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Carl E. Enomoto,
New Mexico State University,
Las Cruces, NM, U.S.A,
E-mail: cenomoto@nmsu.edu

Karl R. Geisler,
New Mexico State University,
Las Cruces, NM, U.S.A,
E-mail: geisler@nmsu.edu

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CULTURE AND PLANE CRASHES: A CROSS-COUNTRY TEST OF THE GLADWELL HYPOTHESIS

ABSTRACT. Early studies found evidence of a positive correlation between Hofstede's power distance scores, which measure the extent to which those without power defer to those with it, and plane accidents in different countries. However, these studies did not control for the level of economic activity (Gross Domestic Product-GDP) and severe weather conditions in these countries. This paper uses regression analysis to estimate the effects of number of flights, GDP, severe weather conditions, and culture on plane crashes in sixty eight countries. It is found that per-capita GDP and country scores on the cultural dimension of individualism are inversely related to plane accidents while power distance scores and number of flights are directly related to plane accidents. Continued training for pilots and copilots in direct cockpit communication can help overcome cultural barriers and reduce plane accidents.

JEL Classification: Z1, Z13

Keywords: plane accidents; culture; power distance; miscommunication

Introduction

> The kinds of errors that cause plane crashes are invariably errors of teamwork and communication. One pilot knows something important and somehow doesn't tell the other pilot. One pilot does something wrong, and the other pilot doesn't catch the error. A tricky situation needs to be resolved through a complex series of steps – and somehow the pilots fail to coordinate and miss one of them.
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> "The whole flight deck design is intended to be operated by two people, and that operation works best when you have one person checking the other, or both people willing to participate", says Earl Weener, who was for twenty years chief engineer for safety at Boeing. Airplanes are very unforgiving if you don't do things right. And for a long time it's been clear that if you have two people operating the airplane cooperatively, you will have a safer operation than if you have a single pilot flying the plane and another person who is simply there to take over if the pilot is incapacitated.
>
> (Gladwell, 2008, pp. 184-5)

Gladwell (2008) cited several cases where plane crashes were a result of poor communication between the pilot and copilot or between the pilots and air traffic control. Copilots may often use what Gladwell referred to as "mitigated speech", a term borrowed from linguists. Mitigated speech is a form of communication that is watered down to take the edge taken off so as to avoid conflict with another individual. Rather than commanding another person to take an action, a polite request is made in its place which may be interpreted as a request that does not require immediate attention. This could lead to serious consequences in the case of a copilot communicating with the pilot or air traffic control.

Why is it that some pilots and copilots have had difficulty in communicating between themselves and air traffic control? Gladwell suggested that it has something to do with culture. Geert Hofstede, a Dutch psychologist, sociologist, and anthropologist, and his colleagues came up with several dimensions of culture which have been used by researchers worldwide (Wu, 2006). These dimensions include power distance, uncertainty avoidance, individualism, and masculinity. If a country ranks high in power distance, the order of inequality and hierarchy is well defined and one's place in society is known and accepted. In such a society individuals are deferential to their leaders and have a high regard for them. If a country ranks high in individualism, there is a greater emphasis in that society on individual achievement and rewards and less of an emphasis on team decisions and achievements. If a nation ranks high in uncertainty avoidance, society prefers formal rules and structure while change is not readily accepted. If a nation ranks high in masculinity, that society is generally more competitive and assertive in nature. Gladwell noted that in many cases involving plane accidents, the flight crew was from a high power distance country. In such cases, he found that the copilot spoke using culturally-accepted mitigated speech in order to show deference and respect to authority. Herein lays the problem. When faced with a crisis in the cockpit, what is needed is strong and direct communication between the pilot, copilot, and air traffic control. The mitigated language and deference to one's elders typically found in high power distance societies do not sufficiently convey enough correct information about the urgency of the problem at hand.

