Report

DYNAMO 93

1/4 2017

Hearing stars

Part I

September 14, 2014[1]. A mere chirp, captured in the highly sophisticated Laser Interferometer Gravitational-Wave Observatory (LIGO)[2], caused a roar in cosmological scientific research. After an intense data-checking work that lasted about 18 months – more precisely, on February 11, 2016 – the fact was announced by the LIGO team to the general public at a press conference in Washington D.C.. The novelty was shared and commented on digital platforms, provoking emotion and curiosity even in those who could not understand its precise meaning. It was enough to simply know that the Universe, that enigma that reduces us to minute beings, was at that moment a little less unconquerable. The collision of two giant black holes, located more than one billion light years away, each about 30 times the mass of the sun, generated gravitational waves (GWs) that were captured on Earth by two giant antennas. The first located in Louisiana, and the second in Washington, both in the USA, were built in an "L" shape, with perpendicular arms of about four kilometers in length. The antennas, separated by robust three thousand kilometers, a distance that a modern jet would take three and a half hours to cross, recorded the phenomenon in the interval of seven thousandths of a second, precisely as predicted by the academic models of LIGO's experimental physicists. A prodigy of the not always perfect human intelligence. It is one of those moments that seem to suggest that God does not actually play dice. As a corollary, the experiment was an empirical confirmation, for the first time, of the existence of pairs of black holes cohabiting a nearby region in Space. The conjugation of such bodies, devourers of everything (by the extraordinary force of gravity of the hyper-concentrated and compact mass), including light, was until then unobserved theoretical proposition.

After crossing through much of the Cosmos, suffering the interference from the countless galaxies it had to pass through in its path, the GWs arrived on Earth intact and primordial. Transformed by scientists into sound waves, they produced the long-awaited noise, confirming the predictions produced by the Theory of General Relativity a century ago. Einstein, the master of physical thinking (his method of constructing hypotheses) would have rejoiced to see the physical captured. Or perhaps not so much, so great was his certainty that the phenomenon was real, even though he believed it would never be proved. It was the last of his predictions that remained unconfirmed. But the interstellar ringer that could be heard by anyone close to LIGO's apparatus goes far beyond the mere confirmation of a theoretical speculation. We may be approaching the echoes of the Big Bang, the primeval explosion that occurred 14 billion years ago and gave rise to the Universe. Electromagnetic waves allowed us to understand what happened since about 400 thousand years after the Big Bang, when light began to pour through space. But before that, in its singularity, the Cosmos was opaque. Opaque, but permeable to gravitational waves. Through them, even in its first seconds, the Universe is transparent. Translucent within its deep darkness.

The impactful announcement by LIGO's technicians was the climax of a hundred years of complex propositions, fifty years of heroic attempts at designing experiments, and over twenty-five years of refinement of instruments so sensitive that they could detect a change

1 As usual, for a simple matter of space-time, we refer to the Library menu in our website for the bibliographic references used in this Report.

2 The construction of LIGO equipment involves high technology. We suggest to the interested reader the article by Nicola Twilley in The New Yorker of February 11, 2016.

smaller than the thickness of a human hair between the solar system and its nearest star (four light-years away from here). Of course, given the reach of the results obtained after so much work and persistence, we here at Dynamo, always attentive to the development of successful mental models, had to pay attention.

It was a monumental event, but it followed something that began about 200 years ago, when Michael Faraday sought to understand how an action was transmitted through the Cosmos. By what means did the Sun compel the Earth to follow it, in constant orbit? Something had to be going through space, transporting the force of gravity, since the idea of a steel cable holding the two bodies together was only a useful Newtonian metaphor. Such thoughts inspired J. C. Maxwell to initially study how electric force travels through air. From there, he gained an understanding of the processes of light propagation, and was able to predict radio waves. Faraday and Maxwell were Albert Einstein's heroes. They are the giants whose shoulders Einstein climbed to see his theory of gravitational fields – which answers the question above, by predicting that the gravitational force was carried by waves, gravitational waves.

