

---

## EURASIAN JOURNAL OF SOCIAL SCIENCES

[www.eurasianpublications.com](http://www.eurasianpublications.com)

---

### SOME CONSIDERATIONS ON “BLACK SWAN THEORY”, COVID-19 AND INVOLVED HEURISTICS †

**Vincenzo Costa** 

Corresponding Author: University of Cassino and Southern Lazio, Italy  
E-mail: [vincenzo.costa@unicas.it](mailto:vincenzo.costa@unicas.it)

**Antonio Raviele** 

University of Cassino and Southern Lazio, Italy  
E-mail: [raviele.a@gmail.com](mailto:raviele.a@gmail.com)

Received: March 27, 2023

Accepted: May 12, 2023

---

#### Abstract

In this paper, we investigate the widespread claim – in scientific literature and mass-media - that COVID-19 constitutes an example of a “Black Swan”. This is an important feature in order to classify some rare events. Given the high speed of dissemination of information via mass-media and the Internet, with the possible consequences on the financial markets, it is relevant to ask whether this attribution is right or not. Thanks to more precise use of the different color definitions introduced by the famous researcher and our more explicit description of the relative properties, we show instead that the correct shade to be attributed to the Swan for this pandemic is gray. Besides, we also explain misclassification as the effect of some behavioral heuristics.

**Keywords:** Black Swan Theory, COVID-19, Economic/Financial Crisis, Rare and Unpredictable Events, Behavioral Finance, Heuristics

---

#### 1. Introduction

The definition “Black Swan” refers to the long-held belief in the Western world that all swans are white, simply because specimens of different colors have never been sighted. It was an assessment considered irrefutable at the time, given that it was confirmed by empirical evidence (even if, in terms of logic, the use of the characteristic of irrefutability is risky, see paragraph 4.1). This held true until that assumption was overturned. In fact, in the first decades of the seventeenth century, the Dutch explorer and ornithologist Williem de Vlamingh first of all discovered Australia and, then right there, crossed paths with the first black swan in the world (Taleb, 2004, 2010). Taleb, referring to this historical event in ornithology, introduced the so-called “Black Swan Theory”, according to which a rare event can be classified in three ways: “Black Swan”, or “Gray Swan”, or “White Swan”. Well, taking into account in particular its (only) rarity, its (supposed) unpredictability and absence of its precedents, the character of “Black Swan” has been attributed to the COVID-19 pandemic which appeared in China precisely in 2019, for its effects in health, economic/financial field and as a cause of consequent crisis (National Commission for Companies and the Stock Exchange, CONSOB, 2020a, 2020b). This seems surprising, on the one hand,

† We are grateful to an anonymous referee for helpful suggestions and comments.

because Taleb himself had stated in an interview that it did not satisfy what was due for the attribution of the color black (Occorsio (2020); on the other hand because, even if not in the form of scientific literature, articles had appeared which argue that black was not the right color (Avishai, 2020; Spadafora, 2020). The reference to a metaphor introduced by Giovenale (1535), Santorelli (2011), Various (2006). In fact, Giovenale spoke of "*rara avis in terris, nigroque simillima cygno*", i.e. "a rare bird on earth, almost like a black swan". The point is that, in his allegory, the Latin poet himself refers to an impossible or highly improbable event, which only partially includes the characteristics of the Black Swan à la Taleb. In summary, Giovenale's "rare bird" – in terms of classification - constitutes a more general category than Taleb's one. Yet both before and after this interview with the latter, the belief that COVID-19 is a Black Swan has increasingly spread, to the point of assuming more than some relevant content in scientific papers (Deshmukh *et al.* 2022; Hysa *et al.* 2022; Yarovaya *et al.* 2022; Gong and Mao, 2022), articles on websites and not (Apostolico, 2022; Dassù and Menotti, 2020; Porcu, 2020; Santangelo, 2021), books (Cirasola *et al.* 2020), or in a purely political-economic report such as the Economic and Financial Document of the Italian government (Italian Ministry of Economy and Finance, 2020), up to the extensions of the classification that introduce the class of "Green Swan". This latter concept seems to combine the general idea of risk, Taleb's theory and assessment with an environmental or "green" approach (Bolton *et al.* 2020). All this exploiting, among other things, deliberately or not, the notoriety of a film released in 2010, precisely Aronofsky's "Black Swan" (see Morandini *et al.* 2022). Another aspect is the one developed by Ferguson (2020), through a parallelism between the First World War and Covid-19, in a work in which he speaks of the Black Swan à la Taleb, of the "dragon king" à la Sornette (2009) and of the "gray rhino" à la Wucker (2016). In any case, Ferson (2020) focuses the attention on similarities/differences in historical terms.

The right classification to be attributed to rare events according to Taleb's (2010) useful idea is then relevant, since this theory has become more and more famous and because information is spreading faster and faster now. This obviously increases the consequences on the financial markets of a false belief, for a construction of common sense starting from the mass media (hence the use of some articles on the mass-media as part of our sources, see the ones just mentioned); for the influences of social networks on prices (see Valle-Cruz *et al.* 2022), especially during the pandemic); also for possible predictions of future prices (see Khan *et al.* 2022).

Our first contribution is, on the one hand, to describe more explicitly the properties that characterize the three different color of Taleb's Theory, in order to be able to highlight how one of the related characteristics of a Black Swan is missing from the "Covid-19 pandemic" event and one second is only partially satisfied by it. On the other hand, as a consequence of what may occur, we show how it is more correct to classify this pandemic as a Gray Swan.

Our second contribution is to explain the mistake made in the attribution of color by resorting to a behavioral methodology, specifying some heuristics that come into play: the player's fallacy, the confirmation bias, the (heuristic of) focus, the illusory truth effect, the herd effect and anchoring.