Previous studies have established that there is a strong correlation between culture and plane crashes, though they do not control for other important factors such aviation infrastructure or severe weather. Using regression analysis, this paper confirms the previous work that culture affects the number of airline accidents while also highlighting other important factors. In the next section, a review of the literature will be presented, followed by a model of information given by the copilot to correct a mistake or oversight of the pilot. The empirical findings will then be discussed, followed by the conclusions and a summary.

1. Literature review

Gorodnichenko and Roland (2011) gave a brief history of the development and use of the Hofstede dimensions of culture. They stated that Hofstede started with a survey of IBM employees in 30 countries to analyze cultural differences. With additional sampling and surveys, almost 80 countries are now ranked by Hofstede and his colleagues according to the dimensions of power distance, individualism, uncertainty avoidance, and masculinity. The country rankings were accomplished using factor analysis on survey questions. Gorodnichenko and Roland (2011) explained that individualism is typified by high values on "individual freedom, opportunity, achievement, advancement, and recognition" while discounting "harmony, cooperation, and relations with superiors" (p. 492). They find individualism strongly and negatively correlated with power distance, which measures the extent to which "power is distributed unequally" between junior and senior members of society (p. 493).

These dimensions of culture defined by Hofstede have been previously shown to be correlated with airline accidents. A 1993 Boeing study initially linked culture with aviation accident rates.[1] It found that high power distance countries had high rates of airline accidents, while countries with high individualism had lower accident rates.

[1] This study has been often cited, including by Phillips (1994) and Gladwell (2008).

Soeters and Boer (2000) obtained comparable findings when looking at military flights. Analyzing losses from military aviation accidents per 10,000 flying hours from air forces of 14 NATO countries, they found: 1) a negative correlation between individualism and accidents; 2) a positive correlation between power distance and accidents, and; 3) a positive correlation between uncertainty avoidance and accidents. When the authors controlled for the percent of mechanical failures, similar results were obtained.

Using online data on the number of plane crashes involving a fatality, Jing, Lu, and Peng (2001) also found culture to be linked to aviation accidents.[2] They used several survey questions to represent cultural variables, with the percentage who responded in specific ways from different countries then used in regressions where the dependent variable was plane accident rates. This process led the authors to conclude that "authoritarianism", which represents the degree of submission to authority, was the most important cultural variable explaining plane accident rates.

While the effect of culture on aircraft accidents has been looked at, it has not yet been statistically explored in context with other significant contributing factors. Shappell and Wiegmann (1997) pointed out that human error alone rarely causes aviation accidents. Typically these accidents "involve a complex interaction of several factors" (Shappell and Wiegmann, 1997, p. 271). Similarly, Hutchins, Holder, and Perez (2002) argued that aviation accidents are not caused by culture alone but rather by the broadly-defined aviation infrastructure. This aviation infrastructure includes the "…regulatory structure, facilities (airports, navigation and approach systems, etc.), weather forecasting, charts, mail services (to deliver charts), education, maintenance, and more" (Hutchins, Holder, and Perez, 2002, p. 50). The combination of physical and social infrastructure that forms aviation infrastructure can be considered a sociotechnical system. Strauch (2010) defined sociotechnical systems as systems involving the interaction between people (socio) and machines or technology (technical). Such systems included the generation of electricity and the transport of people. While research has shown that culture does make a difference when it comes to perception, neural processing, and cognition, not much work has been done on sociotechnical systems according to the author. The cultural research that has been done has most often cited Hofstede's work. Some of these studies have shown that culture can and does affect team performance, especially when the team members are under pressure and in a stressful situation.

Another third significant factor to consider in airline crashes is weather. Luers and Haines (1983) noted that in spite of improvements to aviation infrastructure related to forecasting and communicating severe weather, "weather remains a cause or related factor in a high percentage of aircraft accidents" (p. 187). It is the complex interaction between the aviation environment, weather, and culture that sets up what the 1993 Boeing study refers to as the 'accident chain'. Should any link be broken, an accident can be avoided. At the critical point when the weather and the aviation environment are aligned to enable an accident, the reactions of pilots – including communication – become the difference between life and death.

