The Startup Cycles

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Abstract

Technological innovation follows a cycle that is inherently controlled by the market dynamics, that always maintains an equilibrium. Startups are the main component of that market, and they try to always disrupt that equilibrium. We propose a new model, based on the Schumpeter business cycles, identifying the contraction and expansion of both medium and long-term periods. As well as a mathematical model that identifying dates where innovation happen and its influence on the course of the market for the next cycle.

1. Introduction

Capitalist societies use the word *"revolution"* more than any other society. They break the things they create with their own hands, and in this process, create more wealth and make life better. It would've historically been accurate if the capitalists had the hammer, not the communists.

In the heart of this capitalist revolution, we have startups. They are who we call "*disruptors"*. They break the old ways, adopt new technologies and explore new markets. If that was not hard enough, they all know they are in a death race. Those that are left behind will die. If your product shifts away from the market's direction, or not innovative or fast enough, not fueled with capital… you die.

It shocks no one that it is a revolutionary mentality. That you are willing to die for the cause, and that most of the disruptors will. However, those that survive will be leading the new world. They will dictate its direction, form strict protocols of what should and should not be permitted, and most importantly, prevent any new rebellion from happening.

The only difference in the capitalist system, is the revolutionaries are companies not individuals. They are rebelling against the monopolies, or in other terms, the startups that survived the revolution a long time ago are now leading the market. They are so powerful they dictate the direction and protocols, and any startups daring to go against their vision, will easily be wiped out.

As they have no competition, the customers in the market have no choice but to use their products. They are obliged, and naturally, the monopolies offer them the best effort products to maximize profit. We call this the *"customer's prison".* No matter how free the market is, the monopolies become dictators. Their products deteriorate but the customer have no choice.

But this is not the end of the story. As technology is but a series of new discoveries, scientific innovation happens transparently. The technologists have open access to these groundbreaking discoveries. Entrepreneurs who are visionary enough to understand the possibilities of these new discoveries, know that they finally have a chance to fight these monopolies. The disruptors are born, and they are willing to die for the cause. To free the customers from their prison. In the process make a better and hopeful future, because if they become the leaders, they will lead the market with better compassion.

In the following research, we present a macroeconomic model of the dynamics happening in the technology sector. A model explaining the market regardless of the timeframe, forecasting innovation dates that happens periodically, as well as identifying the technological revolutions that play a role in forming future monopolies. As the model is based on previously predefined cycle theories, it could accurately forecast declines, bear phases, contractions and expansions happening in the technology sector.

The research will start by an overview to define the prerequisites of the model we offer. Then we will state principles that we see vital in the forming of startups that shape the market and the technology behind it. Some intricate principles that are not obvious, and at times counter intuitive. We see them as important as the model itself, because they form the underlying human patterns repeated in successful startups. As the technology itself is not enough to disrupt the market, but the entrepreneurs behind it.

The principles are listed as follow:

- The lemma principle

- Adopters with no standards
- The thing that gets you to the thing
- Economic relativity
- Conservation of data
- The unfair advantage

We will then describe the complete model in “the inevitable cycles”, where we explain in details every part of our model, its component, and the dynamics that emerges out of them.

Then we will talk about the innovation cycles, the dates pointed out by our model and how they all phased with an important event that shaped the market’s vision.

It’s important to note that unlike what is commonly believed, we see that innovation isn’t tied to the human desire or uncertain luck in the technology community, but it is tied to the available capital of investment. As when the financial ground is sound and the market stabilizes, innovation happen. It happens either out of necessity or out of luxury, which is very clear in the model we present.

We will then talk about what can startups learn from this model. We read the current upcoming cycles of Artificial Intelligence startups, we talk about the bubble, and the down turn of the market of 2030.

And lastly, we present a demonstration of the model by calculating the success probability of startups out of it, and compare it to the realistic known percentage of the market.

The appendix contains both the python code to run the model, its mathematical description, definitions, and figures descriptions.

We must note, that this is not a rigorous scientific paper in the classic term. As our goal currently is not to publish this paper in a journal, or spark a debate in the scientific circles. Our goal is to provide a platform for startups to understand the macroeconomics surrounding the market, and empower them with a tool that could accurately (even probabilistically) describe it. We might propose another rigorous paper in the future containing the omitted methodology and proofs that we intentionally skipped.

2. Overview

Nikolai Kundratiev is an economist who remains unknown regardless of his foundational contributions to macroeconomics. His long wave theory was widely criticized, refuted, and refused by economists, and yet, it will be the basis of this white paper. It is impossible to validate or refute a macroeconomic theory. It is usually retrofitted to historical data, describes patterns that emerge out of the global behavior of a particular market. It can only be correctly justified by the test of time, that either judges it is false, or not false yet.

Kundratiev's long wave theory took its last shape on the hands of J. Schumpeter (one of the few economists to acknowledge his work honorably), who is known today as the founder of modern startup ideology, or what he called the principle of "Creative destruction", and what we call: being disruptive.

Every era is created by its researchers. They are the ones who put the early stones of what will become "the revolution". Yet, they only do it by picking up the ashes of the previous revolution. The market behaves in an evolutionary process, or what we might call "economic selection", and only the technologies that survived the previous era would play a role in shaping the current one.

The researchers are driven by technology and innovation. Most of the money fueling the research are grants from universities, or technology monopoly patrons who wants to stay in the loop. Usually there is little to no progress for a while. A lot of other researchers tackling other problems dries out of funds, or hit dead ends, or just get frustrated and move on to other things. We usually have very few teams working on a niche scientific subject, and only a handful of them make it to see applicable results.

Yet as we approach around 16 years of research, things start taking shape and we can see results. Usually, early prototypes are presented and commercial uses are discussed. However, even though big tech companies are in the loop, they do not give any sort of interest, as they already have a pre-established reputation and clients who buy their products. Pushing these research projects that no one asked for to the market is an unjustified risk. The people who are interested to take this risk, are startups. They usually have no reputation, no customers, and they are willing to present an unstable and immature product to the market.

These early-stage startups trying to find their product-market-fit, attract some investors, who fuel their innovation through venture capital. Once a startup

launches a successful product, other startups emerge to imitate and compete, which drives even more VCs. This usually lasts for 18 years, and by the end of this cycle, the market is crowded by innovative products, competition based on value is at its high, and users experience is at its peak.

It is important to note that these two cycles, cycle A {16 years}, cycle B {18 years} do see emergence of monopolies in them. They both go through a recession and an ascension phase. They are considered medium-term cycles. They fuel the emergence of a third similar cycle that will shape a new class of monopolies.