The paper is organized as follows: after the introduction, in Section 2, we present a brief description of what the Coronavirus is. In Section 3, in three subparagraphs, we recall the definitions of Black Swan Theory (Taleb, 2010); in details, we present a more explicit definition of this theory, in order to clarify the properties and after we give an example of "Black Swan"; finally, we analyze the characteristics of the COVID-19 pandemic, precisely to verify whether the common statement that it constitutes an example of a Black Swan is correct or not. In particular, we show instead that it is a Gray Swan. In Section 4, we make some preventive valuation and afterwards we draw attention to some useful heuristics involved in misclassification, which may explain why people see the COVID-19 Swan "in Black". Finally, we present our conclusions in Section 5.

## 2. The Coronavirus

Coronaviruses (CoV) are a large family of respiratory viruses, which can cause mild to moderate or serious illness; from the common cold to severe lower respiratory tract infections such as

“Middle East Respiratory Syndrome” (MERS) or “Severe Acute Respiratory Syndrome” (SARS). Between the end of 2019 and the beginning of 2020, an infection generated by a virus of the SARS-CoV family, which originated in China, precisely in Wuhan - the capital of Hubei province – rapidly spread throughout the world. On January 12, 2020, the World Health Organization (WHO) declared that a new Coronavirus, never before found in human beings, was the cause of the new lung infection that had affected the inhabitants of Wuhan. The International Commission for the Taxonomy of Viruses has assigned the definitive name to the virus that of SARS-CoV-2, to underline that the virus belongs to the SARS family and the fact that it is subsequent to the one that spread (and then self-extinguished) in 2002, also referred to as SARS-CoV-1. The WHO attributes the synthetic name of “COVID-19” to the disease associated with the virus, deriving from the acronym “Corona Virus Disease 19”. In the first studies, it was assumed that COVID-19 spreads from person to person through the so-called “droplets”, or (according to the WHO definition) larger respiratory droplets, subject in particular to the force of gravity, little evaporable and which tend to fall in the vicinity of whoever issued them. These particles are released from the mouth, nose and hands; or emitted by breathing, speaking, coughing, sneezing and/or saliva. More precisely a group of researchers (see Buonanno *et al.* (2020a, 2020b, 2022; Jimenez *et al.* 2020; and Morawksa and Milton, 2020), in an open letter to the WHO which has become famous and signed by a total of 239 researchers) have shown that an even more relevant factor is that of “airborne transmission” - *i.e.* of airborne particles - even of smaller dimensions (having diameters of less than 100  $\mu\text{m}$ ), definable as an “aerosol”, *i.e.* a metastable suspension of solid or liquid particles dispersed in a fluid. These “droplets” will tend to float in any closed environment and, therefore, to saturate it according to what is assumed by convective motions of the environment but over distances that cannot be predicted using only the emission speed. Infection can in particular occur due to a direct contact with an infected person, if you are at a distance of less than one meter from the latter, and an indirect contact, through objects and surfaces contaminated by infected people, on which they have released aerosols and droplets.

The disease, especially in cases where the infected person is elderly or has other pathologies, can progress towards a more serious form such as: pneumonia, severe acute respiratory failure, renal failure and, even and unfortunately in many cases, death. It should be emphasized that the symptoms listed above do not affect all infected people. In fact, among these there are also people defined as “asymptomatic positive subjects” or (pauci-symptomatic), *i.e.* subjects who test positive for the virus but who do not present any symptoms or who have mild and imperceptible ones. These individuals may be potentially the most dangerous since, being unaware of having contracted the virus, they contribute to its spread among the population. The methods of transmission of the virus and the presence of a very large number of asymptomatics make the spread of SARS-CoV-2 extremely high and fast. This is why the WHO had already declared on 11 March 2020 that the SARS-CoV2 infection could be considered a pandemic given that, on that date, 118,598 cases had already been registered globally, in more than one hundred countries. In particular, while the so-called “social distancing” (for example the “lockdown”) can be effective in preventing the contagion caused by droplets (maintaining a distance of 1 or 2 meters between the subjects or even imposing periods of lockdown), the prevention for aerosol diffusion can be more effective with the use of devices such as masks (in particular FFP2, which are better for both the wearer and those close to them than surgical ones) and, above all, with the activation of replacement implants air, as suggested by the aforementioned 239 scholars or specified in Draisci *et al.* (2021).

The initial variants of COVID-19, at beginning were named with the geographical names of the first places where they were discovered, then instead classified as variants Alpha (the initial strain), Beta, Gamma, Delta, Omicron. The first two variants were very dangerous due to their consequences on health or life, especially for those infected who had previous comorbidities. They mainly affected the lower respiratory tract and, in the initial phase, caused a series of symptoms similar but stronger than those of the flu including fever, cold, cough, shortness of breath, muscle pain, loss or taste alteration and/or smell and gastro-intestinal disturbances.

Let us recall that in the “Susceptible, Infectious, Recovered” (SIR) model (see Bailey 1975; Hethcote, 2020), the  $R_0$  index indicates how many people are infected by a sick person in the initial state of the pandemic (*i.e.* at instant 0), while the  $R_t$  one represents the number of people

infected by a patient at the instant  $t > 0$  but taking into account the property that this second value is influenced by the activities implemented to reduce the number of contagious (such as social distancing which we will discuss shortly). For the COVID-19, the first three variants had an  $R_0$  contagion index of about 2 or 3 up to certain cases 8, that is, a sick person infects 2 or 3 or 8 people. The subsequent variants, Delta and above all Omicron, with its sub-variants Omicron 1, 2, and 3 and especially the more recent 4, 5, and BQ.1, tend to remain in the upper tracts and to manifest themselves with greater contagion capacity, because the  $R_0$  index also reaches 12 and more but the consequences in terms of health have diminished, above all for the diffusion of vaccines discovered in the meantime. These latter variants have led to hypothesize the passage to an endemic situation (therefore of constant diffusion). Among other things, their symptoms have also changed a little or, in some cases, have worsened in the situations of crossbreeding of the variants (leading to those XE and XJ, for example, which were born from mutations that incorporated the Delta and the Omicron together).

