Journal of Ekonomi 13 (2025) 60–94

Ekonomi

journal homepage: https://dergipark.org.tr/ekonomi

A short history of geoeconomics and geopolitics of the internet for the age of the USA-prc technology war

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ARTICLE INFO

Keywords:

Ai
BAT
Big data Bitcoin
Blockchain
Cambridge analytics
Cloud
Digital payments encapsulation
Ethereum
Digital payments
FAAMG
The trade and technology

JEL: O

ABSTRACT

The www is a network whose nodes are documents and whose links are URLs that allow us to 'stuff' with one click from one web document to another exceeding in size even the human brain. With Trump declared TRADE AND TECHNOLOGY war in 2018 INTERNET has become a strategic battleground of the war as USA and PRC try to win by ring-fencing their supply chains. ARPANET, funded by PENTAGON, was the brainchild of Paul Baran for packet switching, Vint Cref for writing TCP/IP protocols and Sir Tim Berners Lee for developing the world wide web that connected computers to each other so that people could see what was on other nodes than their own hard drive. The INTERNET was built without memory. Self-governing cyber-communities can escape geography and rely in open source, peer-to-peer networking. OPEN-SOURCE collaborative network created a very large portion of the lines of code on which the INTERNET, smartphones, stock markets and airplanes. But in 21st Century, governments developed techniques for controlling offshore INTERNET communications, thus enforcing their laws by exercising coercion within their borders. The INTERNET's design was not the result of some grand theory or vision. Open design was necessitated by the particularities of specific engineering challenges. With the ascendancy of FACEBOOK, AMAZON, APPLE, MICROSOFT, and GOOGLE [FAANG] in the USA and BAIDU, ALIBABA, and TENCENT [BAT] in the PRC in 21st Century to solve the 'trust' problem of money transactions the industry retreated to the centralized CLOUD abandoning the distributed architecture for centralized monopolies. The CLOUD is gargantuan data centers composed of immense systems of data storage and processors linked together by millions of miles of fiber optic lines and consuming electric power and radiating heat that exceeds most industrial enterprises in history. The INTERNET may have ushered in a new age of sustainable open systems, but as APPLE and MICROSOFT have shown an integrated closed system monopoly remains as irresistible as ever both in the USA and PRC.

1. *Introduction*

DATAISM regards the universe to consist of data flows and the value of any phenomenon or entity to be determined by its contribution to data processing. **DATAISM** was born from the confluence of life sciences that came to see organisms, since the publication of Charles Darwin`s **ON THE ORIGIN OF SPECIES**, as biological algorithms and Alan Turing`s idea of **TURING MACHINE**. Computer scientists have learned to engineer increasingly sophisticated electronic algorithms. An algorithm is a methodical set of steps that can be used to make calculations, resolve problems and reach decisions. An algorithm is not a particular calculation, but the method followed when making the calculation.

DATAISM puts the two together pointing out that the same mathematical laws apply to both biochemical and electronic algorithms. **DATAISM,** eliminating the barrier between animals and machines, expects electronic algorithms to eventually decipher and outperform biochemical algorithms. According to **DATAISM**, Mozart`s Magic Flute, stock market bubble, HIV virus are three patterns of data flow that can be analyzed using the same basic concepts and tools.

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Received: 10 September 2024; Received in revised from 04 December 2024; Accepted 12 December 2024
https://doi.org/10.58251/ekonomi.1546745

George Dyson in **ANALOGIA: THE EMERGENCE OF TECHNOLOGY BEYOND PROGRAMMABLE CONTROL** tells: "Nature uses coding, embodied in strings of DNA, for the storage, replication, modification, and error correction of instructions conveyed from one generation to the next, but relies on analog coding and analog computing, embodied in the brains and nervous systems, for real-time intelligence and control. Coded sequences of nucleotides store the instructions to grow a brain, but the brain itself does not operate, like a digital computer, by storing and processing digital code. …. In a digital computer, one thing happens at a time. In an analog computer, everything happens at once. Brains process three-dimensional maps continuously, instead of processing one-dimensional algorithms step by step. Information is pulse-frequency coded, embodied in the topology of what connects where, not digitally coded by precise sequences of logical events. "The nervous system of even a very simple animal contains computing paradigms that are orders of magnitude more effective than are those found in systems built by humans,' argued Carver Mead, a pioneer of the digital microprocessor, urging a reinvention of analog processing in 1989. …. Electronics underwent two critical transitions over the past one hundred years: from analog to digital and from high-voltage, high-temperature vacuum tubes to silicon's low-voltage, low-temperature solid state. That these transitions occurred together does not imply a necessary link. Just as digital computation was first implemented using vacuum tube components, analog computation can be implemented, from bottom up, by solid state devices produced the same way we make digital microprocessors today, or from top down through the assembly of digital processors into analog networks that treat the flow of bits not logically but statistically: the way a vacuum tube treats the flow of electrons, or a neuron treats the flow of pulses in a brain. …. The vacuum tube, treating streams of electrons as continuous functions, was an analog device. The logical processing of discrete pulses of electrons had to be imposed upon it. …. In the analog universe time is a continuum. In the digital universe, time is an illusion conveyed by sequences of discrete, timeless steps" (Dyson, 2020).

"The most basic difference between human cognition and computer/medium processing can be attributed to the fact that human perception and cognition are situated physically in a tangible world. A human being has an active and autonomous relationship to its environment. This is of crucial importance to the versatile perception and cognition in the so-called 'perceptual cycle'. The basic principles of this perceptual cycle are perceptual activities that are controlled by continuously changing mental schemata. This is caused by the direct intentionality of the human mind. Intentionality is inspired by the needs and values of human beings as biological and social beings in a particular environment. This is the basic principle used by neurobiologist Gerald Edelman and his Neurosciences Institute. Edelman's work, summarized and popularized in his books **BRIGHT AIR, BRILLIANT FIRE: ON THE MATTER OF THE MIND** (Basic Books, 1993), and with Giulio Tononi, **A UNIVERSE OF CONSCIOUSNESS: HOW MATTER BECOMES IMAGINATION** (Adelman and Tononi, 2000) rejects the principle of most cognitive psychologists that the human brain can be compared to a computer or to a power plant of neurons. He claims it is more like an organic jungle of continuously changing groups and connections of neurons that are unique for every human being. They are only partly specified by genes. The needs every human being appears to have in their ongoing interaction with the environment cause a continuous selection of neurons in the Darwinian sense, changing the human brain ceaselessly. A process of trial and error produced by these needs shapes the brain. The workings of the human brain should not be separated into the functioning of hardware (brain) and software (mind), as most cognitive psychologists do. According to Edelman, the complete human brain/mind, but obviously not particular thoughts, can be explained by neurobiology" (Dijk, 2012).

Joseph LeDoux in **THE DEEP HISTORY OF OURSELVES: THE FOUR-BILLION-YEAR STORY OF HOW WE GOT CONSCIOUS BRAINS** adds, "The psychologist Richard Gregory argues that because neural processing compresses sense data so much, the brain has to reconstruct what is there using what Helmholtz called the 'likelihood principle'. That is, we use prior knowledge to unconsciously infer what is there. In recent years, this general idea has received renewed attention in the form of what has come to be known as the predictive coding hypothesis. The essence of the idea is simple – that top-down unconscious predictions based on retrieved knowledge, or memories (which are called 'priors' in this context), shape what we consciously see. ….. Andy Clark and Anil Seth, both enthusiasts of predictive coding, characterized conscious perception as 'controlled hallucination', and Chris Frith described it as a fantasy that coincides with reality. Lucia Melloni went further, writing, "The images that reach consciousness often bear little resemblance to reality". She quotes the Austrian scientist and philosopher, Heinz von Foerster, to support this point:" The world, as we perceive it, is our own invention." Seth nicely summarizes the predictive coding approach: "Our perceptual experience – whether of the world, of ourselves, or an artwork – depends on the active top-down interpretation of sensory input. Perception becomes a generative act, in which perceptual, cognitive, affective, and sociocultural expectations conspire to shape the brain's best guess of the causes of sensory signals" (LeDoux, 2019 pp. 290-292). "Perception and processing in computers or other media, in the other hand, can only start with some kind of derived intentionality. Computers are programmed by others and only reproduce or present programs. ….. The principle of computer processing is programmed instruction following algorithms, not neural selection as in mental processing. Computers and media are programmed for various purposes and environments. So to some extent they are context-free and abstract. They are intended (instructed by a command) and they follow a rational planning model of the human mind. In her book, **PLANS AND SITUATED ACTIONS: THE PROBLEM OF HUMAN-MACHINE COMMUNICATION**, Lucy Suchman (Suchman,1987) has severely criticized this model. In her empirical, anthropological study of the ways people use modern electronic equipment in everyday-life, Suchman came to the conclusion that people do not use this equipment according to a certain plan, the way developers of this equipment expect them to do. Planning models of human action and thinking do not match the reality of 'situated action', which Edelman claims is inspired by neural selection following needs. Large parts of these selections are unconscious, in this way raising doubts about the predominance of conscious will. Suchman feels plans are merely an anticipation and a reconstruction of action. They are a way of thinking, not a real-life representation of action. "Situated action is an emergent property of moment-by-moment interactions between actors and between actors and the environment of their actions. This interaction has four features that go substantially beyond the three levels of interactivity that computers and media have been capable of supporting so far (two-way communications, synchronicity and, to some extent, control from both sides" (Dijk, 2012).

In **A WORLD BEYOND PHYSICS: THE EMERGENCE & EVOLUTION OF LIFE** (Kauffman, 2019), Stuart A. Kauffman sums the economy to be a network of complements and substitutes that he calls the **ECONOMIC WEB**. Like the biosphere, **ECONOMIC WEB**'s evolution cannot substantially pre-tested, and is "context dependent". And creates its own growing "context" that subtends its "adjacent possible". The adjacent possible is what can arise next in this evolution. This evolution is sucked into the very adjacent possible opportunities it itself creates. And Ken Binmore adds: "Evolution is about the survival of the fittest. Entities that promote their fitness consistently will therefore survive at the expense of those that promote their fitness only intermittently. When biological evolution has had a sufficiently long time to operate, it is therefore, likely that each relevant locus on a chromosome will be occupied by the gene with maximal fitness. Since a gene is just a molecule, it can't choose to maximize its fitness, but evolution makes it seem as though it had. This is a valuable insight, because it allows biologists to use rationality considerations to predict the outcome of an evolutionary process, without needing to follow each complicated twist and turn that process might take. When appealing to rationality in such an evolutionary context, we say that we are seeking an explanation in terms of ultimate causes rather than proximate causes" (Princeton University Press, 2009). David Eagleman in **LIVEWIRED: THE INSIDE STORY OF THE EVER-CHANGING BRAIN** (Eagleman, 2020) adds: "Our genetics bring about a simple principle: don't build inflexible hardware; build a system that adapts to the world around it. Our DNA is not a fixed schematic for building an organism; rather, it sets up a dynamic system that continually rewrites its circuitry to reflect the world around it and to optimize its efficacy within it. ….. Neurons in the brain are locked in competition for survival. Just like neighboring nations, neurons stake out their territories and chronically defend them. They fight for territory and survival at every level of the system: each neuron and each connection between neurons fights for resources. As the border wars rage through the lifetime of a brain, maps are redrawn in such a way that experiences and goals of a person are always reflected in the brain's structure."[1]

Robert M. Sapolsky in **DETERMINED: A SCIENCE OF LIFE WITHOUT FREE WILL** adds, "Show me a neuron (or brain) whose generation of a behavior is independent of the sum of its biological past, and for the purposes of this book, you have demonstrated free will. The point of the first half of this book is to establish that this can't be shown" (Sapolsky, 2023).

The 80-year history of Information technology is an example. While the first industrial age emerged from a mastery of the masses and theories of Isaac Newton, the computer age sprang from a practical grasp of the particles and paradoxes of the quantum theory of Erwin Schroedinger, Werner Heisenberg, and Albert Einstein. As World War II drew to a close, the race to build the hydrogen bomb was accelerated by von Neumann's desire to build a computer, and push to build von Neumann's computer was accelerated by the race to build a hydrogen bomb. Computers were essential to the initiation of nuclear explosions, and to understanding what happens next. Numerical simulation of chain reactions within computers initiated a chain reaction among computers, with machines and codes proliferating as explosively as the phenomena they were designed to help us understand. This numerical simulation approximated the physical reality of a nuclear explosion closely enough to enable some of the first useful predictions of weapons effects. It is no coincidence that the most destructive and the most constructive of human inventions appeared at exactly the same time. Hopefully, the collective intelligence of computers could save us from the destructive powers of the weapons they had allowed us to invent.

"Godel set the stage for the digital revolution, not only by redefining the powers of formal systems – and lining things up for their physical embodiment by Alan Turing – but by steering von Neumann's interests from pure logic to applied. It was while attempting to extend Godel's results to a more general solution of Hilbert's **ENTSCHEIDUNGSPROBLEM** – the "decision problem" of whether provable statements can be distinguished from disprovable statements by strictly mechanical procedures in a finite amount of time – that Turing invented his **UNIVERSAL MACHINE**. All the powers – and limits to those powers – that Godel's theorem assigned to formal systems were captured by Turing's **UNIVERSAL MACHINE**, including von Neumann's version. Godel proved that within any formal system sufficiently powerful to include ordinary arithmetic, there will always be undecidable statements that cannot be proved true, yet cannot be proved false. Turing proved that within any formal (or mechanical) system, not only are there functions that can be given finite description yet cannot be computed by any finite machine in a finite amount of time, but there is no definite method to distinguish computable from non-computable functions in advance. …… Godel assigned all expressions within the language of the given formal system unique identity numbers – or numerical addresses – forcing them into correspondence with a number bureaucracy from which it was impossible to escape. The Godel numbering is based on an alphabet of primes, with an explicit coding mechanism governing translation between compound expressions and their Godel numbers – similar to but without the ambiguity that characterizes the translations from nucleotides to amino acids upon which protein synthesis is based. This representation of all possible concepts by numerical codes seemed to be a purely theoretical construct in 1931. …. What Godel and Turing proved is that formal systems will, sooner or later, produce meaningful statements whose truth can be proved only outside the system itself. ", explained George Dyson in **TURING'S CATHEDRAL: THE ORIGINS OF THE DIGITAL UNIVERSE** (Dyson 2012).

"Leo Szilard, John von Neumann, Eugene Wigner, Theodore von Karman and Edward Teller were five Hungarians whose migration to America in 1930s sparked the development of nuclear weapons, digital computers, and the intercontinental ballistic missile. Leo Szilard analyzed the thermodynamic consequences of minimal physical representation of what we now term one "bit" of information, but it would be another two decades until the current terminology took hold. Szilard's insights, along with those of communication theorists Harry Nyquist and Ralph Hartley, influenced John von Neumann and Nobert Wiener, anticipating Claude Shannon's formulation of information theory in 1948. … After helping to bring nuclear weapons into existence, Szilard campaigned against them for the rest of his life" (Dyson, 2020).

"The fundamental, indivisible unit of information is the bit. The fundamental indivisible unit of digital computation is the transformation of a bit between its two possible forms of existence as structure (memory)or as sequence (code). This is what a **TURING MACHINE** does when reading a mark (or the absence of a mark) on a square of tape, changing its state of mind accordingly, and making (or erasing) a mark somewhere else. To do this at electronic speed requires a binary element that can preserve a given state over time, until, in response to an electronic pulse or some other form of stimulus, it either changes or communicates that state. Most of the essential elements or "cells" in the machine are a binary or "on-off" nature" (Dyson, 2012).

"Mathematical and Numerical Integrator and Computer (**MANIAC**) became operational in 1951 by mingling of data with instructions and breaking the distinction between numbers that mean things and numbers that do things. Hydrogen bomb was a result. Until stored-program digital computers, numbers represented things. With coded instructions, termed "order codes", were given the power to do things – including, the power to invoke another instruction or make copies of themselves. …. Strings of bits gained the power of self-replication, just like strings of DNA. Thus began a chain reaction, with the order codes persisting largely unchanged, like the primordial alphabet of amino acids, over seventy years since they were released. …. The **MANIAC**'s descendants, replicated first in vacuum tubes, next in discrete semiconductors, and now in monolithic silicon, are characterized by word length, governing how much memory they can address, and clock speed, governing how many instructions they can execute in a given period of time. ….. The underlying "clock", however, are there not to measure time but to serve as a clock work escapement regulating an orderly sequence of events. In the digital universe, time as we know it does not exist. In the analog universe, time is a continuum. Any two moments, no matter how close, have other moments in between. In the digital universe, there is no continuum, only finite if unbounded series of discrete steps" (Dyson, 2020). In **THE IDEA OF THE BRAIN: THE PAST AND FUTURE OF NEUROSCIENCE**, Matthew Cobb reminds, "Von Neumann was ferociously brilliant man as well as playing a leading role in the Manhattan Project (he designed the implosion-based detonation device for the bomb that obliterated Nagasaki, and helped select the target) he also developed the basic elements of game theory, now used in economics and ecology, and, most importantly, he began planning for future development of computers. In June 1945 von Neumann wrote a proposal for a stored-program general purpose computer, which dealt with 'the structure of a very high speed automatic digital computing system, and in particular with its logical control'. ….. Despite being framed in the language of binary logic and in terms of electrical wiring and glowing valves, at the heart of von Neumann's conception of the structure and logical control of a computing system were McCulloch and Pitts's hypothetical nerve nets. …… The real novelty of McCulloch and Pitts's work was that it focused attention on processes rather than on anatomical regions. Explaining the brain now appeared to involve describing algorithms that could be embodied in networks of neurons, or in interactions between organs. The key issue was the relation between the component parts and the way that function emerged from organization. …… At this moment of its birth, von Neumann's computer was seen as a brain. The direction of the metaphor between machine and brain had switched. Before the metaphor settled into its current form – seeing the brain as a computer – there were a number of years in which studies of brains and computers interacted in the most dynamic fashion possible" (Cobb, 2020).

"At the very beginning of the computer age, scientists were struck by the parallels between these new machines and brains and were inspired to use them in different ways. Some ignored biology and focused simply on making computers as smart as possible, a field that became known as artificial intelligence (**Ai** – the term was coined by John McCarthy in 1956). But in terms of understanding how the brain works, the most fruitful approach came from those who did not attempt to create a super-intelligent machine, but instead tried to model the functions of the brain by exploring the rules governing the interconnections in the model - a neuronal algebra, if you like. An early attempt to simulate the nervous system came in 1956, when researchers at **IBM** tested Hebb's hypothesis about neuronal assemblies being a basic functional unit of the brain. They used **IBM**'s first commercial computer, the 701, a value-based machine composed of eleven large units that literally filled a room (only nineteen were sold). The team simulated a net of 512 neurons, although these components were not initially connected, they soon formed assemblies that spontaneously synchronized their activity in waves, just as Hebb suggested. Despite the limits of what was a very crude model, this suggested that some aspects of nervous system circuits simply emerge from very basic rules. One of the first people to use a computer model to shed light on how the brain might function was Oliver Selfridge, a mathematician who was one of Wiener's students and was close to Pitts, McCulloch and Lettvin. In 1958, Selfridge unveiled a hierarchical processing system called **PANDEMONIUM**, which had developed out of his work on machine-based pattern recognition. …… At the same time, another US scientist, Frank Rosenblatt, presented a slightly different model, the **PERCEPTRON**. This was also focused on pattern recognition, using the same idea of flexible hierarchical connections – an approach that became known as connectionism. Rosenblatt argued that a brain and a computer shared two functions – decision making and control – both of which were based on logical rules in both machine and brain. Brains, however, carry out two further, intertwined functions, interpretation and prediction of the environment. All these functions were modelled in the **PERCEPTRON** – 'the first machine which is capable of having an original idea', claimed Rosenblatt" (Cobb, 2020).

Modeled on mammalian brains, neural networks function at the system level, arraying transistors into networks of neurons inspired by the nodes of the human brain. The basic steps in seeking solutions are guess, measure the error, adjust the answer, feed it back in a recursive loop. Rosenblatt's view of multilayered recognizers prefigured machine learning. Learning is essentially the capacity to recognize patterns in data. The machine processes the pixels in tagged or identified images of your face hundreds or thousands of times. Then by comparative processes – in essence, superimposing images on top of each other and finding mathematical commonalities – it can flag new images of your face.

In a famous experiment, Ivan Pavlov showed that dogs can be taught to salivate at the tick of a metronome or the sound of a harmonium. This connection of cause to effect, known as associative or reinforced learning, is central to how most animals deal with the world. Since the early 1970s the dominant theory of what is going on has been that animals learn by trial and error. Associating a cue, a metronome, with a reward, food happens as follows. When a cue comes, the animal predicts when the reward will occur. Then, it waits to see what arrives. After that, it computes the difference between prediction and result – the error. Finally, it uses that error estimate to upgrade things to make better predictions in the future.

Belief in this approach was itself reinforced in the late 20th century by two things. One of these was the discovery that it is also good at solving engineering problems related to artificial intelligence, **Ai**. The other reinforcing observation was a paper published in 1997 that noted that fluctuations in levels in the brain of dopamine, a chemical which carries signals between some nerve cells was known to be associated with experience of reward, looked like prediction-error signals. Dopamine-generating cells are more active when the reward comes sooner than expected or is not expected at all, and are inhibited when the reward comes later or not at all – precisely what would happen if they were indeed such signal. The explanation looks forward, associating cause and effect. Huijeong Jeong and Vijay Namboodiri proposed a model of associative learning that suggests that the associative learning theorists have gotten things backwards. They propose the opposite. It associates effect with cause. They think that when an animal receives a reward or punishment, it looks back through it memory to work out what might have prompted this event. Dopamine's role in their model is to flag events meaningful enough to act as causes for possible future rewards or punishments. Associating effect with cause deals with two things that have bugged the old model. One is sensitivity to timescale. The other is computational tractability. The timescale problem is that cause and effect may be separated by milliseconds, like switching a light bulb and experiencing illumination, minutes, like having a drink and feeling tipsy, or even hours, like eating something bad and getting food poisoning. Looking backward, associating effect with cause, permits investigation of an arbitrary long list of possible causes. Associating cause with effect without always knowing in advance how far to look is much trickier. This leads to the second problem. Sensory experience is rich, and everything therein could potentially predict an outcome. Making predictions based on every single possible cue would be somewhere between difficult and impossible. It is far simpler, when a meaningful event happens, to look backwards through other potentially meaningful events for a cause. In practice, however, it is hard to distinguish experimentally between the two models. Jeong's and Namboodiri's laboratory experiments measured, in real time, the amount of dopamine being released by the nucleus accumbens, a region of the brain in which dopamine is implicated in learning and addiction. Their experiments verified associating effect with cause model. More experiments are needed to confirm, but the 180-degree turnabout in thinking will suggest that the way **Ai** works does not, as currently argued, have even a tenuous link with how brains operate. It might also suggest better ways of doing **Ai**.

"In 1969 the pioneer of artificial intelligence, Marvin Minsky with colleague Seymour Papert presented a mathematical analysis of the power of the **PERCEPTRON** which suggested that the approach was a dead end, both for **Ai** and understanding the brain – because of the way **PERCEPTRON**s were constructed, they could not internally represent the things they were learning. ……. Despite the failures of both **PANDEMONIUM** and the **PERCEPTRON** to produce insights that could be applied to biological pattern recognition systems, both these programs changed the way researchers thought about the brain – they showed that any effective description of perception in humans or machines, had to include a substantial element of plasticity. They were therefore utterly different from the old models that were based on mechanical or pressure metaphors. …… In the mid-1980s, neuroscientists and psychologists became very interested in new computational approaches that made it possible to overcome the limitations of **PANDEMONIUM** and the **PRECEPTRON**. This new method, called parallel distributed processing [**PDP**], was announced in a two-volume book that described innovative computer models of behavior and their potential psychological and neurobiological equivalents. …… The ability of **PDP** networks to perform tasks so effectively is largely based on the use of what is called back propagation (generally abbreviated to backprop), which involves information going both ways between layers in a form of feedback loop. This enables the program to refine its behaviour rapidly to a more accurate output" (Cobb, 2020).

2. Mıcrochips' Mutation to Personal Computers, to Internet, and to Big Data Monopolists

IBM made the first commercial machines, expecting to sell only a few. But the mainframe eventually sold widely, and the invention of the microchip paved the way for the personal computer.