We have arrived in a new era in astronomy post LIGO's discovery, because we have always limited ourselves to seeing the Universe, and now we can also hear it. We were dependent on light to glimpse at what goes on out there, in outer space. Now we begin to incorporate a new element: sound. And it is worth remembering that only about 5% of the Universe is illuminated. The remainder is what is often called the dark matter (68% of the Universe) and dark energy (27% of the Universe). Even our most powerful telescopes are not able to decipher the mysteries of the dark regions. But antennas will probably be able to listen to them, so we will begin to understand what they are made of and what they mean.

If we do not have prominent Brazilian physicists involved in this brilliant history, there's no harm in summoning, as a lyrical compensation, our Prince of Poets. A precursor of the auditory possibilities of the celestial world. Olavo Bilac, an exceptional Parnassian, says in the poem of the Milky Way: "'Well (you'll say) hearing stars! Certainly / You've lost your mind!' And I will tell you, however, / That, to hear them, many times I wake / And open the windows, pale with awe…". If science imitates art, it is always with much effort and some inspiration. Although LIGO's equipment, once perfected by its engineers, was able to find the desired noise in a matter of weeks, it took several months to compare the received signal to sophisticated black hole collision simulations to make sure the observation matched the theoretical template. Only then was the classical scientific arch of prediction, experiment, and confirmation complete: first, physicists and mathematicians deduced the real characteristics of the GWs. Then they decided what evidence they would need to look for, that is, what could be picked up by the antennas in the laboratory. Finally, they designed the highly nontrivial experiment that would close the cycle. Once all the steps were successfully completed, the event was celebrated. And it was not for nothing.

First, because of the Promethean triumph of a path that begins with the intelligence of a creative theoretical postulation and ends with its empirical verification, after over 40 years of experiments and US$1.1 billion in investments. It is science fulfilling its Popperian[3] cycle of progress. Temporary truths that undergo empirical tests are confirmed and remain accepted, or, if not confirmed, are replaced by new formulations. To propose hypotheses the way pure science does, and to try to falsify them the way applied science does, paves the construction of the best knowledge that mankind is capable of producing. Apart from mathematics, with its absolute truths which cannot be falsified, knowledge is, as Xenophon[4] suggested long ago, simply a series of postulates, opinions, and speculations, however grounded they may be. In the natural sciences, propositions are testable, and so can aspire to the status of temporary truths. In the social sciences, there is only persuasion to support their "theorems". It is perhaps not enough, as recognized, but it is what we have. At least while the Data Science revolution does not make more behavior-related variables measurable on a large scale[5]. In any case, and as

3 *We refer here to the work of Karl Popper, who proposed a definition of what should be considered science and what should not, and about whom we will write more about later in this Report.*

4 *A Greek thinker, versatile disciple of Socrates who wrote on the most varied subjects.*

5 *The evolution of Artificial Intelligence and Data Science is undoubtedly one of the most important themes for the future of corporate life and even social life in general. We are not yet prepared to address this theme in a Report, but we intend to do so in the not too distant future. It is coming faster and faster in our direction.*

a warning to ourselves when we exaggerate the scientific character of our fundamentalist analysis, it is always worth remembering the wise words of Isaac Newton: "I can calculate the motion of heavenly bodies, but not the madness of people".