At beginning, with the increase in the contagion curve, many national health systems have turned out to be fragile and have entered a crisis. Given that the virus immediately appeared highly contagious and human-to-human transmission is possible even from asymptomatic individuals, the governments of the affected countries have resorted to the only measure capable of containing the contagion curve - before some desirable vaccines, the real and effective solution against the pandemic - which is the lockdown. According to Farboodi *et al.* (2020) - who, in April 2020, presented a model explaining the internal and external effects of social distancing in a pandemic - the optimal choice to deal with an epidemic caused by a highly contagious virus is the immediate application of measures aimed at limiting social interaction between individuals. In fact, although they cannot completely stop but only slow down the spread of the infection, they are effective in reducing pressure on the health system and allowing the refinement of the techniques of tracing the infections and treating the sick. By the way, the specific "zero infections" objective is very difficult to achieve and can lead to paradoxically negative effects in the eventual transition from a pandemic to an endemic phase. In recent months, the same countries that had long pursued this pandemic containment policy are opting for the more extensive use of vaccines.

If we pay attention to the consequences of the lockdown, it has led to restrictions on the mobility of individuals; forced the closure of schools, universities and public buildings; the shutdown of commercial activities and non-essential services; the downsizing and reorganization of essential production activities, aimed at guaranteeing the health of workers; the quota of import and export activities as well as the zeroing of tourist activities. Even if it has made it possible to contain the contagion curve, allowing the various national health systems to recover, at an economic and financial level, it has had very negative repercussions on the various countries of the world. In general, the economic consequences of a health emergency, during which social distancing is required, depend on the direct and indirect effects on supply and demand. In fact, with the implementation of the lockdown and, therefore, with the interruption and limitation of production activities, there is a contraction in supply, as a direct effect. Demand also undergoes a shock as, by limiting the movement of individuals, a drop in consumption is generated. In turn, the latter are also negatively affected by the closure of productive activities, since most families, suffering a reduction in income or the loss of their job, enjoy lower disposable income. Finally, the contraction in demand amplifies the supply shock, resulting in the transition from a health crisis to an economic/financial one (even if, during these periods, there is always someone who is able to gain a lot; see Forbes Staff, 2020). In the case of the COVID-19, this has led to the largest stock market crash since the so-called "great recession of 2007/08" with some particular and specific phenomena that can only be explained in terms of behavioral finance (see Raviele, 2021). If, on the other hand, the importance of contagiousness through aerosols is underlined, mechanical systems for controlling and exchanging the air seem much more effective, also for reconciling the maintenance of social contacts, as proposed by Draisci *et al.* (2021). Whatever the main assessment to be made, it is obviously through the vaccines which, in the case of COVID-19, were rapidly discovered, thanks to a significant public funding and the help of private ones, and overall exploiting some of the ideas of previous research against SARS-CoV-1, such as the so-called mRNA vaccines (Pardi *et al.* 2018, 2020).

### 3. The “Black Swan Theory”

#### 3.1. The “Black Swan Theory”: the Taleb’s definition

As indicated in the introduction, the term “Black Swan” has its origin in ornithology and Taleb’s later use of this concept for a more specific classification of some events in his theory, into three classes of Swans: “Black”, “White” and “Gray”. Our goal is to classify the COVID-19 under the assumptions of this theory and, for obtaining that, our methodology will consist here in three steps: in this first subsection, we recall the related definitions introduced by Taleb (2010); in the second one we will go deeper, dividing the characteristics of the aforementioned classes (according to color: Black, White, Gray) into further sub-features, that is listing them separately. This will lead to better highlighting the properties present in the general events and, in the specific case of the Coronavirus; in particular, which ones are possessed and which are not by it. As a consequence, in the third sub-part, we will be able to attribute the correct color to this pandemic.

Thus, as fundamental first step and in detail according to Taleb’s theory, an event can be classified as “Black Swan”, if it has the following three characteristics:

- i. If it is a rare event (*i.e.* with a very low probability of occurrence), isolated (*i.e.* which is rarely occurred and, above all, which does not recur in close periods of time), which goes beyond the normal expectations (*i.e.* if does not fall within the events that common sense considers feasible even if rare), since nothing in the past can plausibly indicate its possibility of happening;
- ii. if it has a huge impact on society and/or the world (*i.e.* its wide-ranging consequences, in economic/financial or social or health terms or lifestyles or more generally psychological perception of reality, greatly modify or upset the average or median or historical values of the indicators used);
- iii. if, despite its nature as an isolated event, human nature pushes us to elaborate, *a posteriori*, justifications for its occurrence in order to make it explainable and predictable (as if it was not exceptional and the signals predicting its realization had been underestimated feasibility).

We note that, for complementarity, even a highly probable event that does not actually occur, turns out to be a “Black Swan”. Indeed, the occurrence of an extremely improbable event implies the non-occurrence of an extremely probable one, its complementary set. In fact, it is like hypothesizing an event A has probability very close to 0 (although not 0), then its complementary set in the reference probability space, indicated by  $A^c$ , will have probability very close to 1 (although not 1). This interpretation - in order to use continuous models - could be “extreme”, given that events with 0 probability can occur, as they are represented by non-empty sets; just as events with probability 1 may *not* occur, as they are represented by sets that do not coincide with the whole space.