At this point, the technology becomes mainstream as it's useful to the end user, the user experience is intuitive and it's cheap or free due to competition. Venture Capitalists fuel the growth more than before, as mass adoption takes place. Late VCs usually come around this time, trying to capitalize on the long-gone train, they start pouring more money in very risky startups with very low value or product-market-fit. It is at this stage where we see clearly the market-leaders forming, usually those that started at the end of the research phase. Their product is stable and profitable. They usually become public at this point, allowing early investors to cash out and increasing their liquidity for research and acquisitions.

It's apparent that these companies are becoming monopolies. At this point they start acquiring competitors threatening their core products, and evangelizing their ideology to the market. They become a central body with smaller players orbiting around them.

By this phase, which will last for 20 years, most of the startups fueled out of hype by late investors are usually wiped out. Mass layoffs happen, products discontinued and investors tightening their wallets as they become more critical in where they put their money in.

The second half of this phase is characterized by a slow decline of those monopolies, which is usually accompanied by a recession. Layoffs becoming more often as they cut non-central activities, close off locations and more importantly, deal with the lawsuits. As it is usually at this point where lawsuits of their previous practices take place, they start piling up one after the other. Sometimes with the court acting; either cutting some of their core products, forcing changes, or splitting the company in parts. As these cracks appear, disruptive startups emerge threatening their central profitable product, making them weaker, unable to acquire them, and unable to compete. They simply fade out as an old product with a very humble market share. Then the cycle repeats itself back to phase 1.

It important to note that the last phase of previous cycle, and the first one of the next cycle actually overlaps. As the research and development of new technologies, usually starts during the maturity of the monopolies, and they have these moments where they reach prototypes, and early startups disrupt the market share of the monopolies in decline. (Explained in detail in chapter 9)

3. The lemma principle

Technological progress is evolutionary in nature. It builds up on previous work done by other technologists or companies. For that matter, no technology is a standalone in the era. It must be the result of the convergence of many technologies before it.

Early computers (ENIAC) were built upon advancements in electric circuitry, in typewriters as well as mathematical progress in proof systems. Smaller personal computers only existed due to microprocessors evolving, memory, as well as progress made in CRT TVs that made them smaller and compatible with microcomputers, electric keyboards. Internet built upon phones and computers … and the list goes on.

Let's call our new revolutionary technology ***Rt***. It would be naïve to try to list all the technologies that make Rt, because it's not a composition, it's an ***encapsulation***. Made of many technologies who are intertwined and encapsulating other technologies, which in turn encapsulating other technologies … etc.

Rt is like a theorem, once it's proved, it becomes a lemma that we can use to prove other theorems. But in our case of technological progress, Rt happens periodically and each one that happens is encapsulated in the next one. Electric revolution, encapsulated within the computer revolution, encapsulated within the internet revolution, encapsulated within the smartphone revolution, encapsulated within the artificial intelligence revolution…etc.

For that matter, no revolution stops from existing. It only stops being relevant. Research and progress are still made in the electric field even though the electric revolution ended more than 80 years ago. We still made progress in ultracapacitors, in smart grids, in solar, electric batteries ... etc. This explains why in 2010s, even though the Internet revolution was at its peak, we saw smartphones emerging that only made it more convenient for customers, even if the computer revolution has already ended. It's because progress in microcomputers didn't end. Researchers

still found ways to make the chips even smaller, the screens even smaller, batteries last more … which ended up with a computer in our pocket, thus fueling the internet adoption.

Some startups that were built for this cycle of Internet on Smartphones, like Instagram, took the market share of Facebook that was built for "Internet on Computers". It was inevitable and a logical progress of technological evolution.

This principle helps us define which revolution is plausible and which is not. Like biological computers, quantum computers, blockchain, NFTs, satellite internet, brain-computer interface, artificial general intelligence, … these are not plausible (perhaps after the end of the current era) as they do not build upon progress made on previous cycles. Their definition literally cut cord with the previous revolutions and is not possible to be built upon what we have today. They always require some "groundbreaking" research to be made to unlock it, which is absurd. No groundbreaking research comes from thin air; it always encapsulates previous ones.

Artificial General Intelligence (AGI) is the promise of having a human brain with electronic capacity. It's merging a human-like cognition, a machine processing power and memory capacity in one computational system. That's the vision.

But the current progress in neuroscience only displays we have 10% in the functional understanding of the neurological processes. Progress in artificial intelligence only made so far is in pattern recognition, using massive labeled data and statistical forecasting. On the other hand, the promise of this AGI doesn't take into consideration the previous technological revolutions, computer, internet, smartphones…

According to our *Lemma Principle*, AGI cannot exist within the current cycle, and according to our model, not before 2073. It's simply we don't have the components that will be encapsulated in it yet. The same goes for quantum computers, programmable matter, and all the hype created by big monopolies to pave their way predominantly in new markets.

4. "Adopters with no standards" Principle

When a new technology is presented to the market, it doesn't have customers or even product-market fit. It is new to the public that is not familiar with the technology. As the reward is high for such an empty market, so is the risk of

investing in a product that might not find its customers. The question is: who are the people who adopt these new beta-products that barely function?

Before I answer that, I must lay out the foundation of customers demographics. The younger the customers get, the lower the standards become. As they have no predefined concepts of quality, which only comes through years of experience. The same for older customers, as they have plenty of experience, they have the highest standards and not easily impressed with new technology. So, the principle is as you grow older, your standards of quality grow as well.

At every moment of the cycle, we have customers from all demographics, but only younger people adopt these new products. However, when you inspect these products carefully, they are mostly faulty, expensive, low quality and doesn't add any value. Yet, they pave their way through the market, by riding on the new generation that is in the process of building their quality standards.

This principle explains the current startup ideology focusing on growth and speed of delivery, rather than the product quality. Because they target the younger generation, even if economically speaking, they don't have any purchasing power yet. We can clearly observe a certain implicit foundation that emerged organically: startups products target late teenagers, and only focus on growth. Products and value don't matter at that moment. The promise is these same teenagers, will grow into becoming paying customers, and avid adopters of the technology.

That's why some products like "Apple Vision Pro", are doomed to fail from the beginning. It has no value to the end users regardless of demographics; uncomfortable and forcing a new experience than the public is accustomed to. For those reasons, it must be targeting the younger generation who have no standards yet, and more likely to adopt it. What we saw was the opposite, The price is expensive and marketed towards professionals in their 30s with kids, who logically have that purchasing power, but very high standards
The same goes for the Metaverse, the product is of beta-quality, very low value to the end user, and demand a new experience to what he's accustomed to. So logically it must target late teenagers or early 20s, but somehow, they targeted professionals over 30 to work on a virtual space. It's no surprise it flopped.

