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Consequences of aviation industry development on air safety; comparative study (Boeing/Airbus)

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Abstract: The purpose of this paper is to highlight the relationship that may exist between the development of the aeronautical industry and aviation safety, this latter is an object of interest in the aviation world both in economic and security terms. In order to achieve this, we carried out a comparative study between the two most important aircraft manufacturers (Boeing and Airbus). After then, we performed an econometric analysis by linear regression to determine the most impacting factors on crashes.

The first results revealed that there are predominance of crashes for Boeing more than Airbus, and there are four types of recurrent engine are involved in the crashes (CFM56, JT8D,JT9D and CF6).
The second analysis results show no explanatory relationship between crashes and high production of both Boeing and Airbus. Conversely, the results showed a positive relationship between air disasters and the use of certain engines. The CFM56 is the most common engine in crashes.

Keywords: Aviation, Air crash, technology, aviation safety.

JEL Classification :C01,C04,C10,B23

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Introduction:

The airline industry has an important role in economic activity and remains one of the fastest growing sectors of the global economy, which development has led to the need for organized, secure logistics and increased demand for international transport thus allowing the development of air traffic. The international organizations regulate air safety through conventions. However, the attacks of 11 September 2001, called into question the mechanisms put in place by these organizations and the security rules imposes. Security is not limited to terrorist attacks, human factor or climate conditions, also technology may eventually cause dysfunction in midflight, or landing as some disasters have shown. In order to prevent such risks and in responses to the increase in global air traffic improvements have been made based on the experience of disasters in order to improve navigation conditions, both in terms of safety and the innovation of new technologies and systems. Therefore, competition has developed between aircraft manufacturers Boeing and Airbus, launching into innovations and performances war.

But these new technologies and competition can have an impact on the occurrence of air crashes, what leads us to ask: **Does new aviation technologies have an impact on aviation safety?**

To answer our hypothesis, we opted for a several analyses:

in the first place, a descriptive analysis to present the composition of air traffic in terms of the aircraft production. This injection of new aircraft reflects the density of air traffic, which allows us to know the impact of this development on the occurrence of crashes, by projecting crashes over the same production period.

Secondly, we carried out a statistical analysis of air crashes: depending on the type of aircraft and of engine used, to determine which factors may explain these crashes: these two statistical analyses allow us to have a first glimpse into the impact of new generation aircraft and new powerful engines on the occurrence of crashes, which is the subject of our study.

However, in order to quantify this impact, it is necessary to carry out an econometric analysis by linear regression and to determine the explanatory parameters if these are proven.

Many studies have been done on aviation safety and on the development of navigation devices, but few researches has been done on the relationship between these two phenomena, many studies have covered the role of man in aviation safety: Pascal Salembier and Bernard Pavard (2004), studies human and machine cooperation with problem of technology in air traffic control.

Anthropologists and sociologists have also invested in the field aeronautics around,in particular issues related to the increasingly important presence of automata in social relations. The main reference here is to studies by Alain Gras, Caroline Mariot, Sophie Poirot Delpeche and Victor Scardigli (1994) that have focused on air traffic control automation. But all of these studies have foreshadowed the human factor to the technological. David Gillen and William G Morrison (2015) examined the cost of financing new aviation safety process that reduces the costs of investment and consumption that are harmful to an economy. Michel Itabu issasadiki (2015), for his part, worked on his thesis entitled “aviation safety in Africa: the autistic communication within the collective which studies the impact of communication in the occurrence of disasters and demonstrated that the practice of autistic communication dominates civil aeronautics in the Democratic republic of Congo which is the cause of several disasters, he concluded that standardized communication must be applied. But this study, covered only the human factor of crashes and was limited to a single country.

The technological development of aviation is materialized by more sophisticated aircraft and more efficient engines, that what explains our choice for these analyses in order to answer the above mentioned question.

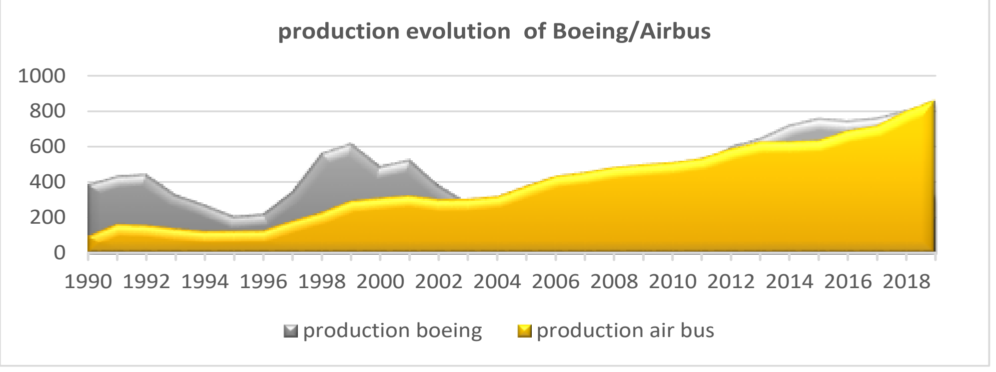
I. Comparatives study on Airbus/Boeing:

I.1.statistical analysis of production:

The boom in air traffic has allowed the development of aerial navigation plane, thus generating competition between Boeing and Airbus. increasingly sophistical air craft with new components are taking up the area to meet a larger and more demand in terms of comfort and safety.

The follow graphic (figure 01) shows the competitive production between Boeing/Airbus:

Fig 01: Evolution of production Boeing /Airbus



Source: Compiled by the authors from crash1001.com data

The graph above shows a strong increase in production for Airbus, taking the monopoly from 2002 to 2012 or Boeing taking over which, however, had overtaken its competitor in the 1990s, producing 385 aircraft, against a 95 for air bus entering the market.

The fleet of aircraft in service built by Boeing remains the largest, including the McDonnell Douglas fleet (incorporated into Boeing in 1997), because many Boeing 737s or MD80S over 30 years old are still flying, whereas the A320's appeared 20 years ago. At the end of 2010, Airbus built 6,500 aircraft, 6,200 of which are in service

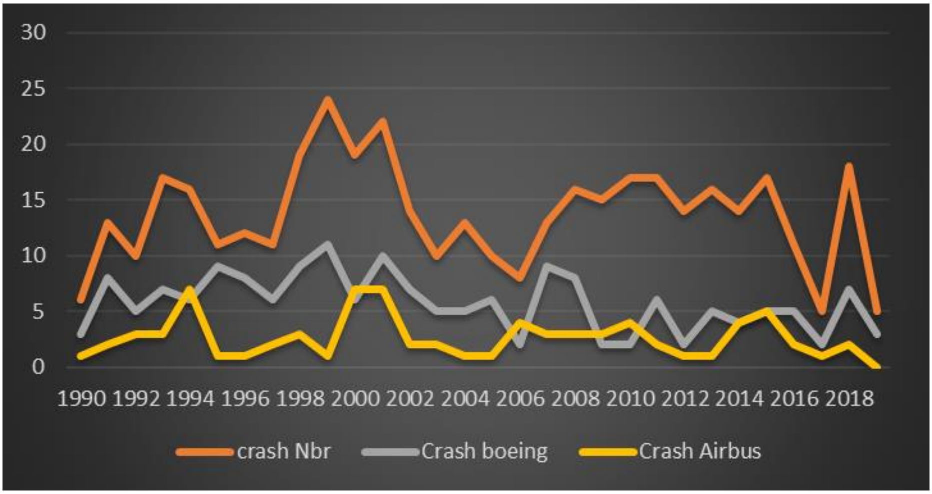
Several records have been broken by Airbus since January 2011, with massive orders from Indigo (180 aircraft), AirAsia (200 aircraft), then American Airlines (260 aircraft, 130 A320 classic and 130 NEO).

Boeing and Airbus are the leaders in aviation, with their large fleet of aircraft and flights around the world. However, this race for innovation and competitiveness can lead to losses. The rush to launch the new models and the large number of orders that have to be answered, encourages manufacturers to shorten the test times and the time allowed for checking before deliveries, which implies accidents and even crashes, such as the case of the Boeing 737 MAX which has been banned from flight since March 2019, following the double crash of the model at Lion Air and Ethiopian Airlines, causing significant loss of life (346 people). Nearly 700 aircraft have since been grounded, between aircraft delivered and aircraft stored by Boeing. These incidents had a negative impact on the number of orders for the model. The production suspension took place in January 2020.In an industry as competitive as civil aviation, improving crash resistance is a matter of obligation. For in aviation, any new safety element can have an impact on the weight of the aircraft and on its consumption. In this respect, for an Airbus A330, an extra kilo will generate fuel consumption of 162 liters more in the year.

I.2.Statistical analysis of air crashes:

In order to understand and analyze the various crashes recorded by Boeing and Airbus, we present the following graph (figure2).