In the next section, a model of how culture affects the amount and quality of information given by the copilot to the pilot is outlined. The results of the model will show how the skill and training of the flight crew, maintenance and safety features of the aircraft, aviation infrastructure, weather, and culture all interact to affect plane accidents across countries.

[2] Jing, Lu, and Peng (2001) used data from planecrashinfo.com.

2. Methodological approach

To model the effects of culture on plane accidents, it is assumed that the flight crew consists of a junior copilot (the first officer) and a senior pilot (the captain). The junior copilot benefits from correcting an improper action initiated by the senior pilot since a plane crash may be avoided and lives saved. However, there is also a psychic cost to the junior co-pilot who may perceive that he or she is questioning the actions of a superior.

In countries with a high power distance ranking where inequality is well defined and the less experienced defer to older more-experienced leaders, the psychic cost of more direct communication is high to the junior copilot. In low power distance countries, the psychic cost of direct communication is much lower. Assuming the benefit to the junior pilot from direct communication with the pilot is the same for all cultures, the junior pilot who performs a benefit-cost analysis would find it in is his/her interest to communicate more directly with the pilot when both are from a low power distance country.

Combining this framework of psychic cost with the findings of past studies and other theoretically important factors in crashes, the number of plane accidents in a country can now be specified as follows:

$$accidents = f(F, S, M, R, W, x) + \varepsilon, \qquad (1)$$

where "accidents" represents the number of plane accidents in a country, F represents the number of flights in a country, S represents the skills, training, and experience of the flight crew, M represents maintenance of the aircraft and any other safety features of the plane, R represents up-to-date runways and air traffic control systems, W represents weather conditions, x represents the amount and quality of information communicated by the copilot to the pilot to coordinate actions of the flight crew and is related to culture, and ε, is the stochastic disturbance term reflecting the effects of hijackings, birds, or other random factors that may affect flights.

In this equation it is expected that the number of plane accidents experienced by a country are inversely related to the skills of the flight crew, the maintenance of the aircraft and its inherent safety features, modern aviation systems, and the ability of the copilot to successfully communicate, coordinate, and correct the pilot which is a function of culture. Severe weather conditions and number of flights are expected to be positively related to plane accidents. In the next section, equation (1) will be estimated.

3. Conducting research and results

The number of plane accidents for 68 countries from 1970 to 2012 was collected from *Aviation Safety Network* at the website www.aviation-safety.net/database/country. The dataset includes accidents for airliners, cargo planes, corporate jets and military transport aircraft. The plane accidents are categorized as either A1 for damaged beyond repair or A2 for substantial airplane damage. Both types of accidents were recorded in this study as plane accidents. Incidents that were not used in this study included: aircraft explosions caused by grenades, airplanes being fired upon from the ground, aircraft destroyed by a nation's air force that was suspected of drug trafficking, hijacking incidents, aircraft damaged by colliding with another aircraft on the runway, and aircraft damaged by engine fire during maintenance work.

As a proxy for number of flights in each country over the period 1970-2012, the number of departures which were "domestic takeoffs and takeoffs abroad of air carriers registered in the country" was taken from the World Bank Development Indicators which come from the International Civil Aviation Organization, Civil Aviation Statistics of the World, and ICAO staff estimates.

As noted by Hutchins, Holder, and Perez (2002), aviation accidents are caused in part by a complex interaction of physical and social factors which comprise aviation infrastructure. They stated that poor nations may have higher accident rates because they lack the wherewithal to support a first-rate aviation infrastructure. To date, all previous cross-country studies involving plane accidents have lacked data involving the investments that countries make in physical airport infrastructure, maintenance expenditures, and education. These factors are all critical components of aviation infrastructure. One reason that previous studies may have excluded the inclusion of aviation infrastructure is data availability; although data for these factors exist for some counties, it does not exist for all.