One last example of this principle is OpenAI. Every professional knows that neither the text, the code, or the images of the LLMs are of incredible quality. They are passable, because they lack the creative and reasoning engine within the human brain that plays a role in producing professional text and code. A trained person

who has been writing for years, research or code or novels or reports or any sort of human composition of words, the parroting of LLMs is below average. Yet, just after a couple of years of their release, we have seen a shift in their initial focus to the younger generation (who have little to no standards), by popularizing Vibe Coding. Which simply means copy and paste from LLMs without even reading the code, and iterating through the errors until you have the final result. Without even using 1% of your cognitive power! This influenced other startups like Cursor to leverage in a tool that practically does this Vibe Coding within the IDE, who just recently secured $900 million in funding (surely from VCs who missed the initial wave and wanted to capitalize on it lately, and only creates startups who will disappear after the monopolies are shaped.)

So, the transition of ChatGPT from a "revolutionary" technology that affects all of humanity to a tool made for younger generation with no standards, practically states that it has little to no value yet. It's a new product for a new market. This repositioning of their targeted demographic was the right move to do, something that Apple and Meta missed in their release of revolutionary products.

5. The thing that gets you to the thing

Every technology that is at the core of any cycle displays a certain behavior. It always starts as something we see, but over time it disappears within the background. It operates from there, it controls our access, it guides our user experience, yet remains hidden. The most successful line of products of any technology are the ones that display such a behavior. It's the market's non disclosed desire to always gravitate towards technologies that disappears in the background.

The computer started as a bulky machine on the desk. Today all we see on that computer is a bezel-less monitor, that we barely notice. Its job is to open the consumer to something else to consume, and not be the main thing to be consumed directly. Smartphones, as a product, behave in the same way. Historically, the design was analog, bulky, and tactile. As time went on, almost all the smartphones from different vendors became alike. They are barely noticed. They're just a piece of glass that pushes towards something else to be consumed, and they their design purposefully pushes them to the background.

Hardware isn't the only thing that behaved in this principle. They're goal is to be a gateway to something else, so is the software in them. Operating Systems in its first design was a tangible platform, grew to become intangible. The browser as a

transformative software that opened to a whole world of web followed the same principle. Bookmarks, links, plugins ... were always apparent. Today all it displays is the website. Now the first generation of websites was the thing to be consumed. It had a design, unique to each user, to each page, and each component. If you compare a YouTube platform from that time to today, we realize that all we see today is the content. The background, the logo, the icons, the website have disappeared. Nothing is there except the content. It acts as a hidden platform that takes me to something else to consume.

Today, we use the four lines of generational technologies within a phone displaying content, unconsciously. We don't see the smartphone, neither the OS, neither the browser, neither the website. All we see is the content.

This principle explains the evolution in design towards white minimalism in all technologies alike. The last design of every technology is no design.

As an example, among all the apps, TikTok abruptly ate the market share of social media giants like Meta and YouTube. Within a couple of years, they had over 1,5 billion monthly active users, and their ad revenue is projected to surpass YouTube and Meta combined by 2027. Yet when you see their design is like there is no design, all you see is content. You don't search for it, you don't click or swipe, you just watch. From day one the platform acted like an invisible platform that gets you to the thing you want to watch. Compared to Instagram or Facebook or YouTube or X, where you need to take a decision to watch something, the friction of usage makes it impossible to compete at the same level, and they simply can't because their app model was built from day one to serve the internet users of 2006 or 2012 not internet users of 2020.

The only thing we see today is the *content*. By that I mean any form of media displayed on any website (text, image, video, and others). Just like there was a time we saw the website and it disappeared, we are currently seeing the content that will soon disappear. This validates the path that Google is taking or OpenAI through AI by scraping the entire web and just presenting you a minimal form. Yet the technology is not complete yet, as we still see something. The goal by the end of this cycle (2019-2037) is the content itself will disappear.

To my own speculation, I believe Artificial Intelligence's true use will be each piece of content any platform shows will be tailor made to the user's taste. Search, video, music, podcasts, text, books … you name it. The goal will be to have a system that reads the user's intent just by whatever he selects. Imagining a

TikTok's algorithm with Stable diffusion model. The platforms I imagine would be different than the ones we have seen in the web 2.0, will be the startups that will survive the burst of the current bubble around the end of this same cycle (2035-2037). I think a new Spotify would be generating music on the spot after each refresh. My user profile model on their servers would have very detailed description of my taste in terms of melody, harmony, rhythm, tempo, lyrics…etc. That revolution will be built upon the previous web 2.0, smartphones, 5G, LLMs and others, and will make the content achieve its final prophecy: to become a platform. The content becoming the host of something else to be consumed.

This principle of *"The thing that gets you to the thing"* is how we identify a technological revolution or a platform that will take over the next cycle. It is a platform for other startups and technologies to be built upon, and most definitely impact society drastically. It must be an empty window, an invisible frictionless thing that you don't see.

ChatGPT is not that thing. You can clearly see it, interact with it, and requires a deal of your attention. It is a final product that can't open you up to something else. There won't come a day where you don't see the Chatbot and interact with it, because it is in the Chatbot's design to be interactive, and that crosses it from the list of revolutionary technologies.

However; the model behind it is that thing. It opens you up to another world of composition of various fields, that makes you see the composition without seeing the model or interacting with it. If OpenAI's true masterplan is to be a sort of AI ISP for the world with their models, processing powers and fuel the possibilities that smaller startups can create, then we are seeing the future tech monopoly. Only that way it might cross the trillion-dollar valuation.

6. The unfair advantage

The early startups that work on bringing their first product to market, face many challenges. The most important one is how fast they can deliver. Because as momentum builds up, they are not the only ones who have heard about the new results happening in the technology community. Other entrepreneurs did too, and they're all finding solutions to bring products with very limited funds.

The few investors who might be interested in their risky ventures, are not willing to go all the way without market proof. So, these constraints limit the startups from

finding effective and innovative engineering solutions that are crucial to penetrate this new market as fast as possible, before others do too.

As have been shown by various economists, that self-interest is the driver of the free market. This principle guides the startups towards gaining economic advantage. As the foundation of the technology is not built yet, neither is the legal sphere surrounding it. They tend towards unethical or sometimes illegal practices. It is a principle that companies do not police themselves, but the legislations and government institutions that does this policing to maintain the order of the free market. As companies behave in their own self-interest, they are also willing to "unfairly" gain the advantage in the market if those legislations did not exist.

