Numbers of Science and Ideology.

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"What is a number" is an important question to a scientist. This is because numbers carry information, and correct information has considerable power as evidence. Though politicians and policy makers are aware of this power, the fact that numbers as "scientific evidence" are context dependent is rarely pointed out. Therefore the real question when numbers are used in societal matters should be: is there an ideology behind the numbers? Ideological convictions - a cornucopia of economic and political ideas - generally serve the interests of the rich and the powerful, but not those of society. The history underlying the specific instances of the use of numbers may serve to clarify their ideological contexts.

To begin with it may be noted that the information content of numbers in mathematics and the physical sciences are not the same. Numbers carry information independent of the physical reality only when they are treated as pure intellectual abstractions. The famous Ramanujan Hardy number, 1729, was, is, and always will be, the smallest number that is the sum of two different cubes in two different ways. This logical self-consistency of numbers, however, does not give them the status of absolute truth. As the celebrated mathematician Kurt Gödel had shown, all consistent axiomatic formulations of the number theory include undecidable propositions. To put it simply this means that those propositions are either inconsistent, or else they contain truths that cannot be proved.

In contrast to the abstract world of mathematics, numbers in the sciences are derived from measurements. The physical constants such as Avogadro's number,

Planck's constant, Boltzmann's constant etc., belong to a unique class of numbers. They exhibit remarkable agreements with science's interpretation of the physical world; and science's ability to change it through technology. The most important outcome of these numbers, however, was at a conceptual level. They mathematized the age-old philosophical concepts of 'change', 'order', and 'equilibrium', and endowed them with great scientific significance.

The two laws that reflected this change are called the 1st and 2nd law of thermodynamics. They showed that in the physical world certainty is based on statistics and probability. The first law of thermodynamics says that energy cannot be created or destroyed. It is impossible to create a "perpetual motion machine", i.e., a machine that once started continues to work without the input of any more energy. The second law deals with the interaction of heat with matter. In its original formulation it says that the amount of useful work (w), that can be obtained from heat (q) in a given system, is always less than the amount of heat supplied, i.e., $q > w$. Some heat or energy must leak out and be wasted.

The leaked or missing energy (q-w) of the system, gets distributed among the atoms and molecules outside the system. This increases the randomness or the disorder in the distribution of energy, which is called entropy. Later on it was shown that for all spontaneous changes, the *overall* entropy must increase. As the universe is always changing and never in equilibrium, the 2nd law simply states that the entropy of the universe is always increasing.

However, an apparent or dynamic equilibrium in an isolated system is possible. This may happen if all the time dependent changes in that isolated system cancel each other

out. More importantly if a dynamic equilibrium is disturbed, the changes may become random, or chaotic. In rare instances they may also lead to exquisite patterns, or isolated systems of low entropy such as a living cell. Alan Turing, a pioneer of artificial intelligence (AI), published a mathematical model of morphogenesis long ago. He showed that "a system…may…develop a pattern…due to an instability of the…equilibrium".[1]

Such pattern developments and chaotic color changes can be demonstrated in a chemical reaction called the Belousov-Zhabotinsky (BZ) reaction. The BZ reaction has a fascinating history and was the first reaction in which oscillating color changes were observed. So novel was the observation, that the full account of the work remained unaccepted for publication for many years.[2] The oscillation in color results from the time dependent changes of the various components, involving feed-back mechanisms called autocatalysis.

The reader at this point may well wonder what relevance the laws of thermodynamics have to ideology, or more specifically to numbers as used in economics and politics. The answer may be found by revisiting the first great economic shock of this century, the global financial crisis (GFC) of 2007-2009, and its aftermath. When Alan Greenspan, the chairman of the Federal Reserve of the USA from 1987 to 2006, was asked why he failed to regulate the market to avoid the shock, his answer was, "To exist you need an ideology…the structure that defines how the world works". When pressed further he added "free…markets are…the way to organize economies", but admitted that he "found a flaw in the… structure" after the event.[4]

The observation that an ideology is necessary to organize economies is a fact. It may be planned, or unregulated, or something in-between. What it leaves out is that the economic component of any ideology is umbilically joined to political power. In the free market ideology, "value" is equated with its market determined "price" and society has little or no say in the matter. The intriguing relationship between value and price is made more complex by dressing it up with mathematical abstractions, and in more recent times by adding a qualifier such as "shadow price". This perspective of value has an interesting history and been questioned by many.[3,4]

Value addition to any natural resource, e.g., conversion of crude oil to petrol, or limestone to cement, involves the consumption and transformation of energy into useful work. As energy cannot be created or destroyed, the value addition process must include that part of the energy that leaks out as entropy. Even in a so-called "circular economy", like in the idealized Carnot's cycle of thermodynamics, this cannot be avoided. Limitless economic growth is therefore as impossible as perpetual motion machines. Many economists and scientists in the past noted this. They argued for an alternative strategy for economic growth where sustainability is the focus, the leakage of energy and the power of money are minimized, and appropriate technologies are used.[5]

The number that played a pivotal role in peddling the free-market ideology over the last several decades, is the rate of growth (g), as measured by GDP statistics. However, the question that Simon Kuznets the man who invented GDP statistics posed many years ago, viz. "more growth of what and for what", was rarely asked. Numbers show that for a long time, both globally and in India, wealth accumulation by a few, and the rise in economic inequality went hand in hand. In India, the wealth of politicians and their

corporate friends increased spectacularly, while public health and job creation were ignored.[6-8]

For instance under two different political regimes, the total wealth of all members of Parliament (MPs) in India increased about ten times. The rate of increase in the wealth of the legislative assembly members (MLAs) was even more spectacular. From 2015 to 2018, with the NDA government at the center, the combined total wealth of all the MLAs went up about 13 times. More specifically, while India continued to be the home to the largest numbers of the extreme poor, it became third in the world in terms of the number of billionaires. The government spent less than fifteen hundred rupees a year for the health of an average citizen, and the total number of employed people fell by 9 million. In 2017-18 the unemployment rate was at a 45-year high.