Fig 02 : Crashes recorded by Boeing/ Airbus (1999-2018)



Source: Compiled by the authors from the database (1001crashes.com)

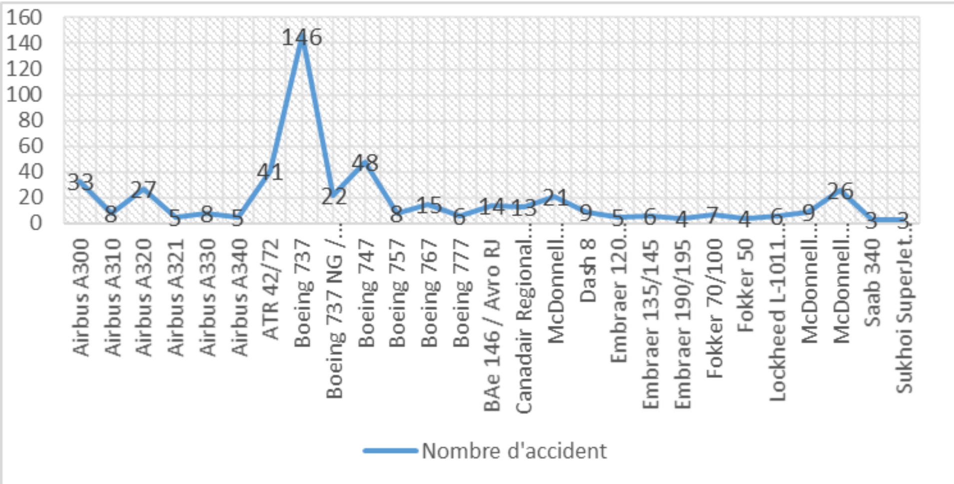
The statistics analysis shows the position of each of the two manufacturers in the representation of crashes in the world, we can distinguish a predominance of Boeing crashes with a peak of 81% in 1995 and 69% in 2007, while its peak production was in 2018, with 806 aircraft against a single peak of 50% in 2006 for Airbus with a maximum production of 863 in 2019. We can, priori, see a link between the peak of 2006 with the peak accident the following year (2007) due to the fact that, any production of an aircraft is an injection into air traffic, which would increase the probability of crashes. We can only confirm this link after an econometric study.

For more detailed results, we will therefore carry out two statistical analyzes of crashes recorded, depending on the type of aircraft and the type of engine.

1.2.1.Breakdown of crashes by type of device:

Our database was built from aviation disasters recorded over several years. For our first analysis, we have selected a 50-year period from 1969 to 2019 that covers crashes by type of aircraft. The following graph was obtained:

Fig 03: Number of crashes by type of engine (1969–2019)



Source: Compiled by the authors from data www.d'airfleets.fr

The chart shows that Boeing 737 has the highest number of crashes at 146, and that all of Boeing's aircraft account for 49% of crashes (all types), while Airbus at 17%. Based on this first observation, the rest of our study will focus on the two manufacturers BOEING and AIRBUS, in order to more understand the relationship between their high presence in air traffic and their share in crashes.

1.2.2.Breakdown of crashes by engine type

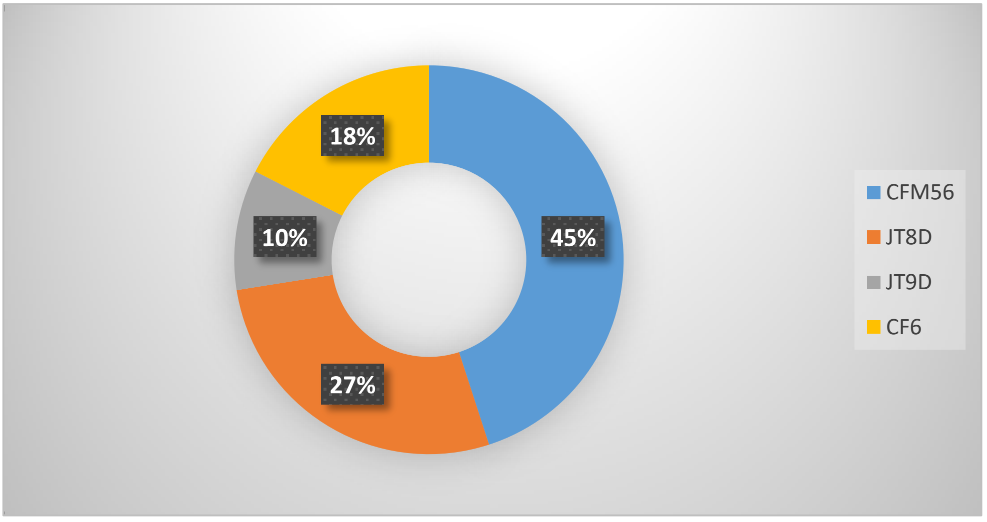
We distinguish several aircraft engines: CFM, Rolls-Royce, General Electric and Pratt & Whitney, which are competing hard to serve the best navigational devices: Boeing and Airbus in the single aisle segment only (A320, 737). The engine manufacturer CFM estimates the global market at $500 billion over the next 20 years, with 40,000 engine deliveries expected. The sector is as strategic as it is exciting. For, if the engine ($9 million each) is sold without a margin, the engine manufacturer can count on the after sales rent, where the margins exceed 30% during the twenty years of an engine's life.