In the startup community, this unfair advantage is what's known as "It's better to ask for forgiveness than permission". The true economic motives behind, as our model also shows, is that the volatility of the startups in their genesis is at its highest peak. Their products, their vision, their customers, everything is risky at this point. Yet as they grow and stabilizes themselves within the market, volatility decreases.

Examples of that are plenty. Apple that stole the designs of the Xerox Alto machine, replicated its original concepts to the minute and presented it as "original apple innovation". Microsoft selling to IBM an operating system (MSDOS) that they did not have, and then bought it from a local software company and presented it as theirs, the deal that put officially Microsoft as a company in the software industry. Marc Andreessen quitting NCSA (the research team that created the first graphic browser MOSAIC), to create a competitor company MOSAIC Nescape crushing its market share to nearly 0% in 3 years. Zuckerberg hacking to the Harvard database of students, scraping it and using it as a basis for TheFacebook and marketing it to the university's students through emails collected from there. The same for Spotify creator, who in fact was the creator of uTorrent, a peer-to-peer sharing of media that is usually not approved by the media distributer, and thus ethically in the gray area. The money and the technology used in uTorrent was a transferrable knowledge that influenced the fast rise and success of Spotify as a platform. OpenAI using extensive amount of scraped data from the internet, without the consent of its users, to train their models that would become ChatGPT. The same behavior was done by Google during its launch, which was the nonconsensual scraping of the web pages, without users agreeing on having them cached and indexed on Google servers.

The list goes on and on, to the points where it appears it is a rule rather than an exception. Yet, these startups face legal repercussions later in the decline phase and only after becoming global leaders in the technology market.

7. Economic Relativity

It only makes sense that after the products becoming platforms, the monopolies behind them becoming platforms as well. From an economical perspective, monopolies such as Apple, Google, Amazon, Meta, and any publicly traded technology company holds a weight in the market. That weight makes smaller companies and mostly startups gravitate towards them. They mimic their products, they use their services, and they follow the trends evangelized by their management. VCs funding them also follow the same trend as we always see big tech as a central stable pole in the market. Creating a principle of "whatever you do, you'd be fine if you're orbiting around them". And this form of indirect control creates a stable technological market for a while, where the innovative products pushed to users serves indirectly the monopolies, thus creating a stable investment platform for VCs.

However, during the monopolies decline, many of those startups lose their central object, and the market's innovation volatility skyrocket, with many of them going the opposite to the market's needs and thus creating a bubble. Exactly what is happening in the ascending period of current the current cycle (2023-2032).

8. Conservation of data

"Nothing is lost, nothing is created, everything is transformed"

After each era we go through, the market produces two things: the technological capital (by companies), and data capital (by users). Just as every innovation encapsulates the previous ones that came before it, it also encapsulates the data produced before it, and use it to form itself.

This is how we see the Lavoisier principle very relevant in the technological progress. Data is conservated. No innovation surpasses the previous one, neither on impact or market value. They amplify their effects by creating a platform where the previous ones operate better. As it amplified the previous technologies, it builds upon the residual data that was produced by its usage.

No data or technological production from previous times is lost or abandoned, it's simply transformed into something new. You can't see it but it's there. The information age produced data. As computers flooded the market in the 1980s, users flooded their devices with data. Then when the internet came in the 1990s, this data that was residing in their computers found a way to be amplified and move along other computers. Then when web 2.0 paved its way through search engines and social media, more data was created, and more links were formed, and was amplified even more.

Now that the Intelligence Era came along, it got from the previous Information era a substantial amount of residual data that was created for the last 54 years. It's there waiting to become something else, and it will become something else. The AI models started the cycle by feeding on those search engines. What will come is them encapsulating the data created on social media and all websites used during the web 2.0 period, until no data is left unprocessed by those models.

9. The Inevitable Cycles

Kundratiev and Schumpeter are the basis of our research, and based on that, we present a new model for technological innovation and economic cycles for the tech market. We based it on previous observable patterns and data collected in the global market, mostly in the US.

Kundratiev's cycle are the best we possess to see the tech market from a macroeconomic perspective, to display patterns that appear frequently, and perhaps make predictions of future trends in the making.

In economic literature, *Kundratiev cycle (long term)* lasts for 54 years. Schumpeter explains that there is another cycle that composes it, called *Juglar cycle (short term)*. Juglar as an economist, proved that there is a cycle that lasts 7 ~ 11 years, describing business investment in fixed capital. When companies are optimistic, they invest more in means of production, and when they're pessimistic, they cut back. This rise and fall create a contraction and expansion in the economy, which impacts the industry entirely.

There is a third cycle that goes alongside the *Kundratiev cycle*, called *Kuznets cycles (medium),* lasting approximately 15 ~ 25 years. Schumpeter proved that each *Kundratiev cycle* is composed of 3 *Kuznets cycles.* (we will call them Kuznets).

The classical presentation of Schumpeter that embodies all the 3 (short, medium, and long cycle) looks like this:

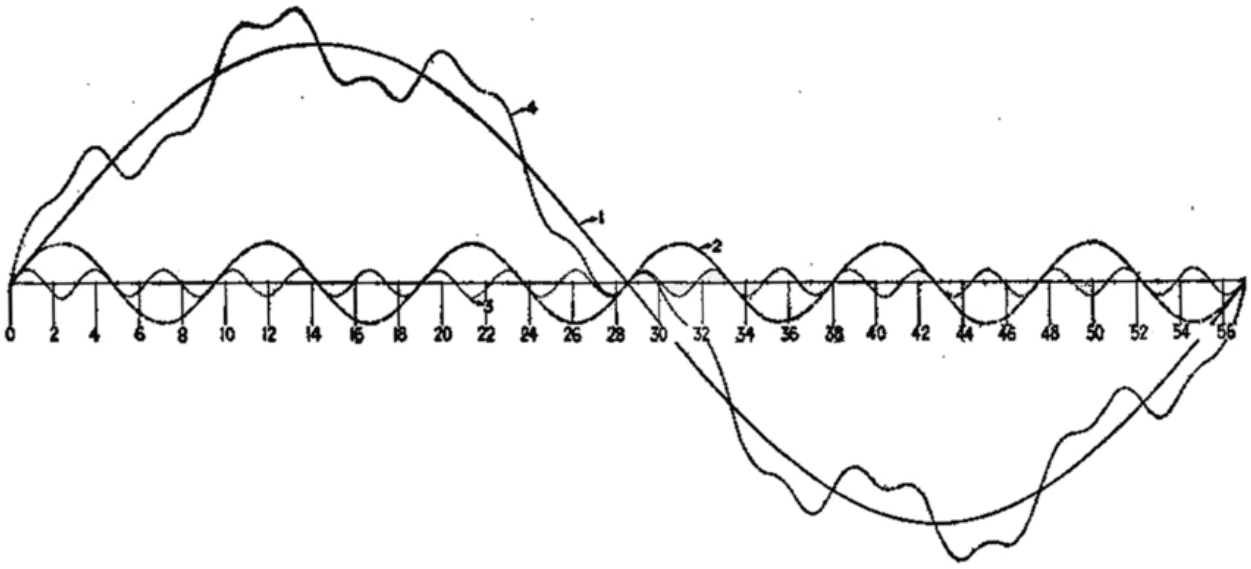


CHART I.—Curve 1, long cycle; curve 2, intermediate cycle; curve 3, short cycle; sum of 1–3.