Even the Wall Street crash of 2008 and GFC did not change anything either in the USA or in the rest of the world. Private credit markets expanded and reached the staggering number of 9 trillion US dollar globally. In India, between 2004-2019 scheduled commercial banks wrote off 114 billion dollars to the corporates as bad loans.[9] It was only after the arrival of COVID-19, that a government advisor in the U.K. pointed out the obvious: "the Federal Reserve's massive cash injection…bailed out monetary chicanery more than… individuals". [10]

'Monetary chicanery' is not a new phenomenon. A hundred years ago it was called 'finance capitalism', and a few decades ago 'casino capitalism'. It had a significant role in precipitating the two world wars and the Russian revolution. It originates from the difference between the rates of interest earned by capital (r), and growth (g). Painstakingly-collected data conclusively show that for the last couple of centuries, the

average of "*r*" has always been greater than the average of "*g*". The remarkable similarity of $r > g$ with that of the 2nd law of thermodynamics', $q > w$, is obvious. Finance capital, the '*r*-*g*' part of the economy is its entropy. It consists of paper money and shadow banking instruments such as stocks, bonds, derivatives, futures, etc.[11]

The accumulation of finance capital has a two-fold societal impact. First, economic inequality rises rapidly. In the technical language of economics, the coefficient of the Pareto distribution (which measures the degree of inequality) is a steeply increasing function of $r - g$. The latest inequality estimates in India, with the richest 1 per cent holding more than four times the holding of the bottom 70 per cent of the country's population, are therefore not surprising.

Secondly, the accumulation of finance capital, like autocatalysis in chemistry, is self-referential. It accelerates the further accumulation of finance capital, but inhibits innovations that deliver social benefits. In a market economy, growth is supposed to come from innovations. Big innovations that deliver public benefits almost always came from inventions in the public domain. Moderna's RNA, or AstraZeneca's adenovirus based vaccines could be made in record time only because of years of research at the National Institute of Allergy and Infectious Diseases and Oxford university respectively. Such innovations require a long-term horizon unlike that required for quick profits from either "innovative financial products", or by cutting the cost of labor, or by dodging tax.

Difference equations and linear programming are routinely used in economic policy making. The future evolution of GDP numbers are modeled by feeding existing time series data. Readers familiar with the logistic map and the two "fundamental laws of capitalism" would have no difficulty in seeing that the equation that determines $r - g$, is

just one step away from the simplest non-linear difference equation with its boom bust factor. [12] As was said more than 40 years ago, we would all have been better off had economic experts taken serious note of simple non-linearity and the underlying faulty ideology.

Till about the early 20th century, free market ideology developed through the commodification of land, labor, and money. Contrary to common wisdom, the commodification of numbers, statistical data, and the use of "AI" to make profit, is not as recent as it is often made out to be. A company called Simulmatics played a pivotal role in the electoral campaign and outcome of the 1960's closely fought US presidential election. [13] An IBM 407 computer was used to analyze approximately five hundred voter types, and more than fifty clusters of 'issues of concern'. At that time what Simulmatics did was called 'what if analysis', but now it has the fashionable name 'artificial intelligence (AI)'.

The outcomes of both the 2015 Brexit referendum and the 2016 US presidential election triggered off an official investigation into the misuse of personal data in the election campaigns. It turned out that Cambridge Analytica, now a defunct company, had siphoned off personal data from Facebook without the consent of the individuals concerned. The Information Commissioner in the U.K. concluded that there were "systemic vulnerabilities" in the democratic systems. Such vulnerabilities are inevitable in an ideology that commodifies everything. AI in such an ideology, is all about profit and ideological propaganda. As has been said, the ignorance of history maybe a badge of honor in Silicon Valley, but it has costs, both economic and ethical.

The level of global unpreparedness to meet COVID-19 once again emphasized the costs of ignoring historical lessons. The H1N1 virus of the 1918 pandemic had killed at least 50 million people. It reappeared as H2N2 in 1957-58, and then again as a pandemic in 2009. So far COVID-19 has killed 4 million, but with at least five documented strains and, given the huge number of people yet to be vaccinated, the pandemic is on its way to becoming pan-endemic. The current total value of lost lives, or the burden of the disease, has been estimated to be about 21 million years of life.[14] The life insurance industry would understand the economic implications of this number well because it translates into a huge number of dollars.

This is even more devastating in a country like ours because overwhelmingly large numbers of Indians do not have any life insurance and trying to measure the value of lost lives in India in terms of money means little. The number of people who died without any insurance cover is more revealing. Recent data shows that as many as 86% of the deaths in India did not result in any insurance claim. [15] In other words, those lost lives have zero value in India's aspirational market economy. Given this and the recent horrific images of dead bodies floating in the Ganges, one can only conclude that over the last fifteen years crony capitalism in India has mutated to its latest strain: carnage capitalism.

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