Second, because of what the discovery of GWs reveals. We know that mass curves time-space. Therefore, when a body moves it should cause ripples through wherever it goes. Just like a gymnast walking on a stretched out rubber trampoline. However, the mathematical models required to predict this phenomenon are extremely complicated. There is a profusion of ripples transiting in space. To distinguish only those that are specifically arising from what is called gravity is a respectable additional complication. Finally there is the incredible challenge of correctly designing the experiment. As GWs pass through Earth (and we now know that they pass through here all the time), distort distances by compressing them in one direction and extending them in a perpendicular direction. Such variations occur in the precision of a thousandth of the size of a proton – a subatomic particle too small to be seen by even the most powerful microscopes. The scientific discipline and technological care required to rigorously record this occurrence are impressive. One can imagine the difficulty in making sure that the detected noise was indeed what one intended to find and not any other interference. And yet, the disturbances detected by LIGO are unequivocal and completely convincing. Even though they were "supposed" to exist, expecting is very different from finding. Predicting falls far short of measuring.

From now on, cosmological physics will be better equipped to answer essential questions about the origin of the Universe. With a little exaggeration, it can be said that there has been a paradigm shift. Astronomers have always seen the Cosmos as a calm, expanding sea. That has changed radically. The collision of the two giant black holes created a violent storm, a hecatomb in the fabric of space-time that accelerated and slowed Time, deforming Space in multiple directions. A storm that, through spectacular human ingenuity, we can hear. We will repeat ourselves again, underlining the years and years of hard work of information analysis that was necessary to obtain this shocking discovery.

As Charles Munger (a star we like to hear) has always been careful to emphasize, mental models, whichever they are, help us think, whatever the objects of our reflections. So we studied what occurred in this chapter of GWs, with no pretension other than to learn another successful model. It was then that we came across a particular aspect that surprised us. With the modesty of those who know we deal with incomparably simpler truths than the LIGO technicians sought, we intend to show how the incredible history of the discovery of GWs has accessory angles that indicate a method of working that we seek to cultivate here at Dynamo, and that now we come to describe.

Part II

One of the mental models that we incorporate in our daily lives is Popper's falsificationism. We have mentioned a few times how this model has become not only an individual tool in our research work, but also a design element of our collective decision-making process.

Karl Raimund Popper (1902-1994) is regarded as the most important philosopher of science of the twentieth century. The central theme of his reflection was the question of finding a criterion through which one could classify a theory as scientific or not. Until then, the prevailing understanding was that the empirical method, essentially inductive reasoning starting from empirical observations, would be the best criterion. The truths contained in theories would become evident from the innumerable observations that confirm them. Along this line of reasoning, the incessant flow of these observations would serve to verify the hypotheses in question, confirming them. The belief was that science advanced from empiricism to theory.

This was an unsatisfactory criterion in Popper's view: a thousand observations cannot assure the robustness of a thesis, since we know nothing about observation one thousand and one. Moreover, it is usually a trivial task to obtain verifications for a theory, as long as we look for them. Popper proposed the inverse logic. Instead of confirming a theory, we must seek to refute it, that is, prove that it is wrong. Starting from a conjecture, the scientist's role is to look for evidence that disproves the proposed thesis. The genuine test of a theory is the attempt to refute it. This would be the true solution to the so-called problem of demarcation, the criterion that can distinguish between science and pseudoscience. To be considered scientific, an assertion must be able to conflict with possible or conceivable observations. The truths of science are always temporary, subject to deconstruction by the permanent testing of their predictions.

A nowadays classic example explored by Popper himself comes from natural history. It was always believed that all swans were white, until 1697 when Dutch explorers became the first Europeans to find black swans in Australia. Thousands of observations about white swans should not serve as a scientific basis for the general theory of swans. On the other hand, a single observation brought more information content than all the previous extensive cataloging. You can get closer to the truth through the negative instances. This is a powerful asymmetry. As Nassim Taleb reminded us, our body of knowledge does not grow from confirmatory observations, like the presumptuous turkey who believed that every day he would be fed at nine in the morning until he was tragically slaughtered on Christmas eve.