The OECD publishes data on airport investment and maintenance for selected countries (OECD, 2013). Data on investment in physical airport infrastructure was available for 24 of the 68 countries used in the dataset for this study, while data on maintenance expenditures for airports was available for 15 of the 68 countries. While these numbers are too small to allow for reliable regression estimation, their correlation with Gross Domestic Product adjusted for purchasing power parity (GDP) demonstrated in Table 1 means that we can use GDP as a proxy for these physical aspects of aviation infrastructure.

Data was collected for per-capita GDP in constant 2011 dollars adjusted for purchasing power parity for the countries of interest. This data was obtained from the World Bank Development Indicators. The average of the per-capita GDP figures from 1990-2012 was used for each country (with some exceptions outlined in the footnotes to the data table provided in *Appendix 1*).

Similarly, GDP can also proxy for education. Data on school life expectancy from the CIA World Fact Book was available for 65 of the 68 countries. The correlation coefficients between per-capita Gross Domestic Product adjusted for purchasing power parity (GDP), education as measured by school life expectancy (Education), investment spending on airport infrastructure (Investment), and maintenance spending on airport infrastructure (Maintenance) are given in *Table 1*.

Table 1. Correlation Coefficients

	GDP	Education	Investment	Maintenance
GDP	1			
Education	0,19	1		
Investment	0,142	0,031	1	
Maintenance	0,048	-0,08	0,677	1

Table 1 shows positive correlations between per-capita GDP and education, GDP and investment spending on physical airport infrastructure, and GDP and maintenance spending on physical airport infrastructure, although the correlation between GDP and maintenance spending is low. Thus country differences in per-capita GDP may not only reflect differences in standards of living, but also differences in education of the flight crew, differences in investment in physical airport infrastructure, and differences in maintenance of that infrastructure. This makes GDP a good variable to capture the main components of the overall aviation infrastructure.

Previous studies of aviation accidents have also neglected to include the importance of weather in regression analysis. Omitting the importance of weather ignores the fact that severe weather conditions is a common factor in plane accidents. To account for these impacts the regressions below include the variable Weather, which is the sum of precipitation in freezing months for each nation. This quantity, measured in inches, was compiled using data from the website weatherbase.com.

The Hofstede scores for the dimensions of power distance, individualism, uncertainty avoidance, and masculinity were used as the culture variables and were obtained from www.harzing.com/download/hgindices.xls. It should be noted that these dimensions of culture are not independent of one another. A nation ranking low in power distance may rank high in individualism since in highly individualistic societies, individuals seek recognition and achievement. As a result they may be less willing to defer to authority figures. Similarly, a nation ranking high in masculinity where assertiveness and competitiveness are stressed may rank low in uncertainty avoidance where change is not desired. Because dimensions of culture are interrelated, they will be entered into the model separately. The data used for this study (68 country observations) appear in *Appendix 1*.

3.1. Application of multiple linear regression analysis

The model of plane accidents in equation (1) was estimated using ordinary least-squares where the dependent variable was plane accidents from 1970 to 2012 by country and the independent variables included: 1) Number of flights from 1970 to 2012 by country (Flights); 2) Per-capita GDP in constant 2011 dollars adjusted for PPP (GDP) as an approximate measure of the overall aviation infrastructure, including education and training of the flight crew (S), maintenance of airport infrastructure and aircraft (M), and investment in airport infrastructure (R); 3) The sum of precipitation in freezing months (Weather) to represent severe weather conditions; and, 4) One of Hofstede's dimensions of culture [either power distance (PD), uncertainty avoidance (UA), individualism (IND), or masculinity (MAS)] to represent communication and coordination in the cockpit (x). The regression results are presented in *Table 2*.

In *Table 2*, four versions of equation (1) were estimated. In the first model, the cultural dimension of power distance was included. In Models 2 through 4, the cultural dimensions of individualism, uncertainty avoidance, and masculinity were included, respectively. The variance inflation factors (VIFs) for all models were low (less than 2.5) indicating that multicollinearity among the regressors was not a problem. Furthermore, all four models were estimated using White's robust standard errors.