Each sale of a reactor ensures at least fifteen years of after-sales, between the different technical visits that pace the life cycle of an aircraft, which explains the turnover achieved in this niche for the engine manufacturers. These are key players in the aviation sector: engines cost between one-third and one quarter of the price of an airplane. Their performance is the main driver of fuel savings for new generations of aircraft, which forces aircraft manufacturers to work closely with engine manufacturers on any new aircraft program. Here we find their concern for aviation safety because they themselves certify their engines, separately from the certification of the aircraft.

Their decision to participate in a program may depend on the commercial success of a device, but also its safety. The engine plays a very important role in the aircraft reliability.

Based on the available data, we have broken down the air crashes by type of engine used on the crashed plane where we obtained the curve shown in Figure 04.

Fig 04: **Repartition of crashes by engine**



Source: Compiled by authors in 1001crash.com database

The graph shows that the CFM56 engine accounts for the largest share of air crashes with 48%, this statistic is validated by the case of Boeing 737 max equipped with the CFM56 engine and which caused two crashes at four month intervals, which forced the manufacturer to stop production of this type of aircraft in January 2020, thus weakening the industry and Boeing's image. By this event, we see that the choice of engine is very important for an aircraft manufacturer.

II. Analysis of aeronautical technology effect on aviation safety:

Aircraft reliability is based on new technologies and processes. The devices themselves are increasingly safe thanks to technologies that offer protection against unforeseen situations. We can talk about the multi-redundant systems and the protection systems of the flight envelope of the aircraft. However, even if new generations of devices are equipped with technologies that reduce accidents, paradoxically, it is clear that the eruption of artificial intelligence in cockpits could put these systems under severe strain. Thus, we assume that the more automated an airplane is, the more it is exposed to a malfunction that man cannot cope with in mid-flight, which we will verify by the use of multiple linear regression of air crashes with respect to the production of the aircraft and then with respect to the types of engines. higher aircraft production reflects the development of air traffic, which justifies our analysis for production and its impact on aviation safety.

II.1. The impact of aircraft production on air crashes (1999-2019):

The increase in aircraft production reflects the development of aircraft with a more sophistical system, so we chose this variable to study the impact on crashes.

The selected data cover 30 years (1999-2019),divided into two types: crashes of both aircraft types and production of the same types over the same period, to determine if there is a relationship between the production and the number of crashes. we put this following equation:

$$CRA = \alpha prodA + \beta prodB \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

CRA : Crashes

Prod B: production of Boeing /year

Prod A: Production of Airbus/year

By applying multiple regression to the database, the following results are obtained:

$$CRA = 10.33 + 0.0154\,prodA - 0.0094\,prodB \ldots\ldots\ldots \;\ldots\ldots.(2)$$

2.28	σ (0.0059)	(0.004)
4.52	t (2.57)	(-2.025)

The correlation coefficient $R^2 = 0.45$ closer to 0 than 1.

The results of the first analysis show that there is no relationship between the increase in production of the Boeing and Airbus aircraft and the occurrence of crashes, the increase in the number of aircraft in service does not necessarily lead to an increase in accidents. increased production can be explained by increased air transport and strong demand for Boeing and Airbus aircraft and the retirement of vetuste aircraft, which can be a brake on crashes, confirming the abcence of impact between these two variables. On the other hand, crashes can reduce the production of an airplane model: by commercial impact or for defective and unsecured model.

By the next regression, we try to determine if “new generation” engines can have an impact on the occurrence of air crashes.

II.2 Analysis of motorization effect on crashes:

The second study approach is to assess the engine impact on crashes, in order to do this, we used multiple linear regression on database which shows crashes by engines type (section I.1.2) and variables used are :

CRASHS: Crashes by year

C: CMF56

J8: JT8D

J9:JT9D

CF: CF6

$$CRASHS = A + \alpha C + \beta J8 + \delta J9 + \theta CF \quad ....3$$

Multiple linear regression with Eviews software gives us the following results:

$$CRASH = 0.11 + 1.30CFM56 + 1.15JT8D + 1.51JT9D + 0.93CF6$$

Std	(0.75)	(0.24)	(0.24)	(0.34)	(0.40)
t- stat	(0.15)	(5.38)	(4.74)	(4.43)	(2.31)

With $R^2=0.77$ we can accept the model that explains 77% of the dependent variable.