The Popperian falsificationism system fits like a glove for us here at Dynamo. For several reasons.

i) By the very way we invest. We always think of capital preservation. Our reflex is to first avoid the downside in our investments, giving less weight to the upside, to eventual gains from "optionalities". Our clinical habit is not to search for results that prove that companies are healthy, but to investigate clues that insinuate signs of dysfunctions. Information such as 'controlling shareholders are selling stocks as if there was no tomorrow' or 'the company has been adopting aggressive accounting practices in its financial statements' are often much more valuable to us than evidence that the sales of a new product are going well, or that a new logistics route has been reducing costs. In statistical language, we often say that we prefer to incur in Type I errors (reject the null hypothesis when it is true), that is, when we lose a good investment opportunity, rather than Type II errors (fail to reject the null hypothesis when it is false), in this case, when we invest in a wrong proposition. From this perspective, negative instances are much more useful to us.

ii) Another consequence of well-enforced falsificationism is that it does not tolerate abuses of authority in investment discussions. As we described in our Dynamo Report 82, our productive arrangement seeks to create an environment of vibrant and plural discussions, of collective construction and creative destruction. There, we said:

"Dynamo is a partnership, where investment decisions are made in a collective manner. An investment thesis is the result of a collaborative process, where each analyst contributes with his time, experience, knowledge and personal network. At a certain point in the research process, the thesis is submitted to an internal discussion, where everyone is invited and encouraged to share thoughts and opinions. At this moment, those who are not directly involved in the case in question will adopt a more critical and skeptical view towards the thesis. They try to test the assumptions, deconstruct arguments, present potential caveats, suspicions, weaknesses and contrary evidences to the case. A collective exercise in falsifying, à la Popper. Under this demarcation criterion, the thesis that survives the discussion is elected to overpass the resistance line of internal consensus, thus finding a place in our portfolio."

For a collective decision to be genuinely Popperian, individual interventions must generate falsifiable propositions. That is, arguments such as "I trust these numbers" or "I regard this as an excellent company" are not taken seriously in our discussions as they lack verifiable content. They need complement, explanations. "I trust these figures because they are compatible with recently released sector data", "I regard this as an excellent company because it was able to grown margins while competitor's margins shrank". Then, a discussion with objective elements, capable of being answered, begins. Intuitively it is as if we are trying to reduce those purely persuasive noises, typical of the social sciences mentioned above, seeking to bring our propositions closer to the objectivity of the purest disciplines. In many discussion forums on investment, corporate performance, and capital markets, it is common to see that non-falsifiable arguments emerge as authoritarian slips out of some presumption of seniority. This is something that does not develop and that we do not accept in our internal investment discussions. That is, the Popperian method also works for us as a great antigen against the trap of experience that we mentioned in Dynamo Report 81, something which can sneak in unnoticed, especially on teams that have been longer on the road.

iii) Popper defined his philosophy of science as a critical rationalism. Fallibilism assumes the absence of a definitive criterion of truth and exposes the limitations of our capacity for knowledge, always leaving open the possibility of finding an experience that contradicts our initial conjectures. When the Popperian critical attitude prevails, knowledge is relegated to a perennial temporary status. As long-term investors, this provision brings a lot of value for us. It rejects the inertia, accommodation, and conformity that might otherwise settle after many times following a 'known' company. One must always be attentive.

iv) The analyst that possesses the Popperian critical attitude fundamentally seeks propositions that may contradict his own hypotheses and not confirm them. The confirmation bias is one of the worst enemies of the investor, and a very frequent one, because it is a natural human characteristic. It can be spotted when we are looking for information that confirms our visions, when we are looking for conversations with individuals who think like us, or in its close cousin, a version of the assimilation bias, when we see all information/data as consistent with our initial beliefs. As Popper himself described, a process of constructing conjectures (an investment thesis) starts from a viewpoint, that is, "a system of expectations, anticipations, presumptions, or interests". At the onset, there are already personal elements that are camouflaged and need to be properly debugged. And this is done by searching for evidence that falsify the initial conjectures, not reaffirm them. At Dynamo, we foster dialogues with competitors, and even with those who are notoriously critical of a target company in our analysis. We seek the contradiction, both in the construction of the investment thesis, and in the process of collective destruction, through the design of a discussion that guarantees a good dose of critical artillery against these possible infiltrated initial dispositions.