Instead, a “White Swan” is an extremely rare event (*i.e.* with probability of occurrence close to 0) that generates positive consequences for individuals.

Let us consider, for example, an investor who takes positions opposite to the prevailing expectations on the future trend of the stock markets, or who follows a so-called “contrarian strategy”, *i.e.* a financial investment which requires the agent to adopt a position opposite to the trend in the prices of a financial security, reflecting the expectations of most agents. In fact, this investor is said to be operating against the trend (Dreman, 2012). Well, for a long time, he/she suffers losses in his/her capital account – going against the prevailing trend. However, upon the occurrence of the highly improbable event assumed and on which he/she had bet, the investor manages to generate a significant capital gain (although initially he/she had to invest a sufficient amount of money). Indeed, such a rare event refutes the dominant beliefs on the future trend of a market (equity or other assets) and, contrary to what happens for him/her, constitutes a “Black Swan” for most investors, resulting in a large capital loss.

Finally, a “Gray Swan” is a rare event, isolated and important but somehow predictable (that is, whose probability of realization can be modeled more precisely); therefore with little “surprise” on its occurrence.

In this third case, such an event could be managed in a “scientific” way. For example, by knowing its impact on one’s financial portfolio, its negative consequences could at least be reduced. If we think of a concrete case, we can refer to forecasts on the future inflation rate of a country, or to its bankruptcy (by carrying out a scenario analysis or stress tests).

### 3.2. An explicit classification of the “Black Swan Theory”

As mentioned before, in this second step, for the three Taleb’s (2010) categories, for our purposes, it is useful and constructive to list their properties separately for each of them. This will lead to better highlighting the characteristics present both in a general event and also in the specific case of the Coronavirus too. In particular, in order to achieve this goal, we present the definitions of Taleb’s theory more explicitly. According to his idea, an event can be classified:

- I) as a “Black Swan” (B stands for black):
  - B.1.1) if it is (extremely) rare;
  - B.1.2) if it is isolated;
  - B.1.3) if it has not similar precedents and, therefore, do not fall within the field of normal expectations;
  - B.2.1) if it has a huge impact - on society and/or the world;
  - B.2.2) if this impact is strongly negative;
  - B.3) if it is predictable only in retrospective and not in prospective terms (even if it is an isolated event).
  
- II) As a “White Swan” (W stands for white):
  - W.1.1) if it is an (extremely) rare event;
  - W.1.2) if it generates positive consequences for individuals.

The presence or absence of precedents, in this case, is not actually relevant in terms of risk, given its positive consequences (it is well known that, in the field of financial risk, much attention - if not the main one - must be paid to the “worst case”, the one that - perhaps very rare - can have harmful consequences. However, if the latter are positive, this can only be welcomed).

- III) As a “Gray Swan” (G stands for gray):
  - G.1.1) if it is (extremely) rare;
  - G.1.2) if it is isolated;
  - G.1.3) if it has a similar precedent and, therefore, falls within the usual expectations (at least of the most “informed” or attentive to its occurrence).

We immediately underline that G.1.1 and G.1.2 are equal to, resp., B.1.1 and B.1.2, while G.1.3 is the opposite of B.1.3.

- G.2.1) If it is very important for its effects;
  - G.2.2) if this impact is strongly negative.
- We note that the properties G.2.1 and G.2.2 constitute another way of describing, resp., the equivalent ones B.2.1 and B.2.2 of a Black Swan.
- G.3) If it is somehow predictable, also in prospective terms (and, therefore, presents little “surprise” on its realization).

We highlight that G.3, compared to B.3, also includes being true *ex-ante* and not only *ex-post*.

Before evaluating the characteristics of COVID-19, let us give an example of a “Black Swan”. To this end, let us examine the attacks that took place on 11 September 2001 in the United States, for some time now referred to as “09/11 – nine/eleven”, understood however as overall and aggregated events. With this, we refer to the 4 hijackings that took place that tragic day: the 2 that led to the collapse of the Twin Towers (evaluable as an attack on the economic sphere), the one on the Pentagon (attack on the military sphere), the one that was foreseen against the

White House (attack on the political sphere); with the latter failed because it was blocked by the heroic reaction of the passengers on the flight. Well, seen precisely in the aggregate, it is a rare event (B.1.1), isolated (B.1.2), unpredictable (property B.1.3; not so much as a terrorist episode on US territory, given that there had already been an attack precisely on Twin Towers – February 26, 1993, but as an aggregated and overall event given the different objectives). It had an enormous impact on society and the world (B.2.1); an impact that was strongly negative (B.2.2). Finally, we tried to give numerous and different *ex-post* explanations, which tried to interpret the aggregate attacks as explicable (B.3).

### 3.3. The correct hut for the COVID-19

We can achieve our goal to attribute the correct color to Coronavirus, under Taleb's (2010) classification. As indicated in the introduction, numerous scholars argue that the Coronavirus is a Black Swan. Probably, they focus their attention on its rarity (the B.1.1 property) as well as its isolation (the B.1.2) and its catastrophic consequences, of enormous impact (B.2.1) and strongly negative (B.2.2). Furthermore, also the absence of similar precedents (B.1.3) and predictability only *ex-post* (B.3) are considered satisfied properties. Instead, as it is natural also looking at the characteristics of the Gray Swan as written in the precedent subsection, it is also true that it is a rare event (the property G.1.1), isolated (that G.1.2); important for its effects (G.2.1) and with a strongly negative impact (G.2.2) – with these two aspects of the Gray Swan which constitute, as indicated above, a rewrites of the analogous ones of the Black Swan.