Under H0, F follows a Fisher $F_{1-\alpha\ (p,\ n-p-1)}$ on α risk,The critical region (rejection of H0 from the test) corresponds to the exceptionally large value of F

with $F \text{ calculated} > F_{1-\alpha\ (p,\ n-p-1)}$ 5

This test allows to evaluate the significance of the model by comparing the values of calculated F and the theoretical F:

$F_{calculated} = 12.009$

$F_{(p,\ n-p-1)} = F_{(4,15)\ theories} = 8.66$....................6

$F_{c} > T_{t}$ we deduce that the model is globlly significant.

- $t_{cfm56} = 1.3066/0.2428 = 5.38 > t_{0.975} = 2.13$
- $t_{JT8D} = 1.1586/0.2455 = 4.71 > t_{0.975} = 2.13$
- $t_{JT9D} = 1.513/0.3412 = 4.434 > t_{0.975} = 2.13$
- $t_{CF56} = 0.93/0.402 = 2.312 > t_{0.975} = 2.13$

For 5% of risk, the critical threshold is at $t_{0.975}(15) = 2.13$ (according to the usual t test table) we get all the coefficients associated with the variables are significant.

The Durbin Watson coefficient D=1.89 is close to 2, so we can confirm the null hypothesis of no auto-correlation of estimated model errors.

The parameters obtained in this second regression shows that there is a close relationship between the engine type and the crashes, so according to the results, the engine most involved in crashes is CFM56.this result is confirmed by experienced crashes of Boeing 737 Max 8 in 2019, for months apart and whose engine are CFM engine manufacturer. Therefore, Boeing reduced the rate production of Leap1B by half following the temporary shutdown of the 737 Max since 1st January, so 737 Max is, in fact exclusively equipped with reactors produced by CFM international, this latter increased from 1.736 engines in 2019 to 10 LEAP per week in2020, following the flight suspension of the Boeing 737 Max since march 2019.

The investigation report implicated the aircraft stall avoidance flight stabilization system (MCAS) designed for the new heavier and larger MAX737 engines it would have malfunctioned shortly after takeoff. The aircraft experienced irregular climbs and descents during the climbs phase before crashing in the same manner as the Lion Air. if the trigger is a computer problem, the competition is the indirect cause of these two crashes, as the design of the 737 Max8 would have been accelerated to surpass the Airbus A320 Neo launched in 2016.

Conclusion:

In this research, we have tried to answer the question: does aeronautical development have an impact on aviation safety. To do this, we have opted for two approaches:

First, we conducted a descriptive and comparative analysis between Airbus and Boeing in terms of production, which reflects the intensity of air traffic and in terms of accidents that reflect aviation safety. Record collision years (1995 and 2007) do not match record production periods (2006 and 2018).

Subsequently, the statistical analysis of the crashes showed that Boeing is the most affected by the crashes at 49%, unlike Airbus, which has a low crash rate, while it has the same orders and deliveries as Boeing. we have concluded that Airbus is less prone to accidents, this can be explained by the fact that Boeing is ordered by several airlines of different safety levels, while Airbus is acquired by airlines well classified in terms of safety (Emirates, Lufthansa...).

The second econometric multiple linear regression approach showed no explanatory relationship between accidents and aircraft development, the high production of Boeing and Airbus does not lead to an increase in accidents,

Then, we analyzed the impact of engines on the accident rate, the results showed a positive relationship between air accidents and some types of engines: The CFM56 is the most common engine in accidents, this high rate can be explained by the fact that it is the world's best-selling engine for Boeing and Airbus manufacturers (it is used in 6000 aircraft), but also by the fact that Boeing registers more disasters, previously demonstrated, which explains why the engine is more present in these tragic events. Paradoxically, it is the most efficient and reliable, suggesting that accidents are not caused by the engine itself.

In other side, Competition for the launch of new models has also forced some manufacturers to scrape out test and approval times, thus putting into service aircraft that represent a threat to air safety. (Boeing 2019 IT system failures).

The interpretation of our results must be done within the limits of our research, in the context limited by our data and analyses, based on the technical factor, in coordination with our problem, but this work may be the beginning of another more comprehensive research that will address other factors affecting aviation safety, human and natural factors.

From the foregoing, we can answer our problem and affirm that the technological development of aviation has no direct relationship with air safety. However, the combination of several factors may cause the occurrence of air crashes. This requires an exhaustive analysis of the factors.

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