In all models, the number of flights in a country is significant; the more flights, the more plane accidents. The results indicate that for every million flights, the number of plane accidents increases on average by five. It was also found that per-capita GDP was negatively related to plane accidents in all models as expected. Richer nations have more resources to allocate to aviation infrastructure including better runways, air traffic control support, education of pilots and airport staff, maintenance of aircraft, and a host of other factors that make air travel safer.

Table 2. Regression results

	Dependent Variable: Plane Accidents			
Variable	Model 1	Model 2	Model 3	Model 4
Constant	-2.104	***49.558	30.279	**41.067
	(-0.149)†	(3.34)	(1.50)	(2.38)
Flights	***0.000005	***0.000005	***0.000005	***0.000005
	(-59.57)	(50.64)	(72.77)	(61.81)
GDP	***-0.0006	**-0.0005	**-0.0007	**-0.0007
	(-2.83)	(-2.57)	(-2.43)	(-2.52)
Weather	2.983	3.014	2.029	2.097
	(0.961)	(0.977)	(0.656)	(0.681)
PD	**0.498			
	(2.38)			
IND		**-0.538		
		(-2.147)		
UA			0.036	
			(0.145)	
MAS				-0.163
				(-0.465)
R-square	0.924	0.925	0.921	0.921
Adj. R-sq	0.919	0.92	0.916	0.916
AIC	10.64	10.63	10.68	10.67

†t-stats in parentheses
***significant at the 1% level
**significant at 5% level

The sum of precipitation in freezing months was positively related to plane accidents in all models although the effect was not statistically significant. The training that pilots receive and advanced technology in use may have made bad weather flying more of an inconvenience to commercial pilots rather than a disaster waiting to happen. Pilots simply fly around severe weather when possible. It may also be that bad weather by itself may not be a major problem, as Gladwell (2008) suggested, unless it is in combination with a tired pilot, mechanical problems, and miscommunication in the cockpit and with air traffic control.

In Model 1, power distance was found to be significant and positively related to number of plane accidents, even after controlling for flights, per-capita GDP, and weather conditions. This result confirms what other studies have found when looking at simple correlations between power distance scores and plane accidents: the more deferential less experienced juniors are to more experienced seniors, the more mitigated the speech will be from the less experienced pilot and the greater the likelihood of miscommunication in the cockpit. The result of higher power distance is more plane accidents.

In Model 2, individualism was the cultural variable used as an independent variable. It was significant at the 5% level and negatively related to plane accidents. This is no surprise since Gorodnichenko and Roland (2011) found that power distance was "…strongly negatively correlated with individualism" (p. 494). In nations that rank high in individualism such as the United States, individuals speak up and say what is on their mind, giving the U.S. its low score in power distance. Having junior pilots who are not afraid to point out the mistakes of their superiors, makes for safer flying. Finally, uncertainty avoidance and masculinity had no significant effects on plane accidents as shown in Models 3 and 4 in *Table 2*.

In *Table 3*, Models 1 through 4 from *Table 2* were re-estimated using standardized variables denoted with the # symbol. With standardized variables in a regression there is no constant term. The results were very similar to those presented in *Table 2* with power distance being positively related to plane accidents and individualism being negatively related to plane accidents. The benefit of using standardized variables is that the beta coefficients can be directly compared. For example, in Model 5 of *Table 3* standardized plane accidents increase by 0.98 standard deviations when standardized flights increase by 1 standard deviation. They decrease by 0.07 standard deviations when standardized GDP increases by 1 standard deviation and finally, they increase by 0.06 standard deviations when standardized power distance (PD#) increases by 1 standard deviation. These results show that the contributions of standardized power distance and GDP are roughly the same in explaining standardized plane accidents, while increases in standardized flights are responsible for the majority of increases in standardized plane accidents.