Chip-making was an in-house affair for Americans at the onset of the industry until 1961 when **FAIRCHILD SEMICONDUCTOR** began assembling and testing products in Hong Kong mostly to arbitrage labor costs. "Fairchild was the first semiconductor firm to offshore assembly in Asia, but Texas Instruments, Motorola, and others quickly followed. Within a decade, almost all US chipmakers had foreign assembly facilities. Fairchild began looking beyond Hong Kong. The city's 25-cent hourly wages were only a tenth of American wages but were among the highest in Asia. In the mid-1960s, Taiwanese workers made 19 cents an hour, Malaysians 15 cents, Singaporeans 11 cents and South Koreans only a dime. Fairchild's next location was Singapore, a majority ethnic Chinese city-state whose leader Lee Kuan Yew, had 'pretty much outlawed' unions, as one Fairchild veteran remembered. ….. The semiconductor industry was globalizing decades before anyone had heard of the word, laying the grounds for Asia-centered supply chains we know today. Fairchild's managers had no game plan. They would have just as happily kept building factories in Maine or California had they cost the same. But Asia had millions of peasant farmers looking for factory jobs, keeping wages and guaranteeing they would stay low for some time. Foreign policy strategist in Washington saw ethnic Chinese workers in cities like Hong Kong, Singapore, and Penang as ripe for Mao Zedong's Communist subversion. Fairchild' managers saw them as capitalist dream. 'We had union problems in Silicon Valley. We never had any union problems in the Orient.' They noted." wrote Chris Miller in **CHIP WAR: THE FIGHT FOR THE WORLD'S MOST CRITICAL TECHNOLOGY** (Miller, 2022).

In 1987, when **FUJITSU** attempted to buy **FAIRCHILD SEMICONDUCTOR** President Reagan's secretary of commerce and secretary of defense objected to the deal on national security grounds, claiming the US military could not be dependent on foreign powers for crucial communications technology. In 1988, Congress passed the **EXON-FLORIO** amendment, which further empowered the president to block such mergers or acquisitions of domestic firms by foreign companies if they harm national security. Internationalization of the production processes has accelerated as microchips have become more complicated and more manufacturing processes have been outsourced to specialized firms

firms that emerged in Asia.

In 1971, **INTEL** developed a general-purpose chip, or microprocessor. A single device that could serve many functions paved the way for the construction of a mini-computer. At **XEROX PARC** in 1972, Butler Lampson built the **ALTO**, a machine which differs little in appearance from a modern desktop computer. Lampson's team added many of the features we take for granted today. While **XEROX** was perfecting the **ALTO**, personal computers were developed by hobbyists. The **ALTAIR** desktop, a self-assembly kit for $400 was first advertised in **POPULAR ELECTRONICS** magazine in 1974. Home computers used tape cassettes for storage and television sets as monitors. **AT&T** and **SONY** sold desktop machines. All these initiatives failed.

Dmitry Orlov reminds with his narration of the Schumpeterian history of computer technology in **THE FIVE STAGES OF COLLAPSE: SURVIVOR'S TOOLKIT,** "There was a time when computers were made by different manufacturers came with their own different and incompatible operating systems. The manufacturers liked this state of affairs, in spite of the fact that it greatly inconvenienced the users, because it created lock-in switching from one manufacturer's hardware to another's involved an expensive and time-consuming rewrite of their software. Then it just happened that two minds at Bell Labs dreamt up a very simple and primitive operating system called Unix (the name was initially a joke) that was written in a language they invented called "C" that ran on a lot of different computers – and it virally took over the world. Then Unix became a commercial product, instantly going from anarchical to hierarchical. But anarchy triumphed again when it was rewritten, through various efforts, in a way that pried it away from grubby corporate hands. Self-selected leaders played a big role in all this. Richard Stallman's GNU project (the acronym stand for "GNU is Not Unix") created GCC, a free "C" compiler, and rewrote a great many Unix utilities to be free as well. Linus Torvalds, a graduate student in Finland, didn't like the Microsoft Windows system that his university-provided PC was running (he thought it was crap) and so he wrote the Linux operating system, a Unix variant that initially ran on PCs but now runs inside a great many devices, from Android smart phones to WiFi hotspots and routers to the Google search engine to virtually all of the world's super computers. Eventually even Apple saw the light, and its OS X operating system is based on a Unix variant. Unix is now ubiquitous; the last non-Unix holdout is Microsoft, which is now clearly a dinosaur and sinking fast, while Linux-based Google and Unix based Apple are eating its lunch. It started out as a nerdy joke and then went viral and took over" (Orlov, 2013).

In 1981, **IBM** launched a personal computer, simultaneously abbreviated to **PC** and achieved world-wide acceptance. What many users thought the performance of the **PC** was not at par with the machines already in the market did not matter. More users begot more users. Network effect. **IBM** outsourced **PC**'s operating system to a small company, **MICROSOFT**. In the 1990s, **MICROSOFT** held a commanding position as the supplier of the world's most popular **PC** operating system, **MICROSOFT WINDOWS**. The operating system was a technical achievement protected by a web of intellectual property rights. Yet the real key to **MICROSOFT**'s security was not its technical complexity or intellectual property, but rather the thousands of applications written to operate with **WINDOWS**. Personal computer operating systems are platforms with strong cross-platform network effects. Computer users value the number and quality of applications that run on the operating system, and application developers value the number of operating system users. Motivating developers to write applications that would run on a new operating system is a barrier to entry that new operating system entrants must cross to become viable competitors.

IBM confronted the applications barrier after it spent more than $1billion to develop, test, and market a **PC** operating system to compete with **WINDOWS**. **IBM** created the first mass-market **PC**, but it did not have proprietary software or hardware that could enable the company to fully monetize its technologies. When **IBM** attempted to regain control with a new and more sophisticated operating system, **OS/2**, it was too late. **MICROSOFT**'s **MS-DOS** powering **WINDOWS 3.1** was everywhere. **IBM** ultimately abandoned **OS/2**, not because it was technologically inferior to **WINDOWS**, but because it failed to attract a sufficient number of applications to make computer users switch from **WINDOWS**. Despite **MICROSOFT**'s success in suppressing challengers in 1995, **MICROSOFT** was behind the curve on a new technology, the internet. Internet users were connecting to the **WORLD WIDE WEB** with a new program, the **NETSCAPE NAVIGATOR** browser. **MICROSOFT**'s leadership was concerned that the browser was a Trojan horse that would break the applications barrier to entry by creating an alternative platform for software development.

NAVIGATOR is a type of software called middleware, which occupies a space between the operating system and applications. Like operating systems, middleware facilitates application software development by exposing application programming interfaces (**API**s), which are routines that perform certain widely used functions. Unlike operating systems, the **NETSCAPE API**s were not specific to a particular operating system. **NETSCAPE** employed a new programming language, **JAVA**, which allows applications to run on different operating systems. **MICROSOFT**'s leadership understood that middleware such as **NETSCAPE**, which promoted the use of the platform-independent **JAVA** programming language, could level the PC market and fracture the **WINDOWS** monopoly. Nearly every purchaser of an **IBM**-compatible **PC** wanted the computer to be equipped with the **WINDOWS** operating system. By bundling **INTERNET EXPLORER**, (**IE**), with the operating system consumers didn't pay extra for the **MICROSOFT** browser, but if they wanted **NAVIGATOR** as an add-on, they would have to pay an additional $49 or so. **MICROSOFT**'s efforts to suppress **NETSCAPE**, along with improvements to **IE**, allowed the company to increase its **IBM**-compatible **PC** browser share from about 5% in 1995 to more than 50% by 1998. The DOJ and the European Commission sued **MICROSOFT** in 1998 for monopolizing the markets for **PC** operating systems and browsers in violation of the Sherman Act. The final judgements ordered **MICROSOFT** to offer potential rivals licenses at reasonable and nondiscriminatory terms to supply information to improve interoperability between third party products and **MICROSOFT** products. The browser tying investigation was settled after **MICROSOFT** agreed to pay fines and include a start-up display that allowed users to install different browsers products and choose a default browser. That obligation expired at the end of 2014, and aptly so because **IE**'s share of browser usage was half that of the **GOOGLE CHROME** browser by that date.

The US and Europe are an ocean apart regarding obligations of dominant firms to assist their rivals. US law is arguably too accommodating to conduct by dominant firms that excludes rivals, while European antitrust law fails to identify the conditions under which an obligation to assist rivals is procompetitive. Nonetheless, even if failure to support interoperability is not an antitrust violation, a requirement to support interoperability is a valid remedy for anticompetitive conduct. The purpose of a remedy is to restore competition and deter future anticompetitive conduct. The Final Judgement that solved **US v. MICROSOFT** did not accommodate the plaintiffs' initial request to cleave **MICROSOFT** into separate operating system and application companies. Some believe that the divestiture would have created incentives for the independent applications company to port applications to competing operating systems and for the operating system company to facilitate competition in applications and middleware. As an integrated supplier of operating systems, application software, and middleware, **MICROSOFT** has an incentive to exclude or disadvantage rival products. The divestiture would have eliminated or significantly reduced the incentive for **MICROSOFT** to preference its own applications and middleware.

The computer industry evolved in ways that the DOJ and plaintiff states did not envisage in their complaint. Cloud computing has transformed the industry by providing a remote server-based platform for applications that is agnostic to client's desktop operating system. Cloud computing has achieved some of the objectives of the **MICROSOFT** antitrust litigation by moving applications off the desktop. But cloud computing has not commoditized the operating system, and it owes its success more to industrywide internet protocols than to adoption of a common **JAVA** technology. The prohibitions on restrictive agreements in the Final Judgement likely facilitated competition for internet browsers, **GOOGLE CHROME** is the most popular internet browser by a large margin and delivers some of the promise of **US v. MICROSOFT** by enabling web-centric applications, many of which are powered by servers that run on **UNIX** and **LINUX** operating systems.

Dominant firms are often able to identify nascent competitive threats in these industries and eliminate them before they mature into significant competitors. The Arrow replacement effect teaches that an incumbent firm's profits deter investment in a new product that would replace the firm's existing profits. Weak antitrust enforcement is at least as likely to increase an incumbent's profits from its existing products as it is to increase profits from new products. Therefore, it is likely that the next effect of weaker antitrust enforcement would be to increase the Arrow replacement effect and deter innovation by an established firm. Firms that are new to an industry have stronger innovation incentives than established firms if they can obtain comparable benefits from successful inventions. New entrants do not have profits that are at risk from innovation. They do not suffer from the Arrow replacement effect.

Kenneth Arrow and Joseph Schumpeter are known for their theories associated with competition and innovation. Neither Arrow's nor Schumpeter's describe innovation incentives that apply more generally to dynamic markets. Innovation is quintessentially a dynamic process. Furthermore, it is typically cumulative, with discoveries providing a knowledge base that enables future discoveries. Yet most theories, including the Arrow replacement effect, assume that innovation is a single discrete event with only limited consequences for the future evolution of industry technology and market structure. But industrial structure shapes the incentives for firms to invest in R&D and is shaped by innovations that result from those investments. Industrial structures in which firms compete to improve technologies in discrete steps show that modest increases in competition can increase the probability of innovation, but intense competition can make innovation less likely.

Joseph Schumpeter's name has become shorthand for the proposition that scale and market power enable a more stable and productive platform for R&D. Schumpeter did not speak directly to the effects of market structure on the ability to appropriate the value of innovations. He was more concerned with the failings of models of perfect competition to account for innovation and entrepreneurship and emphasized the power of "creative destruction" to invigorate economic progress, which can come from any source. Schumpeter provided no formal economic model to describe his vision of monopoly power and innovation incentives, and his emphasis on the ability of large firms to attract capital is outdated, given developments in the availability of venture capital. Nonetheless, his criticism of perfect competition as the ideal engine of innovation is valid. Perfect competition is not viable in industries such as semiconductor fabrication, for which new facilities incur multibillion-dollar sunk costs, or industries such as computer software or genomics, for which the marginal cost of technology licensing and distribution is only a small fraction of the R&D costs required to create the licensed products. Pricing these products at or close to their marginal production costs would not generate sufficient profits to justify the R&D expenses that brought them to market. According to this Schumpeterian perspective, a reduction in rivalry can enhance appropriation in several ways. A reduction in rivalry can allow an innovator to profit from a higher profit-maximizing price for the innovation. In that case, antitrust enforcers would have to weigh the adverse effects on prices from a reduction in rivalry against possible benefits for innovation.

Meanwhile, Steve Jobs and Steve Wozniak began assembling **APPLE** machines in 1976 in Job's garage. Although **MICROSOFT** understood that ease of use was important for commercial success. It was Jobs who extended this vision further and conceived a computer that you could use without understanding anything about computers. Jobs drew on another invention from **XEROX PARC**- the graphical interface. **APPLE** integrated software and hardware. **APPLE**'s determination to maintain its proprietary system failed in the face of widespread adoption of more open standard of the **IBM**'s **PC**, **WINDOWS**, a combination of **APPLE**'s graphical user interface with **MICROSOFT**'s ubiquitous **MS-DOS**, won the world. By mid 1990s, **APPLE** was at the edge of bankruptcy. The result was a multi-national complex constellation of thousands of companies that The **ECONOMIST**[1] roughly lumped into three categories. Designing [**AMD, INTEL, BROADCOM, NVIDIA, QUALCOMM, XILINX, ARM, SYNOPSYS, ZUKEN**]; Manufacturing [**INTEL, SAMSUNG, MICRON**, **TSMC**] Packaging/Assembly [**AMCOR**, **JCET**, **ASE**, **KING YUAN**]. Manufacturing, and Packaging/Assembly is supplied by **AIR LIQUIDE**, **APPLIED MATERIALS**, **ASML**, **KMG CHEMICALS**, **LAM REASERCH**, **NAURA**, **SUMCO**, **TOKYO ELECTRON**, **HITACHI HIGH-TECNOLOGIES**.

A typical itinerary of raw silicon to completed microchip is a fair illustration of the elaborate supply chains that emerged. Microchip's initial travel may start in the Appalachian Mountains in north America, where deposits of silicon dioxide are of the highest quality. The sand may arrive in Japan to be turned into pure ingots of silicon. The ingots of silicon are then sliced into standardized wafers, 300mm across, and sent to a “fab”, a chip factory, in Taiwan or South Korea for high-tech and to China for low-tech. It is in this stage that the slices will be imprinted with a particular pattern using photolithography equipment made in Holland by **ASML**. A single company, **TAIWAN SEMICONDUCTOR MANUFACTURING,** dominates the physical production of chips globally. While many US companies develop software and designs for chips, They operate with a fabless business model, meaning they contract out the chips’ production. Indeed 80% of production of the final product takes place in Asia, only 12% in the United States, and the rest in Europe. According to **BOSTON CUNSULTING GROUP**, about 75% of semiconductor manufacturing capacity, as well as many suppliers of key materials – such as silicon wafers, photoresist, and other specialty chemicals – are concentrated in China an and East Asia, a region significantly exposed to high seismic activity and geopolitical tensions. Furthermore, all of the world’s most advanced semiconductor manufacturing capacity is currently located in South Korea, 8%, and Taiwan, 92%. The vast majority of advanced chips are produced in **TSMC** produces the chips crucial to the production of nearly every electronic device**.** A single company in a single tiny country in one of the most geopolitically contested parts of the world has become the choke point for the global digital economy. The United States largely gave up on chip production over the last few decades as part of the neoliberal global outsourcing model in which the companies off-loaded factory production which is expensive and lower margin and kept the high-value knowledge work at home. The only leading pure-play silicon chip foundry in the United States, the **GLOBAL FOUNDRIES** in Malta, New York, is owned by the Emirate of Abu Dhabi, via a sovereign wealth fund. The cost of a state-of-the-art chip-fabrication operation is around $12billion. The ultraviolet lithography tool necessary for making top-line chips can cost $150 million.

“By the 2000s, it was common to split the semiconductor industry into three categories. ‘Logic’ refers to the processors that run smartphones, computers, and servers. ‘Memory’ refers to DRAM, which provides the short-term memory computers need to operate, and flash, also called NAND, which remembers data over time. The third category of chips is more diffuse, including analog chips like sensors that convert visual or audio signals into data, radio frequency chips that communicate with cell networks, and semiconductors that manage how devices use electricity. The third category has not been primarily dependent on Moore’s Law to drive performance improvements. Clever design matters more than shrinking transistors. Today around three-quarters of this category of chips are produced on processors at or larger than 180 nanometers, a manufacturing technology that was pioneered in the late 1990s. As a result, the economics of this segment are different from logic and memory chips that must relentlessly shrink transistors to remain on the cutting edge. Fabs for these types of chips generally don’t need to race toward the smallest transistors every couple of years, so they’re substantially cheaper, on average requiring a quarter the capital investment of an advanced fab for logic or memory chips. Today, the biggest analog chipmakers are American, European, or Japanese. Most of their production occurs in these regions, too, with only a sliver offshored to Taiwan and South Korea. The largest analog chipmaker today is Texas Instruments, which failed to establish an Intel-style monopoly in the PC, data center, or smartphone ecosystems but remains a medium-sized, highly profitable chipmaker with a vast catalog of analog chips and sensors. There are many other U.S.-based analog chipmakers now, like Onsemi, Skyworks, and Analog Devices, alongside comparable companies in Europe and Japan. The memory market, by contrast, has been dominated by a relentless push toward offshoring production to a handful of facilities, mostly in East Asia. Rather than a diffuse set of suppliers centered in advanced economies, the two main types of memory chip – DRAM and NAND – are produced by only a couple of firms. For DRAM memory chips, like the type of semiconductor that defined Silicon Valley’s clash with Japan in the 1980s, an advanced fab can cost $20billion. There used to be dozens of DRAM producers, but today there are only three major producers. In the late 1990s, several of Japan’s struggling DRAM producers were consolidated into a single company, called Elpida, which sought to compete with Idaho’s Micron and with Korea’s Samsung and SK Hynix. By the end of the 2000s, those four companies controlled around 85 percent of the market. Yet Elpida struggled to survive and in 2013 was bought by Micron. Unlike Samsung and Hynix, which produce most of their DRAM in South Korea, Micron’s long string of acquisitions left it with DRAM fabs in Japan, Taiwan, and Singapore as well as in the United States. Government subsidies in countries like Singapore encouraged Micron to maintain and expand fab capacity there. So even though an American company is one of the world’s three biggest DRAM producers, most DRAM manufacturing is in East Asia. The market for NAND, the other main type of memory chip, is also Asia-centric. Samsung, the biggest player, supplies 35 percent of the market, with the rest produced by Korea’s Hynix, Japan’s Kioxia, and two American firms – Micron and Western Digital. The Korean firms produce chips almost exclusively in Korea or China, but only a portion of Micron and Western Digital’s NAND production is in the U.S., with other production in Singapore and Japan. As with DRAM, while U.S. firms play a major role in NAND production, the share of U.S. – based fabrication is substantially lower.” informs Chris Miller in **CHIP WAR: THE FIGHT FOR THE WORLD’S MOST CRITICAL TECHNOLOGY** (Miller, 2022) and adds: “Yet demand for chips was ‘exploding’. China’s leaders realized, driven by ‘cloud computing, the Internet of Things, and big data’. These trends were dangerous: chips were becoming even more important, yet the design and production of the most advanced chips was monopolized by a handful of companies, all located outside of China. China’s problem isn’t only in chip fabrication. In nearly every step of the process of producing semiconductors, China is staggeringly dependent on foreign technology all of which is controlled by China’s geopolitical rivals – Taiwan, Japan, South Korea, or the United States. The software tools used to design chips are dominated by U.S. firms, while China has less than 1 percent of the global software tool market, according to data aggregated by scholars at Georgetown University’s Center for Security and Emerging Technology. When it comes to core intellectual property, the building blocks of transistor patterns from which many chips are designed, China’s market share is 2 percent; most of the rest is American or British. China supplies 4 percent of the world’s silicon wafers and other chip making materials; 1 percent of the tools used to fabricate chips; 5 percent of the market for chip design. It has only a 7 percent market share in the business of fabricating chips. None of this fabrication capacity involves high-value, leading-edge technology. Across the entire semiconductor supply chain, aggregating the impact of chip design, intellectual property, tools, fabrication, and other steps, Chinese firms have a 6 percent market share, compared to America’s 39 percent, South Korea’s 16 percent, or Taiwan’s 12 percent, according to the Georgetown researchers. Almost every chip produced in China can be fabricated elsewhere.”

"The microprocessor industry is an excellent candidate to explore the effects of competition and antitrust policy on innovation for durable goods." writes Richard J. Gilbert in **INNOVATION MATTERS: COMPETITION POLICY FOR HIGH-TECHNOLOGY ECONOMY**, and adds: "Microprocessors are durable goods; they can function without depreciation for many years. A consumer's incentive to replace a microprocessor is often the desire to upgrade to a more powerful processor. The industry has a duopoly for decades, with **INTEL** and **ADVANCED MICRO DEVICES** (**AMD**) accounting for about 95 percent of desktop PC microprocessor sales. Innovation can be measured by the clock speed of the microprocessor. Both **INTEL** and **AMD** have invested heavily in microprocessor R&D. Clock speeds for the newest microprocessors roughly doubled every seven quarters over the twelve-year period examined by Goettler and Gordon (1993-2004). **INTE**L has been the target of several antitrust actions related to conduct allegedly excluded **AMD** from microprocessor sales. In 2009, **INTEL** paid **AMD** $1.25billion to settle charges that **INTEL** violated antitrust laws offering rebates to Japanese **PC** manufacturers who agreed to eliminate or limit purchases of rival microprocessors. In the same year, the European Commission (**EC**) fined **INTEL** 1.06billion euros and ordered the company to end its rebate program. In 2010, the US Federal Trade Commission (**FTC**) and **INTEL** settled charges that **INTEL** unlawfully maintained a monopoly in microprocessors and attempted to acquire a second monopoly in graphics processors using a variety of unfair methods of competition. ……. Concerns about the effects of rising market concentration in the US economy on innovation are not limited to the effects of concentration on the level of R&D investment. An additional concern is that large firms in concentrated industries have a bias toward incremental improvements in existing products and technologies rather than transformative innovations" (Massachusetts Institute of Technology, 2020).

The **INTERUNIVERSITY MICROELECTRONICS CENTRE** [**IMEC**] in Leuven, Belgium does not design chips, manufacture them or make any of the complicated gear to manufacture them. Instead, it creates knowledge used by everyone in the $550billion chip business. Given chips' centrality to modern economy and increasingly to post-President Trump geopolitics make it one of the most essential industrial research and development [**R&D**] centers on the planet.

IMEC was founded in 1984 by a group of electronics engineers from the **CATHOLIC UNIVERSITY OF LEUVEN** who wanted to focus on microprocessor research. In the early days it was bankrolled by local Flemish government. Today **IMEC** maintains its neutrality to a financial model in which no single firm or state controls a big share of the budget. The largest share comes from the Belgian government, 16%. The top corporate contributors provide no more than 4% each. Keeping revenue sources diverse and finite gives **IMEC** the incentive to focus on ideas that help advance chip-making as a whole rather than any fir in particular.

A case in point is the development of extreme ultraviolet lithography [**EVU**]. **EVU** is a delicate process involving high-powered lasers, molten tin and ultra-smooth mirrors. The bus-sized machines that generate **EVU** are made by **ASML** and used by **TSMC** and **SAMSUNG**. It took 20 years of **R&D** to turn the idea into manufacturing reality. **IMEC** acted as a conduit in the process. That is because **EUV** must work seamlessly with kit made by other firms. Advanced toolmakers want a way to circulate their intellectual property [**IP**] without the big companies gaining sway over it. The large companies, meanwhile, do not want to place all their bets on any one experimental idea that is expensive and could become obsolete soon.

IMEC's neutrality allows both sides to get around this problem. It collects all the necessary gear in one place, allowing producers to develop their technology in tandem with others. And everyone gets rights to the IP the institute generates. Progress in the chip industry has been driven by the free exchange of knowledge, with **IMEC** acting as a 'funnel' for ideas from all over the world. This model has lured ever more contributors. Several hundred are active at **IMEC** according to the institute. They range from startups to global firms.

The deepening rift between the United States, home to some of the industry's biggest firms, and China which imported $378billion worth of chips in 2020, threatens **IMEC**'s spirit of global comity. American and European export controls limit the extent to which **IMEC** can work with Chinese semiconductor companies. Chinese make up 3.5% of people working at **IMEC**, the 5th largest group and ahead of Americans at 1.5%. There is little that **IMEC** can do about the growing distance between the American and Chinese techno-spheres.