v) Lastly, of course, this Popperian collective decision-making process may contain pitfalls of which we are not exempt. In the eagerness to make it as reliable as possible, we may arrive at incorrect refutations. These are what we might call the "ducks that are painted black", and which we take for the black swans, and so mistakenly abandon a thesis that might merit further investigation. This is the typical case of committing the "tolerable" Type I error we mentioned above, that is, of letting a good investment proposition go by.

Even after this collective process of attempting to deconstruct the candidate thesis, we still commit genuine Type II errors. Maybe at lower frequency and magnitude, but we nonetheless do. When faced with this situation, we return to the specific case to dissect it, to identify the reasons that led us to failure. The idea is to deeply imprint the lessons we learned, incorporating them as individual and collective experience, seeking to transform them into antigens that further strengthen our immune systems in our next investments. Our collection of errors is extremely valuable, and is often worth revisiting. There we find, recorded, the steps of our evolution (we hope) as managers.

Errors are the raw materials of our knowledge. Our 'factory' design is all about making the most of learning, building intelligence, and accumulating experience not only in those cases that have produced good returns to our investors, but – perhaps most importantly – where we have committed some flaw in the investment process itself. We examine the misunderstandings of those proposals that did not progress in the collective discussion, reflect on the situations that we did not invest in but which proved successful and, especially, dissect those cases that passed through the critical threshold of collective competence and ended up turning into poor investments.

Establishing a method of Popperian critical rationalism in a collective decision-making model is easier said than done. In addition to good intentions and straight characters, other ingredients are necessary, such as having participants that really cultivate reciprocal trust, respect and admiration. Human reflexes that may be rare in the work environment. As we wrote in the same 82nd Dynamo Report, the success of this design "[is ultimately] a function of the personalities of the people comprising a group. Personal detachment becomes a necessary ingredient, a permanent disposition to perform diverse functions, always placing the partnership's aims as more important than personal agendas."

We have no doubt that the effort to pursue these falsificationist provisions here at Dynamo has been extremely positive. It has become so entrenched, we can say that it is part of our culture, and has greatly helped in dealing with the increasing challenges in the investing task. It is a fact that acceleration of technological innovation has made the world vastly more interconnected and, therefore, more complex. Simply because the more connections there are, the more things will influence other things. We have to go further and further to identify the genesis of, and to explain, the behavior of phenomena. And this undoubtely applies to the investment environment. In order to understand this multifaceted reality, with exponentially more connections, investors need to equip themselves with a tool that is compatible with the challenge. From the height of his long experience as Warren Buffett's main partner in Berkshire Hathaway, Charlie Munger suggests a path to be followed: one must form a certain amount of worldly wisdom, incorporating a vast repertoire of mental models, borrowed from several different disciplines.

Dynamo Report 38 (Q2'03) was entirely dedicated to this fascinating subject. We recalled that "these models are constructions of our intellectual and scientific history (more of the latter than of the former) of proven explanatory power over a variety of phenomena". From then on, our admiration for Munger and his latticework of mental models has only grown. Not less because he himself acknowledged that his ongoing quest to hone his decision-making process has certainly paid off. Devoid of any false modesty, Munger admitted with his usual good humor that he had made more mistakes when he was younger than at his more mature phase, and he saw visible progress in his purpose of becoming a little less stupid over time.

It is not easy to develop this multidisciplinary ability. Our natural tendency is to cling to the familiar, holding our positions and convictions. Since we are already in good company: Buffett often says that we are experts in interpreting new information in a way that keeps our previous conclusions intact. And Munger warns us that a year that we have not destroyed one of our favorite ideas would be a wasted year. The exercise must be permanent, the "learning machine" must remain at full capacity. This is the only way we might avoid parking at a biased way of thinking, and might hope to deal with the increasingly complex reality.