Yet, as promising as this cycle looks, it failed to accurately predict market shifts, trends and transformative dates that plays a crucial role in technological investments, for both capital investors and skilled laborers.

Schumpeter pointed that the next cycle starts earlier before the end. But the model doesn't fit because you can't have 2 upswings at the same time. Carlota Perez, another economist, explains that the transition phase is a chaotic period, unstable and unpredictable.

Our approach here, is to answer that question by altering the original Kundratiev cycle and answer crucial questions in the model.

Every business cycle in economic literature goes through 4 phases: Prosperity, Recession, Depression, Recovery. Just like it's shown on the chart above. However, the opposite seems more plausible and realistic if we talk about technological innovation. We see it more fitting if we start by a depression, as it's Research & Development that drives the revolution of the era. The core technologies that will be the central bodies of the entire cycle, must be researched first and be a result of scientific endeavor. The scientific progress that leads to these technologies, is mainly funded by public institutions and the patronage of

technological monopolies. But how are we going to have research and monopolies at the same time? Our model answers that.

Our model is described as follow; Kundratiev cycle spans for 54 years. Composed of 3 Kuznets, with their lengths respectively: 16 years, 18 years, 20 years. The Juglar cycles, with their lengths respectively: 11 years, 9 years, 7 years. Yet, starting 7 years earlier than the Kundratiev and Kuznets, who starts simultaneously.

The cycles of Kundratiev as they describe technological progress, should be seen from a technological perspective that drives the market, rather than economic ones which usually comes last after the technology. In this regard, the cycle makes more sense when it's divided into 4 phases:

1. Research & Development
2. Startups
3. Monopoly
4. Decline

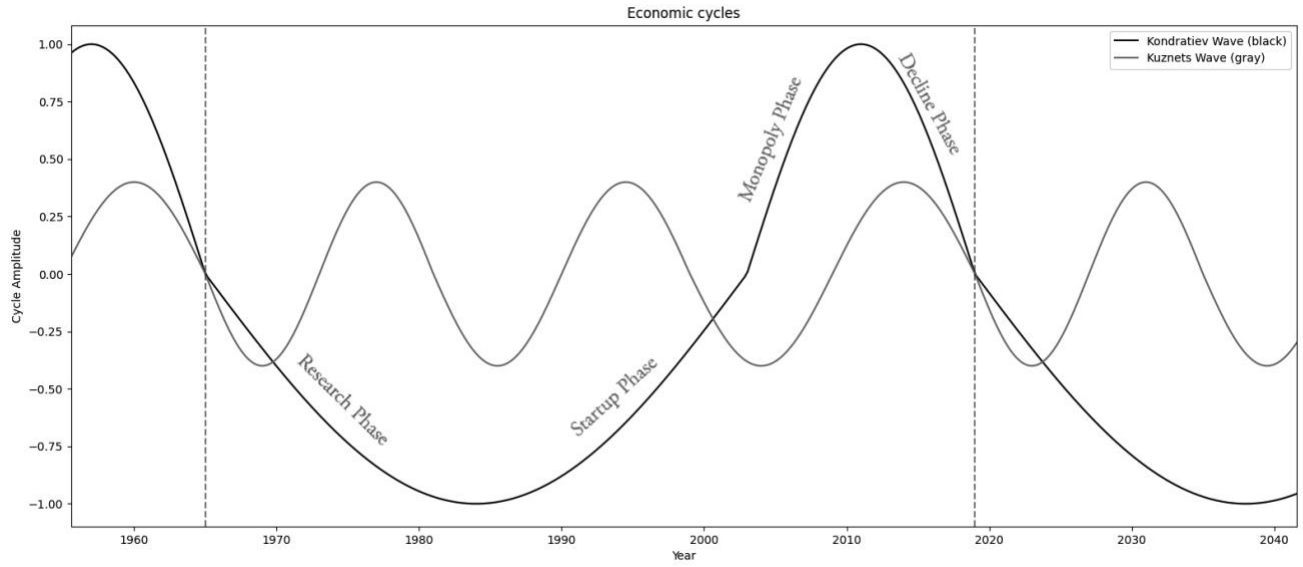


Figure 1: One Kundratiev & Kuznets cycles

The phases (1) and (2) takes the longer, as research and startups funds are usually limited before they reach market fit. The momentum of the market fit only appears on the monopoly forming side, as late investors come into play. Usually after monopolies reacting to the startup traction that competes directly with their core products. By adapting the frequency, we realized the first half of each Kundratiev should be 2 Kuznets long, as it's the momentum of many iterations of many

technological advancements either scientifically or entrepreneurial that pushes towards the monopoly phase, which lasts for half a Kuznets, and the other half for the decline.

However, our model currently is uncomplete and doesn't fit the whole picture. To be complete, the *research phase* of the next cycle must start before the decline. Fitting it around 1.5 Kuznets make more sense, as momentum takes place and capital starts flooding the market, not only the startups who engineer products based on the previous R&D results, but also researchers being funded by private sectors who wants to fuel the research even more.

A recent example of that is Ilya Sutskever, who was part of the research team starting this wave of artificial intelligence through innovative research. He played a role in the founding and engineering of OpenAI startup that implemented those results into a product. Yet, even after leaving it, he received over a $1 billion in funding for his future research that would mostly impact the next cycle. We didn't even finish the *startup phase* and the *research phase of next cycle* already in place.