ASML is not the only maker of photolithographic machines, which use light to etch integrated circuits into silicon wafers. It competes with **CANON** and **NIKON** of Japan. By 2019, the Dutch firm's market share has nearly doubled, to 62%, since 2006. **ASML** has harnessed "**EXTREME ULTRA-VIOLET**" [**EUV**] light with wavelengths of just 13.5 nanometers. Shorter wavelengths allow the etching of smaller components, vital for chip makers striving to keep pace with **MOORE'S LAW**, which posits that the number of components that can be squeezed into a given area of silicon doubles roughly every two years. The world's three leading chipmakers, **INTEL**, **SAMSUNG**, and **TAIWAN SEMICONDUCTOR MANUFACTURING COMPANY** [**TSMC**] have become as reliant on **ASML** as the rest of the technology industry is on theirs. **ASML**'s revenues reflect this. $13.2billion in 2019 that grew by 8%, with neither **CANNON** nor **NIKON** pursuing **EUV** technology. **ASML**'s market cap grew tenfold since 2010, at $130billion, it is worth more than **SIEMENS** or **VOLKSWAGEN**. The firm started as a joint venture with **PHILIPS** and **ASM INTERNATIONAL**. In 1995, it listed its shares in New York and Amsterdam and shortly afterwards, the firm bet that **EUV** lithography would be the future of chip-making. Big chipmakers planned to use **ASML**'s machines by around 2007.

ASML has around 5000 suppliers. **ASML** is so vital to **INTEL**, **SAMSUNG** and **TSMC** have stakes in the firm. **EUV** lithography is on the **WASSENAAR LIST** of "dual use" technologies that have military as well as civilian applications. China is keen to foster advanced chip-making firms of its own, an ambition that President Trump tried to thwart. In 2018, **ASML** received an order for an **EUV** machine from a Chinese customer widely thought to be the **SEMICONDUCTOR MANUFACTURING INTERNATIONAL CORPORATION**, a Chinese big chip-maker. Under American pressure, the Dutch government has yet to grant **ASML** an export license. **ASML** announced its compliance with US Commerce Department's decision that blacklisted **HUAWEI** and its 70 affiliates in 2019, and notified **HUAWEI** of its decision. The particular pattern will be determined by the overall design of the chip. This design might come from **ARM**, a British company acquired by **NVIDIA** in 2020 from **SOFTBANK**, a Japanese asset manager. The design can be tweaked for specific applications by one of the company's many licensees.

In its next phase, it must be assembled into a package, in which the etched silicon is placed inside the ceramic or plastic containers that are dotted across any circuit board. Then testing follows. Packaging might take place in China, Vietnam or the Philippines. The integration into a circuit board could happen somewhere else again. The final result will be one of the many components that arrive at factories from Mexico to Germany to China, for assembly into a final product: an industrial robot, a smart vacuum cleaner or a tablet. China's domestic microchip industry started at the lower-value end of this process, **SEMICONDUCTOR MANUFACTURING INTERNATIONAL CORP**, China's largest maker of semiconductors. Fueled by a fast growing domestic market, China established **NATIONAL INTEGRATED CIRCUIT INDUSTRY INVESTMENT FUND** help to turn promote design and higher-value manufacturing.

The 2011 earthquake and tsunami in Japan besides revealing how globally integrated the manufacturing had become, starkly revealed that Japanese firms have been producing the bulk of chemicals and other materials to make microchips. Japanese firms had substantial control over copper foils for printed circuit boards, silicon wafers to make chips, and resin to package them. For many components Japan was the home of biggest, sometimes the only, supplier.

Microprocessors are chips that do most of the grunt work in computers. They are built around Instruction-Set Architectures, [**ISAS**], owned either by **INTEL** or **ARM**. **INTEL**'s **ISAS** power desktop computers, servers and laptops. **ARM**'s power phones, watches and other mobile devices. Though there are others, together **ARM** and **INTEL** dominate the market. An Instruction-Set Architectures [**ISAS**] is a standardized description of how a chip works at the most basic level, and instructions for writing software to run on it. Computer scientists at the University of California, Berkeley, wrote **RISC-V** for use for publishable research because commercial producers of **ISAS** were reluctant to make theirs available. The **ISAS** are proprietary, **RISC-V** is available to anyone, anywhere, and is free. **RISC-V** was introduced in 2014 at the **HOT CHIPS MICROPROCESSOR CONFERENCE** in California. It is now governed by a non-profit foundation. It recently moved to Switzerland out of American jurisdiction. The reason for shifting to **RISC-V** is the nature of open-source itself. Since the instruction set is already published online, American export controls do not apply to it. This has made it particularly popular with Chinese IT firms. **ALIBABA** announced its first **RISC-V** chip in July, 2019. **HUAMI** is mass producing smart watches containing processors based on **RISC-V**. Led by **HUAWEI**, many are moving toward the **RISC-V** architecture with its open source code free to all to use.

The most famous "open" governance system is **LINUX**, an operating system created and maintained through cooperative efforts to which all are, in principle, free to contribute and from which all are welcome to benefit. Others are "closed", as is the convention among many corporate-software makers, such as **ORACLE**. Some are run like absolute monarchies, such as **APPLE** under Steve Jobs, who was the final arbiter over the smallest details in his tech empire. America is a platform like **MICROSOFT**'s **WINDOWS** and **ANDROID**, **GOOGLE**'s mobile operating system. These mix aspects of open and closed systems, allowing others to develop applications for their platforms, but also closely control it. America combines monopolies and a state with competition. China is more like **APPLE** and **ORACLE**, which combine being closed with internal competition. The European Union is best compared to an open-source project like **LINUX**, which needs complex rules to work. India, Japan, Britain, Taiwan, and South Korea all run differently and have technology bases to match.

To advocates, open, public block-chains provide a second chance at building a digital economy. The fact that the application built on top of such block-chains all work with each other, and that the information they store is visible to all, harks back the idealism of the internet's early architects, before most users embraced the walled gardens offered by the tech giants. The idea that a new kind of "decentralized" digital economy might be possible has been bolstered over recently as numerous applications are built on top of various block-chains. Perhaps, the most significant part of that economy has been decentralized- finance [**DeFi**] applications, which enable users to trade assets, get loans, and store deposits. **ETHEREUM**, the leading **DeFi** platform with its near-monopoly, is being challenged by the new startups. The idea behind **DeFi** is that block-chains – databases distributed over many computers and kept secure by cryptography – can help replace centralized intermediaries like banks and tech platforms. Until recently the **ETHEREUM** block-chain was the undisputed host of all this activity. It was created in 2015 as a more general-purpose version of **BITCOIN**. **BITCOIN**'s database stores information about transactions in the associated cryptocurrency, providing proof of who owns what at any time. **ETHEREUM** stores more information, such as lines of computer code. An application that can be programed in code can be guaranteed to operate as written, thereby removing the need for an intermediary.

Current block-chain technology is clunky. Both **BITCOIN** and **ETHEREUM** use a mechanism called proof of work, where computers race to solve mathematical problems to verify transactions, in return for a reward. This slows the networks down and limits its capacity. **BITCOIN** can process only seven transactions per second. **ETHEREUM** can handle only 15. At busy times transactions are either very slow or very costly and at times both. A growing number of networks, such as **AVALANCHE** and **SOLANA**, process thousands of transactions a second. Because of the nature of open, public block-chains, anyone can access the data they produce and view their operating code, making it possible to build bridges or applications that work across many block-chains, or which aggregate information from different block-chains. Some applications, like **1inch**, already scan exchanges on several block-chains in order to find the best execution price for various crypto transactions. Multi-chain block-chains, like **POLKADOT** and **COSMOS**, act like bridges between different networks, making it possible to work across them.

In **COINTELEGRAPH**, "**AVALANCHE** is a high performance, ecofriendly block-chain that scales hard math and science, rather than expensive, energy-intensive hardware. At its core, the innovation of the **AVALANCHE** consensus reduces the amount of communication required between validating nodes, which also decreases the hardware power required to secure the many billions of dollars in value on the network. Taken a step further, **AVALANCHE** is a quiescent protocol, meaning that if network activity slows, nodes will not perpetually expand energy as we see on almost every other platform. Nodes will simply wait until they hear another transaction to broadcast and move swiftly toward the next decision. Sustainability is critical to the block-chain industry's ability to overtake traditional infrastructures, as well as core ethic of this entire ecosystem of using innovation to better the lives of people. Much of the inertia that climate change activists have faced is from incumbents who wield far too much power. Decentralizing their power and putting more economic control in the hands of individuals, rather than institutions, is an incredible step forward. Momentum toward mass adoption of decentralized services continues to accelerate and users are also witnessing that high performance and eco-friendliness of a block-chain are not enemies. In fact, they are necessary champions to achieve mass adoption doing right for both people and the planet." reports Selva Ozelli.[1]

The 21st century **INTERNET** would evolve to be a **SPLINTERNET** was, perhaps, inevitable. It is not just that nations act in their own interest; they also have different preferences and values, for instance regarding privacy. High digital borders behind which data get stuck, however, are not in the best interests of most countries – though they may be in the interest of some governments. Russia wants to create a "sovereign internet" that can be cut from the rest of the online world at the flip of a switch while retaining the capability to participate around in more open systems. Economies interested in using flows of data to improve their citizens' lot, though, will see few advantages. In a **SPTINTERNET** world choices will be limited, costs higher and innovation slower. And all the while China, with the biggest silo and thus greatest access to data, loses least.

President Trump's **WEAPONIZATION OF INTERDEPENDENCE**, his threats to cut off foreign financial institutions from **SWIFT** banking network and the dollar clearing system for doing business with countries or entities he does not like highlighted China's vulnerabilities. One of the gravest is China's dominant role in electronics assembly. China is home to half of the world's capacity. In May 2019 Commerce Department blacklisted **HUAWEI** and its 70 affiliates, barring American firms from selling certain technologies without government approval to them. On May 15, 2020 Trump administration expended its restrictions from chips to the tools used to make them. Most of them come from **APPLIED MATERIALS**, based in California builds kit used to etch patterns into silicon that has 90% of its assets in US, **LAM RESEARCH**, a maker of equipment used by **TSMC** and others to process silicon wafers has 88% of its assets in US, **TERADYNE** has 69% in US. **ASML** has almost all of its assets in Netherlands, and **TOKYO ELECTRON** and **HITACHI HIGH-TECHNOLOGIES** in Japan.

This shed light on another global network: microchip industry. The industry's geographic scope had already become broader, and less American over time. A crude yardstick for this is to track where the firms' assets are geographically located. Only 20% of the plants of top dozen global semiconductor firms are in America. When Asian firms located their factories at home, American firms have diversified geographically. **INTEL**, for example, in 2019 had 35% of its physical assets, a rough proxy for manufacturing capacity, abroad. Some $8billion was in Israel, $4billion in Ireland, and $5billion in China, its biggest market. $20billion of **INTEL**'s $72billion revenues in 2019 was from China. Another example is **ANALOG DEVICES**, an American firm which makes radio-frequency chips for **HUAWEI** for the assembly of telecoms base stations. Half of **ANALOG DEVICES**'s assets are in the Philippines, Ireland, Singapore and Malaysia.

Around half of the modem chips to manage wireless connections of the world's baseband processors are made by **QUALCOMM**. Virtually all "server-class" chips used in world's data centers are made by **INTEL**. Chips based on designs licensed from **ARM** are ubiquitous in almost every advanced smart-phone. In September 2020, **NVIDIA**, a designer of chips for gaming and **Ai** agreed to buy **ARM** from **SOFTBANK** for $40billion and in October 2020, **ADVANCED MICRO DEVICES** [**AMD**], **NVIDIA**'s main rival in the gaming market and **INTEL**'s **GPUS** which makes blueprints for graphics and general purpose chips agreed to buy **XILINX,** the maker of an accelerator chip called **FIELD PROGRAMMABLE GATE ARRAYS** [**FPGAS**] that **MICROSOFT**'s **AZURE** opted for $35billion. As for the **ARM** acquisition by **NVIDIA**, it became an aborted deal. **SOFT-BANK** paid $32billion for **ARM** in 2016 and as of June 2022 planned to refloat its shares by March 2023 with a secondary listing in London alongside the primary in New York. **ARM**'s customers include all the world's chipmakers as well as **AWS** and **APPLE**, which uses **ARM** chips in **iPhones**. **NVIDIA**'s objective is to use **ARM**'s design process to engineer central processing units [**CPUS**] for data centers and **Ai** users that would complement **NVIDIA**'s existing strength in specialized chips known as graphics-processing units [**GPUS**]. Some have complained that **NVIDIA** could restrict access to the chip designer's blueprints. The **Gravitona**, **AWS**'s tailor-made server chip, is based on an **ARM** design. **NVIDIA** said it had no plans to change **ARM**'s business model. Western regulators had to decide whether to approve the deal. UK's competition authority, which had until July 30th, 2021 to scrutinize it was the first one to issue a ruling. China was unlikely to welcome an American takeover of an important supplier to its tech firms from **SOFTBANK**.

A big reason why **ARM**'s technology triumphed over rival chip architectures was low prices. Unlike firms such as **INTEL**, which sells chips that it both designs and manufactures, **ARM** trades only in intellectual property [**IP**]. For a fee, anyone can license one of its off-the-shelf designs, tweak it if necessary, and sell the resulting chip. Besides licensing revenue, **ARM** takes a small royalty from every sale of a chip built with its technology. In 2021 licensing revenues accounted for a bit over $1billion, while royalties brought in $1.5billion. Removing the need to design a chip – complicated, highly specialized job – has made **ARM**'s off-the-shelf designs popular especially as chips have become more and more complicated. **ARM** is the dominant designer of the smartphone chips. In 2020 **APPLE**, which has long used **ARM** chips in **iPhones**, began replacing **INTEL** silicon in its laptops and desktops with **ARM**-based designs. **ARM** has also increasingly been competing in the high-margin business of servers, the high-spec machines found in data centers. That market has for decades been dominated by **INTEL**, but in recent years **ARM** has scored notable victories. **AMAZON WEB SERVICES** [**AWS**] uses **ARM**-derived **GRAVITON** chips. The emergence of **RISC-V** a novel chip architecture that lacks royalties and license fees is the new challenger in the industry.

For its first 20 years or so **NVIDIA** made **GPUS** that helped video games look lifelike. In the past decade, though, it turned out that **GPUS** also excel in another area of computing. They dramatically speed up how fast machine-learning algorithms can be trained to perform tasks by feeding them oodles of data. Owning **ARM** would give **NVIDIA** the **CPU** chops to complement those in **GPUS**, as well as its new abilities in network-interface cards needed in server farms. For their part, **QUALCOMM**, **ARM** and other chip designers depend on foundries to turn silicon into microprocessors. **INTEL**, **SAMSUNG**, and **TSMC**, in turn, rely on a bevy of specialized equipment suppliers to equip their factories. The emerged technically interdependent complexity of chip-making is multinational as its financial structure. Furthermore, **WEB** giants like **AMAZON** and

GOOGLE are developing their own designs. They are joined on demand for hardware tuned for the needs of **Ai** and networking. The ballooning costs of keeping up with advancing technology mean that the explosion of chip designs is being funneled through a shrinking number of companies capable of actually manufacturing them. Only three firms in the world are able to make advanced processors: **INTEL**, **TSMC** and **SAMSUNG**. **INTEL** announced that it has decided to outsource some of its own production to **TSMC**. Before Trump's declaration of technology cold war, globally, the industry looked poised to polarize further into every greater effervescence in design and ever more concentration in production.

"Perhaps no company represents the quandaries of the post-neoliberal political economy better than, Qualcomm, the U.S. multinational that designs the wireless chips that are the smartest thing in your cellphone." wrote Rana Foroohar in **HOMECOING: THE PATH TO PROSPERITY IN A POST-GLOBAL WORLD**. "It has for decades been one of the most important American firms pushing the development of the internet communications network that is set to culminate in the 5G network that will connect the much-heralded internet of things by which electronic devices, from dishwashers to basketball shoes, will be able to record and transmit valuable user data. ….. But Qualcomm's hands have been tied in recent years by two entities that represent the pinnacle of both private and public sector power: Apple and China. For the last four years, Apple battled Qualcomm on three continents in an effort to reduce the licensing fees it charges for the designs that power the chips Apple needs for all its iPhones. Qualcomm has depended on that income, which amounts to fully half of its global profits, to support its research to win the global 5G competition. Meanwhile, it has in recent years gotten roughly half its revenue from China. But thanks to the tech and trade war between the United States and China, it's become harder to grow there. Indeed, the future of any U.S. tech company doing business in China is precarious, as economic decoupling between the two countries play out. …… 5G is being heralded as a fourth industrial revolution that could boost U.S. GDP by a half trillion a year, just to start, with returns only to boom from there. …… It is not an exaggeration to say that none of this would have happened without Qualcomm, which, over the last several decades, has been spectacularly innovative company, the Bell Labs of the current generation of tech firms. …… CODE DIVISION MULTIPLTE ACCESS [CDMA], a patented coding system (developed by Qualcomm) emerged as one winner of the holly wars to make its way into millions of cellphones in the United States (and around the world for that matter), it was deemed by the U.S. Patent Office an "essential" technology. This was a high honor, but also a tremendous burden. For it meant that Qualcomm was obliged to provide CDMA chips to any U.S. communications company that asked for it. But that very obligation to sell capped the price: set it too high, and the cell manufacturer would complain to the Patent Office that Qualcomm was denying it essential component. In effect, Qualcomm was being penalized for its core product's indispensability. This became glaringly true in 2017, when Qualcomm's legal troubles began. For years leading up to the litigation, Apple had a deal with Qualcomm to sell its iPhones using only Qualcomm chip designs. In addition to paying for the chips, Apple had to pay a licensing fee for the intellectual property that enabled the phones to connect to the internet through the core processor. Qualcomm gave Apple some special discounts in exchange for exclusivity, but it made quite a lot of money from patent licensing – too much, according to Apple, although not enough according to Qualcomm. The cost (to the consumer) of an iPhone XS in 2020 was $999. Apple paid $7.50 per device to Qualcomm, but wanted to pay $1.50. For years, the tech giant didn't have the muscle to wage a legal war with Qualcomm and risk losing access to the technology that allowed its phones any value at all. But as it got bigger and bigger, Apple decided to start working with another chipmaker, Intel (which in the beginning of 2022 announced its first new manufacturing site in forty years, in Ohio, to produce its own chips, in a move away from the fabless model, back toward more vertical integration within the chip sector). Apple also started to cooperate with regulators all over the world to push back on Qualcomm's royalty policies. First, Qualcomm was hit with a Federal Trade Commission suit charging anticompetitive tactics in its supply and licensing terms. Three days later, it was hit again when Apple sued for a billion dollars, claiming unpaid licensing rebates and exclusive fees. Almost immediately, both Apple and Qualcomm began suing each other for billions of dollars on three different continents, over royalty rates and access to crucial technology. …… Once Apple pressed its suit, it simply stopped paying Qualcomm any licensing fees at all, even as it continued to install Qualcomm chips in its iPhones, slashing Qualcomm's worldwide profits nearly in half. Stymied by Apple, Qualcomm relied more and more on its profits in China. But because the Defense Department had deemed China the chief strategic adversary of the United States, this posed new security concerns, particularly as the Trump trade war heated up. …… This left American companies doing business in China in a terrible bind. They were under pressure from U.S. shareholders over quarterly losses, while facing down a one-party state that, playing the long game, thought in terms of decades, if not centuries. Locked into a legal battle with Apple, Qualcomm was suddenly subjected to new restrictions on its operations in China. Its two profit centers were getting walled off by government edicts on both sides. Desperate to find a new revenue stream in China, Qualcomm moved to acquire a Chinese semiconductor firm, NXP. But this required Chinese approval. Now, as the Chinese considered Qualcomm's bid for NXP, they decided the offer price was insufficient, although it was well above market rate. Qualcomm duly raised it. No again. Submitted again. No again. Repeat. The U.S. government, cognizant of importance of Qualcomm, pushed to get the deal through by removing some of its own tech export bans, including one on U.S. tech companies selling components to ZTE, a big Chinese telecom firm. Still no dice. …… Meanwhile, Qualcomm found itself caught not only between Apple and China, but between Trump and Xi. Its share price weakened from years of battling Big Tech and Beijing, Broadcom, a massive Singaporean-owned player in the chip space, saw its chance to acquire the company on the cheap. Broadcom had an unsavory reputation for acting like a private equity firm during its acquisitions, picking targets clean for their IP and leaving them to die. First, it swooped in to make an unsolicited bid to acquire Qualcomm for $103billion, before turning to a hostile takeover for $121billion. But the president decided it was too great a security risk to let Qualcomm fall to another company if it could result in the former's essential technology reaching Chinese hands. Trump vetoed the Broadcom acquisition. At this, coincidentally or not, China rejected Qualcomm's twenty-ninth and, as it proved, final bid for NXP. …….. Government officials fretted that Broadcom, which lined up $106billion in debt financing from private equity groups Silver Lake, KKR, and CVC for the deal, would indeed take a short-term-profit approach and cut Qualcomm's R&D budget. If Qualcomm were to be starved of investment, the United States would lose a "national champion" in the technology race against China. But their arguments failed to take into account the looming elephant in the room: the neoliberal model of trade itself and how it is fundamentally at odds with the new realities of state capitalism" (Foroohar, 2022).

"Nearly every chip in the world uses software from at least one of the three U.S.-based companies, Cadence, Synopsys, and Mentor (the latter of which is owned by Germany's Siemens but based in Oregon). Excluding the chips Intel builds in-house, all the most advanced logic chips are fabricated by just two companies, Samsung and TSMC, both located in countries that rely on the U.S. military for their security. Moreover, making advanced processors require EUV lithography machines produced by just one company, the Netherland's ASML, which in turn relies on its San Diego subsidiary Cymer (which it purchased in 2013), to supply irreplaceable light sources in its EUV lithography tools. It is far easier to control choke points in the chip-making process when so many essential steps require tools, materials, or software produced by just a handful of firms. Many of these choke points remained in American hands. Those that didn't were mostly controlled by close U.S. allies" (Miller, 2022). Another example of the neoliberal trade model's promises' stark contrast to the emerged realities of the global economy.

In 2020, **APPLE** announced that it would replace **INTEL**'s products with tailor-made ones. In 2018, **AWS** began replacing some **INTEL** chips in its data centers with its own **GRAVITON** designs, claiming that its chips are 40% more cost-efficient than **INTEL**'s. Around the same time **GOOGLE** began offering its custom **TENSOR PROCESSING UNIT** chip to boost **Ai** calculations to its cloud clients. **BAIDU** claims that its **KUNLUN** outpace offerings from **NVIDIA**.

Taiwan had no comparative advantage in semiconductor manufacturing in the 1980s. Yet the Taiwanese government made a political decision to create state-sponsored **TAIWAN SEMICONDUCTOR MANUFACTURING COMPANY**. The Taiwanese government nurtured **TSMC** with tariffs and subsidies in its early days when it was most vulnerable to foreign competition. **TSMC**, now, is a publicly traded company, a status the company could not have achieved without Taiwanese government's help. Those who shamelessly teach Ricardo's comparative advantage as science in their international economics classes should note that the Taiwanese created their comparative advantage, as **SAMSUNG** did in South Korea.

The mainframe did not cause the invention of the personal computer, but the wide market the mainframe created enabled the rather easy penetration of the personal computer into an expanding market. In addition, the spreadsheet is often described in histories of technologies as the killer app that caused an explosion of the personal computer market. The spreadsheet is the complement of the personal computer. Each helped the other gain market share. The personal computer did not cause but enabled the invention of word processing, and software companies like **MICROSOFT** emerged, which was originally founded to make the operating system for **IBM** personal computers.

The invention of word processing and abundant files invited the possibility of file sharing, and the modem was invented. The existence of file sharing did not cause, but invited, the invention of the **WORLD WIDE WEB**. The existence of the **WEB** did not cause, but enabled, selling on the **WEB**, and **eBay** and **AMAZON** emerged. And **eBay** and **AMAZON** put content on the **WEB** as did myriad other users, enabling the invention of **WEB** browsers; and also companies like **GOOGLE** emerged. Thence has followed social media and **FACEBOOK**.

When Tim Berners-Lee released his first **WORLD WIDE WEB** browser in March 1991, it was not at all obvious that a near-monopoly in searching would arise. **MOSAIC**, the first popular **INTERNET** browser became available in 1993 and during the next five years, before **GOOGLE**'s launch, there was a mini-universe of search engines, from **ALTA VISTA** and **ASK JEEVES** to **WEBCRAWLER** and **YAHOO SEARCH**. But then **GOOGLE** either eliminated the competition or relegated other options to marginal shares, and now anybody with a computer or a mobile phone is able to access most of the reproduced, copied, or encoded historical, technical, medical, and scientific information – as well as to download any recipe, famous painting, photograph, how-to advice, or out-of-copyright text.