The point is that, however, understood as a pandemic, the Coronavirus has had historical precedents. Just think of that of the “Spanish flu”, which occurred during the First World War, which therefore makes condition G.1.3 satisfied and not instead the B.1.3. Furthermore, the Coronavirus had a degree of scientific predictability, so much so that the same WHO was already studying a school case in 2019 which predicted the rapid and therefore pandemic spread of a virus, thanks to air travel (such as consequence and trade and tourism), as shown by a report of September of that year (Global Preparedness Monitoring Board, 2019). This constituted for SARS-CoV-2 a form of predictability also *ex-ante* and not only *ex-post*. Besides, it could be said that it was a question of extending - precisely in prospective terms - the arrival of SARS-Cov-2 understood as an “evolution”, unfortunately in much more negative terms and consequences, of its “pro-parent”, the SARS-CoV-1 (clearly, here the terms “evolution” and “pro-parent” are understood in a broad sense and not strictly biological). Consequently, also the property G.3 is satisfied and not, instead, the B.3.

From what has been said, it appears evident that in terms of Taleb's (2010) classification, the Coronavirus constitutes a “Gray Swan” and not a Black one and, therefore, it is the gray color (the third category of Taleb's Theory) that must be attributed to it.

## 4. On the involved heuristics for the misclassification

### 4.1. Preventive considerations

First of all, it should be underlined that the primordial idea in ornithology that there were no black swans was already misplaced in logical terms and confused the idea of *irrefutable* with that of *unrefuted*. In fact, it was incorrect to think that repeated verifications of encounters of only white swans constituted proof of the absence of black swans. Suffice it to say that the conjecture “there are no black swans because all swans are white” can be refuted by meeting even one black swan but, instead, it can only be rated more probable or plausible if there have been countless white swan encounters. Therefore, from a mistake in logic follows one in probability. Already from this, we can see how the heuristic called “player's fallacy” has a role, for which individuals tend to misuse probability both from a theoretical point of view and, above all, from a practical one. By the way, this heuristic, among other things, seems to increasingly constitute a rather relevant class in its own right in economic/financial applications, in more general terms with respect to its collocation as a sub-case of the representativeness heuristic (within the classical framework of three “basic” macro-categories for behavioral distortions: anchoring, representativeness and availability), as reported in Costa (2022). In addition to this heuristic, there is also the effect of the

“distortion for confirmation” for which, when a rule or a conjecture is given, the human being as such tends to try to confirm it and not instead to refute it, when maybe this second way can prove to be more profitable and faster. In particular, typically, in the presence of numerous and repeated verifications of one’s own thesis (in other words following many “positive responses” which confirm one’s idea), a person will tend to see it strengthened, convincing himself/herself that it is verified, which is false in general or could be false in the specific case. In this sense, it would be much more constructive to try to refute one’s thesis (that is, to look for “negative answers”). Think of the well-known example of the “Wason cards” (in this regard, see Costa, 2022; Legrenzi, 2009; Legrenzi and Massarenti, 2015). By the way, the third characteristic of a Black Swan and, the more explicit property N.3 are affected by the same heuristic most directly represented by the hindsight bias.

#### **4.2. On the heuristics regarding the color of the Swan COVID-19**

If now we look more closely at the evaluation of why the characteristics of the Black Swan are attributed to COVID-19, rather than the correct ones of the Gray Swan, as shown in paragraph 3.3, it is a matter of evaluating which heuristics come into play. The attribution of the black color to the Swan related to COVID-19 has suffered the effect of “focusing”, a heuristic that constitutes the tendency to concentrate on the characteristics under consideration, neglecting the others (for this and the other heuristics and moreover for considerations about bounded rationality, see Kahneman, 2003, 2011; Kahneman *et al.* 1982, 2021; Kahneman and Tversky, 1971, 1974, 1979; Simon, 1982; Thaler, 2015; Viale, 2020). In the case in question, various works have taken in account the great impact in terms of health, death, economic/financial aspects, neglecting the other characteristics of Taleb’s (2010) classification. In particular, in the case of COVID-19, the assessment of the importance of the presence of historical precedents and the relative predictability of such a pandemic has been omitted, focusing on other properties. In terms of poor assessment of predictability, among other things, the player’s fallacy described above has also occurred here. Furthermore, both the “illusory truth effect” came into play, which leads to the belief that news already heard and initially deemed true or at least plausible (heuristics very present on the Internet and often used to spread false news). In details, the idea that there were no precedents (even if the Spanish pandemic had its notoriety) and above all - and again – that one about the absence of predictability of such a phenomenon weighed. In fact, further checks or analyses on the characteristics of COVID-19 have been neglected. In this context, the so-called “framing effect” can be identified, since the decisions of individuals were influenced according to how the information was framed. In fact, a “negative framing” was used for describing the pandemic, in order to raise awareness of peoples on it and for obtaining the observance of the rules on social distancing. Vice versa, with the aim of a social and/or economic recovery, a “positive framing” was realized, by communicating the daily number of healings rather than that of deaths. Of all the heuristics involved, once the mechanism of the initial diffusion of the news was triggered with the wrong attribution of the color black to the Swan, the distortion from the “herd effect” naturally presented its consequences, *i.e.* from the attitude for which people tend to follow “fashions”. This aspect was influenced by both the rapid diffusion of Taleb’s (2010) theory and also a plausible influence of the notoriety that the film “Black Swan” had had, even if the connection between this and Taleb’s paradigms did not exist. In fact, then there was also an influence of the distortion called “anchoring”, with respect to which we tend to anchor concepts, variables or anything else to quantities or phenomena totally disconnected from them. Last but not least, but here we end up on an even more psychological field, the color black in itself determines an immediate association with something related to fear, a feeling definitely and obviously present as an emotional consequence of the pandemic. With a more incisive effect compared to the emotions aroused by a color such as gray, for which it is more appropriate to think of fear rather than fright (see Kumarasamy *et al.* 2014; Kaja and Epps (2004) and the related references and Valdez and Mehrabian, 1994, for example).