This time, we sought inspiration in a remote province, in the confines of the Cosmos. The arguments in Parts I and II, which seem scattered, like celestial bodies, need to be connected by some gravitational force. This is the purpose of the third part of the Report. Now, back to Space!

Part III

What is reported in this third part of the Report is based on the article "The Astrophysicists Who Faked It – the inside story of the gravitational wave signal injection", published in Nautilus magazine on November 3, 2016. The authors, Jonah Kanner and Alan Wienstein, are senior technicians of LIGO.

The opportunity to discover something important to not only the sciences, but to natural and human histories, such as deciphering the language of the universe through the measurement of the GWs, brings deep and important repercussions to all of those involved. A guaranteed Nobel Prize, financial reward and professional recognition, the achievement of a life project, not to mention the possibility of recording one's name in history, with a definitive contribution to the understanding of the Cosmos and perhaps the origin of our existence on the Earth.

In September 2010, five years before the extraordinary discovery we described in Part I, LIGO scientists had detected the same pattern of a strong 'chirping', which seemed to be an unprecedented and very consistent gravitational signal. After countless analyzes, calculations, checks and rechecks, indeed a dense collective scientific effort, they concluded that it was a genuine astrophysical signal, a gravitational wave traveling through the fabric of Space-Time.

In March 2011, in a solemn event at a California hotel, the paper describing the 'evidence' of detection would finally be published after passing the threshold of around 700 scientists, and the incredible achievement would be officially announced to the world. Before the announcement, there were speeches that praised this long journey, as well as the sophistication with which the incredible instruments of measurement were made and the dedication of the tireless researchers. Champagne bottles were open, and glasses arranged for the great celebration. At that point, the director of LIGO came into the room with an envelope that had been in his pocket for over six months. The announcement would be the opposite of the expected: the detected signal was a fraud...

With so many rewards and acknowledgments at stake, the very scientists involved in the project realized that the situation was not compatible with the process of scientific discovery and confirmation, where hard, technical, subtle and even tedious work, as well as sobriety, are required. High emotional content and reputational involvement could lead to unwanted detours when deciding whether to prove a great discovery.

They therefore decided to establish a mechanism that could neutralize these effects. A few team members were allowed to generate noisy data, which would act as fake GWs, an "a priori falsification". They called these "blind injections". As with vaccines, the scientists self-injected viruses in order to develop their own immune systems. All other participants in the research effort knew of this procedure, but did not know if, how, and when the false signal would be created. The mere existence of this possibility kept them in a state of constant alertness, skepticism, and austerity desired. Each episode of deception by false noise was met by further refinements of LIGO's instruments and intelligence. Thus has evolved the research work of the laboratory.

The interesting thing was that the contents of that unsuspected envelope did not provoke commotion or even discouragement among the scientists at the ceremony. The celebration followed in the same way it would were the announcement the expected one. Already at that time, scientists realized that the system of checks and balances they designed was working, and that this would eventually lead to the 'true' discovery, which indeed did actually happen five years later.

The reports about the saga of the detection of GWs are unanimous in pointing out the "blind injections" as a fundamental element from the trajectory until the definitive announcement of discovery. This made us here at Dynamo think, and soon see a plausible parallel with our falsificationist method of provoking error as a tool for uncovering the truth. For some time we have realized that the proximity to error produces a genuine mentality of doubt, which is the best foundation for building a robust investment thesis. When we saw the similar principle being applied by those on the edge of scientific rigor and sophistication, we could not resist tracing the symmetry.