Table 3. Regression results using standardized variables

	Dependent Variable: Plane Accidents#			
Variable	Model 5	Model 6	Model 7	Model 8
Flights#	***0.979	***0.991	***0.970	***0.971
	(60.04)	(51.04)	(73.35)	(62.30)
GDP#	***-0.073	**-0.064	**-0.083	**-0.084
	(-2.86)	(-2.595)	(-2.45)	(-2.54)
Weather#	0.067	0.068	0.046	0.047
	(0.969)	(0.985)	(0.66)	(0.687)
PD#	**0.062			
	(2.4)			
IND#		**-0.074		
		(-2.164)		
UA#			0.005	
			(0.146)	
MAS#				-0.014
				(-0.468)
R-square	0.924	0.925	0.921	0.921
Adj. R-sq	0.921	0.92	0.918	0.918
AIC	0.361	0.35	0.4	0.4

†t-stats in parentheses
***significant at the 1% level
**significant at 5% level

Conclusion

The early studies involving culture and plane crashes looked at correlations between Hofstede's power distance scores and number of plane crashes across countries. Critics were quick to point out the misleading nature of these studies. If the skills of the flight crew, the expenditures put into air traffic control support, maintenance of the aircraft, up-to-date flight systems and runways, government regulations and oversight and weather are not controlled for, the correlations between Hofstede scores of cultural dimensions and plane accidents have little meaning. To overcome this criticism, this study has made the following contributions to the literature. (1) The effects of investment in aviation infrastructure including physical airport infrastructure and the education of airport personnel have been accounted for by the use of per-capita GDP adjusted for purchasing power parity. (2) The effects of severe weather on plane accidents have been controlled for by using the sum of precipitation in freezing months. (3) The complete dataset used for this study has been included in the paper to enable researchers to replicate the results and extend them.

This study found that many of the early studies were correct in their conclusions even if important variables were not included. In particular, high power distance nations have more plane accidents, *ceteris paribus*, while nations ranking high in individualism tend to have fewer plane accidents. Culture remains important even when aviation infrastructure and weather are accounted for in regression models.

Aviation infrastructure represented by per-capita GDP is also important in determining plane accidents. In all regression models, nations with higher levels of per-capita GDP tended to have fewer plane accidents. In *Table 2*, the U.S. has by far, the largest number of plane accidents of any country. It also has the most flights giving it a low plane accident rate (4.47 accidents per million flights from 1970 to 2012). The U.S. is also a leader in aviation infrastructure (high per capita GDP) and it ranks the highest in individualism and very low in power distance. By way of contrast, Nigeria has a relatively high plane accident rate (75.6 accidents per million flights from 1970 to 2012). It has a relatively low level of per-capita GDP, a high power distance score and one of the lowest scores in individualism. Malaysia Airlines flight 370 has been missing since 2014 and the reasons for its disappearance are still unknown. However, Malaysia is ranked as the highest power distance country.

Other than improving a nation's aviation infrastructure, this study reinforces what major airlines have been doing; training pilots and copilots in communication to overcome cultural barriers – "Crew Resource Management" (Gladwell, 2008, p. 197). Gladwell cites examples of where pilots remind their copilots that the pilots need help in flying a sophisticated aircraft when malfunctions occur. It is only when the entire crew are working together as equals, will the chance of success be greatest.

Limitations of study and future research

In this study, simple OLS models were estimated to determine the effects of number of flights, GDP, weather and culture, on plane accidents for 68 countries. The reason OLS was chosen as a technique was to keep the results of this study comparable to what others have done. The OLS methodology has been used consistently throughout the plane accident literature. However, this is not to say that this is the best method available. In future studies, more sophisticated estimation techniques may be employed. For example, Bayesian regression models which make use of prior distributions for the parameters may yield valuable insights.

Another limitation of this study and all studies investigating plane accidents is lack of detailed airport infrastructure data for the majority of countries. If this data becomes available it would not have to be represented by a proxy variable such as GDP.

Finally, culture has been proven time and time again to have a major influence on behavior. Nations in Latin America, Africa, and the Far East are known to have collectivist societies where individualism and individual achievement are not emphasized. However, it is certainly true that individuals within these societies vary significantly in their attitudes and behavior. Perhaps in the future cultural studies will collect more data to capture these nuances in individual behavior and action.