## 5. Conclusion

The idea of the present work is to evaluate whether - within the classification of Taleb's (2010) Theory - the attribution of the black color to the Swan relating to the COVID-19 pandemic is correct or not, arriving at the conclusion that, instead, the right color is gray. This subject has importance for its consequences on financial framework and on more general fields as false beliefs. We show that the misclassification is due to the presence of behavioral heuristics that influences the decisions of individuals as such.

In our paper, we use a behavioral point-of-view. Taking this into account, a possible evolution of this kind of result is to build a bridge toward a more quantitative framework. For example, one possible line of a future research is to analyze the distributions of some rare events occurring in the financial markets, in order to classify them as a Black Swan or not.

## References

- Apostolico, L., 2022. Covid-19: the last black swan of the financial markets and the world economy. *CLEC Magazine*. University of Cassino and Southern Lazio, (4), pp. 7-8.
- Avishai, B., 2020. The pandemic isn't a black swan but a portent of a more fragile global system. *The New Yorker*. Daily Comment, 21 January 2020. [online] Available at: <<https://www.newyorker.com/news/daily-comment/the-pandemic-isnt-a-black-swan-but-a-portent-of-a-more-fragile-global-system>> [Accessed on 7 October 2022].
- Bailey, N. T. J., 1975. *The mathematical theory of infectious diseases and its applications*. 2nd eds. London: Griffin
- Bolton, P., Despres, M., Pereira Da Silva, L., A., Samama, F. and Svartzman, R., 2020. The green swan. Central banking and financial stability in the age of climate change. *BIS, Banque de France*, January 2020. [online] Available at <<https://www.bis.org/publ/othp31.pdf>> [Accessed on 1 December 2022].
- Buonanno, G., Morawska, L., and Stabile, L., 2020a. Quantitative assessment of the risk of airborne transmission of SARS-COV-2 infection: prospective and retrospective applications. *Environment International*, 145, p. 106112. <https://doi.org/10.1016/j.envint.2020.106112>
- Buonanno, G., Stabile, L. and Morawska, L., 2020b. Estimation of airborne viral emission: Quanta emission rate of SARS-COV-2 for infection risk assessment. *Environment International*, 141, p. 105794. <https://doi.org/10.1016/j.envint.2020.105794>
- Buonanno, G., Robotto, A., Brizio, E., Morawska, L., Civra, A., Corino, F., Lembo, D., Ficco and G., Stabile, L., 2022. Link between SARS-COV-2 emissions and airborne concentration: Closing the gap understanding. *Journal of Hazardous Materials*, 428, p. 128279. <https://doi.org/10.1016/j.jhazmat.2022.128279>
- Cirasola, V., Cirasola Ga., and Cirasola Gi., 2020. *Covid-19. Come cambierà il lavoro dell'assicuratore [Covid-19. How will the work of the insurer change?]*. Milano: MFC editore.
- Costa, V., 2022. *Financial risk and behavioral finance*, monograph, preprint.
- Dassù, M. and Menotti, R., 2020. L'anno del Cigno Nero [The year of the Black Swan], *Editoriale [Editorial]*. *Aspenia* (88), March 2020, pp. 1-6. [online] Available at <<https://www.aspeninstitute.it/aspenia/numero/lanno-del-cigno-nero>> [Accessed on 27 October 2022].
- Deshmukh, P., Sharma, D. and Sharma, P., 2022. Do socially responsible indices outperform the market during Black Swan events: Evidence from indian markets during global financial and COVID-19 crises. *Australasian Accounting, Business and Finance Journal*, (16)5, pp. 19-37. <https://doi.org/10.14453/aabfj.v16i5.03>
- Draisci, R., Attias, L., Baldassari, L., Catone T., Cresti, R., Fidente, R., M., Marcello, I., Buonanno, G. and Bertinato, L., 2021. Raccomandazioni ad interim sulla sanificazione di strutture non sanitarie nell'attuale emergenza COVID-19: ambienti/superfici [Interim recommendations on sanitizing non-healthcare facilities in the current COVID-19 emergency: environments/surfaces]. *Aggiornamento del rapporto ISS COVID-19* [Update of the ISS