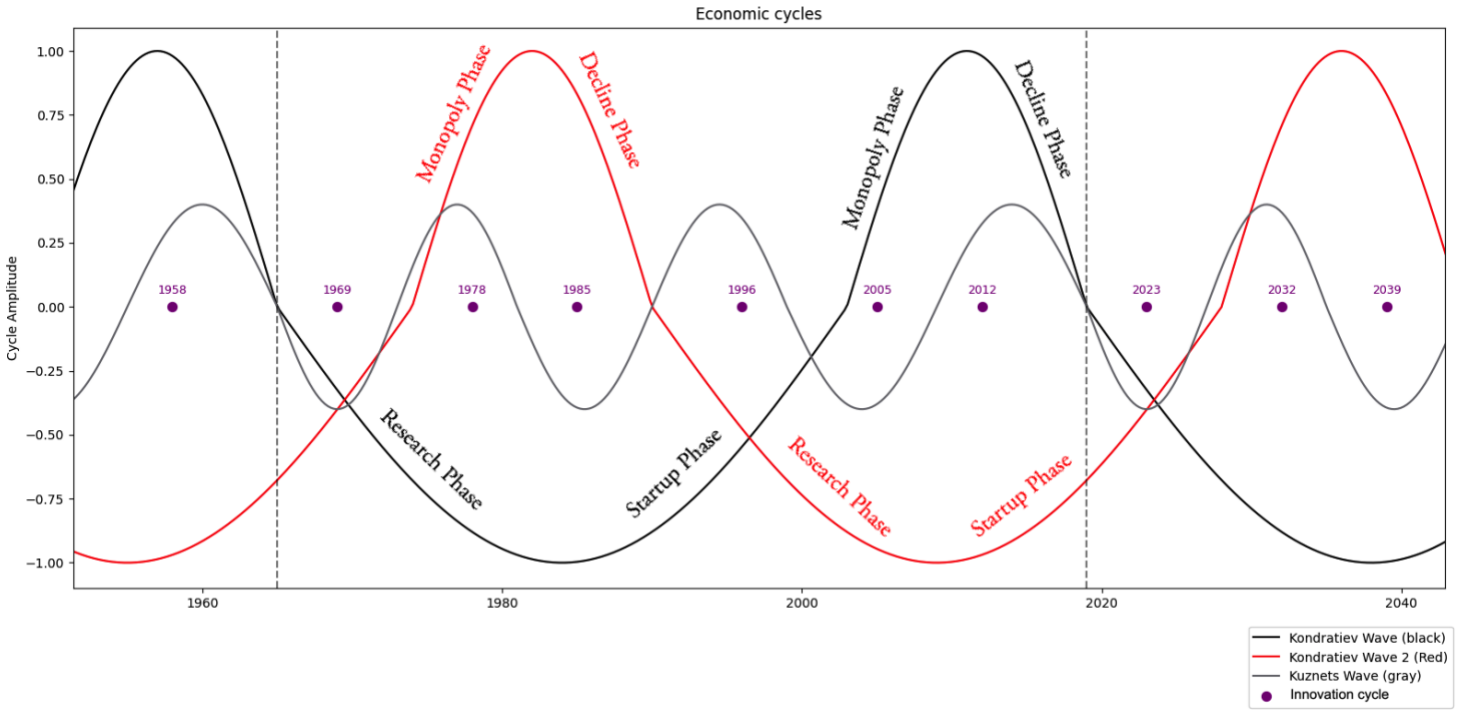


Figure 2: Two overlapping kundratiev cycles

We only displayed the relevant period from *1950* to *2040*, for more details, the code to provide a detailed and broader view is available in the appendix.

- The red cycles are *2k+1 kundratiev* waves (5th wave, 7th wave...)
- The blue cycles are 2k *kundratiev* waves (4th wave, 6th wave…)
- The gray cycles are *kuznets* cycles.
- The dotted line is the delimiter of *kundratiev* cycle, The ending of one and beginning of another (2019 on the image).
- The purple dots are major technological innovations driving the market. Either through research or startups (disruptors) providing a technology that will be the leading figure of the next cycle until a new innovation comes along to build on it. They point to the beginning of each Juglar cycle, as we interpret the recovery of the market related to fixed capital, as a sign of expansion in entrepreneurial activities, thus innovation in impactful technologies related to it.

Phase 1: Research & Development

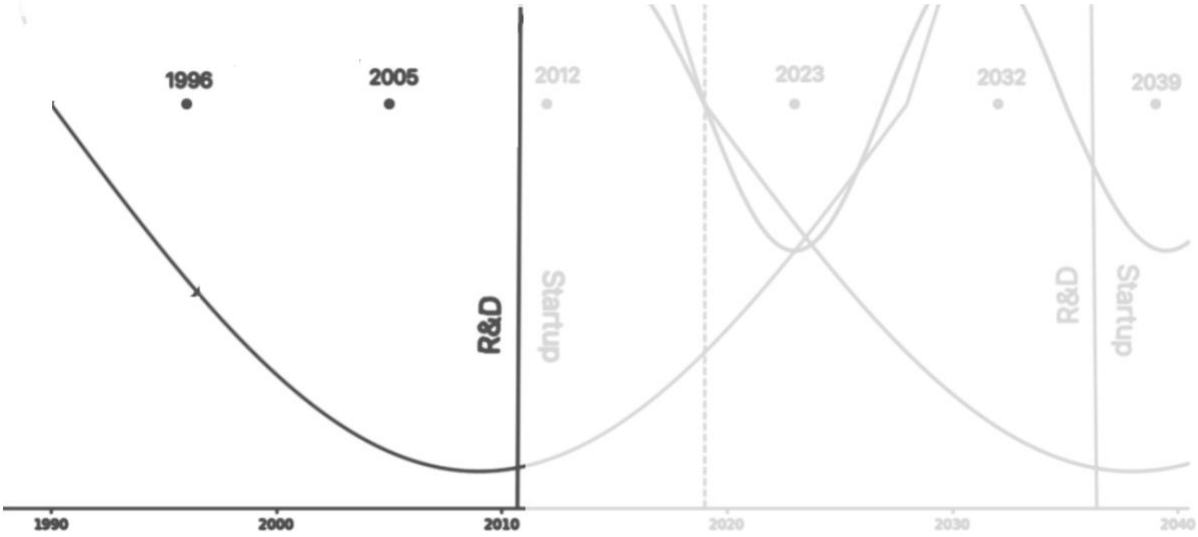


Figure 3: Research Phase

Scientific research is the process of investigating a topic to understand, develop or innovate new principles. It is usually composed of a handful of researchers in universities or non-profit organization, funded by government agencies and big tech companies. The latter have interest in funding those type of research, as they

unlock new markets and innovative technologies, and being in the loop means they get a saying in the direction when things become promising.

IBM, for example, played a huge role in funding most of the technological research of the 20th century. They created the first high-level programming language (FORTRAN), RISC architecture, first commercial hard drive, relational databases & SQL, and others. These technologies were crucial in the development of computers. Google is another one as many of the era defining technologies have been developed under their patronage (ex; Transformers, TensorFlow).