There are many differences, of course. In astrophysics, the falsification took place through precise and objective action. In our environment, the data about companies and their businesses are far less accurate, and are amenable to interpretation. On the other hand, the nature of their problem – measuring undulations that distort space-time by less than the diameter of a proton – significantly complicated the task of refutation. In the

Dynamo Cougar x IBX x Ibovespa
Performance up to March 2017 (in R$)

Period	Dynamo Cougar	IBX	Ibovespa
60 months	83.7%	21.7%	0.7%
36 months	57.2%	28.6%	28.9%
24 months	32.2%	26.5%	27.1%
12 months	17.7%	29.2%	29.8%
Year to date	8.9%	8.1%	7.9%

NAV/Share on March 31 = R$ 666.705550900

DYNAMO COUGAR x IBOVESPA
(Performance – Percentage Change in US$ dollars)

	DYNAMO COUGAR*		IBOVESPA**	
Period	Year	Since Sep 1, 1993	Year	Since Sep 1, 1993
1993	38.8%	38.8%	7.7%	7.7%
1994	245.6%	379.5%	62.6%	75.1%
1995	-3.6%	362.2%	-14.0%	50.5%
1996	53.6%	609.8%	53.2%	130.6%
1997	-6.2%	565.5%	34.7%	210.6%
1998	-19.1%	438.1%	-38.5%	91.0%
1999	104.6%	1,001.2%	70.2%	224.9%
2000	3.0%	1,034.5%	-18.3%	165.4%
2001	-6.4%	962.4%	-25.0%	99.0%
2002	-7.9%	878.9%	-45.5%	8.5%
2003	93.9%	1,798.5%	141.3%	161.8%
2004	64.4%	3,020.2%	28.2%	235.7%
2005	41.2%	4,305.5%	44.8%	386.1%
2006	49.8%	6,498.3%	45.5%	607.5%
2007	59.7%	10,436.6%	73.4%	1,126.8%
2008	-47.1%	5,470.1%	-55.4%	446.5%
2009	143.7%	13,472.6%	145.2%	1,239.9%
2010	28.1%	17,282.0%	5.6%	1,331.8%
2011	-4.4%	16,514.5%	-27.3%	929.1%
2012	14.0%	18,844.6%	-1.4%	914.5%
2013	-7.3%	17,456.8%	-26.3%	647.9%
2014	-6.0%	16,401.5%	-14.4%	540.4%
2015	-23.3%	12,560.8%	-41.0%	277.6%
2016	42.4%	17,926.4%	66.5%	528.6%

	DYNAMO COUGAR*		IBOVESPA**	
2017	Month	Year	Month	Year
JAN	10.2%	10.2%	11.9%	11.9%
FEV	3.9%	14.5%	4.0%	16.4%
MAR	-2.1%	12.0%	-4.6%	11.0%

Average Net Asset Value for Dynamo Cougar (Last 12 months): R$ 2,720,124,222

(*) The Dynamo Cougar Fund figures are audited by Price Waterhouse and Coopers and returns net of all costs and fees, except for Adjustment of Performance Fee, if due. (**) Ibovespa closing.

case of an investment thesis, our decision to refute it is simpler and more direct.

Differences apart, in both cases this way of producing decisions greatly increases the chances of success in the task of validating conjectures. In the melting pot of critical refutations arise the purest investment nuggets. Following the physicists, we also attribute a great part of our correct investment decisions to the method. The process of critical collective discussion has been decisive for our performance over time.

Popper on several occasions acknowledged his intellectual debt to Einstein. From the testimony of LIGO's scientists, we might say that the validation of an important theory of Einstein was arrived at by a Popperian trick. Physics and philosophy intertwine collaboratively, illustrating once again the power of Munger's latticework of mental models.

Dynamo and LIGO, together in the same text. How daring. We recognize it is a more than bold analogy on our part. Therefore, we cannot conclude without first a final caveat to our patient readers. It was only due to our obsession to improve our internal processes and the quality of our research, to produce better results, that we befriended people of such high caliber in this Report. Therefore, ladies and gentlemen, please do not take us the wrong way, we intend merely dedication and effort, not pretension or arrogance.

Rio de Janeiro, April 20, 2017.

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