Almost all of these successive innovations are the complements of the preceding ones. The existing goods and services at each state are the context in which the next good and/or service emerges. Word processing is a complement of the personal computer, the modem a complement of word processing, the **WEB** is a vast interconnected modem and is a complement and much more to file file-sharing. The opportunity to share files invited the invention of the modem. Accordingly, Schumpeter's depiction of capitalism's cycles of creation and destruction need to be modified to reflect goods and services as contexts that do not cause, but enable, the invention and introduction of the next good or service. Enablement is neither a Schumpeterian nor a neoclassical equilibrium theory concept.

The industrial revolution was the greatest transformation in economic history. For centuries scholars have sought to understand why this process occurred in Britain around 18750. But without the ability to run counter-factual experiments, it is hard to prove any single explanation. Researchers have and are testing theories why similar parts of Britain industrialized at different rates. So far, they have provided evidence for a few key factors: slave-owners' capital; entrepreneurs who stood to benefit from investing; and shortages of lower-skilled workers. Industrialization requires investment, which requires capital. The riches Britons extracted from slaves in America flowed mainly to a few cities, such as Liverpool. By the 1930s these regions had large numbers of cotton mills and shares of workers employed in manufacturing. In 1536-1540, Henry VIII dissolved the monasteries and sold their land. The buyers could farm or rent it on market terms. Researchers' evidence shows that areas once held by monasteries were at the vanguard of industrialization. By 1830s these areas had unusually large numbers of workers in trades and crafts, agricultural-machine patents, textile mills and grain separators. Researches claim that market-based firms, common on ex-monastic land, created an entrepreneurial class and incentives for technological advances. Low-skilled labor shortages were largely caused by Britain's wars with France during 1793-1815 when conscription shrank the workforce abruptly. Researchers found that adoption of devices replacing manual labor was greatest in areas that provided the most servicemen, so long as those regions also had mechanics. The effect was weaker without such skilled workers, and on non-labor saving machines. The strength of evidence for each of these causes implies that industrialization probably required a complex mix of conditions. Many important variables are hard to test statistically. But measuring even a few is promising advance.

"The Industrial Revolution started in eighteenth-century Britain, where most of the population had little political or social power. Predictably, the direction of progress and productivity growth in such a two-tiered society initially worsened the living conditions of millions. This began changing only when the distribution of social power shifted, altering technology's course so that it raised the marginal productivity of workers. Also critical were institutions and norms for robust rent sharing in workplaces, ensuring that higher productivity translated into wage growth. This struggle over technology and worker power started to transform the highly hierarchical nature of British society in the second half of the nineteenth century. ….. Twentieth-century US technology moved even more decisively in the direction of raising worker marginal productivity. In this way it laid the foundations of shared prosperity, not just domestically but also in much of the world, as American techniques and innovations spread globally and enabled mass production and rise of a middle class in scores of countries. …. The United States has remained at the forefront of technology over the last fifty years, and its production methods and practices, especially its digital innovations, are still spreading throughout the world, but now with very different consequences. The US model of shared prosperity broke down as power became concentrated in the hands of big corporations, the institutions and norms of rent sharing unwound, and technology went in a predominantly automating direction starting around 1980. … All of this was underway, and the vision that animates the use of technology for automating work, monitoring, and squeezing out workers was firmly in place, before the latest wave of Ai. We were already on our way back to a two-tiered society long before the 2010s. With a heightened Ai illusion, we are seeing this process accelerate. Modern Ai amplifies the tools in the hands of tech elites, enabling them to create more ways of automating work, sidelining humans, and supposedly doing all sorts of good deeds such as increasing productivity and solving major problems facing humanity (they claim). Empowered by Ai, these leaders fell even less need to consult the rest of the population. In fact, many of them think that most humans are not wise and may not even understand what is good for them" (Acemoglu and Johnson, 2023) wrote Daron Acemoglu and Simon Johnson in **POWER AND PROGRESS: OUR 1000-YEAR STRUGGLE OVER TECHNOLOGY & PROSPERITY** and offer a thousand years of history and contemporary evidence in organizing new ways of production and communication to either serve narrow interests of an elite or become the foundation for widespread prosperity depending on the collective choices made in implementing technological improvements. "In the 1960s, only about 6 percent of American men between the ages of 25 and 54 were out of labor market, meaning they were long-term unemployed or not seeking a job. Today that number is around 12 percent, primarily because men without a college degree are finding it increasingly difficult to get a well-paid jobs. …… New digital technologies are everywhere and have made vast fortunes for entrepreneurs, executives, and some investors, yet real wages for most workers have scarcely increased" (Acemoglu and Johnson, 2023).

Three business models embraced by firms born after the dot.com crash and subsequently by investors were: the movers which shuttle people or things around urban centers; the streamers which offer music and TV on line; and the creepers which make money by watching their users and selling well-targeted advertisements. Since 2021, the firms that epitomize these business models: **UBER** and **DoorDash**; **NETFLIX** and **Spotify**; **Snap** and **META** have shed two-thirds of their market capitalization on average by the third quarter of 2022. **UBER** in its 13-year life has burned $25billion, equivalent to roughly half its current market value. **DoorDash**, the leader in food delivery, remained a loss maker in 2022. So did **Spotify** despite rising revenue and **Snap** on top of sharply slowing sales in 2022. **META**'s revenues shrunk in two consecutive quarters the same year, but was profitable. **NETFLIX** that has been a streamer since 2007 was profitable in 2022, but with only 6% growth on year on year revenue in the third quarter of 2022 compared to a historical average of more than 20%. On the surface, the movers, streamers and creepers and their problems look distinct. On closer look, however, their business all turn out to face the same main weaknesses: misplaced faith in network effects; low barriers to entry; and a dependence on someone else's platform.

Network effects, called "flywheels" in Silicon Valley, is the idea that a product's value to a user rises with the number of users. Once the user base passes a certain threshold, the argument goes, the flywheel powers a self-perpetuating cycle of growth. This explains why so many startups seek growth at all cost, spending millions acquiring ever more customers to get the flywheel spinning. Though network effects are real, they also have their limits. **UBER** believed that its head-start in ride-hailing gave it a ticket to riches, as more riders and drivers would mean less idle time for both, drawing ever more users into an unstoppable vortex. Instead, it encountered high unit costs and diminishing returns to scale: reducing average wait times from two minutes to one would require as many drivers, even though most riders would barely notice the difference. **DoorDash**'s customers likewise only require so many alternative Italian restaurants to choose from, and what network effects the movers enjoy are local. **Spotify** and **NETFLIX** also try to capitalize on network effects, as data on the listening and viewing habits of similar users promised to deliver an unbeatable product. Belief that **NETFLIX**'s user data would give it a winning edge in creating content has been shattered by a series of flops. For the creepers, whose social networks are a network-effects business par excellence, the risk is what happens if the flywheels start spinning in reverse. **META** had a warning shot in the 4th quarter of 2021, when it lost one million users. It has added users since. The second problem, low barriers to entry, is another boon turned bane. Advances in technology, from smart phones to cloud computing, allowed all manner of startups, including movers, streamers and creepers, to build consumer software cheaply and quickly. But it also enabled copycats to emerge, Fed's gift of cheap and easy credit allowed the copycats to offer generous discounts to quickly build the minimum necessary scale. Although in the United States **UBER** faces only one rival, **LYFT**, its global expansion soon was met by local competitors as **DIDI** in China, or **GRAB** and **GOJEK** in South-East Asia. The barriers to entry for the streamers are higher. **NETFLIX** and **Spotify** spend a lot of money making or licensing content, but they are not insurmountable for cash rich rivals like **DISNEY**.

The third problem common to the three business models is their reliance on distribution platforms that are not their own. **UBER** and **DoorDash** pay substantially to advertise on **APPLE**'s iPhone and **ALPHABET**'s Android app stores. **Spotify** pays over 15% commission on subscriptions purchased on iPhones. **NETFLIX** avoids the commission by forcing users to subscribe through their web browser, possibly missing out on some subscriptions. Worst affected by the lack of their own platforms are the creepers. Their dependence on the iPhone-Android duopoly is an existential threat. **APPLE**'s requirement that users give iPhone apps permission to track their activity across other apps and websites, a move replicated by **ALPHABET** can cost **META** substantial foregone revenue.

Seventeen years after the launch of the iPhone, most people understand the bargain with smartphones. You get navigation anywhere in the world, the web and email on the go and as much music as you can stream, but first you must sacrifice some privacy. Your location, preferences and habits will be transmitted to some corporation to be parsed for insights and sold on to advertisers keen to sell what they want to sell. Some companies profit from tools that allow people to be snooped on without their consent. **NSO Group**, an Israeli firm, is probably the best known. It sells **Pegasus**, a piece of spyware that allows the program's operators, typically spies and secret police, to see everything a mobile phone's owner does. By reading messages directly off the phone's screen, it can bypass the encryption built into apps such as **WhatsApp** or **Signal**. **Pegasus** can even surreptitiously activate a phone's camera and microphone, uploading whatever it hears or sees to its controllers.

As the 21st century developments in digital technologies enabled firms to generate and amass data, data have become increasingly central to firms to recast their relations with their employees, their customers, and competitors. A new business model has emerged, the platform, capable of extracting and controlling unimagined amounts of data, and with this development, there emerged gigantic monopolistic data owning centers. Primarily, platforms are digital infrastructures that enable two or more groups to interact. Instead of having to build a marketplace from the ground up, a platform provides the basic infrastructure to mediate between different groups. This is platforms' key advantage over traditional business models when it comes to data. A platform positions itself between users, as the medium upon which their activities take place, hence giving the platform the privileged access to record the users' activities and store and own them.

Moreover, digital platforms produce and depend on 'network effects', more users begetting more users which develop their innate inertia to monopolize. The ability to rapidly scale many platform businesses by relying on pre-existing infrastructure and low marginal costs with few limits to growth further enables monopolization. Platform owners set the rules of service and development, as they set marketplace interactions. In their intermediary positions, platforms gain not only access to more data but also control and governance over the rules of the game. Far from simply being the owners of data, these data giants are emerging to become the owners of the emerging infrastructures of societies in the future.

The monopolistic **DNA** of these platforms must be taken into account in any analysis of their effect on the broader economy. "Capitalism without competition is not capitalism." warn Jonathan Tepper with Denise Hearn (Tepper and Hearn, 2019). But not according to vocal defender of the monopoly form, Peter Thiel, a Silicon Valley entrepreneur and the author of **ZERO TO ONE: NOTES ON STARTUPS, OR HOW TO BUILD THE FUTURE** (Theil, 2014). Peter Theil's view is that commercial success is built in 4 strategies: building a proprietary technology; exploiting network effects; benefiting from economies of scale; and branding. The management literature calls these "strategic resources", and says they have three characteristics. They are valuable; rare; and hard to imitate. But, one strategy of successful business that Theil seems to omit is building a good organization. Labelling the competitive-economy a "relic of history" and a "trap", as robber barons did at the turn of 20th century, he proclaims that "only one thing can allow a business to transcend that daily brute struggle for survival: monopoly profits." **FACEBOOK** to "bringing the world together" requires a global monopoly. Meanwhile, **GOOGLE** wants to organize the world's information and **AMAZON** wants nothing more than all the information to serve the world's consumers. Neoclassicals' economic model to explain and predict the platform world in the making is not helpful, but actually distorting. Since platforms are grounded on the extraction of data and generation of network effects, the following broad strategies seem to have emerged from the competitive dynamics of these large platforms. Expansion of **DATA EXTRACTION STRATEGIES** by driving cross-subsidization of services to draw users into their network. **GATEKEEPER STRATEGIES** by positioning as a gatekeeper to occupy key positions within the ecosystem around a core business neither by horizontal nor vertical nor conglomerate mergers. They are more like rhizoidal connections driven by permanent effort to place themselves in key platform positions. **CONVERGENCE OF MARKETS STRATEGIES**. The convergence thesis is the tendency for different platform companies to become increasingly similar as they encroach upon the same market and data areas. **SILOED PLATFORM STRATEGIES** by enclosing ecosystems and funneling of data extraction into siloed platforms. Their strategic choices are being installed in the 21st century ecosystems.

Ariel Ezrachi and Maurice E. Stucke in **VIRTUAL COMPETITION: THE PROMISE AND PERILS OF THE ALGORITHM-DRIVEN ECONOMY** (The President and the Fellows of Harvard College, 2016) warns: "Competition as we know it - the invisible hand that distributes the necessities of life - is being displaced in many industries with a digitalized hand. The latter, rather than being a natural force, is man-made, and as such is subject to manipulation. The digitalized hand gives rise to newly possible anticompetitive behaviors, for which the competition authorities are ill-equipped." (Ezrachi and Stucke, 2016) "The upsurge of algorithms, **BIG DATA** and super-platforms will hasten the end of competition as we know it - a decline of the market system to which we have become accustomed. …. The innovations from machine learning and **BIG DATA** can be transformative …….. lowering entry barriers, creating new channels for expansion and entry, and ultimately stimulating competition …….if companies' incentives are aligned with consumers' interests, and on their actions' collective impact on markets." (Ezrachi and Stucke, 2016) But, data-driven online markets do not have the built-in incentives to correct the market realities that emerged as declining upward mobility, diminishing rates of small-company creation, increasing market concentration and power, and widening wealth inequality. According to Ezrachi and Stuckle big companies use three main strategies supported by software technology. The first is collusion. While traditional illegal agreements for competitors to fix prices were made in back rooms, today computer algorithms fix prices automatically. Prices of airfares vary at different times before departure. Flight carriers and reservation platforms use algorithms that compare consumer demand for their own supply and the supply of their competitors. The second strategy is price discrimination, which is also made by algorithms processing large amounts of personal and user data to give different prices to their best or not so best customers. Lastly, the platforms simultaneously compete in their own market. The markets of platforms partly overlap and are partly different. In equal or overlapping markets, competition is alive.**APPLE** and **MICROSOFT** compete in software and hardware, **ALIBABA** and **AMAZON** in retail, **FACEBOOK** and **GOOGLE** in targeted personal advertisements. However, in their primary markets - **GOOGLE i**n searching for information and **FACEBOOK** in social networking – the oligarchies are close to becoming a monopoly. "Despite having one of the older antitrust laws, the United States is no longer viewed as the intellectual leader of antitrust." (Ezrachi and Stucke, 2016) The US antitrust laws barely work on the dynamic market of platform and data companies acting in networks where all actors are linked, moving and merging all of the time, and where actors work with data continually recorded, coped, exchanged, sold or given away for free. Continually they extract, capture and exchange personal data.

Continuous production may still be going strong, in fact stronger than ever thanks to industrial robots, but it has lost its excitement of the early and middle twentieth century particularly in the United States, with the emergence of **ASSET MANAGER CAPITALISM**. The platform company, which uses software to bring together buyers and sellers of goods and services, represents a new kind of efficiency, based less on the organization of machines and human labor than on gathering, analysis, and exchange of data. This is disruptive business process innovation. It reduces transaction costs by matching buyers and sellers with automated software.

The platform era that began in the late 1990s with **AMAZON.com** entered a new phase in the 21st century with the rise of search engines, smartphones, social media, networked web-based software, and a revival of artificial intelligence. In the 1990s Greenspan's monetary policies fueled Wall Street's romance with platform-based efficiency and diverted capital and talent from riskier but ultimately more broadly beneficial market creating innovation to dot.com IPOs. The dramatic run-up in dot.com stocks transferred trillions of dollars from those that bought to those that sold dot.com stocks. Retirement funds of the rich countries that fell under Greenspan's spell were major buyers, therefore major losers. The money managers of the retirement funds, however, kept their bonuses. Rasputin would have envied.

The continuous process innovations did not just reduce friction. In eliminating some jobs, they created many others, often more skilled and higher paid. Some believe that this phase of technology was a one-time event that will not be repeated by 21st century platform companies. Such a view is not tweeted by President Trump who has promised to bring the off-shored jobs back to his nostalgic supporters. Now, we are in the midst of the third saltation that McAfee and Brynjolfsson call it the second machine age in **THE SECOND MACHINE AGE: WORK, PROGRESS, AND PROSPERITY IN A TIME OF BRILLIANT TECHNOLOGIES** (Brynjolfsson and McAfee, 2014), and in **MACHINE, PLATFORM, CROWD: HARNESSING OUR DIGITAL FUTURE** (McAfee and Brynjolfsson, 2017), they offer explanations of these technologies, and argue that exponential progress in computing is on the verge of delivering explosive advances in machine capabilities that has marked the start of another fierce debate between optimists and pessimists about technological change.

Erik Brynjolfsson and Andrew McAfee in **THE SECOND MACHINE AGE** offer a bleak view of the impact of digitalization on the future of employment in the United States. Digitization, they suspect, will make workers with ordinary skills increasingly redundant. As tasks from car painting to spreadsheet manipulation are done by computers or robots, highly educated workers who are adaptable and can program and install the robots will become more and more valuable, but other workers who can be replaced will find themselves without jobs unless they accept extremely low salaries. Accordingly, artificial intelligence will be the final nail in the coffin of these ordinary workers.

Survey of recent American business cycles offers yet another perspective. Recent American recoveries have tended to be 'jobless', meaning that labor markets have taken far longer to regain lost ground than has overall production. During the seven recessions from 1948 to 1980, it took an average of about five quarters for GDP to surpass its previous peak. Employment took only a little longer to recover: six quarters on average. From the 1980s onwards, however, the recovery in employment began to lag behind that in in output. Across the four downturns preceding COVID-19 crisis, GDP regained its peak in just six quarters, on average. But employment did not pass its previous high for full fifteen quarters. America was producing more output than it managed before the recessions with fewer workers. Jobs-rich recoveries were productivity-poor ones, and visa versa.

Nick Bostrom calls the third saltation superintelligence in **SUPERINTELLIGENCE: PATHS, DANGERS, STRATEGIES** (Bostrom 2014), Max Tegmark's moniker is life:3.0 in **LIFE 3.0: BEING HUMAN IN THE AGE OF ARTIFICIAL INTELLIGENCE** (Tegmark, 2017). **GOOGLE**'s in house technology guru Ray Kurzweil declares **THE SINGULARITY IS NEAR: WHEN HUMANS TRANSCEND BIOLOGY** (Kurzweil, 2005), and also in **HOW TO CREATE A MIND: THE SECRETS OF HUMAN THOUGHT REVEALED** (Kurzweil, 2013). Ray Kurzweil's notion of singularity, i.e. to the mathematical meaning of the term as a point in time at which a function assumes an infinite value. Kurzweil predicts that, come 2045, machine intelligence will have surpassed human intelligence, what he calls biological and non-biological intelligence will merge, and machine intelligence will fill the universe at infinite speed. Kurzweil explains the many layered process: A hierarchical machine learner will recognize letters at one level, words at another, phrases at another, and on up the scale paragraphs and deeper meanings. **GOOGLE** calls its Go-mastering machine learning division **DEEP LEARNING**. These writings either imply or explicitly posit the arrival of singularity when the contributions of artificial superintelligence will rise to such a level that they will be transformed into an unprecedented runaway process. This implies not only artificial intelligence surpassing any human capabilities imaginable but also coming ever closer to an instantaneous rate of physical change. Kurzweil predicted that as computer power and artificial intelligence expands to the point that it has the capacity to improve itself, computers effectively designing and creating more computers that is, the nature of humanity will irrevocably transcend our biological limitations. Kurzweil's prediction for artificial intelligence taking over is for 2045. In **THE DEEP LEARNING REVOLUTION** (Sejnowski, 2018), Terrence J. Sejnowski gives us a concise history of learning algorithms that extract information from raw data; how information can be used to create knowledge; how knowledge underlies understanding; and how understanding leads to wisdom.

In 1999, Ray Kurzweil launched a hedge fund based on complex mathematical strategies called **FatKat**, short for **FINANCIAL ACCELERATING TRANSACTIONS** from Kurzweil's **ADAPTIVE TECHNOLOGIES**. **FatKat** deployed algorithms to ceaselessly comb through the market for new opportunities. The algorithms competed against one another in a Darwinian death match. The algorithms that made money survived. The weak died off. Many financial operations mandate making choices based on pre-defined rules. In performing these predefined rules as fast as possible machines were deployed. This is where the bulk of automation has taken place so far, transforming financial markets into ultra-fast hyper-connected networks for exchanging information. High-frequency trading is a prime example. Algorithms developed to model fluctuations in financial markets gained control of those markets, leaving human traders behind.

"The essential tool of econometrics is multivariate linear regression, an 18^{th} century technology that was already mastered by Gauss before 1794. Standard econometric models do not learn. It is hard to believe that something as complex as 21^{st} century finance could be grasped by something as simple as inverting a covariance matrix. …. If the statistical toolbox used to model these observations is linear regression, the researcher will fail to recognize the complexity of the data, and the theories will be awfully simplistic, useless. I have no doubt in my mind, econometrics is a primary reason economics and finance have not experienced meaningful progress over the past decades." writes Marcos Lopez De Prado in **ADVANCES IN FINANCIAL MACHINE LEARNING** (Wiley, 2018). Discretionary portfolio managers, [**PM**s], make investment decisions by consuming raw news and analyses, but mostly rely on their judgement or intuition rationalizing their decisions by some story. There is some story for every decision. Discretionary **PM**s are at a disadvantage when betting against a machine learning, [**ML**], algorithm, but better results are possible by combining **PM**s with **ML**s in "quantamental" way.

"What the Americans termed "artificial intelligence" the British termed "mechanical intelligence", a designation that Alan Turing considered more precise. We began by observing intelligent behavior (such as language, vision, goal seeking, and pattern-recognition) in organisms, and struggled to reproduce this behavior by encoding it into logically deterministic machines. We knew from the beginning that this logical, intelligent behavior evident in organisms was the result of fundamentally statistical, probabilistic processes, but we ignored that (or left the details to the biologists), while building "models" of intelligence – with mixed success. Through large-scale, probabilistic information processing, real progress has been made on some of the problems, such as speech recognition, language translation, protein folding, and stock market prediction – even if for the next millisecond, now enough time to complete a trade. …. The behavior of a search engine, when not actively conducting a search, resembles the activity of a dreaming brain. Associations made while "awake" are retracted and reinforced, while memories gathered while "awake" are replicated and moved around William C. Dement, who helped make the original discovery of what became known as **REM** (rapid eye movement) sleep, did so while investigating newborn infants, who spend much of their time in dreaming sleep. Dement hypothesized that dreaming was an essential step in the initialization of the brain. Eventually, if all goes well, awareness of reality evolves from the internal dream – a state we periodically return to during sleep. "The prime role of 'dreaming sleep' in early life may be in the development of the central nervous system", Dement announced in **SCIENCE** in 1996" (Dyson, 2012).

"Only one-third of a search engine is devoted to fulfilling search requests. The other two-thirds are divided between crawling (sending a host of single-minded digital organisms out to gather information) and indexing (building data structures from the results). The load shifts freely between the archipelagoes of server farms. Twenty-four hours a day, 365 days a year, algorithms with names such as **BigTable**, **MapReduce**, and **Percolator** are systemically converting the numerical address matrix into a content-addressable memory, effecting a transformation that constitutes the largest computation ever undertaken on planet Earth. We see only the surface of a search engine – by entering a search-string and retrieving a list of addresses, with contents, that contain a match. The aggregate of all our random searches for meaningful strings of bits is a continuously upgraded mapping content, meaning, and address space: a Monte Carlo process for indexing the matrix that underlies the World Wide Web. …. The Monte Carlo method was invoked as a means of using statistical probabilistic tools to identify approximate solution to physical problems resistant to analytical approach. Since the underlying physical phenomena actually are probabilistic and statistical, the Monte Carlo approximation is often closer to reality than the analytical solutions that Monte Carlo was originally called upon to approximate" (Dyson, 2012).

The information theory of Kurt Godel, John Von Neumann, Alan Turing, and Claude Shannon tells us that human creations and communications are transmissions across a channel, whether that channel is a wire or the **www** measure the outcome as its "news" or surprise, defined as entropy and consummated as knowledge. Entropy is higher or lower depending on the freedom of choice of the sender. The larger the available alphabet of symbols – that is, the larger the set of possible messages – the greater the composer's choice and the higher the entropy and information of the message. Information is not order but disorder, not the predictable regularity that contains no news, but the unexpected modulation, the surprising bits.

"Claude Shannon used "entropy" to designate information content in a communication channel. More entropy in Shannon's theory signifies more information. In Shannon's terms, entropy is a measure of unexpected bits, the only part of a message that actually bears information. Otherwise the signal is telling you what you already know. To send unexpected bits – a high entropy message – you need a low entropy carries: a predictable vessel for your meaning. You need a blank sheet of paper that does not alter or obscure the message inscribed on it. … In order for the message to be high entropy (full of information), the carrier must be low entropy (empty of information). In the ideal system, the complexity is the message rather than in the medium. … Another word for a low entropy carrier is a dumb network. The dumber the network the more intelligence it can carry." stated George Gilder in **TELECOSM: HOW INFINITE BRANDWIDTH WILL REVOLUTIONIZE OUR WORLD** (Gilder, 2000). Low entropy corresponds to low uncertainty and little information being revealed. When an outcome occurs in a low-entropy system, such as sun rising in the east, we experience little surprise. In high-entropy systems, such as the drawing of numbers in a lottery, the outcomes are uncertain and when realized, they reveal information. We are surprised. Entropy measures the uncertainty associated with a probability distribution over outcomes. It therefore also measures surprise. Entropy differs from variance, which measures the dispersion, but the two differ. Distributions with high uncertainty have nontrivial probabilities over many outcomes. Those outcomes need not have numerical values.

