicate a safe track record — Australia's Qantas, for instance, which is [famous for avoiding crashes](#) — has a safety score of +0.71. By contrast, Pakistan International Airlines has a score of -1.49.

First-World Airlines Have Fewer Crashes

Safety scores for 1985-1999 and 2000-2014 are based on incidents, fatal accidents and fatalities per available seat kilometers flown

*Includes regional subsidiaries

	PER CAPITA GDP OF AIRLINE'S HOME COUNTRY	SAFETY SCORE		
		1985-99	2000-14	COMBINED
Southwest Airlines	34,970	+0.89	+0.82	+0.86
Cathay Pacific*	24,970	+0.91	+0.85	+0.88
Lufthansa*	25,555	+0.80	+0.86	+0.83
British Airways*	25,870	+0.90	+0.85	+0.88
Air Canada	22,205	+0.73	+0.73	+0.73
Qantas*	21,770	+0.28	+0.85	+0.57
United / Continental*	34,970	+0.37	+0.86	+0.61
KLM*	26,058	+0.46	+0.76	+0.61
Virgin Atlantic	25,870	+0.57	+0.62	+0.60
Singapore Airlines	21,143	+0.80	+0.26	+0.53
All Nippon Airways	35,014	+0.57	+0.57	+0.57
TAP - Air Portugal	12,445	+0.51	+0.51	+0.51
Finnair	25,234	+0.42	+0.47	+0.45
Hawaiian Airlines	34,970	+0.47	+0.41	+0.44
LAN Airlines	4,959	+0.12	+0.82	+0.37
Austrian Airlines	26,588	+0.35	+0.35	+0.35
Aer Lingus	25,848	+0.26	+0.40	+0.33
American*	34,970	+0.40	+0.29	+0.35
Delta / Northwest*	34,970	-0.18	+0.76	+0.31
Iberia	31,447	+0.03	+0.46	+0.24
Air New Zealand*	15,176	+0.39	+0.06	+0.23
Condor	25,555	+0.00	+0.44	+0.22
COPA	4,074	-0.05	+0.66	+0.22
Alaska Airlines*	34,970	+0.39	-0.00	+0.20
Aerolineas Argentinas	7,970	+0.03	+0.36	+0.18
EI AI	19,577	+0.04	+0.34	+0.19
Air France	24,950	+0.15	+0.18	+0.16
Japan Airlines	36,026	-0.45	+0.76	+0.14
Turkish Airlines	3,942	+0.11	+0.17	+0.14
South African	3,029	-0.24	+0.47	+0.11
Aeromexico*	6,073	-0.00	+0.22	+0.08
Swiss*	34,039	-0.31	+0.42	+0.05
Thai Airways	1,859	-0.54	+0.87	+0.01
SriLankan Airlines / AirLanka	889	-0.08	+0.10	+0.01
Alitalia	21,258	-0.34	+0.33	-0.01
SAS*	29,207	+0.28	-0.31	-0.01
Korean Air	9,005	-0.98	+0.76	-0.12
TACA	2,152	-0.20	-0.05	-0.13
US Airways / America West*	34,970	-0.59	+0.34	-0.13
TAM	7,414	-0.13	-0.18	-0.15
Xiamen Airlines	864	-0.68	+0.32	-0.17
Gulf Air	10,026	+0.32	-0.77	-0.23
Vietnam Airlines	378	-0.98	+0.46	-0.28
Air India*	489	-0.50	-0.19	-0.35
Saudi Arabian	8,360	-0.87	+0.07	-0.40
Malaysia Airlines	3,855	+0.28	-1.10	-0.42
Royal Air Maroc	1,407	-1.11	+0.15	-0.48
Philippine Airlines	1,081	-1.28	+0.04	-0.83
Avianca	2,429	-1.89	+0.43	-0.71
Kenya Airways	464	+0.23	-2.71	-0.74
EgyptAir	1,463	+1.49	-0.01	-0.25
Garuda Indonesia	687	-1.42	-0.21	-0.81
China Airlines	13,535	-2.45	-0.32	-1.38
Pakistan International	879	-1.90	-1.07	-1.49
Ethiopian Airlines	374	-2.74	-0.84	-1.88
Aeroflot*	1,354	-4.50	+0.08	-2.24

The chart also lists the [per-capita gross domestic product](#) for the airline's home country as of 1999 (the middle of the 30-year period). The correlation between a country's wealth and the crash rates of its airlines is quite strong.⁶ Over the past 30 years, the top 10 safety scores belong to two airlines from the United States (Southwest Airlines and United Airlines), two from the United Kingdom, and one each from Canada, Australia, Hong Kong, Singapore, Germany and the Netherlands. By contrast, the 10 worst scores are for airlines from Colombia, Egypt, Ethiopia, Indonesia, Kenya, Morocco, Pakistan, the Philippines, Russia and Taiwan. In fact, if you want to predict an airline's future rate of crashes, you're best off looking at its home country's GDP and largely ignoring its track record.⁹

Perhaps this shouldn't be surprising. Commercial airlines are subject to extremely stringent safety standards, and the same standards are applied to all airlines from the same country or region. Richer countries, in air travel and [many other aspects of public planning](#), can afford to buy more safety in the form of higher prices and more expensive regulations.