The average duration it takes for research to yield practical results is *18 years*. Which means two decades of consumption before any productive return. This would've created an imbalance within the sector if the profitable monopolies did not exist, which in turn, spend two decades of production with little consumption. This balance is what stabilizes the market and feed the emergence of innovation. Just as research organizations are behaving in a "high risk, low reward" principle, their counterpart in the technological market are the monopolies, "low risk, high reward".

This phase doesn't prevent startups from emerging. However, the investments available are usually tight during this period, so only those with stable business plans and solid products are funded. The startups emerging in this phase are not era defining ones, however they are stable businesses, that will grow to become important players in the sector, yet marginal in their impact as they are not the heavy poles of the market.

In our model, two important dates stated by the Juglar innovation cycle appear. 1996 and 2005. Respectively, they are both the emergence of ***Web2.0*** and the ***Smartphone***. Yet they will not be adopted in those dates as they just emerged within the tech community, and it will take a couple of years before their commercial release.

Every research phase is characterized by only two defining technologies. The next big tech monopolies are going to be startups being built on these research innovations that appeared in these dates.

The question being asked, *what makes these special innovations special than any other ones in other years?* The answer is clear, they encapsulate in them the previous innovative technologies. Every innovation that ignores some of the previous ones from previous Juglar cycles cannot sustain in comparison to the ones

that encapsulate them. We might call it the ***"innovative momentum".*** As every technology doesn't only hold the weight of what it does, but also the weight of the technologies it is built upon. If the innovation presented on that date crosses all the previous ones, it's certainly the next defining era innovation.

Blockchain couldn't sustain that rule, even though it is an incredible innovation in the tech sector, yet you will not see a monopoly coming out of it. It crosses the computer innovation cycle that happened in 1978, it crosses the internet cycle of 1985, but it stops there. The web 2.0 of 1996 that changed the course of how we use the internet isn't included in the Blockchain technology, neither is the Smartphone cycle of 2005, later it catches attention using the AlexNet cycle in 2012 that directly affected the GPU-based research technologies. Its impact will not be seen because it's a marginal innovation.

A hypothesis that keeps appearing in historical data, is the emerging new technology always competes and has the potential to defeat the monopoly's core products. In other sense, the startups that are going to be built around these innovations will play a crucial role in the decline of those monopolies as they capture their market share, and become monopolies themselves in the next cycle.

The results that the *research phase* produces are only 2 innovation cycles, the first one appears after 16 years of the beginning of the Kundratiev cycle, which plays the most important role in fueling and empowering startups into becoming monopolies, the second one appears after 18 years, is the one that creates the innovation that competes directly with the core products of monopolies. The startups that are built upon these new innovations, in the *startup phase,* are the ones that race towards becoming monopolies themselves and dethrone the current ones.

That's how we classify innovative research, by their *innovative momentum*. The innovations that act as platforms hosting the previous ones before them, are the ones most likely to lead the market direction.

Phase 2: Startups

The research phase builds the momentum for the appearance of startups. Through two main reasons: technological innovation and capital stagnation. As monopolies stabilize the market (we will see later how), investment capital also stabilizes and stagnates, which creates tension among venture capitalists and investors. This leads to an optimistic change in their behavior as they see two decades long of scientific

progress bringing its fruits. Prototypes are formed, as well as a promising future vision for the technology sector. This creates a window for entrepreneurs and technologies who are deep within the research communities. Up to this point, they are a niche. Only researchers or enthusiasts know about their progress, they are not mainstream yet.

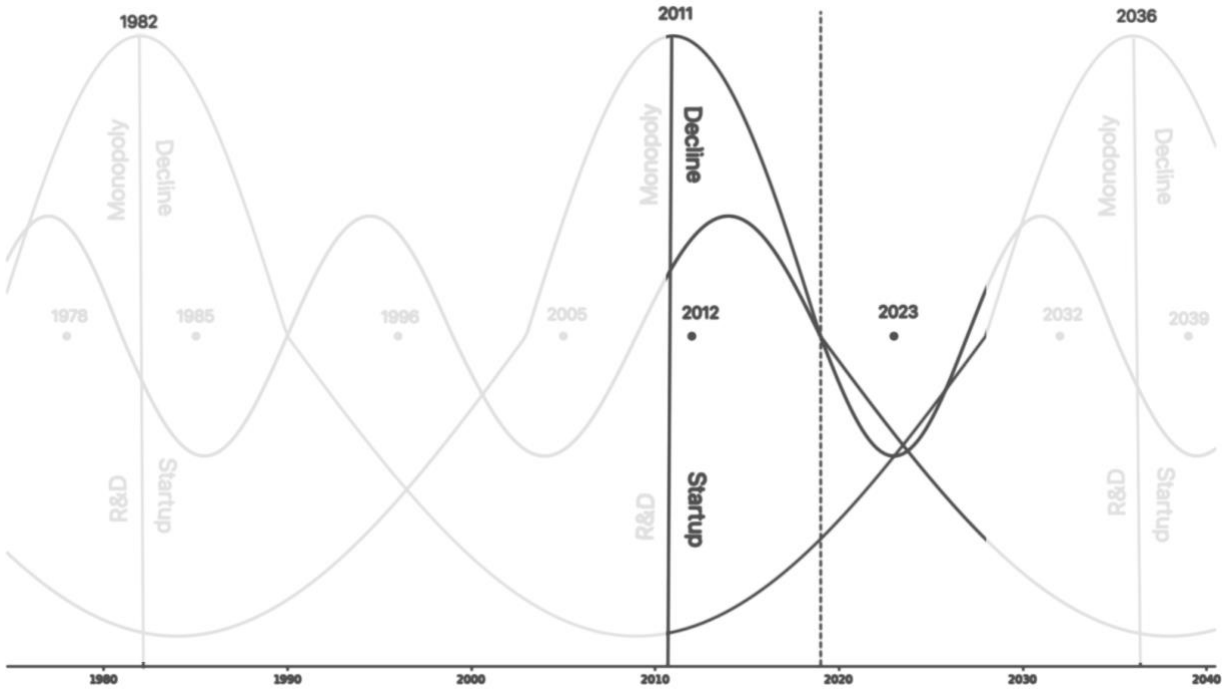


Figure 4: Startup Phase

The very early entrepreneurs are people deep within the community, who managed to present to the market a product implementing the new research, which obviously will unlock investments from stagnated investors looking for risky ventures. These are the people we call ***disruptors*** and the entrepreneurs are considered ***visionaries***. While in fact, they unknowingly had the advantage of what we can call the *"disruptor's formula"*.