Distributions with high dispersion take on extreme numerical values. Using entropy, we can compare disparate phenomena, and distinguish between 4 classes of outcomes: equilibrium, periodicity, complexity, and randomness.

Equilibrium outcomes have no uncertainty and therefore, have an entropy equal to zero. Cyclic, or periodic processes have low entropy that does not change with time, and perfectly random processes have maximal entropy. Complexity has intermediate entropy. It lies between ordered and random. While entropy provides us a definitive answer in the two extreme cases, equilibrium and random, it does not for cyclic and complex outcomes.

"Information theory provides a measure of the amount of information conveyed by a message. …. This measure is based on the extent of surprise, or unexpectedness of the message to the receiver." (Lev and Gu, 2016) write Baruch Lev and Feng Gu in **THE END OF ACCOUNTING AND THE PATH FORWARD FOR INVESTORS AND MANAGERS** (Lev and Gu, 2016), and add "over the past 60 years, the role of corporate earnings, book values, and other key financial indicators in setting share prices diminished rapidly, and in terms of information timeliness or relevance to investors' decisions, financial report information (not just earnings and book values) is increasingly preempted by more prompt and relevant information sources" (Lev and Gu, 2016). "It is not only fraudulent information (**ENRON**'s; **WORLDCOM**'s) that impedes investment and growth; it's mainly the poor quality of "honest" financial reports, legitimately disclosed under the current, universally used accounting system, that seriously harms the capital allocation system and economic growth" (Lev and Gu, 2016).

But, human creativity and surprise depend upon a matrix of regularities, from the laws of physics to the stability of money and Isaac Newton was the godfather of both. Since these creations and communications can be business plans or experiments, information theory provides the foundation for an economics driven not by equilibrium or order but by falsifiable entrepreneurial surprises. Information theory has impelled the global ascendancy of information technology. From worldwide webs of glass and light to a boom in biotech based on treating life itself as chiefly an information system, a new system of the world is transforming our lives. And, the static neoclassical economic theory is not at all helpful in understanding this transformation, actually a hindrance.

Claude Shannon's breakthrough was mapping electrical circuits to **BOOLE**'s symbolic logic and then explaining how **BOOLEAN** logic could be used to create a working circuit for adding 1s and 0s. Shannon had figured out that computers had two layers: physical [container] and logical [the code]. While Shannon was working to fuse **BOOLEAN** logic onto physical circuits, Turing was testing Leibniz's language translator that could represent all mathematical and scientific knowledge. Alan Turing combined mathematical insight with mathematical theory to give us a principled way of finding computationally complete sets of instructions – sets of instructions that, subject to constraints of memory size, can be sequenced to define any conceivable algorithm. In a similar way, the vast and bewildering array of chemical reactions observed by alchemists became organized and, in principle, predictable once we had Mendeleev's periodic table of the elements and their "valences". The system got synthesized by combining a simple, fixed set of building blocks: rules, axioms, instructions, or elements. Much the same can be said for the five axioms of Euclidean geometry. After two millennia of study, geometers are still discovering new theorems. More prevalent to our current concerns, the "machine code" of a contemporary computer chip usually involves 32 or 64 basic instructions, and a program is simply a sequence of these instructions. Turing aimed to prove what was called the **ENTSCHEIDUNGSPROBLEM**, or "decision problem", that is: no algorithm can exist that determines whether an arbitrary mathematical statement is true or false. The answer would be negative.

Alan Turing was able to prove that no algorithm exists, but as a byproduct, he formulated a mathematical model for an all-purpose computing machine. Alan Turing figured out that a program and data it used could be stored inside a computer. Turing's universal machine intertwined the machine, the program and the data. From a mechanical standpoint, the logic that operated circuits and switches also encoded into the program and data. The container, the program, and data were part of a singular entity. Not unlike humans. We too are containers [our bodies], programs [autonomous cellular functions], and data [our DNA combined with indirect and direct sensory information]. The mind, accordingly, consists of a collection of content-specific information-processing modules adapted to past environments. This was the high point of what is called the **COGNITIVE REVOLUTION**. "Theories of cognition have evolved through multiple stages." writes Gyorgy Buzsaki in **THE BRAIN FROM INSIDE OUT**. "The first was the outside-in, empiricist view, postulating that the brain is an associational representational device that analyzes the world around us and makes judgements. Then came the Pavlovian reflex theory, which did not make much space for cognition; everything was hierarchy of associative reflexes. Similarly, the behaviorist paradigm argued that there is no need to think about cognition as actions can always be explained as a response to immediate external cues. In response to these views, a hard-thinking minority argued that behavior cannot be understood simply as input-output function and activity in the hidden layers of the brain is critical. ….. Humans and likely other animals can imagine into the future and recall the past. ….. The core idea is that cognition depends on prior action-based experiences of the world, which allow internally generated sequences to test 'what if' scenarios and anticipate the possible consequences of alternative actions without actually taking them. This process then helps to select future actions. …… For the brain network, there is no difference between sensory inputs or activity conveyed by the same upstream neuronal group in the absence of external inputs. Without external constraints, disengaged processing in the brain can create an internalized 'virtual world' and new knowledge through vicarious or imagined experience, tested against preexisting and stored knowledge. This process – which most scientists and philosophers would call cognition – provides dramatic advantages in predicting the consequence of actual behavior in complex environments and at long time scales. ….. At times, they are connected to sensory input or motor output, directly or indirectly, and vary their cell assembly contents at the pace of changing sensory inputs. At other times, they rely largely on their internal dynamics, often maintained by brain rhythms" (Oxford University Press, 2019).

Gyorgy Buzsaki has been applying Hebb's ideas about cell assemblies to modern data sets, in particular in terms of fluctuating interactions between networks of cells during brain activity. This has led him to argue for what he called an "inside-out" view of brains, which he sees as systems for taking action, rather than for simply receiving and processing information. The activity of cell assemblies needs to be seen in terms of their output and its implications for the organism, rather than simply representing the outside world. According to Buzsaki, the brain is not simply passively absorbing stimuli and representing them through neural code, it is actively searching through alternative possibilities to test various options. His conclusion, building on the insights of Helmholtz and Marr, is that the brain does not represent information: it constructs it. However, while this view is welcome recognition that brains are not passive structures, it has yet to be widely accepted.

Though it now owes much to the tragic genius of Alan Turing, with his extraordinary mathematical proof that reasoning could take mechanical form, that it was a form of computation, the **COGNITIVE REVOLUTION** actually began in 1950s with Noam Chomsky. Contrary to Alan Turing's empirical view of the brain as a notebook with lots of blank sheets that sensory experience progressively fills out, Chomsky argued that the universal features of human language, invariant throughout the world, plus the impossibility of a child deducing the rules of language as quickly as it does merely from the scanty examples available to it, must imply that there was something innate about language. Much later Steven Pinker in **THE LANGUAGE INSTINCT: HOW THE MIND CREATES LANGUAGE** (Pinker, 1995) and in **HOW THE MIND WORKS** (Pinker, 1997) dissected "language instinct", the notion that what the mind was equipped with was not innate data but innate ways of processing data.

Bret Stetka in **A HISTORY OF HUMAN BRAIN: FROM THE SEA SPONGE TO CRISPR: HOW OUR BRAIN EVOLVED** elaborates: "Chomsky argues we are born with innate language ability, which arose once in one species. Steven Pinker agrees we have a universal capacity for language, but believes its evolution followed a more gradual Darwinian course, driven by certain key mutations along the way, like those allowing for syntax. There are four laws of behavioral genetics that together describe how genes influence our behavior. The first three are: All human behavioral traits are heritable (affected by genes). The effect of being raised in the same family is smaller than the effect of genes. A substantial portion of the variation in complex human behavioral traits isn't accounted for by the effects of genes or families. In short, they say human behaviors are heritable, but that depending on our upbringing, the environment also shapes the differences between us. …… The fourth law states that most heritable behavioral traits are a result of many genes working together, each with only a very small effect on its own. 'Though a single gene can disrupt a psychological trait, no single gene can install one,' says Pinker. 'This is consistent with the mechanism of natural selection, in which a beneficial ability, because it is statistically rare, is astronomically unlikely to have arisen by a single lucky mutation.' He believes the same explanation goes for language acquisition. …… In 2002, researchers reported on a gene called **FOXP2** that appeared to be Chomsky's language gene" (Stetka, 2021). In **BECOMING HUMAN: A THEORY OF ONTOGENY**, Michael Tomassello disagrees: "All this language learning rests on biologically evolved cognitive and social capacities and is carried out with biologically evolved social learning skills. However, there is much controversy over the nature of humans' biological predispositions for linguistic communication. At the extreme, Chomsky and his followers have maintained that children are born with a kind of innate template that guides language acquisition, a so-called universal grammar, modelled as a quasi-mathematical system. The evolution of its particular structure was a kind of accident, as it has nothing to do with human cognition or communication. The problem is that this proposal is contradicted by cross-linguistic investigations, which do not find any of the kinds of universal structures that universal grammar supposedly makes available to all the world's languages. It is also contradicted by empirical investigations of language acquisition, which have not found the kinds of abstract linguistic representations that universal grammar is supposed to make available to children. Moreover, there are fundamental logical problems of how a child is born with a universal grammar, abstract enough to fit any of the world's 6,000 languages, could actually link its structures to the particular conventions she experiences. At the other extreme, at least since the demise of behaviorism, there have been no serious proposals that children acquire language by the same kind of simple and straightforward learning processes as other animals. Human beings are clearly biologically prepared for special forms of communication, including linguistic communication based on social conventions. The key is that this preparation is not about specific linguistic structures, as the universal grammar hypothesis claims, rather, it is about more general and basic psychological processes that we recruited for this specific task. ….. For this account to work we need a theory of word learning of rich variety that is not based on association learning as employed by animals, but rather is based again in joint attention, communicative intentions, and conventional symbols. And finally, for this account to work we need a theory of acquisition of grammar that is not based in contentless abstract rules, but rather is based in a schema-based notion of linguistic constructions acquired with the same basic cognitive and social processes as all other aspects of conventional linguistic communication" (The President and Fellows of Harvard College, 2019).

Michael Tomasello in **A NATURAL HISTORY OF HUMAN THINKING** adds further, "In general, humans are able to coordinate with others in a way that other primates seemingly are not, to form a 'we' that acts as a kind of plural agent to create everything from a collaborative hunting party to a cultural institution. …. Important aspects of human thinking emanate not from culture and language per se but rather from some deeper and more primitive forms of uniquely human social engagement" (The President and Fellows of Harvard College, 2019) and, Michael Tomasello with Carol Dweck, Joan Silk, Brian Skyrms, and Elizabeth Spelke in **WHY WE COOPERATE** add "There is evidence for at least five cognitive systems in young infants: what I call systems of core knowledge. There are systems for representing and reasoning about (1) inanimate, material objects and their motions, (2) intentional agents, and their goal-directed actions, (3) places in the navigable environment and their geometric relations to one another, (4) sets of objects or events and their relationships of ordering and arithmetic, and (5) social partners who engage with the infant in reciprocal interactions. Each of these cognitive systems emerges early in infancy (in some cases, at birth) and remains present, and essentially unchanged, as children grow. Thus, the systems are universal across our species, despite the many differences in the practices and belief systems of people in different cultural groups. Most important, these core knowledge systems are relatively separate from one another and limited in their domains of application" (MIT, 2009).

Stanislas Dehaene in **HOW WE LEARN: WHY BRAINS LEARN BETTER THAN ANY MACHINE…FOR NOW** (Dehaene, 2020) argues that the basic circuitry is the same in all of us, as is the organization of our learning algorithm, the four pillars of learning - focused attention, active engagement, error feedback and the cycle of daily rehearsal and nightly consolidation – that lie at the foundation of the universal human learning algorithm present in all our brains, children and adults alike. He adds "by constantly attending to probabilities and uncertainties, it optimizes its ability to learn. During its evolution, our brain seems, to have acquired sophisticated algorithms that constantly keep track of the uncertainty associated with what it has learned – and such a systematic attention to probabilities is, in a precise mathematical sense, the optimal way to make the most of each piece of information" (Dehaene, 2020).

"Our quick review of neuroanatomy and neural dynamics indicates that the brain has special features of organization and functioning that do not seem consistent with the idea that it follows a set of precise instructions or performs computations. We know that the brain is interconnected in a fashion no man-made device yet equals. First, the billions and billions of connections that make up a brain's connections are more exact: If we ask whether the connections are identical in any two brains of the same size, as they would be in computers of the same make, the answer is no. At the finest scale, no two brains are identical, not even those of identical twins. Although the overall pattern of communications of a given brain area is describable in general terms, the microscopic variability of the brain at the finest ramifications of its neurons is enormous, and this variability makes each brain significantly unique. ….. Another organizing principle that emerges from the picture we are building is that in each brain, the consequences of both a developmental history and experiential history are uniquely marked. For example, from one day to the next, some synaptic connections in the same brain are likely not to remain exactly the same, certain cells will have retracted their processes, others will have extended new ones, and certain others will have died, all depending on the particular history of the brain. The individual variability that ensures is not just noise, or error, but can affect the way we remember things and events. ….. If we compare the signals a brain receives with those of computers, we uncover a number of other features that are special to brains. First, the world certainly is not presented to the brain like a piece of computer tape containing an unambiguous series of signals. Nonetheless, the brain enables an animal to sense the environment categorize patterns of a multiplicity of variable signals, and initiate movement. It mediates learning and memory and simultaneously regulates a host of body functions. The ability of the nervous system to carry out perceptual categorization of different signals for sight, sound, and so forth, dividing them into coherent classes without a prearranged code, is certainly special and is still unmatched by computers. ……. The brain contains a special set of nuclei with diffuse projections – the value system – which signal to the entire nervous system the occurrence of a salient event and influence changes in the strength of synapses. Systems with these crucial properties are typically not found in man-made devices yet their importance for learning and adaptive behavior is well documented. ….. Finally, if we consider neural dynamics (the way patterns in the brain change with time), the most striking special feature of the brain of higher vertebrates is the occurrence of a process we have called reentry. Reentry, which depends on the possibility of cycles of signaling in the thalamocortical meshwork and other networks. It is the ongoing, recursive interchange of parallel signals between reciprocally connected areas of the brain, an interchange that continually coordinates the activities of these areas' maps to each other in space and time. …… This synchronous firing of widely dispersed neurons that are connected by reentry is the basis for the integration of perceptual and motor processes." inform Gerald M. Edelman and Giulio Tononi in **CONSCIOUSNESS: HOW MATTER BECOMES IMAGINATION** (Edelman and Tononi, 2000).

Gyorgy Buzsaki further suggests "that brains come with a preexisting dynamic even without prior experience, providing a scaffold that allows it to make guesses about the consequences of that actions of the body it controls and to filter which aspects of the world are worth attending. The brain is not a blank tablet to be filled gradually by the truths of the world but an active explorer with a performed dynamics ready to incorporate events from its points of view. The brain's only job is to assist the survival and prosperity of the body it interacts with, independent of whether, in the process, it learns 'objective reality' of the outside world or not. For the tabula rasa brain, knowledge is synthesized from scratch. For the inside-out model, it is experience that adds meaning to preformed neuronal trajectories and their combinations. …… The nervous system may have evolved to mimic the statistical probabilities of the physical world and thus become an efficient predictor of events. As a result, neurophysiological and perceptual brain dynamics, both spanning several orders of magnitude, share a common mathematical foundation: the log rule" (Oxford University Press, 2019).

Gyorgy Buzsaki sweepingly declares, "We have two brains in our skull or at least two virtual divisions. First, there is the 'good enough' brain. This is largely prewired and acts quickly via a minority of highly active and bursting neurons connected by fast-conducting axons and strong synapses into a network. The good-enough brain judges the events in the world in a fast and efficient way but is not particularly precise. The privileged minority of this virtual division is responsible for perhaps half of the spikers in the brain at any given time and share information among themselves and have faster access to the rest of the brain than remaining majority of neurons. The strongly interactive circuits that form the good-enough brain can generalize across situations but with less than perfect fidelity. In short, 10% or so of the synapses and fast firing neurons in the brain do the heavy lifting at all times. …… To perform better, we also need to deploy the second virtual brain: a large fraction of slow-firing neurons with plastic properties that occupy a large brain volume connected by weaker synapses into a more loosely formed giant network. Their work is absolutely critical for increasing the accuracy of brain performance. Of course, I am not thinking about two discrete brains in one skull, but instead a continuum of a broad distribution of mixed networks that performs apparently different qualitative computations at the left and right tails. This distribution allows the brain to implement anything from preexisting rigid patterns to highly flexible solutions. Thus there is no definable boundary between the 'fast decision, low precision' and 'slow decision, high precision' networks. Brain performance is a tradeoff between speed and accuracy" (Oxford University Press, 2019) Thus provides a neurological explanation of Amos Tversky and Daniel Kahneman's **THINKING, FAST AND SLOW**.

The progress of digital technology is generally associated with Gordon Moore of **MOORE'S LAW** which state that computer processing speeds grow exponentially, doubling every 18 months or so. The one about the growth in data transmission, associated with George Gilder, is called **GILDER'S LAW** which state that the data transmission rates would grow 3 times faster than computer power. Data transmission speeds did grow much faster than processing speeds for few years, but then slowed to about the same pace as Moore's law. The one about the growth of usefulness of digital networks, associated with Robert Metcalf, is called **METCALF'S LAW** which states that the value of a network grows faster than the number of people connected to it. It grows twice as fast. The outcome is sometimes called **TIPPING-POINT ECONOMICS**. When the size of a thing gets past its tipping-point, it can snowball into something very big, very fast. Thus, it also explains the winner-take-all outcomes seen with on line competition among networks. The one that explains the mind bogging pace of innovation, associated with Hal Varian, is called **VARIAN'S LAW** which state that digital components are free while digital products are highly valuable. Innovation explodes as people try to get rich by working through the nearly infinite combinations of components in search of valuable digital products.

These Laws help to explain why the economy in cyberspace seems to act differently than the economy in real space. **METCALF'S LAW** helps to explain the tendency of virtual economy to act as a winner-take-all contest. The power of networks and the eruptive pace of raw computing and transmission power are not the only thing driving the inhumanly fast pace of digitech. There is something very different about innovation in the digital world compared to the industrial world. The nature of digital innovation is quite different. It is radically faster because the nature of the underlying components is different. It is **DIGITAL COMBINATORIC INNOVATION** that is what Hal Varian calls it. The components are open-source software, protocols, and **APPLICATION PROGRAMMING INTERFACES** [**API**s], all free to copy.

3. Discussıon: how did open, anarchic, decentralized free internet become centralızed profit seeking data monopolıes monetizing data extracted from surveillance? Technofeudalism? Surveillance capitalism?

"The largest industry in the world now is quite literally the attention-seeking industry. Just as in the nineteenth and twentieth centuries the global economy was dominated by natural-resource extraction, today the world's largest companies have grown as large as they have entirely on the promise of providing to their clients the attention, however fleeting, of their billions of users. And these users are, at the same time, being used. One vivid and disconcerting term that has begun circulation in social media to describe anyone who spends time on line is 'data-cow'. The role that users of 'free' on line platforms occupy might sometimes feel creative, or as if it has something in common with traditional work or leisure. But this role sometimes appears closer to that of a domesticated animal that is valuable only to the extent that it has its very self to give. We do not usually provide our bodily fluids, and are not usually asked to do so, though sites such as Ancestry. com do ask for saliva as part of their data-collecting efforts, and health bracelets and other such devices owned by Apple and Amazon are increasingly discovering ways to monitor a number of our vital fluid levels. But even if we are not giving our fluids, we are giving something that has proven more valuable to the new economy than milk ever was in the system of industrial agriculture: information about who we are, what we do, what we think, what we fear. Some of us continue to have old-fashioned careers in the twenty-first century – we are doctors, professors, lawyers, and truck drivers. Yet the main economy is now driven not by what we do, but by the information extracted from us, not by our labor in any established sense, but by our data. This is a revolution at least as massive as the agricultural and industrial revolutions that preceded it. Whatever else happens, it is safe to say that for the rest of all of our lifetimes, we will only be living out the initial turbulence of this entry into a new historical epoch. This then is the first thing that is truly new about the present era: a new sort of exploitation, in which human beings are not only exploited in the use of their labor for extraction of natural resources; rather, their lives are themselves the resource, and they are exploited in its extraction." observes Justin E. H. Smith in **THE INTERNET IS NOT WHAT YOU THINK IT IS: A HISTORY, A PHILOSOPHY, A WARNING** (Smith, 2022 pp. 14-15).

A brief history of the institutionalization of deception is pertinent in understanding the prevalence of propaganda by the state to manage political choices of the voters and advertising by the profit seeking private companies to manage consumers' choices. "'Guided democracy' was first formulated in the 1920s by the American journalist Walter Lippmann, the leading media theorist and one of the most influential intellectuals of his time. …… Lippmann was of the opinion that in a modern democracy there are two kinds of people. On the one hand, there is the 'bewildered herd', whose unqualified opinions are based on short-sighted self-interests. The complexity of modern societies is too much for them to cope with, so their participation in political life must be limited to choosing every four years between two competing factions of the 'specialized class'. The 'specialized class' on the other hand, are the only ones who know to control the complexities of the Megamachine in the interests of the general public. For this reason, it is necessary for the experts to steer the herd by specifically influencing public opinion, which Lippmann called the 'manufacture of consent". …… Lippmann's views are in line with those of Madison and most other American founding fathers. His thoughts were further developed by Edward Bernays, who is considered the founder of public relations along with Ivy Lee. Bernays, a nephew of Sigmund Freud, used his uncle's theories about the unconscious in order to influence the wishes, feelings and thoughts of crowds. He wrote in the introduction to his 1928 book **PROPAGANDA**: 'The conscious and intelligent manipulation of the organized habits and opinions of the masses is an important element in democratic society. Those who manipulate this unseen mechanism of society constitute an invisible government which is the true power of our country. We are governed, our minds are molded, our tastes formed, our ideas suggested, largely by men we have never heard of.' What Bernays wrote sounds like a full-fledged conspiracy theory with dark figures pulling the strings that society dances to." is Fabian Scheidler's concise reminisces in **THE END OF THE MEGAMACHINE: A BRIEF HISTORY OF A FAILING CIVILIZATION** (Zero Books, 2020).

"Cambridge Analytica is the American brand of the English-based Strategic Communication Laboratories (SCL) group also the most widely-publicized analytics firm for their utilization of Big Data. Although just a small and typical Big Data operation, they are the most infamous firm of their kind as a consequence of their role in the U.S. 2016 presidential election. Politics is irrelevant to the analysis of this event: Instead, it is significant as proof that human behavior is reducible to bits. ……. CA is an analytics company that worked to maximize the effectiveness of online advertisements. Its data collection consisted of demographic data (race, gender, age, income, geographic features, etc.) and psychographic data (advertising resonance, life style data, consumer confidence, etc.), amounting to as many as 5,000 data points on 220million Americans. With a sample size somewhere in the millions, data was collected with online quizzes measuring levels of what behavioral psychologists call the big five personality traits: Openness, Conscientiousness, Extroversion, Agreeableness, and Neuroticism (OCEAN). Cross-referencing the resulting behavioral data with that of social networking sites (SNS) provided the algorithmic precondition for personality blueprints from SNS data alone.

In other words, someone who took the personality test that was high in agreeableness will have measurably different clicking patterns than someone who was scored as disagreeable. This was done with individual traits, but with the unique combinations formed from all five. After analyzing thousands of the test-takers and their on line activity, every clicking behavior could be accurately linked to personality traits. You no longer need to take a personality test for companies to understand you: Just browsing the web is sufficient. Personality profiling results were then used to connect offline data with the cookies of different sites to deliver individualized ads." informs Evan McFarland in **BLOCKCHAIN WARS: THE FUTURE OF BIG TECH MONOPOLIES AND THE BLOCKCHAIN INTERNET** (McFarland, 2021).