So should you never fly an airline from a developing country again? No, that would be silly — commercial airline travel is an [extraordinarily safe means of transit](#) overall. What you should do is avoid airlines on blacklists, such as that periodically [put out by the European Union](#). (None of the airlines on the list of 56 above is currently on the EU's blacklist, although one, Pakistan International Airlines, [has been in the recent past](#).) Otherwise — even on Malaysia Airlines — the risk of being involved in a crash is very low, and that risk doesn't increase much after a recent disaster.

CORRECTION (July 23, 9:54 a.m.): The tables in a previous version of this post used an incorrect denominator in calculating incidents, fatal accidents and fatalities. They had been assuming 80 percent rather than 100 percent of seats were filled by passengers, in accordance with standard industry [load factors](#). However, the definition of an available seat kilometer (ASK), the statistic used elsewhere in the article, is based on the number of seats available and not how many of them were filled. The numbers in the tables have been changed to reflect the proper definition of an ASK.

In addition, we double-checked the numbers for all 56 airlines and found a small number of accidents that had previously been missed, as well as a couple of typos. These have been corrected. These changes do not significantly affect the relative ordering of the airlines or the overall conclusion of the article.

UPDATE (July 23, 9:54 a.m.): A number of readers were confused about the numbers described in the tables. They list the number of incidents, fatal accidents and fatalities per one trillion available seat kilometers (ASKs) flown, and not the raw numbers. This is an important distinction: For

instance, United Airlines flies about 24 times more miles than Royal Air Maroc. United has had more accidents overall, but it has had considerably fewer per ASK. However, we've inserted the following table for people who would prefer to see the unadjusted numbers.

AIRLINE	AVAILABLE SEAT KM PER WEEK	1985-1999			2000-2014		
		INCIDENTS	FATAL ACCIDENTS	FATALITIES	INCIDENTS	FATAL ACCIDENTS	FATALITIES
Aer Lingus	321m	2	0	0	0	0	0
Aeroflot*	1,198	76	14	128	6	1	88
Aerolineas Argentinas	386	6	0	0	1	0	0
Aeromexico*	597	3	1	64	5	0	0
Air Canada	1,865	2	0	0	2	0	0
Air France	3,004	14	4	79	6	2	337
Air India*	889	2	1	329	4	1	158
Air New Zealand*	710	3	0	0	5	1	7
Alaska Airlines*	965	5	0	0	5	1	88
Alitalia	698	7	2	50	4	0	0
All Nippon Airways	1,841	3	1	1	7	0	0
American*	5,228	21	5	101	17	3	416
Austrian Airlines	358	1	0	0	1	0	0
Avianca	397	5	3	323	0	0	0
British Airways*	3,180	4	0	0	6	0	0
Cathay Pacific*	2,582	0	0	0	2	0	0
China Airlines	813	12	6	535	2	1	225
Condor	418	2	1	16	0	0	0
COPA	550	3	1	47	0	0	0
Delta / Northwest*	6,526	24	12	407	24	2	51
EgyptAir	558	8	3	282	4	1	14
El Al	335	1	1	4	1	0	0
Ethiopian Airlines	489	25	5	167	5	2	92
Finnair	506	1	0	0	0	0	0
Garuda Indonesia	613	10	3	260	4	2	22
Gulf Air	301	1	0	0	3	1	143
Hawaiian Airlines	494	0	0	0	1	0	0
Iberia	1,173	4	1	148	5	0	0
Japan Airlines	1,574	3	1	520	0	0	0
Kenya Airways	277	2	0	0	2	2	283
KLM*	1,875	7	1	3	1	0	0
Korean Air	1,735	12	5	425	1	0	0
LAN Airlines	1,002	3	2	21	0	0	0
Lufthansa*	3,427	6	1	2	3	0	0
Malaysia Airlines	1,039	3	1	34	3	2	537
Pakistan International	349	8	3	234	10	2	46
Philippine Airlines	413	7	4	74	2	1	1
Qantas*	1,917	1	0	0	5	0	0
Royal Air Maroc	296	5	3	51	3	0	0
SAS*	683	5	0	0	6	1	110
Saudi Arabian	860	7	2	313	11	0	0
Singapore Airlines	2,377	2	2	6	2	1	83
South African	652	2	1	159	1	0	0
Southwest Airlines	3,277	1	0	0	8	0	0
SriLankan Airlines / AirLanka	326	2	1	14	4	0	0
SWISS*	793	2	1	229	3	0	0
TACA	259	3	1	3	1	1	3
TAM	1,509	8	3	98	7	2	188
TAP - Air Portugal	619	0	0	0	0	0	0
Thai Airways	1,703	8	4	308	2	1	1
Turkish Airlines	1,946	8	3	64	8	2	84
United / Continental*	7,139	19	8	319	14	2	109
US Airways / America West*	2,456	16	7	224	11	2	23
Vietnam Airlines	625	7	3	171	1	0	0
Virgin Atlantic	1,005	1	0	0	0	0	0
Xiamen Airlines	430	9	1	82	2	0	0

*Includes regional subsidiaries

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