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Appendix 1. Plane accidents, flights, accident rates, GDP, weather, and Hofstede Indices

Country	Accidents	Flights	Acc.rate	GDP.PPP	Weather	PD	UA	Ind	Mas
Algeria	14	1769510	7.911795	10777.39	0	80	68	38	53
Australia	54	13730045	3.932981	35142.99	0	36	51	90	61
Austria	10	3438588	2.90817	37140.9	12	11	70	55	79
Bangladesh	9	507135	17.74675	1531.351	0	80	60	20	55
Belgium	14	4300847	3.255173	35991.83	5	65	94	75	54
Brazil	229	18749176	12.21387	11578.51	0	69	76	38	49
Bulgaria	10	867986	11.52092	11152.29	6	70	85	30	40
Canada	323	23480074	13.75635	35673.12	16.7	39	48	80	52
Chile	35	2451121	14.27918	15166.08	0	63	86	23	28
China	59	25701942	2.295546	4796.34	3	80	30	20	66
Colombia	215	6410398	33.53926	9154.046	0	67	80	13	64
Costa Rica	22	865461	25.41998	9886.244	0	35	86	15	21
Czech Republic	15	1722222	8.709679	21279.12	8.1	57	74	58	57
Denmark	13	2978549	4.364541	39270.7	3.1	18	23	74	16
Ecuador	59	1261430	46.77231	8055.774	0	78	67	8	63
Egypt	27	1547343	17.44927	8056.273	0	80	68	38	53
El Salvador	10	705345	14.17746	6255.796	0	66	94	19	40
Finland	7	3828753	1.828272	32706.66	8.6	33	59	63	26
France	127	20248307	6.272129	33386.66	0	68	86	71	43
Germany	88	21974237	4.00469	35844.6	6.4	35	65	67	66
Great Britain	128	29342088	4.362334	30949.39	0	35	35	89	66
Greece	35	3573689	9.793801	25187.38	0	60	112	35	57
Hong Kong	5	3199429	1.562779	37267.78	0	68	29	25	57
Hungary	12	1210548	9.912866	18762.89	4.4	46	82	80	88
India	108	9452474	11.42558	2980.037	0	77	40	48	56
Indonesia	214	8718659	24.54506	6235.739	0	78	48	14	46
Ireland	13	6503791	1.998834	36242.85	0	28	35	70	68
Iran	70	2759085	25.37073	11930.09	1.9	58	59	41	43
Israel	6	1397186	4.294346	24772.27	0	13	81	54	47
Italy	8	11313867	0.707097	33350.62	0	50	75	76	70
Jamaica	4	822829	4.861277	8351.574	0	45	13	39	68
Japan	52	22115722	2.351268	32554.77	0	54	92	46	95
Jordan	4	716400	5.583473	8655.015	0	80	68	38	53
Korea (South)	15	5863378	2.558252	20810.14	4.4	60	85	18	39