Vaclav Smil in **INVENTION AND INNOVATIN: A BRIEF HISTORY OF HYPE AND FAILURE** provides another genesis of deception, "On August 12, 2013, Elon Musk, at the time the chairman of TESLA, released his Hyperloop Alpha Paper. At its very beginning, when outlining the background of the idea, he asked whether there was "a truly new mode of transport- fifth mode after planes, trains, cars and boats"- that would be safer, faster, costs less, and be more convenient while being immune to weather, sustainability, self-powering, resistant to earthquakes, and not disruptive to people living along its route. …… Unfortunately, none of these have panned out." ……. The historical record shows that there is nothing new about any of these ideas, that the basic concept for the fifth mode of transportation has been around for more than two hundred years, and that during the intervening time various patents were filed, several detailed proposals were made, and some models and muck-ups of specific components were built. And yet not a single (near) vacuum- or low-pressure-tube, superfast transportation project (be it for people or goods, or both) has been completed and put into operation, not even a trial short-distance link encompassing all of the design's basic components." (The MIT Press, 2023) and, adds: "In 2008, 49 percent of America's electricity was generated by coal combustion, 20 percent by natural gas, about 20 percent by nuclear fission, and 6 percent by hydroelectricity; the rest was produced from fuel oil, wind, and geothermal energy. …….. This means that an all-electric national fleet would offer no overall primary energy savings and no carbon emissions advantage compared to the alternatives of a highly efficient gasoline-car fleet or the large-scale adoption of hybrid vehicles – unless, of course, all electricity consumed by all electric vehicles were generated by renewable conversions rather than by the current mix of generation relying on coal, natural gas, nuclear fission, and water power." in **ENERGY MYTHS AND REALITIES: BRINGING SCIENCE TO THE ENERGY POLICY DEBATE** (The American Enterprise Institute for Public Policy Research, 2010).

"The **WWW** is a network whose nodes are documents and whose links are the URLs that allow us to "stuff" with a click from one web document to another. With an estimated size of over one trillion documents (N=10 to 12th power), the Web is the largest network humanity has ever built. It exceeds in size even the human brain (N=10 to 11th power neurons). It is difficult to overstate the importance of the **WWW** in our daily life. Similarly, we cannot exaggerate the role the **WWW** played in the development of network theory: it facilitated the discovery of a number of fundamental network characteristics and became a standard testbed for most network measures.", informs Albert-Laslo Barabasi in **NETWORK SCIENCE** (Cambridge University Press, 2016 p.113) In **INFORMATION RULES: A STRATEGIC GUIDE TO NETWORK ECONOMY** (Shapiro and Varian, 1999), Carl Shapiro and Hal Varian popularized the term **NETWORK EFFECT** which came to mean that in digital world size easily begets size. Hal Varian has been described as the Adam Smith of the discipline of **GOOGLENOMICS** and the godfather of **GOOGLE**'s advertising model.

"To understand what networks really are and how they 'behave', we have to realize that they have particular structural properties. These can be summarized in a number of 'laws' of the Web. They are not some kind of natural laws. These are defining and enabling conditions that exert pressure on human behavior in networks, but that can also be changed, as usually happens to structures according to structuration theory. Understanding these 'laws' helps to explain things we can observe on the Web and it assists in finding mechanisms to intervene in the network structures concerned. Seven laws that summarize a large part of the general theoretical argument are: the law of network articulation [In the network society, the social relations are gaining influence as compared to social units they are linking.]; the law of network externality [Networks have effects on things/people external to the network. The more people participate in a network the more others are likely to join. There is a pressure to connect.]; the law of network extension [When networks such as the Web grow, they tend to become too big. Network units lose oversight and do not reach each other anymore. To solve this problem intermediaries, such as search engines, portals, and social networking sites are necessary.]; the law of small worlds [In large-scale networks, most units are not neighbours, but still can reach almost every other unit in a few steps (six degrees of separation) creating a small world. Explanation: units are grouped in clusters with strong ties, and they reach people in other clusters by long-distance and often weak ties. Taking these steps, the influence of people by contagion reaches three degrees.]; the law of the limits to attention [As everybody in a network is able, in principle, to connect and communicate to everyone else in the network, there is a limit to attention because the time to read, listen, or view for receivers runs out. The more people write/produce content on the Web, the smaller on average their audiences become.]; the power law in networks [In large, scale-free networks those units already having many links acquire even more, while most units keep only a few links. The mechanisms are a continuous growth of links, preferential attachment and social contagion.]; the law of trend amplification [Networks are relational structures that tend to amplify existing social and structural trends. When technologies such as ICT networks and computers are used, they serve as reinforcing tools.]", informs Jan van Dijk in **THE NETWORK SOCIETY** (Jan van Dijk, 2012 pp.37-42).

Jack Goldsmith and Tim Wu in **WHO CONTROLS THE INTERNET: ILLUSIONS OF A BORDERLESS WORLD** (Oxford University Press, 2008) tells the story of the death of the dream of self-governing cyber-communities that would escape geography forever, and also tells the story of the birth and early years of a new kind of **INTERNET**, a bordered network where territorial law, government power, and international relations matter as much as technological invention. As China and America wall off their respective digital markets from one another, each are looking for growth in the rest of the world. A divided world wide web or **SPLINTERNET** is already a reality, as China's internet grows behind a great firewall of censorship. **AMAZON** is promoting payment services in India. China's **ALIPAY** service is active in Brazil.

The **INTERNET** has become a new kind of battleground for the world's great powers. No longer a single entity, the **INTERNET** is becoming a **SPLINTERNET** as the Unites States and China fight to control the way in which it will be run and regulated, as part of a larger rivalry to control high-growth high-tech industries. Both rivals are increasingly nationalistic, supporting their own home grown companies in an effort to win the tech cold war by ring-fencing some of their supply chains to prepare themselves for a long-term tech and trade war. Emphasizing the organization and the relation of elements entails less attention to the elements and units themselves. The characteristics of units and elements among them human individuals, and the way they are made up, are not the focus of attention. Instead every network approach in the natural and social sciences stresses the relations of elements. It is opposed to atomistic views of reality and methodological individualism of orthodox economic theory which measures social reality by adding individual attributes. Hence, orthodox economic theory is not useful, actually distorting understanding of networks.

ARPANET, funded by Pentagon, was the brainchild of Paul Baran of the **RAND CORPORATION** who relied on the idea called packet switching. Baran's main goal was to develop something that would survive a Soviet first strike and still transmit messages to missile bases to retaliate. Hence the decentralized nature of the network. The **INTERNET** is more than packet switching. It requires computers, communications, all sorts of software and other protocols, many of which the government-funded research projects bought from the private sector. The **ARPANET** was effectively privatized in the 1990s.

Paul Baran for packet switching, Vint Cerf for writing **TCP/IP** protocols that proved crucial in allowing different programs to run on the **INTERNET**, and Sir Tim Berners Lee for developing the worldwide web were instrumental in the emergence of an open means of connecting computers to each other so that people could see what was on other nodes than their own hard drive.

To understand the internet's recent history, it helps to keep in mind that like most digital systems, it is designed in layers. At the bottom are all the protocols that allow different sorts of networks and devices to exchange information, or **INTERNETWORK**; hence **INTERNET**. At that level, it is still largely decentralized. No single company controls these protocols, although the number of firms providing internet access has dropped sharply. The **INTERNET**'s base was designed to move data around and publish information, so its protocols did not record what had been transmitted previously by whom.

The **INTERNET** was built without memory. The **INTERNET**'s arrival seemed to herald a new way of ordering human affairs that would free us from the tyranny of territorial rule. Self-governing cyber-communities would escape geography forever. It was to rely in open source, peer-to-peer networking. The **INTERNET** was created by, and continues to be shaped by, decentralized groups of scientists and programmers and hobbyists freely sharing the fruits of their intellectual labor with the world. **OPEN-SOURCE** collaborative network created a very large portion of the lines of code on which the **INTERNET** depends, and not just the **INTERNET**, but smartphones, stock markets, and airplanes. But the last decade has shown that national governments have an array of techniques for controlling offshore **INTERNET** communications, thus enforcing their laws, by exercising coercion within their borders.

"Now a forgotten company, subsumed into Verizon's vast telecom empire, UUNET is worth recalling because, in addition to illustrating the power law, it illuminates two features of venture investing. First, it showcases the distinct roles of government-backed science and Venture-capital-backed entrepreneurs in driving technological progress. Second, it demonstrates a paradox at the heart of venture capital's impact on society. Venture Capital [**VC**] as individuals can stumble sideways into lucky fortunes: chance and serendipity and the mere fact of being in the venture game can matter more than diligence or foresight. At the same time, venture capital as a system is a formidable engine of progress - more so than is frequently acknowledged. UUNET began life in 1987 as an obscure Northern Virginia nonprofit. It mission was to address the central limitation of the INTERNET as it existed then: only around 100,000 computers were connected to it. Having started out as a military communications system funded by the pentagon, the internet had become an email, bulletin board, and a file-sharing platform for scientists at government labs, including government-backed ones at universities. Private companies and individuals were barred from the network, and commercial activity prohibited. But by the late 1980s, a growing community of nongovernment scientists wanted a similar utility. Armed with $250,000 loan guarantee from a loose association of programmers, UUNET set out to be their internet service provider. UUNET's founder was Rick Adams an engineer who worked for the government's CENTER FOR SEISMIC STUDIES. Still holding down his government job, Adams worked part time on the rudiments of a parallel internet for private-sector scientists who were excluded from the main one. Typically, major private corporations had linked up their employees via local area networks, but sending messages from one corporation to another was horribly expensive. Adams combined CISCO routers and networking software to build cheaper connections. He charged for the service but only enough to recover costs. At first, almost nobody noticed. The INTERNET had always been a government project. Most people assumed that if anyone was going to bring online connections to the masses, it would be the government, again, in July 1990 a young Tennessee senator named Al Gore laid out a public sector vision for an 'information superhighway'. Rather than operating on the existing telephone lines, as the INTERNET did, Gore's superhighway envisioned brad-new fiber-optic pipes would turn household TVs into interactive terminals. The jump to fiber optics would allow information and entertainment to reach American household in dazzling Technicolor, replacing the INTERNET's drab bulletin boards. Initially, the flashy superhighway plan generated broad excitement. In 1991, Gore championed a $1.74billion government spending. ….. Scientists at corporate labs began flocking to UUNET, which finding itself awash with revenue, gave up its non-profit status. Then, acknowledging the progress of UUNET and one or two smaller rivals, the NATIONAL SCIENCE FOUNDATION [NSF]announced a policy reversal.

Rather than trying to keep private users off the government network, it would invite internet service providers into the tent; in fact, it would let them take over its management. The government had invented the INTERNET, to be sure. But as far as the NATIONAL SCIENCE FOUNDATION was concerned, the job of turning the INTERNET into a mass medium that democratized information and changed lives was best entrusted to the private sector. Gore's government-led fiber-optic superhighway was still dominating headlines, But the way Mitch Kapor saw things, it would be prohibitively disruptive and expensive. Rather than ripping up the ground to lay fiber-optic cable, it would be cheaper by far to build out the copper-wire-based internet. Responding to insatiable customer demand, not political edict, UUNET was already grafting routers and servers into the existing phone networks, turning voice lines into data lines, and now the NSF's privatization announcement opened the way to even faster progress. As a way of getting millions of users online, this market-led movement would eclipse Gore's grandiose project. Kapor, the first investor to back UUNET, had passed the baton to Arthur Patterson at ACCEL. In turn, Patterson had passed it to Peter Barris, who, because of his East Coast base, would be the most hands-on of the three venture backers." explains Sebastian Mallaby in **THE POWER LAW: VENTURE CAPITAL AND THE MAKING OF THE NEW FUTURE** how the **UUNET** version of information future trumped that of the US vice-president. [Mallaby, 2022 pp. 132-134]

"Tim Berners-Lee, a creator of the web, thinks the **INTERNET** itself is dying. In 2014 the web took a very dark turn. Beforehand, traffic to websites came from many places and the web was a lively ecosystem. But starting in 2014, over half of all traffic started coming from **FACEBOOK** and **GOOGLE**. Five years later, over 70% of traffic was dominated by these two sources" (Tepper and Hearn, 2019). "The **INTERNET** was meant to be open, anarchic, decentralized, and above all free. In the 1990s, **AMERICA ON LINE** helped people get online and discover content. It was a walled garden. **AOL** determined and curated the user experience, which was contrary to the spirit of the web. Once users started going online with their local cable company, **GOOGLE** helped them find anything on the web, most consumers did not go back to **AOL**. **FACEBOOK** has become **AOL 2.0**, a centrally designed internet for its users. You discover only what the company wants. It is as restraining as **AOL** with a lock on user's life history, photos, friends, and family connections. Countless articles and videos appear only behind **FACEBOOK**'s guarded gate. **FACEBOOK** has become a digital passport, and many apps and sites will not let a user join without a **FACEBOOK** account." (Teeper and Hearn 2019). "There is now a vast imbalance of power between individuals and private companies. The web is no longer free when two companies control most of the traffic. …. Faced with a closed web controlled by two private companies, users are demanding that **FACEBOOK** and **GOOGLE** fix themselves. As Matt Taibbi has succinctly put it, 'For **GOOGLE** and **FACEBOOK** to be the cause of and the solution to problems tells you how irrelevant governments and regulators have become" (Tepper and Hearn, 2019). **INTERNET** has split apart and is becoming bordered. Far from flattening the world, the **INTERNET**, its language, its content, its norms, is conforming to local conditions. The result is an **INTERNET** that differs among nations and regions that are increasingly separated by walls of bandwidth, language, and filters. This bordered **INTERNET** reflects top-down pressures from governments that are imposing national laws on the **INTERNET** within their borders. It also reflects bottom-up pressures from individuals in different places who demand an **INTERNET** that corresponds to local preferences, and from the web page operators and other content providers who shape the **INTERNET** experience to satisfy these demands.

The **INTERNET**'s design was not the result of some grand theory or vision that emerged fully formed. Rather, open design of the **INTERNET** was necessitated by the particularities of the specific engineering challenges. The **INTERNET**'s creators, mainly academics operating within and outside the government, lacked the power or ambition to create an information empire. They faced a world in which the wires were owned by **AT&T** and computing power was a patchwork of fiefdoms centered on the mainframe computers, each with idiosyncratic protocols and systems. The construction and maintenance of networks were and are tasks largely performed or contracted out by network operators and carriers. The network operators and carriers serve as gatekeepers for networks. Telephone operators, Internet platforms, Internet service providers and broadcasting operators largely decide who and what has access to networks and how expensive particular applications on networks are. "In the last three decades, the world market for telecommunications and computer network equipment has been controlled by 10 companies. Important names in this content are **HUAWEI**, **CISCO SYSTEMS**, **ALCATEL-LUCENT** (**NOKIA**), **FUJITSU**, and **ERICSSON** in 2020. These companies involved have to make extraordinarily capital-intensive investments and they have extremely high research and development costs. Therefore, high turnovers and profits are required. This is a problem because profit margins on hardware are much lower than those on software and services in the information and network economy. Usually they are less than 2% or 3% of total revenue. Considering the production of terminal equipment (telephones, computers, modems, decoders, radios, and televisions), big companies are also on the rise, and for the same reasons: low profit margins. The giants of computer equipment manufacturing in 2020 are **LENEVO**, **HP**, **APPLE**, **DELL**, **SAMSUNG**, **ACER**, and **ASUS**. Four of the are East Asian and three are American." (van Dijk, 2020).

Successful implementation of **WASHINGTON CONCENSUS** in 1980s and 1990s privatized big national public monopolies in telephony and broadcasting and split them into parts with different functions, such as a carrier or a content provider. "However, after 2000, a second trend of monopolization in the form of oligopolization recurred in the private sector. The trend in operating and carrying telephony and broadcasting has gone from public monopolies to private oligopolies. Public monopolies acted on a national scale. Contemporary private oligopolies increasingly operate on an international level. In fixed telephony, they are companies such as **AT&T**, **CHINA TELECOM**, **NTT**, **VERIZON**, **DEUTSCHE TELECOM**, and **TELEPHONICA**. In mobile telephony, they are among others **CHINA MOBILE**, **AIRTEL** (India), **VODAFONE** (UK), **TELEFONICA** (Spain), and **AXIETA** (Malasia). In broadcasting companies such as **TIME WARNER**, **NEWS CORPORATION** (Murdoch), **BERTELSMANN**, **CANAL+**, **UPC** (Liberty Global) and **MICROSOFT NBC** dominate the international market. There are no complete monopolies in telephony and broadcasting – basically, there is competition – but companies can split the world market among themselves, fix prices and benefit from international regulations on standardization and interconnectivity. Increasingly, large international telephone and broadcasting companies cooperate and merge. A handful of conglomerates are preparing to divide the world market. The final result will be a replacement of a national government-controlled public monopoly without competition by a small number of international private oligopolies with limited competition and scarcely any public responsibility. Operators and providers on the Internet are either concentrated and big or fragmented and small. The internet platforms, increasingly the core of all network producers have become oligopolies right from the beginning. They are the Big Five American platforms – **APPLE**, **AMAZON**, **ALPHABET** (**GOOGLE**), **MICROSOFT**, **FACEBOOK** and the giant Chinese platforms – **ALIBABA** and **JINGDONG** for e-commerce, **TENCENT** for communication and **BAIDU** as search engine. Platforms from other countries are much smaller. The data companies and cloud computing services are also concentrated. There is a close relation with the Internet platforms. The biggest in 2020 are **AMAZON WEB SERVICES**, **MICROSOFT, GOOGLE** and **ORACLE**. Instead, at the start, the Internet providers were relatively small and fragmented on a local scale. There were countless **INTERNET SERVICE PROVIDERS** [**ISP**s] in the world. After some time, they also merged with privatized national telephone carriers and big private carriers" (van Dijk, 2020).

Internet works over an infrastructure that does not belong to those using it. The owner is always someone else, and in the 1970s, it was generally **AT&T** in the United States. It was designed to link human brains, but it had no control over their activities than that. Egalitarianism born of necessity would persist as the network grew over decades to include everyone.

The concept of **ENCAPSULATION** was how a network interconnected with other networks. It means wrapping information from local networks in an envelope that **INTERNETWORK** could recognize and direct. In what would come to be known as **TRANSMISSION CONTROL PROTOCOL** [**TCP**] created a standard for the size and flow rate of data packets, thereby furnishing computer users with a **LINGUA FRANCO** [**ESPERANTO**] that could work among all networks. As a practical matter, this innovation would allow the **INTERNET** to run on any infrastructure, and carry any application, it packets traveling any type of wire or radio broadcast, even those owned by an entity as given to strict controls as **AT&T**.

It was an electronic information network independent of the physical infrastructure over which it ran. The invention of **ENCAPSULATION** permitted the layered structure of the **INTERNET**, whereby communications functions are segregated allowing the network to negotiate the differing technical standards of various devices, media, and applications. This was also born of necessity to link different types of networks by inventing a protocol that took account of the existence of many networks over which the creators had limited power.

TRANSMISSION CONTROL PROTOCOL/INTERNET PROTOCOL [**TCP/IP**] and other aspects of the **INTERNET**'s architecture rested on the founders' beliefs about networks. In technical jargon, they created a network with **OPEN ARCHITECTURE**, or **END-TO-END DESIGN**. In non-technical terms, the founders embraced a design that distrusted centralized control. In effect, they built strains of American liberalism, and even 1960s idealism, into the universal language of **INTERNET**. The **INTERNET**'s design was open, minimalist and neutral. It was open, because it was willing to accept almost any kind of computer network to join in one universal network-of-networks. It was minimalist, because it required very little of the computers that wanted to join in. Finally, it was neutral between applications.

The concept of network neutrality grew out of the **END-TO-END DESIGN** structure of the **INTERNET**, which favored the users rather than the network providers. While users pay for **INTERNET** connection, and the price they pay can depend on the speed or quality provided by their **INTERNET** service provider, once connected, their transmitted packets are treated the same way everyone else's by the network providers. Network providers are trying to secure control of information exchanged over the **INTERNET** for commercial gain. Proponents of network neutrality argue that the network should remain "stupid", thereby allowing end users to collaborate and innovate by developing their own applications. This **DISTRIBUTED INTELLIGENCE** that makes the **INTERNET** such a unique communications medium. The governments and the network providers feel differently. In 2011, Russia, Uzbekistan, Tajikistan and China submitted a proposal to the United Nations General Assembly calling for an international code of conduct for the information society. The preamble to the proposal states that "policy authority for **INTERNET** related public issues is the sovereign right of states." As of 2019, nations pushing for new forms of government control increased to include India, Brazil, South Africa and Saudi Arabia.

The **INTERNET** plays a central role in the American economy as it does in the Chinese. But there is a profound flaw in its architecture. Its software stack lacks a trust and transactions capability. Its **OPEN SYSTEM INTERCONNECTIONS** [**OSI**] model defines seven layers. While some of the layers have merged, none of the existing layers provide trust or validation or factuality or veracity of real monetary values. Perhaps, that abides well with the theoretical mainframe of the MBA programs: the money neutral neoliberal economic theory.

The original distributed **INTERNET** architecture sufficed when everything was "free", as the **INTERNET** was not a vehicle for transactions. When all it was doing was displaying **WEB** pages, transmitting emails, running discussions forums and news groups, and hyperlinking academic sites. The **NET** did not absolutely need a foundation of security. But when the **INTERNET** became a forum for monetary transactions, new security regimes became indispensable. The groups which developed the original protocols, the **INTERNET ENGINEERING TASK FORCE** and the **WORLD WIDE WEB** could have added security regimes to the rule book. But they did so, only belatedly. Perhaps, one reason was that many internet pioneers believed that the protocols would have been enough to prevent centralization. They were proven wrong.

To understand the contemporary **INTERNET**, one needs to start with **STACK**s which imitate hardware and transcend it in virtual threads and cores and chains. The seven-layer **NETPLEX** scheme of the **OPEN SYSTEMS INTERCONNECTION** model of the **INTERNATIONAL STANDARDS ORGANIZATION** consists of a hierarchical stack in which lower functions are controlled by higher functions. At the bottom is the physical layer, the fiber-optic lines, microwave oscillators, mixers, 1550 and 900-nanometer lasers, photodetectors, silicon routers, erbium-doped amplifiers, and twisted-pair telephone wires, antennas, coaxial cables – the list is endless – that carry the data packets across the network at the behest of the layers above it.

In **OSI** stack, above the physical layer is the **DATALINK**. This is the medium where hardware becomes "firmware" and software that define the electrical specifications, timing rules, and electron-photon conversions that enable the transmission of information across a link from one node or computational address to the next. **SWITCHES** operate at level two, passing packets only to the next node. Local area networks such as **ETHERNET** or **WiFi** function at this level. The third layer is the **NETWORK** layer, the domain of routers, which combines with the transport layer [layer four] to establish the end-to-end links that constitute the **TPC/IP INTERNET PROTOCOLS**. This is the entire system of **IP** addresses and **TRANSPORT CONTROL PROTOCOL** traffic shuffles that comprises the connections from end to end across the **NET**.

Layer three does the headers on the packets, the identities and addresses. Layer four does the actual transmission and reception of data packets and traffic management, load balancing and **ACKS** [**I got it!**] and **NACKS** [**I'm still waiting**] that assure connections. Layers three and four tend to be the bastion of central powers, where governments and their intelligence arms chase down domain names and addresses. Layer five governs a particular two-way communication from beginning to end, whether a video stream, a **SKYPE** call, a **SESSION INITIATION PROTOCOL** conference, a messaging exchange, an email post, or a transaction. Layers six and seven are the schemes for presentations and applications – user interfaces, windows, formats, operating systems. These are summed up in schemes of hyperlinks. The 70% of all links came to be handled through **GOOGLE** and **FACEBOOK**, major walled gardens. The **INTERNET** needs a new payment method that conforms to the shape and reach of global networking and commerce. It is to obviate the constant exchange of floating currencies, more volatile than the global economy that they supposedly measure. The new system should be distributed as far as **INTERNET** devices are distributed: a dispersed heterarchy based on peer-to-peer links between users rather than a centralized hierarchy based on national financial institutions. It is invented and called **BITCOIN BLOCKCHAIN**. " Blockchain is just a fancy database, even though it is now often used to refer to much more than that. …… The governing technology behind Bitcoin is cryptography, the mathematical framework that allows blockchain's network consensus to be achieved in a decentralized and pseudonymous manner, and is nothing new. Cryptography long predates the Internet, and its application to currency is nothing extraordinary: About 100 notable cryptographic payment systems were attempted in the 20 years before Bitcoin came out in 2008. Bitcoin's decentralized network concept is nothing new either: Platforms such as Napster, BitTorrent, and Grokster enabled anonymous P2P data transfer with far more usability than blockchain-based equivalents. Using encryption techniques for online anonymity is also not unique to blockchain and has already been made surprisingly easy with standards such as Tor. …… The internet now has a centralized and capitalistic business model based on advertisements and subscriptions. ……… Being the first bclockchain, Bitcoin is a terrible poster child for the technology. Bitcoin is not user friendly. It's slow, inefficient, and expensive, which only gets worse as the network grows." writes Evan McFarland in **BLOCKCHAIN WARS: THE FUTURE OF BIG TECH MONOPOLIES AND THE BLOSKCHAIN INTERNET** (McFarland, 2021).