- COVID-19 report] n. 25/2020, version of 20 May 2021. [online] Available at <[https://www.iss.it/documents/20126/0/Rapporto+ISS+COVID-9+12\\_2021.pdf/4eeb2ce8-648d-b045-4a8c-5dfe1fc7b56a?t=1622463358049](https://www.iss.it/documents/20126/0/Rapporto+ISS+COVID-9+12_2021.pdf/4eeb2ce8-648d-b045-4a8c-5dfe1fc7b56a?t=1622463358049)> [Accessed on 24 November 2022].
- Dreman, D., 2012. *Contrarian investment strategies: the psychological edge*. New York: Free Press.
- Farboodi, M., Jarosh, G. and Shimer, M., 2020. Internal and external effects of social distancing in a pandemic. *Research/Becker Friedman Institute, University of Chicago*. Working Paper, April. 19. [online] Available at <<https://bfi.uchicago.edu/working-paper/internal-and-external-effects-of-social-distancing-in-a-pandemic/>> [Accessed on 1 December 2022]. <https://doi.org/10.3386/w27059>
- Ferguson, M., 2020. The World War of 1914-1918 and the Pandemic of 2020-? *Stanford History Working Paper* (1), Stanford University.
- Forbes Staff, 2020. Coronavirus: come guadagnare dal crollo dei mercati. Un investitore ha realizzato il 4,000% [Coronavirus: how to profit from the collapse of the market. An investor made 4,000%], *Forbes.it*, 14 April 2020 [online] Available at <<https://www.forbes.it/2020/04/14/coronavirus-come-guadagnare-crollo-dei-mercati-investitore-ha-realizzato-4000-per-cento/>> [Accessed on 10 November 2022]
- Giovenale, D., G., 1535. *Satirae. Venetiis. In aedibus haerendum Aidi et Andreae soceri* [Satire. Venice. Aida e Andrea's father-in-law would have remained stuck in the house].
- Global Preparedness Monitoring Board, GPMB, 2019. *A world at risk. Annual report on global preparedness for health emergencies*. September 2019.
- Gong, W., Mao, Y., 2022. BCG Vaccination: a potential tool against COVID-19 and COVID-19-like Black Swan. *International Immunopharmacology*, 108, p. 188870. <https://doi.org/10.1016/j.intimp.2022.108870>
- Hethcote, H. W., 2020. The mathematics of infectious diseases. *SIAM Review*, 42(4), pp. 599-653. <https://doi.org/10.1137/S0036144500371907>
- Hysa, E., Imeraj, E., Feruni, N., Pinait, M. and Vasile, V., 2022. Covid-19 - A Black Swan for foreign direct investment: evidence from European countries. *Journal of Risk and Financial Management* (15)4, 156, pp. 1-21. <https://doi.org/10.3390/jrfm15040156>
- Italian Ministry of Economy and Finance, MEF, 2020. *Documento di Economia e Finanza* deliberato dal Consiglio dei Ministri Italiano [Economics and Finance Document deliberate by Italian Council of Ministers], 24 April 2020. [online] Available at <[https://www.dt.mef.gov.it/it/attivita\\_istituzionali/analisi\\_programmazione\\_economico\\_finanziaria/documenti\\_programmatici/index.html?selezione-anno=2020#selezione-anno](https://www.dt.mef.gov.it/it/attivita_istituzionali/analisi_programmazione_economico_finanziaria/documenti_programmatici/index.html?selezione-anno=2020#selezione-anno)> [Accessed on 24 November 2022]
- Jimenez, J., Marr, L., Randall, K., Ewing, T. E., Tufekci, Z., Greenhalgh, T., Milton, D. K., Tellier, R., Tang, J., Li, Y., Morawska, L., Mesiano-Croolston, J., Fisman, D., Hegarty, O., Dancer, S., Bluysen, Ph., Buonanno, G., Loomans, M., Bahnfleth, W., Yao, M., Sekhar, C., Wargocki, Melikov, A. K. and Prather, K. A., 2020. What were the historical reasons for the resistance to recognizing airborne transmission during the COVID-10 Pandemic? *Indoor Air*, 32(8), p. e13070. <https://doi.org/10.1111/ina.13070>
- Kahneman, D., 2003. A perspective on judgment and choice: mapping bounded rationality". *American Psychologist*, 58 (9), pp. 697-720. <https://doi.org/10.1037/0003-066X.58.9.697>
- Kahneman, D., 2011. *Thinking, fast and slow*. New York: Farrar, Straus and Giroux.
- Kahneman, D., Sibony, O. and Sunstein, C. R., 2021. *Noise. A flaw in human judgment*. London: HarpersCollins Publishers.
- Kahneman, D., Slovic, P. and Tversky A., eds. 1982. *Judgment under uncertainty heuristic and biases*. Cambridge: Cambridge University Press. <https://doi.org/10.1017/CBO9780511809477>
- Kahneman, D. and Tversky A., 1971. Belief in the law of small number. *Psychological Bulletin*, 76 (2), pp. 105-110.
- Kahneman, D. and Tversky A., 1974. Judgment under uncertainty: heuristic and biases. *Science*, 185, pp. 1124-1131. <https://doi.org/10.1126/science.185.4157.1124>
- Kahneman, D. and Tversky A., 1979. Prospect theory: an analysis of decision under risk. *Econometrica*, 47, pp. 263-291. <https://doi.org/10.2307/1914185>