Country	Accidents	Flights	Acc.rate	GDP.PPP	Weather	PD	UA	Ind	Mas
Kuwait	2	675173	2.962204	88437.06	0	80	68	38	53
Lebanon	4	635551	6.293751	13205.12	0	80	68	38	53
Luxemburg	5	859476	5.817498	77700.6	8.4	40	70	60	50
Malaysia	5	5991126	0.834568	16135.52	0	104	36	26	50
Malta	0	381275	0	23976.02	0	56	96	59	47
Mauritania	6	165935	36.15874	2434.473	0	80	68	38	53
Mexico	146	9302458	15.69478	14197.43	0	81	82	30	69
Morocco	15	1358859	11.03867	4994.853	0	70	68	46	53
Netherlands	23	6959329	3.304916	38009.12	1.9	38	53	80	14
New Zealand	25	6421338	3.89327	28024.18	0	22	49	79	58
Nigeria	71	938922	75.61863	3616.708	0	77	54	2	46
Pakistan	34	2252798	15.09234	3595.248	0	55	70	14	50
Panama	30	898982	33.37108	10114.87	0	95	86	11	44
Peru	73	1670794	43.6918	7564.794	0	64	87	16	42
Philippines	86	3185669	26.9959	4561.865	0	94	44	32	64
Poland	48	1987531	24.15057	14900.05	7.5	68	93	60	64
Portugal	23	3214894	7.154202	23739.64	0	63	104	27	31
Qatar	3	1064088	2.819316	128224.2	0	80	68	38	53
Romania	31	1074316	28.85557	12478.56	4.3	90	90	30	42
Saudi Arabia	21	4212759	4.984857	39006.93	0	80	68	38	53
Singapore	5	2291753	2.181736	52759.27	0	74	8	20	48
South Africa	45	4013779	11.21138	10195.28	0	49	49	65	63
Spain	86	14014911	6.136322	29144.48	0	57	86	51	42
Sudan	51	376720	135.3791	2475.099	0	80	68	38	53
Surinam	7	117024	59.81679	11446.53	0	85	92	47	37
Switzerland	24	6617002	3.62702	46874.84	16.7	34	58	68	70
Thailand	47	3397749	13.83269	9901.468	0	64	64	20	34
Trinidad	0	812928	0	20778.29	0	47	55	16	58
Tunisia	2	684581	2.921495	8032.142	0	80	68	38	53
Turkey	43	4204368	10.22746	13723.33	6.5	66	85	37	45
Uruguay	8	340986	23.46137	12676.59	0	61	100	36	38
United States	1335	298387856	4.474043	44806.29	0	40	46	91	62
Venezuela	90	4521515	19.90483	15456.48	0	81	76	12	73
Yemen	19	475578	39.95139	3959.68	0	80	68	38	53

Notes for Appendix 1

1. "Accidents" is number of plane accidents from 1970 to 2012 taken from aviation-safety.net/database/country.
2. "Flights" is the number of departures which are domestic takeoffs and takeoffs abroad of air carriers registered in the country 1970-2012, taken from the World Bank Development Indicators at: http://data.worldbank.org/indicator/IS.AIR.DPRT/countries.
3. "Acc.Rate" is the accident rate which is plane accidents per million flights (departures).

4. “GDP.PPP” is per-capita GDP in constant 2011 international dollars adjusted for PPP (purchasing power parity). The average annual per-capita GDP figure was used over the period 1990 to 2012 with the following exceptions:
   a. Jamaica – average computed without the years 2000-2005,
   b. Kuwait – average computed without the years 1990-1994,
   c. Qatar – average computed without the years 1990-1999,
   d. South Sudan – average computed without the years 1990-2007.
5. “Weather” is the sum of precipitation in freezing months for each nation. This quantity, measured in inches, was compiled using data from the website weatherbase.com.
6. “PD” is Hofstede’s score for power distance (2001).
7. “UA” is Hofstede’s score for uncertainty avoidance (2001).
8. “Ind” is Hofstede’s score for individualism (2001).
9. “Mas” is Hofstede’s score for masculinity (2001).
10. The dataset consists of observations for 68 countries. Some countries do not appear in the table due to the lack of data for one or more of the variables.
11. Hofstede scores for West Africa were used for Nigeria.
12. Hofsted scores have been derived for Arab Countries in general, but not for specific Arab countries. Thus the Hofstede scores for Algeria, Egypt, Jordan, Kuwait, Lebanon, Mauritania, Qatar, Saudi Arabia, Sudan Tunisia, and Yemen are the same.
13. Source of Hofstede scores: www.harzing.com/download/hgindices.xls.
14. The following adjustments were made when calculating accidents and flights due to lack of flight (departure) data for some countries for some years:
   a. Bangladesh – deleted years 1970-72,
   b. China – deleted years 1970-73,
   c. Denmark – deleted years 2007-12,
   d. Hong Kong – deleted years 1970-90,
   e. Jamaica – deleted years 2010-12,
   f. Qatar – deleted years 1970-3,
   g. Surinam – deleted years 1970-75,
   h. Urguay – deleted years 2010-12,
   i. Zambia – deleted years 1995, 1996, and 2009.