Don Tapscott and Alex Tapscott offer a nuanced view: "Bitcoin or other digital currency isn't saved in a file somewhere, it's represented by transactions recorded in a blockchain – kind of like a global spreadsheet or ledger, which leverages the resources of a large peer-to-peer bitcoin network to verify and approve each nitcoin transaction. Each blockchain, like the one that uses bitcoin, is distributed: it runs on computers provided by volunteers around the world, there is no central database to hack. The blockchain is public: anyone can view it at any time because it resides on the network, not within a single institution charged with auditing transactions and keeping records. And the blockchain is encrypted: it uses heavy-duty encryption involving public and private keys (rather like the two-key system to access a safety deposit box) to maintain virtual security. ….. Every ten minutes, like the heartbeat of the bitcoin network, all transactions conducted are verified, cleared, and stored in a block which is linked to the preceding block, thereby creating a chain. Each block must refer to the preceding block to be valid. This structure permanently time-stamps and stores exchanges of value, preventing anyone from altering the ledger. ….. Like the World Wide Web of information, it's the World Wide Ledger of value – a distributed ledger that everyone can download and run on their personal computer. ……… The financial services industry has already rebranded and privatized blockchain technology, referring to it as distributed ledger technology, in an attempt to reconcile the best of bitcoin – security, speed, and cost – with an entirely closed system that requires a bank or financial institution's permission to use. To them, blockchains are more reliable databases than they already have, databases that enable key stakeholders – buyers, sellers, custodians, and regulators – to keep shared, indelible records, thereby reducing cost, mitigating settlement risk, and eliminating central points of failure." (Tapscott and Tapscott, 2016).

On top of the existing seven layers of **INTERNET** infrastructure, the **BITCOIN** ledger builds a new layer of functionality – layer 8 – just as hypertext transfer protocol [http] builds network layer on the **TRANSMISSION CONTROL PROTOCOL /INTERNET PROTOCOL** [**TCP/IP**] network layer. This new transactions layer allows for the separation of the security and identification functions from the network. Based on new breakthroughs in information theory, security can be heterarchical rather than hierarchical – distributed on millions of provably safe devices beyond the network and unreachable from it. It is a security paradigm diametrically opposed to existing morass of passwords, usernames, **PINS**, personal tokens, and post-hack fixes on the network. In a **BITCOIN** transaction, there is no more need for the disclosure of personal information than in cash transactions. "From 1988 to 2016, the American top 1% of people went from controlling just under 30% of the wealth to 39% while the bottom 90% went from holding 33% to less than 23% of the wealth. It is no coincidence that the five largest companies in the S&P 500 by market capitalization are Facebook, Apple, Amazon, Microsoft, and Google (FAAMG). They remain immune to crisis: As the COVID-19 pandemic destroys entire industries, Big Tech continues to see rapid growth in wealth and power. FAAMG is the top 1% of the global wealth Pareto distribution, the steepest corporate Pareto distribution in history. ……… Before the year 2000, people could create and run software but had no easy way to succeed on the Internet.

The Cloud solved this problem by providing computational power, storage, and a place to host software. This opened a new doorway for data sharing and is the bedrock of the Internet today. It also stripped users and developers of ay power they might have had. This kick-started a positive feedback loop, funneling all the Internet's leverage into today's cloud giants. …. Beyond size and control. FAAMG wins by optimizing technology and minimizing overhead better than anyone. Their software can be copied virtually for free, and it scales to infinity. Customers do the work to improve existing systems by providing their data. Digital labor theory validates the idea that users can inadvertently act as workers, especially in social media. FAAMG users are the product, not the customer. The economic proof is apparent when comparing annual economic value per worker in traditional companies to tech titans, such as GM and Facebook: Economic value is $231,000 per GM employee and is $20.5million per Facebook employee" (McFarland, 2021).

With the ascendancy of **AMAZON**, **APPLE** and other on line emporia early in the 21st century, much of the **INTERNET** was occupied with transactions, and the industry retreated to the **CLOUD**. Abandoning the distributed **INTERNET** architecture, the leading Silicon Valley entrepreneurs replaced it with centralized and segmented subscription systems, such as **PAYPAL**, **AMAZON**, **APPLE**'s **iTUNES**, **FACEBOOK**, and **GOOGLE**'s **CLOUD.** **UBER**, **Airbnb**, and other **UNICORNS** followed. These centralized fortresses violate the **COASE THEOREM OF CORPORATE REACH**. "Business should internalize transactions only to the point that the costs of finding and contracting with outside parties exceed the inefficiencies incurred by the absence of real prices, internal markets, and economies of scale.", states the theorem. The industry sought safety in centralization, but centralization is not safe. It turned out to be.

Distributed organizations are as old as the **INTERNET**. Its first users some 50 years ago realized how much can be done by swapping emails and digital files. These exchanges led to the development of **OPEN SOURCE**. Software, jointly written by groups of strangers geographically distant. Today, most distributed startups have **OPEN SOURCE** roots, **GATSBY** is one. Nearly all 1200 employees of **AUTOMATTIC**, best known for **WordPress**, software to build websites, work from home. **GitHub**, which hosts millions of **OPEN SOURCE** products that was acquired by **MICROSOFT** in 2018 may be the world's biggest distributed enterprise. Two thirds of 2000 staff work remotely. Most firms that build blockchains, a type of distributed database, are by their nature dispersed.

Joel Gascoigne, the director of **BUFFER**, which helps customers manage social-media accounts, works remotely from Boulder, Colorado. **STRIPE**, an online-payment firm, has its headquarters in San Francisco and its engineering hub is a collection of remote workers. **d:code:it**, a Fin-Tech, has its head office in London and its design studio in Vienna. Distributed startups exist because of a panoply of digital tools, most obviously corporate-messaging services such as **SLACK** [chat] and **ZOOM** [videoconferencing] as lesser known firms like **MIRO** [virtual whiteboards for brainstorming] or **DONUT**, which pair employees to forge personal bonds. Others like **PROCESS STREET**, **CONFLUENCE** or **TRELLO**, help manage work flow and keep track of what goes on in virtual corridors, crucial when people do not share the same physical space. Firms offering organizational scaffolding for distributed firms include **RIPPLING**, which manages payroll and employee benefits, grants workers access to corporate services and sets up their devices.

GOOGLE developed the integrated model of reality combining a theory of knowledge, named **BIG DATA**, a technological vision, **CENTRALIZED CLOUD COMPUTING**, a cult of commons rooted in **OPEN SOURCE** software. The **GOOGLE** theory of knowledge, **BIG DATA**, is as radical as Newton's as intimidating as Newton's was liberating. Newton proposed a few relatively simple laws by which any new datum could be interpreted and the store of knowledge augmented and adjusted. Hundreds of thousands of engineers have added and are adding to the store of human knowledge by interpreting one datum at a time. John Gribbin, in **DEEP SIMPLICITY: BRINGING ORDER TO CHAOS AND COMPLEXITY** (Gribbin, 2004), shows how chaos and complexity permeate the universe on every scale, governing the evolution of life and galaxies alike. Far from overturning all that has gone before, chaos and complexity are triumphant extensions of simple scientific laws.

BIG DATA's approach is different. The idea of **BIG DATA** is that the previous slow, clumsy, step-by-step search for knowledge by human brains can be replaced if two conditions are met. All the data in the world can be compiled in a single "place", and algorithms sufficiently comprehensive to analyze them can be written. Upholding this theory of knowledge is a theory of mind derived from the pursuit of artificial intelligence. In this view, the brain is also fundamentally algorithmic, iteratively processing data to reach conclusions. Belying this notion of the brain are the studies of actual brains which show human brains to be much more like sensory processors than logic machines.

Iain McGilchrist argues in **THE MASTER AND HIS EMISSARY: THE DIVIDED BRAIN AND THE MAKING OF THE WESTERN WORLD** (McGilchrist, 2010) that one's feelings are not reaction to, or a superposition on, one's cognitive assessment, but the reverse: the affect comes first, the thinking later. We make an intuitive assessment of the whole before any cognitive process come into play, though they will, no doubt, later be used to 'explain' and justify, our choice. We make an assessment of the whole at once, and pieces of information about specific aspects are judged in the light of the whole, rather than the other way around. The implication is that our affective judgement and our sense of the whole, depend on the right hemisphere, occur before cognitive assessment of the parts, the contribution of the left hemisphere of the brain. Marvin Minsky in **THE EMOTION MACHINE: COMMONSENSE THINKING, ARTIFICIAL INTELLIGENCE, THE FUTURE OF THE HUMAN MIND** (Minsky, 2006) offers a nuanced version.

The cloud is the great new heavy industry of gargantuan data centers composed of immense systems of data storage and processors, linked together by millions of miles of fiber optic lines and consuming electric power and radiating heat to an extent that exceeds most industrial enterprises in history. In 2006, **GOOGLE** purchased **ANDROID**, an **OPEN-SOURCE OPERATING SYSTEM** that is endowing companies around the world with ability to compete with **iPHONE**. As **ANDROID** thrives, two things become apparent. The **INTERNET** may have ushered in a new age of sustainable open systems, but as **APPLE** have shown an integrated closed system monopoly remains as irresistible as ever.

The next layer up has become more concentrated, including many consumer services, from on line search to social networking. Centralization is rampant in what could be called the "third layer" of the **INTERNET**. All of its the extensions has spawned. **APPLE**'s **iOS** or **GOOGLE**'s **ANDROID** are what most people use as their smartphones' operating system. **AMAZON**, **GOOGLE** and **MICROSOFT** are the major competitors in cloud services outside of China. **ALIBABA** has a strong global lead in cloud services. In 2017 **ALIBABA** captured 45% of China's fledging cloud services market worth 69billion yuan [$10billion] compared to 10% for **TENCENT** according to **BLOOMBERG**. **TENCET**'s **WeChat**, however, is on 4 in every 5 Chinese smartphones, and thus offers multiple products and a massive market for firms.

FACEBOOK may have been the world's largest social network, but **TENCENT**'s broad product based business model and technology is, by many measures, far superior. Less than 20% of **TENCENT**'s revenue comes from online advertising, 98% of **FACEBOO**K's revenue, the other hand, is from online advertising. **TENCENT** has a digital assistant, **XIAOWEI**, a mobile payment system, **TENPAY**, and a cloud service, **WEIYUN** and also launched a movie studio, **TENCENT PICTURES**. In 2007, it introduced a cloud-based platform that allows companies to offer services to users in **WeChat** via 'mini programs' [i.e. tiny apps.]. More than 1million such 'mini programs' are used by over 200million people every day, and most of them are **WeChat** users. **TENCENT**'s revenue from such mini programs, for now, is marginal, and furthermore, competitors like **ByteDance**, are crowding what is on the offer with their 'mini programs'.

ANT FINANCIAL's **MYbank** **TENCENT**'s **WeBank** have grown fast. Both have used automation, machine-learning and troves of data to define identification and security standards crucial as banks and payments move on line. **WeBank**'s facial-recognition tool has an error rate of less than one in a million, the human eye averages 1%. **MYbank** in 2018 served 20million of the country's **SMES**. **MYbank** also rents its kit to 200 other banks and hopes to use Hong Kong and Singapore as testing grounds for those skills abroad. Investors think internationalization has promise: **ANT FINANCIAL**, which is private, was valued at $150billion in its latest funding round. **WeBank** is taking a different track. It is making the infrastructure it created available on an open-source basis, so foreign banks can build upon it.

PING AN, the Chinese insurer has decided to become a cloud company with 32 stand-alone businesses to help export the tech it hones at home. **OneConnect**, an offspring, that listed in2019 in New York, supplies the artificial brain and nervous system of financial firms that go digital. It serves China's top lenders and 99% of the next tier down. The firm offers cloud-based services that cover everything, from back office to client-facing tasks. It belongs to a new breed of Chinese firms that are re-welding the pipes channeling money in the developing world.

Quick success develops its own downside is a folk-wisdom. In February 2019 in America, **ByteDance**, the parent of **TikTok** paid $5.7million fine for illegally collecting data on users under the age of 13, and in April an Indian court banned the app on the grounds that it abets sexual predators. **ByteDance**'s largest market outside China is in India where 2 of 5 **TikTok** users live. **TikTok**, short-video app no Western teenager can do without these days, stresses its independence from authorities in Beijing. Its parent company less so. **ByteDance** whose valuation in 2019 makes its world's biggest unlisted startup, has teamed up with **SHANGHAI DONGFANG NEWPAPER COMPANY**, a state-run publisher. The joint venture, in which **ByteDance** holds a 49% stake, will among other things, develop **Ai** technologies. Natural though it may appear in China, the joint venture comes weeks after President Trump's government opened a national security review of **TikTok** on worries that it gives Beijing access to data on millions of Americans and censors content the regime does not like. **ByteDance** insists that data on non-Chinese users sit on non-Chinese servers and what Americans are or aren't shown is decided in America.

Donald Trump tried and failed to force **ByteDance** to sell **TikTok**'s American business to a domestic owner towards the end of his presidency. The most frequently cited risk was national security, the same argument American authorities used to ban **HUAWEI**'s superior 5G technologies. China's government has the right to demand whatever data it likes from firms based in China, including data held abroad. For that reason, the Committee on Foreign Investment in the United States [**CFIUS**], a Treasury-led panel which vets deals for national security risks, ordered the reversal in 2020 of a Chinese company's purchase of **Grindr**, a dating app which records users' sexuality and **HIV** status, among other things. Like most social apps, **TikTok** hoovers up information about customers' phones, usage patterns and locations, and uses third-party tracking services. Most of the data collected from **TikTok** users could be scraped from **TikTok**'s front end or bought on line – especially regarding Americans, who are poorly protected by data-privacy laws. The advantage of inside access would be marginal. The bigger, underappreciated problem with **TikTok** is the chance it offers Chinese government to manipulate what the app's vast foreign audience sees. **TikTok** has become a major news platform. A quarter of American users say they consider **TikTok** to be a news source. In countries with weaker mainstream media the share is as high as 50%. **TikTok**'s content moderators are outside China. But the app's algorithm is nurtured in Beijing.

ByteDance is not the only big Chinese tech firm that works closely with state-owned enterprises, especially in **Ai** that the Communist Party regards as strategic. In 2016, **BAIDU** agreed to develop technologies with state-owned telecoms firms. In June 2019, Jack Ma of **ALIBABA** started discussions with **SASAC**, a government body that oversees state-owned enterprises to develop tie-ups to promote digital innovations with state-owned telecom firms. **TENCENT** has been urged to do the same according **SOUTH CHINA MORNING POST**.

According to **SOUTH CHINA MORNING POST**'s **ABACUS**, **BAIDU**, **ALIBABA**, **TENCENT** [**BAT**] hold stakes in 150 companies abroad. **ALIBABA** has 56 data centers overseas, according to **ABACUS**, and **TENCENT**'s equity in **SNAP** is 17.5% and 7.5% in **SPOTIFY**. But in 2018, The Committee on Foreign Investment in the United States, [**CFIUS**], blocked several Chinese firms' investments, largest being $1.2billion purchase of **MoneyGram** by **ALIBABA**'s **ANT FINANCIAL**. In 2019, Chinese firms' investments in America fell below $5billion. It was $46billion in 2016. So far, President Trump's **MAGA** policies seem to be set to defer global spaghetti-like financial entanglements, not untangle them.

CHINA INTERNET INVESTMENT FUND (**CIIF**) owns part of a subsidiary of **ByteDance**, parent of **TikTok** and **WEIBO**, a **TWITTER**-like platform. It has a stake in **SenseTime**, an Ai company and **KUAISHOU**, a short video service. **CIIF** is mostly owned by the **CYBERSPACE ADMINISTRATION OF CHINA** (**CAC**), an internet watchdog, akin to America's Federal Communications Commission taking stakes in tech groups such as **Facebook** and **TWITTER**, appointing board members, then steering them in the direction it sees fit. In 2020, Chinese corporate landscape might best be described as a sprawling complex of state-private commerce. More than 130,000 private companies had formed joint ventures with state-owned companies by 2019, up from 45,000 at the turn of the century.

In 2012 Zhang Yiming founded a software firm called **ByteDance**. Among its first creations were **Neihan Duanzi**, a platform for sharing jokes, and **Toutiao**, a news aggregator that became China's biggest aggregator in ten years. In 2016 Zhang Yiming released **Douyin**, an app for recording and sharing lip-sync videos. **Douyin** was modelled after **Musical.ly**, another Chinese-made lip-synching app that was popular with Americans, but enhanced by **ByteDance**'s Ai discovery engine. It was a hit. The following year **ByteDance** released a twin app outside China, with an identical interface and algorithm but separate content. It used **Douyin**'s logo of juddering musical quaver but had a snappier name **TikTok**. A little after four years, **TikTok** reached 1billion users, a milestone that **Facebook**, **YouTube** and **Instagram** took eight years to pass, albeit at a time when fewer people were online. It has been the world's most downloaded mobile app since 2020. Beneath **TikTok**'s simpleinterface lies fearsomely advanced artificial intelligence. Its knack for learning what people like. **TikTok** makes creating films easy. It has done for video-editing what **Instagram** did for photo-editing, allowing amateurs to turn wobbly recordings into slick-looking films. Better yet, the Ai discovery algorithm dangles the prospect of viral success before unknown creators, who struggle on apps like **Facebook**, which reward those with lots of followers. **TikTok** is also easy to watch. Whereas most social-media apps recommend content from the user's network of friends, **TikTok** requires no network, no searching, nor even any login: its algorithm plucks videos from vast archives and learns what the viewer likes. The format is addictive. In America, **TikTok**'s users spend an average of 46 minutes a day on the app. **TikTok** is monetizing this attention. Its revenues were $4billion in 2021 and is to reach $12billion in 2022. Its effect on competition has been dramatic. In 2020 American trustbusters sued **Facebook**, now known as **Meta**, for alleged dominance of social media. Two years later such worries looked eccentric. **Facebook** is re-engineering its products to mimic **TikTok**. America often accuses China of copying capitalism. Now the boot is on the other foot as was the case with **HUAWEI**'s **5G**. **ByteDance**, **TikTok**'s owner, is incorporated in Cayman Islands and has investors from all over, including America's **General Atlantic** and Japan's **SoftBank**.

The data giants, **AMAZON**, **Facebook** and **GOOGLE**, as they dominate their respective core markets, they also have accumulated more digital information than any other Western company. They use the information they store to sell targeted advertising and to fuel the development of their artificial intelligence [**Ai**] services. At its core, **GOOGLE** is a list of websites and a database of people's search histories. **Facebook** keeps track of their users' identity and interactions among them. **AMAZON** collects credit-card numbers and purchasing behavior.

These data giants' capacities to process, transmit and store data are growing by explosive increments. Scientists define an explosion as the injection of energy into a system at a pace that overwhelms the system's ability to adjust. This produces a local increase in pressure, and if the system is unconfined or the confinement can be broken, shock waves develop and spread outward. These explosive increments are injecting pressure into the prevailing socio-economic systems via job displacement faster than the prevailing socio-economic systems can absorb it via job replacement. The explosive potential emerges from the mismatch between the speed at which disruptive energy is injected into the system by job displacement and the socio-economic system' ability to absorb it with job creation. The displacement is driven by the eruptive pace of digital technology's application to information and communication technology. Artificial intelligence's and tele-migration's [remote intelligence's] elimination of jobs. The replacement is driven by human ingenuity which moves at the leisurely pace it always has. The radical mismatch between the speed of job displacement and the speed of job replacement has been a perennial downside of technological transformations. In the age of hyper-intelligence, the disruptions are faster. Technology produces and economic transformation, the economic transformation produces and economic and social upheaval, the upheaval produces a backlash and backlash produces a resolution according to Richard Baldwin in **THE GLOBOTICS UPHEAVAL: GLOBALIZATION, ROBOTICS, AND THE FUTURE OF WORK** (Baldwin, 2019).

4. Conclusion

So far, the American data giants seem to have adopted the business model of attention merchants. They capture out attention by providing us with free information, services, and entertainment, and they then sell our attention to advertisers. The data giants seem to have far higher goals than any previous **ATTENTION MERCHANTS**. In 1920s, Sigmund Freud's nephew, Edward Bernays, realized that his uncle's psychotherapy opened up a new lucrative world of retail therapy by inventing the public relations industry. Despite being far richer than kings of old, we are too easily trapped on a treadmill of consumerism, continually searching for identity, connection and self-transformation through the things we buy. Edward Bernays's method of persuasion – tastefully named 'public relations' – transformed marketing worldwide and, over the course of the 20th century embedded consumer culture as a way of life. Drawing on his uncle's insights into the workings of the human mind his advertising firm convinced some women on behalf of the **AMERICAN TOBACCO CORP** that cigarettes were their "Torches of Freedom" and reduced **MARLBORO MAN**'s existentialist choice to "Good Taste or Good Tobacco".

These data giants' strategic goal is not to sell adverting, their tactical goal for now is. By capturing our attention, they manage to accumulate immense amounts of data about us, [how, when, where, why we behave] which is worth more than any advertising revenue. It is not accurate to think of **GOOGLE**'s users as its customers. There is no economic exchange, no price, and no profit. Nor do users function in the role of workers. Users are not paid for their labor, nor do they operate the means of production. The user is not the product, but rather they are the sources of raw-material supply. **GOOGLE**'s products are derived from data about users' behavior. Its products are about predicting users without caring what the users do or what is done to the users.

In the medium term, this data hoard opens path to a radically different business model whose victim will be the advertising industry itself. The strategic business model is based on transferring decision making from humans to algorithms, including the authority to choose and buy things. Once algorithms choose and buy things for us, the traditional advertising industry will be redundant. **GOOGLE** is aiming to reach a point where we can ask **GOOGLE** anything and get the "best answer" in the world.

In **THE GREAT TRANSFORMATIOIN: THE POLITICAL AND ECONOMIC ORIGINS OF OUR LIVES** (Polanyi, 1944), Karl Polanyi identified three transformations. First was branding human life as labor. Second was branding nature as real estate. Third was branding free exchanges of goods and services as money. The fourth, Shoshana Zuboff explains in **THE AGE OF SURVEILLANCE CAPITALISM: THE FIGHT FOR A HUMAN FUTURE AT THE NEW FRONTIER OF POWER** (Zuboff, 2019) is "as the emerging economic order that expropriates human experience as free raw material for hidden commercial practices of extraction, prediction, and sales that subordinate production of goods and services to a new architecture of behavioral modification" (Zuboff, 2019) **GOOGLE** was the first in Silicon Valley to understand the concept of "behavioral surplus" in which human experience is subjugated to attention merchants' surveillance capitalism's market mechanisms and reborn as behavior. Everything one does and think on line has the potential to be monetized by platform tech firms. All human activity is potentially raw material to be commodified by the tech firms. "**GOOGLE** is to surveillance capitalism what the **FORD MOTOR COMPANY** and **GENERAL MOTORS** were to mass-production based **MANAGERIAL CAPITALISM**," Shoshana Zuboff wrote. (Zuboff, 2019) Nearly everything we do can be mined by platform companies. But only if they can keep information free. That means keeping value of personal data opaque, ignoring copyrights on content by making it difficult to protect.

"Now, with the rise of the surveillance capitalism practiced by Big Tech, we ourselves are maximized for profit. Our personal data is, for Big Tech companies and others that harvest it, the main business input. .... You are the raw material used to make the product that sells you to advertisers." writes Rana Foroohar in **HOW BIG TECH BETRAYED ITS FOUNDING PRINCIPLES AND ALL OF US: DON'T BE EVIL**. (Foroohar, 2019). "As in any transaction, the party that knows the most can make the smartest deal. The bottom line is that both big-platform tech players and large financial institutions sit at the center of an hourglass of information and commerce, taking a cut of whatever passes through. They are the house, and the house always wins" (Foroohar, 2019). Companies that both create marketplaces or platforms, and then also do commerce within them have an unfair advantage.