- Kaja, N. and Epps, H., L., 2004. Relationship between color and emotion: a study college students. *College Student Journal*, 38(3), pp. 396-405.
- Khan, W., Ghazanfar, M. A., Azam, M. A., Karami, A., Alyoubi, K. H. and Alfakeeh, A. S., 2022. Stock market prediction using machine learning classifiers and social media, news. *Journal of Ambient Intelligence and Humanized Computing* (13), pp. 3433-3456. <https://doi.org/10.1007/s12652-020-01839-w>
- Kumarasamy, J., Subramaniam, M. and Apayee, P. D., 2014. Emotion and expression responses through color: A literature review. *SSRN Electronic Journal*. [online] Available at <[https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=2435741](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2435741)> [Accessed on 9 January 2023]. <https://doi.org/10.2139/ssrn.2435741>
- Legrenzi, P., 2009. *Psicologia ed investimenti finanziari* [Psychology and financial investments]. Il Sole 24-ore.
- Legrenzi, P. and Massarenti, A., 2015. *La buona logica* [Good logic]. Lombardy: Raffaello Cortina Editore.
- Morandini, La., Morandini, Lu. and Morandini, M., 2022. *Il Morandini 2022 [The Morandini 2022]*. Bologna: Zanichelli.
- Morawska, L. and Milton, D. K., 2020. Is It Time to address airborne transmission of Coronavirus disease 2019 (COVID-19). *Invited Commentary, Clinical Infectious Diseases*, 71(9), pp. 2311-2313. <https://doi.org/10.1093/cid/ciaa939>
- National Commission for Companies and the Stock Exchange, CONSOB, 2020a. *La crisi Covid-19 [The Covid-19 crisis]*. [online] Available at <<https://www.consob.it/documents/46180/46181/Rep-covid-19.pdf/02fa9e7c-c7f1-4338-be40-ld39b0c3e545>> [Accessed on 7 October 2022].
- National Commission for Companies and the Stock Exchange, CONSOB, 2020b. *La pandemia di Covid-19 e la crisi del 2020 [The Covid-19 pandemic and the 2020 crisis]*. [online] Available at <<https://www.consob.it/web/investor-education/crisi-covid-19>> [Accessed on 7 October 2022]. <https://doi.org/10.1038/nrd.2017.243>
- Occorsio, E., 2020. Taleb: dal Coronavirus una scossa al sistema ma questo non è il mio cigno nero [Taleb: from the Coronavirus a shock to the system but this is not my black swan]. Interviewed by Occorsio, E. *La Repubblica.it*, 4 March 2020 [online] Available at <[https://www.repubblica.it/economia/2020/03/04/news/taleb\\_dal\\_coronavirus\\_una\\_scossa\\_al\\_sistema\\_ma\\_questo\\_non\\_e\\_il\\_mio\\_cigno\\_nero\\_-301022718/](https://www.repubblica.it/economia/2020/03/04/news/taleb_dal_coronavirus_una_scossa_al_sistema_ma_questo_non_e_il_mio_cigno_nero_-301022718/)> [Accessed on 24 November 2022]
- Pardi, N., Hogan, M. J., Porter, F. W. and Weissman, D., 2018. mRNA vaccines – a new era in vaccinology. *Nature Reviews Drug Discovery*, 17, pp. 261-279. [online] Available at: <<https://www.nature.com/articles/nrd.2017.243>> [Accessed on 24 November 2022]. <https://doi.org/10.1038/nrd.2017.243>
- Pardi, N., Hogan, M. J. and Weissman, D., 2020. Recent advances in mRNA vaccine technology. *Current Opinion in Immunology*, 65, pp. 14-20. <https://doi.org/10.1016/j.coi.2020.01.008>
- Porcu, A., 2020. Coronavirus, cigno nero a impatto esponenziale (e le opportunità che offre). [Coronavirus, black swan with exponential impact (and the opportunities it offers)]. *Econopoly*, 8 March 2020. [online] Available at <<https://www.econopoly.ilsole24ore.com/2020/03/08/cigno-nero-coronavirus/>> [Accessed on 1 December 2022].
- Raviere, A., 2021. *Covid-19 e sue conseguenze sui mercati finanziari in un'ottica di finanza comportamentale [Covid-19 and its consequences on financial markets from a behavioral perspective]*. Master thesis, University of Cassino and Southern Lazio.
- Santangelo, S., 2021. Perché la pandemia è un cigno nero [Why the pandemic is a black swan]. *Huffingtonpost.it*, 25 January 2021. [online] Available at <[https://www.huffingtonpost.it/entry/perche-la-pandemia-e-un-cigno-nero\\_it\\_600ebb16c5b6fe97669e2c53/](https://www.huffingtonpost.it/entry/perche-la-pandemia-e-un-cigno-nero_it_600ebb16c5b6fe97669e2c53/)> [Accessed on 10 November 2022].
- Santorelli, B., 2011. *Giovenale. Satire. Oscar Greci e Latini [Giovenale. Satire. Greek and Latin Oscars]*. Milano: Mondadori. <https://doi.org/10.1515/9783110284010>
- Simon, H., 1982. *Model of bounded rationality*. Cambridge, Mass: MIT Press.

- Sornette, D., 2009. Dragon kings, Black Swans and the prediction of crisis. *Swiss Finance Institute Research Paper Series 09 (36)*. Available at: <<http://ssrn.com/abstract=1470006>> [Accessed on 06 April 2023]. <https://doi.org/10.2139/ssrn.1596032>
- Spadafora, S., 2020. Il Coronavirus è davvero un cigno nero? [Is the Coronavirus really a black swan?]. *Società e Demografia*, 3 May 2020 [online] Available at <<https://www.opencalabria.com/il-coronavirus-e-davvero-un-cigno-nero/>> [Accessed on 14 October 2022]
- Taleb, N., 2004. The Black Swan: why don't we learn that we don't learn. *United States Department of Defense Highland Forum*.
- Taleb, N., 2010. *The Black Swan. The impact of the highly improbable. With a new section on robustness and fragility. 2nd ed.* London: Penguin Books Ltd.
- Thaler, R. H., 2015. *Misbehaving. The making of the behavioral economics*. New York: Norton.
- Valdez, P. and Mehrabian, A., 1994. Effects of color on emotions. *Journal of Experimental Psychology: General*, 123(4), pp. 394-409. <https://doi.org/10.1037/0096-3445.123.4.394>
- Valle-Cruz, D., Fernandez-Cortez, V., López-Chau, A., Sandoval-Almazán, R., 2022. Does Twitter affect stock market decisions? Financial sentiment analysis during pandemics: a comparative study of the H1N1 and the COVID-10 periods. *Cognitive Computation*, 14, pp. 372-387. <https://doi.org/10.1007/s12559-021-09819-8>
- Various, 2006. *Encyclopaedia Britannica*, 11th ed.
- Viale, R., 2020. *Routledge handbook of bounded rationality*. Abingdon: Taylor&Francis Ltd. <https://doi.org/10.4324/9781315658353>
- Wucker, M., 2016. *The gray rhino: how to recognize and act on obvious dangers we ignore*. Manhattan, NY: St. Martin's Press
- Yarovaya, L., Matkovskyy, R., Jalan, A., 2022. The Covid-19 black swan crisis: reaction and recovery of various financial markets. *Research in International Business and Finance*, 59, p. 101521. <https://doi.org/10.1016/j.ribaf.2021.101521>