TWITTER and **FACEBOOK** may look similar at first glance. Each is a social network connecting users online and presenting them with content in a "feed", a never-ending list of posts, pictures and videos of pets. Each employs every trick to glean data from users' behavior that enable advertisers to hit targets precisely for which advertisers pay to influence the decisions users are to make. Dipayan Ghosh in **TERMS OF DISSERVICE: HOW SILICON VALLEY IS DESTRUCTIVE BY DESIGN** (Brookings Institute, 2020) illuminates the differences between the two social networks. **TWITTER** is essentially an internet "Speakers' Corner", where anyone can hold forth and others can talk back. It is "one-to-many" broadcast network. **FACEBOOK** is "one-to-one" or "one-to-few" network, replicating social relationships of the sort between friends, family or colleagues. The difference may seem subtle, but it has several implications for both firms' business.

FACEBOOK is able to gather more data about its users because they are more engaged with others. This makes it easier to target ads. **FACEBOOK** also benefits from stronger "network effects". Each additional subscriber makes the service more useful for others, which attracts more subscribers. **TWITTER** cannot rely on such a turbocharged engine of growth. Having friends is a social need, maintaining a soapbox is non-essential for most, even for some serious extroverts. In 2019 **FACEBOOK** reported 9 times the users, 21 times the revenue and 12 times the profit of **TWITTER**. Moreover, the strong network effects are a prime asset that **FACEBOOK** has defended vigorously. It has spent $1billion in acquiring **INSTAGRAM** in 2012, and $19billion for **WHATS-APP** in 2014. **FACEBOOOK**'s size has made it the dominant outlet for political discourse outside of China.

One particular area of concern is how big tech firms use machines rather than human relationships to judge customers, as Cathy O'Neil exposes in **WEAPONS OF MATH DESTRUCTION: HOW BIG DATA INCREASES INEQUALITY AND THREATENS DEMOCRACY** (O'Neil, 2016, 2017) to hoover up online data by using opaque algorithms and use the data to create customer profiles and sell them. ".... many of these models encoded human prejudice, misunderstanding and bias into the software systems that increasingly managed our lives. Like gods, these mathematical models were opaque, their workings invisible to all but the highest priests in their domain: mathematicians and computer scientists. Their verdicts, even when wrong or harmful, were beyond dispute or appeal. And they tended to punish the poor and the oppressed in our society, while making the rich richer" (O'neil, 2016). What you do online thus may end up affecting opportunities in your offline life.

In the longer term, by bringing together enough data and enough computing power, the data giants could hack the deepest secrets of life, and then use this knowledge not just to make choices for us or manipulate us but also to reengineer organic life and create inorganic life forms. Selling advertisements may be necessary to sustain the giants in the short term, but tech companies often evaluate apps, products, and other companies according to the data they harvest rather than according to the money they generate. The business model of a popular app may be a money loser, but as long as it sucks data, it could be worth billions. Cash rich tech firms have become the financial engineers of the 21st century. The rate of return analysis of corporate finance does not help much.

Tim Wu in **THE MASTER SWITCH: THE RISE AND FALL OF INFORMATION EMPIRES** (Wu 2011) suggest that to understand the forces threatening the **INTERNET** as we know it, we must understand how information technologies give rise to industries and industries to monolithic structures. As with any economic theory, there are no laboratories but past experience. Illuminating the past to anticipate the future is the raison d'etre of economic history, which is conspicuously absent in MBA programs mass-marketed by American universities. Understandably so, because history, many times, negates their neoclassical mantra.

Schumpeter had no patience for what he deemed Adam Smith's fantasy of price warfare, growth through undercutting your competitor and improving the market's overall efficiency thereby. "In capitalist reality as distinguished from its textbook picture, it is not that kind of competition which counts," argued Schumpeter, but rather "the competition from the new commodity, the new technology, the new source of supply; the new type of organization." Schumpeter's theory did not account for the power of law to stave off industrial death and arrest the creative destruction or help to speed up the destructive process by not regulating mergers and acquisitions.

Digital Millennium Copyright Act Congress passed in 1998 gave companies that provided online services "safe harbor" immunity from copyright-infringement liability for their user's actions to protect e-commerce sites from being responsible what third-party actors are selling on their sites. "E-commerce represents about 10% of all US retail and **AMAZON** is by far the largest player, with an estimated share of 43%. In 1998 **AMAZON** accounted for 53% of all the incremental growth of online shopping, which means they are only growing their dominance.

AMAZON's anticompetitive effect stems from its inherent conflict as both a direct seller and the operator of a platform that it invites other sellers to use. … According to **UPSTREAM COMMERCE**, **AMAZON** tracks third-party sales on its site and uses that data to sell the most popular items in direct competition with marketplace members. …. **AMAZON** has a clear conflict of interest when it comes to policing counterfeits and competing with its own partners. As a platform, it wants the maximum number of people selling on its site, much like **FACEBOOK** and **GOOGLE** want the maximum number of eyeballs to sell ads against. Whether that comes from pirated content or not, the tech giants simply don't care. … A recent study by **ProPublica** found that the company is using its market power and proprietary algorithm to advantage itself at the expense of sellers and many customers. When they searched for hundreds of items on the site, about three-quarters of the time, **AMAZON** put its own products above third-party products using its platform, when competing products were cheaper. As a platform, it pays to be the regulator of your own marketplace" (Tepper and Hearn, 2019).

ALPHABET, **GOOGLE**'s holding company, in 2018 was the second largest company in the world. Measured by market capitalization, **APPLE** was first. Joined by **AMAZON**, **MICROSOFT** and **FACEBOOK**, the five form an increasingly feared global oligopoly. "Between **GOOGLE**, **AMAZON**, **APPLE**, **FACEBOOK**, and **MICROSOFT**, they have collectively bought over 436 companies and startups in the past 10 years, and regulators have not challenged any of them. In 2017 alone, they spent over $31.6billion on acquisitions. Most small companies now do not expect to succeed on their own and their only goal is the 'exit' to one of the big tech companies before they are crushed" (Tepper and Hearn, 2019).

In the 1970s, the microprocessor radically reduced the cost of computers. In the 1990s, **OPEN SOURCE** software started to dethrone **WINDOWS**, **MICROSOFT**'s then dominant operating system. Richard M. Stallman of **MIT**'s **ARTIFICIAL INTELLIGENCE LABORATORY** argued that software code was quickly becoming the language of communication between people, and people and things, and that it was immoral and unethical to enclose and privatize the new communications media, allowing few corporate players to determine the conditions of access while imposing rent. To keep software distributed, collaborative and free, Stallman assembled a consortium of programmers and erected an operating system called **GNU** made up of free software that could be accessed, used, and modified by anyone. In 1985 founded the **FREE SOFTWARE FOUNDATION**. **GNU GENERAL PUBLIC LICENSE** [**GLP**], unlike conventional copyrights that give the holder the right to prohibit others from reproducing, adopting, or distributing copies of an author's work, allow an author to give every person who receives a copy of a work permission to reproduce, adapt, or distribute it and require that any resulting copies or adaptations are also bound by the same licensing agreement. **GPL** became the vehicle for the establishment of free sharing of software.

Six years after Stallman's **GNU** operating system and the **GPL**, Linus Torvalds designed a free software kernel for a Unix-like operating system for personal computers that was compatible with Stallman's **GNU** project and distributed it under the **FREE SOFTWARE FOUNDATION**'s **GPL**. The **LINUX** kernel made it possible for thousands around the world to collaborate via **INTERNET** on improving free software code. In 1998, Eric S. Raymond and Bruce Perens created **OPEN SOURCE INITIATIVE**, **OSI**, to dampen **FREE SOFTWARE MOVEMENT**'s fear of commercial interests.

MICROSOFT might never have come to rule **PC** software had **IBM**, accused of monopolizing mainframes, not decided in 1969 to market computers and their programs separately, a move that created the software industry. **GOOGLE** might not have taken off in the way it did had **MICROSOFT** not agreed, at the end of its antitrust trials in America and Europe in the 2000s, not to discriminate against rival browsers and to license technical information which allows other operating systems to work easily with **WINDOWS**.

MICROSOFT's first operating system [**MS-DOS**] that **MICROSOFT** acquired from another firm, **SEATTLE COMPUTER PRODUCTS**, was actually a clone of **CP/M**, another operating system. **MICROSOFT WINDOWS** was a rip-off of the **APPLE MACINTOSH** operating system; **MICROSOFT WORD** and **EXCEL** were copies of **WORDPERFECT** and **LOTUS 1-2-3** respectively. By late 1990s, **MICROSOFT** unleashed its predatory strategy against **NETSCAPE**. **EXPLORER** was **MICROSOFT**'s copy of **NAVIGATOR**, and soon **NAVIGATOR** was nowhere **EXPLORER** was everywhere. In few short years **NETSCAPE** was bankrupt. As Brian McCullough detailed in **HOW INTERNET HAPPENED: FROM NETSCAPE TO THE IPHONE** (McCullough 2018). With minimal antitrust enforcement, **MICROSOFT** would have been in a perfect position to control the future of internet, had Department of Justice not decided to prosecute the last big antitrust case of the 20th century.

MICROSOFT was built as technological walled garden. On April 21, 2020, however, it announced its plans to launch 20 data-sharing groups by 2022 and give away some of its digital information, including data it has gathered on COVID-19. The OECD recons that if data were more widely exchanged, many countries could enjoy gains worth 1-2.5% of GDP. The estimate is based on heroic assumption on opportunities for start-ups. But most agree that readier access to data is broadly beneficial, because data are non-rivalling. Unlike oil, they can be used and re-used without being depleted to power various artificial-intelligence algorithms at once. **MICROSOFT**, besides encouraging non-commercial sharing, is developing software, licenses and rules frameworks to let firms trade data or provide access without losing control. Optimists believe that **MICROSOFT**'s move could be to data what **IBM**'s embrace of **LINUX** operating system was to open-source software in 1990s. **LINUX** went on to become a rival to **MICROSOFT's WINDOWS** and today underpins **GOOGLE's ANDROID** mobile software and much of cloud-computing.

Fewer than 100 firms collect more than half of all data generated on line. More sharing would counteract concentration. Data are more complex than code. Most programmers speak the same language and open-source collectives mainly solve technical problems. People in charge of data often come from different industries without a common vocabulary. Unlike **ALPHABET** and **FACEBOOK** that extract value from hoarded data through targeted advertising, **MICROSOFT** makes most of its money by selling services and software to help others process digital information. The more data shared the better for **MICROSOFT**.

FIREFOX, a web browser made by the non-profit **MOZILLA FOUNDATION**, was born as 'phoenix'. It rose from the ashes of **NETSCAPE NAVIGATOR**, slain by **MICROSOFT**'s **INTERNET EXPLORER**. In 2012, **MOZILLA** created **FIREFOX OS**, to rival **APPLE**'s **IOS** and **GOOGLE**'s **ANDROID** mobile operating systems. **MOZILLA** began life in 1998 after the "browser war" between **MICROSOFT**'s **INTERNET EXPLORER** and

NETSCAPE's **NAVIGATOR**. Even though the fight got **MICROSOFT** into deep trouble with completion regulators, which nearly broke it up, **NETSCAPE** had to capitulate. But released the **NAVIGATOR**'s source code so that an alliance of volunteer developers could keep the browser alive. Even compared with other **OPEN-SOURCE** projects, **MOZILLA** is an unusual hybrid. It boasts a volunteer workforce of nearly 23,000 that contributes about half of the company's code in exchange for little more than recognition from their peers and the satisfaction of chipping in to a project they believe in. It is two organizations in one; the **MOZILLA FOUNDATION** and the **MOZILLA CORPORATION** that has 1,100 employees on payroll. The first is a charity which owns the second and makes sure that it does not stray away from its mission. The corporate arm is in charge of products and gets the cash that search engines pay for appearing on **FIREFOX**'s start page. Together **GOOGLE**, **BAIDU** and **YANDEX** and a host of others paid $542million for the traffic they got from **FIREFOX** in 2017.

MOZILLA has shown that open-source approach can work in consumer software. **FIREFOX** was the first browser to block-up ads and allow users to surf anonymously, promoting commercial browsers to offer similar features.

Unable to compete, **MOZILLA** killed the ill-fated mobile operating system project. Another 'phoenix' has arisen from it. **KAIOS**, an operating system conjured from the defunct software, powered 30million devices in 2017 and another 50millioin in 2018. Most were simple flip-phones sold in the West for about $80 a piece, or even simpler ones which Indians and Indonesians can have for as little as $20 or $7, respectively. **KAIOS**, based in Hong Kong, designed the software for smart-ish phones with old-fashioned number pad and long battery life, plus 4G connectivity, popular apps like **FACEBOOK** and features like contactless payments without snazzy touchscreens. **GOOGLE** invested $22million in **KAIOS** in 2018. Even if **KAIOS** powers another 70million devices in 2019, as the company expects in 2019, that would barely be one tenth of the 1.5billion **APPLE** and **ANDROID** phones sold annually.

A decade ago American firms took an early lead in 4G setting standards for new handsets and applications that spread word-wide. That dominance helped **APPLE**, **GOOGLE**, and other American businesses generating billions of dollars in revenues. China learned its lessons, investing $180billion to deploy 5G networks over the next 5 years and assigning swathes of wireless spectrum to three state providers. In America the same part of the spectrum is largely off-limits commercially because it is used by the federal government. American firms are experimenting with different parts of the spectrum that has some advantages under laboratory conditions but easily blocked by buildings and trees. **AT&T** and **VERIZON** had to delay switching on their of 5G networks in 2021 after Federal Aviation Administration aired concerns that their 5G radio spectrum interferes with avionics on some aging aircraft. Until 2022, actual 5G coverage in America had been limited. Only one of the country's three biggest carrier, **T-MOBILE** offered broad 5G connectivity. The potential consequences of the market power held by the new technology giants are greater and more pernicious than anything seen at the turn of the 20th century. Then the market power of companies like **SWIFT**, **STANDARD OIL**, **AMERICAN TOBACCO**, The **AMERICAN SUGAR REFINING COMPANY**, or **US STEEL** allowed them to raise the price they charged for food, steel, tobacco, sugar and oil. Now, it is about more than just the price.

The equivalent course of action now is to force today's giants to open up their data vaults, thus lowering the barriers to entry and giving newcomers a better chance to compete. Now it is the turn of data. Today online applications bundle user interface, code and data. **FACEBOOK**, for example, is known for its website and app, but both are just the tip of a virtual iceberg. Most of the software and all the information that keep social network going live in the firm's **CLOUD**. Controlling those data gives these companies power. Users are free to move to another service, but they would lose all that information, including the links to their friends.

In the early 1980s, US antitrust regulators allowed **AT&T**, the world's largest network operator then, and **IBM**, the biggest computer firm of the era, to enter each other's markets. **AT&T** started selling personal computers and **IBM** bought **ROLM**, which sold telecoms equipment. Pundits predicted an epic battle between the two giants and a rapid convergence of the telecoms and computer industries into one. Neither the battle nor the convergence materialized. Forty years ago the two markets proved too distinct and the technology was not up to the challenge. In 2022 things look different. Clouds, **AWS** and **AZURE** are becoming able to deal with the task of powering network.

5G was conceived from the start not as collection of switches and other hardware, but as a set of services that can be turned into software, or "virtualized". The telecoms industry is becoming less proprietary, embracing "open radio access network" (**O-RAN**) standards that make it possible to virtualize ever more functions previously performed by hardware. As a result, networks can turn into platforms software add-ons, just as mobiles turned into smartphones which could run on apps. **DISH NETWORKS**, a satellite-service company is launching the fourth **5G** connectivity in America. Except for antennas and cables, it is mostly a cluster of code that runs on **AMAZON WEB SERVICES**. Instead of bulky base stations used in conventional mobile networks, it technology is housed in slender boxes attached to antenna posts. These are connected directly to the **AWS** cloud, which hosts the virtual part of the network. As a result, DISH's network will be cheaper to set up and to run. **DISH** also plans to use Ai to optimize the use of radio spectrum, including by training algorithms which are able to adapt parts of network to specific conditions such as a storm or a mass concert. In 2021, **MICROSOFT** bought **AFFIRMED NETWORKS** and **METASWITCH**, the main software suppliers for the core of **AT&T**' 5G network. In June 2021, **AT&T** sold the technology that powers the core of its 5G network to **MICROSOFT**. **AZURE FOR OPERATORS**, a new business unit, will run it for **AT&T**'s 5G network. **GOOGLE** has a similar unit with forged partnership with **TELENOR**, the Norwegian telecoms company. In November 2021, **AWS** announced a new offering that lets customers set up private 5G networks on their premises. **RAKUTEN**, the Japanese on-line company has already built a DISH-like network in Japan. Rather than outsourcing its cloud operation, **RAKUTEN** has built its own, and launched a subsidiary, called **RAKUTEN SYMPHONY**, to offer the system to other operators. Existing mobile networks will not be replaced overnight. Serious technical barriers remained to be solved in 2022.

EUROPEAN COMMISSION fined **GOOGLE** 4.3billion Euros on 7/18/2018 and ordered to **GOOGLE** to stop emulating the 1990s **MICROSOFT**'s product strategy. To assure its market lead, instead of giving the buyers the option to choose, **MICROSOFT** bundled several software in tie-in contracts and offered the bundle to the buyers. **GOOGLE**'s case involved its mobile operating system, **ANDROID**, and bundled related software and services, such as **GOOGLE PLAY**, its app store, internet search and several other apps. **GOOGLE**, in practice, gives smart phone makers and telecoms operators an all or, nothing choice as **MICROSOFT** did in the 1990s. If, the makers want to install any of these programs on their devices, they have to install them all and show their icons in prominent positions. Since firms need at least the app store to make their products commercially viable, they have no choice but to comply. Furthermore, **GOOGLE** does not allow the phone manufacturers to install competing versions of **ANDROID** on any of their models.

By contrast, in **WEB 3.0** interface, code and data are meant to be kept separate. This would allow power to flow back to users, who would decide which application can access their information. If they were not happy with one social network, they could easily switch to another. With such decentralized applications, [**DAPP**s], users could also interact directly with other users without an information-hoarding intermediary in the middle. Similar ideas have been tossed around. Decentralized services, then called "peer-to-peer" briefly flourished in the late 1990s and 2000s. They fizzed out mainly because a robust decentralized database did not exist.

Combining database and network technologies, **BLOCKCHAIN** is a digital peer-to-peer decentralized platform for tracking all kinds of value exchanged between people. Its name derives from the blocks of data, each one a snapshot of all transactions that have just been made in the network, which are linked together to create a chain of data blocks, adding up to a minute-by-minute record of the network's activity. Since, that record is stored on every computer in the network, it acts as a public ledger that cannot be altered, corrupted or deleted, making it a highly secure digital backbone for the future of e-commerce and transparent governance.

With the invention of **BLOCKCHAIN**, a ledger without a centralized administrator maintained collectively by some of its users, called "miners", who also protect the **BLOCKCHAIN** and keep others in check a robust decentralized system is feasible. The **BLOCKCHAIN** is a specialized database in the form of an immutable record of the transaction history, a digital **BABYLONIAN TABLETS**. Most **WEB 3.0** projects comes with **SMART CONTRACTS**, snippets of code that encapsulate business rules which are automatically executed if certain events occur. The advanced projects focus on building the software infrastructure needed for **DAPP**s. **BLOCKSTACK**, arguably very ambitious, is seen as an operating system for such applications.

One digital currency that uses **BLOCKCHAIN** technology is **ETHEREUM,** which among its possible applications, is enabling electricity micro-grids to set up peer-to-peer trading in renewable energy. These micro-grids allow every nearby home, office or institution with a smart meter, **INTERNET CONNECTION**, and solar panel on its roof to hook in and sell or buy surplus electrons as they are generated, all automatically recorded in units of the digital currency. Such decentralized networks, ranging from a neighborhood block to a whole city, build community resilience against blackouts and cut long-distance energy transmission losses at the same time.

The landscape of Chinese **FinTech** is dominated by two players: **ANT FIANCIAL** of **ALIBABA**, and **TENCENT**, best known for **WeChat**, its social media network. **ANT** was estimated to be worth $150billion in 2017, a little less than **HSBS**. Both firms got their start in payments. **ANT FINANCIAL** stems from **ALIPAY** created in 2004, **TENPAY** was launched in 2005 for **QQ**, **TENCENT**'s online-messaging platform, and was later grafted into **WeChat**. Both have boomed by linking mobile apps with offline payments. Almost all merchants in China provide **QR** codes to be scanned by phone in order to pay. In 2017, **ALIPAY** had 54% of the mobile-payment market. It worked with more than 250 financial firms outside of China so that Chinese tourists can use it.

ANT and **TENCENT** are more interested in hooking users on other financial services than in payments alone. Once a user is on their platforms, mutual funds, insurance products, and virtual credit cards are accessible with a tap of a finger on smart phone. The duo's move into retail banking with **TENCENT**'s **WeBank** and **ANT**'s **MYbank** increased regulator's concerns for money-laundering, but also protecting the banks from **FinTech**'s competition.

The control structures built to ensure the ironclad hold of the founders of corporations are referred as "Key man risk", and is a big point of contention in China and abroad. China does not allow foreign entities to own sensitive assets, such as government licenses needed. These licenses are owned by Chinese individuals, often including the founders, are bundled into **VARIABLE INTEREST ENTITIES**. In addition, the Chinese companies listed in America have "dual class" stock structure which allows founders to own a special class of stocks with superior voting rights. **JD.com**, for example, **ALIBABA**'s rival in e-commerce, has the ratio set at one share to 20 votes, enabling Richard Liu, the founder of **JD.com**, to control 80% of **JD.com** voting rights by owning less than 20% of the stock. **JD.com** has not convened an annual stockholders' meeting since its floatation in 2014 which is allowed under corporate governance laws of Cayman Islands where it is incorporated as most global Chinese tech champions are. Cayman Islands, one of Britain's Caribbean territories, seem to be the most favored location to incorporate for Chinese companies set to list in New York. **BAIDU**, for example, listed in America in 2005, and to list it incorporated in Cayman Islands, but has not held a stockholder's meeting since 2008. **TENCENT** of **BAT** is different. It has **VARIABLE INTEREST ENTITIES**, but one-stock-one-vote, and listed in Hong Kong in 2004.

Another first of **GOOGLE** in Silicon Valley was to introduce a dual-class share structure with its 2004 public offering. The two founders, Page and Brin, would control the super-class B voting stock, shares that each carried 10 votes, as compared to the A class of shares, which each carried only 1 vote. The arrangement inoculated Page and Brin from market and investor pressures. Subsequently, the founders imposed a tri-share structure adding a C class of zero voting rights stock. By 2017, Brin and Page controlled 83% of the super-voting-class of B shares, which translated into 51% of the voting power.

When **GOOGLE**'s leads, many Silicon Valley founders follow. By 2015, 15% of **IPO**s were introduced with dual-class structure, compared to 1% in 2005. In 2012 **FACEBOOK**'s **IPO** with a two-tiered stock structure left Mark Zuckerberg in control of voting rights. The company then issued nonvoting class C shares in 2016, solidifying Zuckerberg's personal control over decisions. While the consequences of these share structures are being debated, absolute corporate control enabled the founders of **GOOGLE** and **FACEBOOK** to aggressively pursue acquisitions of start-ups in facial recognition, deep learning, augmented reality and more. Brin and Page at **GOOGLE** who do not enjoy the legitimacy of the vote, democratic oversight, or the demands of shareholder governance exercise control over their organization and presentation of the world's information, but neither do **BAIDU**'s and **ALIBABA**'s CEOs. Zuckerberg at **FACEBOOK** who does not enjoy the legitimacy of the vote, democratic oversight, or the demands of shareholder governance exercise control over an increasingly universal means of social connection along with the information concealed in its networks. So does Jack Ma.

Jack Ma, a founder of **ALIBABA** is a member of the Chinese Communist Party, and indirectly owns four of its five **VARIABLE INTEREST ENTITIES** with one of his co-founders. In 2019, when Jack Ma steps down as chairman, as he said he would, all **VARIABLE INTEREST ENTITIES** will be transferred to two layers of holding companies, in turn owned by a broad set of **ALIBABA**'s senior Chinese staff. Jack Ma will remain a lifetime member of the **ALIBABA PARTNERSHIP**, which concentrates control of the company in a club of 36 senior staff. **ALIBABA PARTNERSHIP** is empowered to appoint majority of board seats. Thus, Jack Ma will keep to have an influential role in the company's culture and ecosystem. This succession plan will unite **ALIBABA**'s, Chairman and CEO, under Daniel Zhang. He has been an adroit CEO for **ALIBABA** since 2015. The succession plans of the founders of the Chinese tech firms who are now in their 40s and 50s, is expected to develop new challenges for global corporate governance in the next decade.

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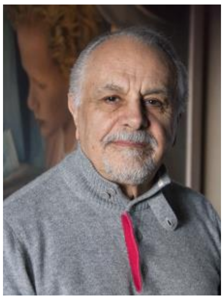

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