We describe it as follow:

- Being deep within the technological research community, who is working on the innovation that encapsulates all the innovations prior to it.
- Building a product around that research, which usually competes directly with established monopolies.
- Technically solving the engineering challenges emerging out of that.
- Playing in the ethical gray era during the engineering process, with practices that would later be considered either illegal or unethical. *(the unfair advantage)*

This formula plays an substantial role in creating the momentum for the early startups as they build their product and they unlock new investments.

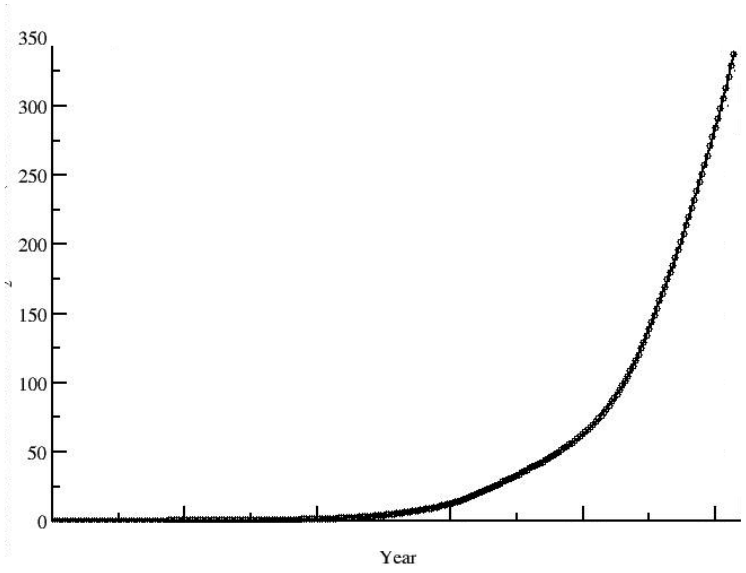


Figure 5: Exponential curve of startups acceleration

The startup phase lasts for the last *kuznets cycle* (20 years). The momentum of the startups follows an exponential curve. As the early ones (the riskiest startups) penetrate the new market and see results, new startups alongside new investors join the race, and the process repeats itself as the number of startups competing to create products out of this new innovative technology increases exponentially.

The startup phase is divided into two parts: the first one lasts for two thirds of a kuznets (13 years), the second one lasts for 7 years. During the first part, the exponential growth of number of startups, fueled by big investors embracing this new technology, creates a volatility in the market that is stable up this point due to the monopolies. This volatility makes the investment barrier low as investors flood the market with risky capital, so do entrepreneurs feed on that with risky products. Most of those products don't add any value to the market, usually mimics of products that already exist or startups in the kill zone, but due to the high volatility of the market they get a chance to exist. This is what we call an ***economic bubble***. It didn't reach the highest point yet, as only after 8 years in the *startup phase* when monopolies notice the threat and react.

Products of promising startups during this period are not of high quality. They're usually very limited compared to the products available. The only thing they have is the innovation that they brought from the *research phase*, which is enough to disrupt the market. That's why the younger generation (as we explained before) are

the targeted audience, as their standards of quality are not formed yet. So, the only thing startups focus on is the *network capital*. To get on board as much people as possible to adopt their new product. Revenue is marginalized, as well as profit, and cost of production. The network capital is the vital thing for startups at this phase to stand a chance, as they are the ones investors would back up when times get hard.

On the counterpart to the *startups phase*, we see the *decline phase* happening to monopolies. This is a natural equilibrium in the tech sector as the volatility increase on one side, affecting the other side. This disruption of order happens due to skillful employees migrating from monopolies to emerging startups, due to investors migrating their capital from low-risk monopolies (and their orbiters) to high-risk startups. Also due to the stagnation in the monopoly's product line, that became obsolete, and due to their weight in the market (in the second half of the *research phase*, 18 years) alternative products were almost inexistent.

At this point, emerging startups are acquired by monopolies, or older big tech giants from previous cycles that were left behind trying to survive, invest in them. According to historical data of startups, as it appears to be a pattern in corporations, they find it cheaper to acquire the competition emerging rather than compete directly (which will come later). For those that either do not sell or too irrelevant to be acquired face hard times during the second part of the startup phase.

The second part, which usually comes after 8 years in the cycle, is when monopolies enter the market. Their market share has been declining for a while, their customers are migrating to alternative products, and their revenue is threatened for the first time in decades. They pour most of their resources into competing directly with these emerging startups. The response to that, on average, enters the market within 2 years. This comes in the form of a solid competing product with a very low price, that starts the *bubble burst*.

Most of the startups inflated during the first half of the *startup phase* go out of business. The first ones are the ones in the kill zone (a zone where their products rely directly on other monopolies, that with one update from them can die). Big startups that might cross the billions in valuation can disappear abruptly in this part of the phase. History have shown that monopolies do win during this part, but can't last for long.

Examples; IBM entered the market (1981) after the disruption caused by Apple and Commodore and other smaller microcomputer manufacturers, who threatened its core revenue products: mainframes. Many startups have been wiped out after that, and they held most of the market share for 8 years, and then they were surpassed in late 1980s when they couldn't sustain the innovations required by this cycle, as like any other big corporation, treat this disruption as a temporary nuisance in the market that needs to be fixed and then back to business. Which is not the case. In the early 90s IBM became irrelevant without any market share.

The same for Microsoft, was being threatened by Netscape in 1995, as software migrated from the OS to the web, and Netscape had the biggest market share. Internet revolution started in 1985, and only in 1997 where Microsoft felt the threat and its core revenue product were hit. So, they entered the market by shipping Internet Explorer for free. This pushed Netscape to bankruptcy, and consequently Microsoft being sued for anti-competitive practices.

Facebook have the same story, when Instagram and WhatsApp and other social media startups gaining traction and threatening their core business, they acquired them and for the others it couldn't buy (ex; Snapchat), it directly competed with them by replicating their features in the newly acquired startups.

Now the same story is repeating itself with Google, as AI companies are slowly threatening their core revenue product, that is the search engine.

This disruption usually comes with a hard time for monopolies as we will see in the *decline phase*, which makes it harder for them to compete with this emerging market, they usually gain traction for a while due to the abundance of capital and skills, but cannot sustain for long as it requires more.

The startups that aren't acquired during this phase, and held an important market share after the monopolies entered the market, as well as an important network capital, they usually move on to become monopolies, as the current monopolies start declining and find it harder to compete with them.

Phase 3: Monopoly

A monopoly is a market structure where a single provider controls the supply of a good or service, with no close substitute available. It's the highest form of market dominance a company could have, and the tech sector is no different.

The startups that survive the burst of the bubble, that are innovative enough to compete directly with the robust products offered by the monopolies in the previous phase, and have acquired a substantial user or customer base, are elected to become monopolies.

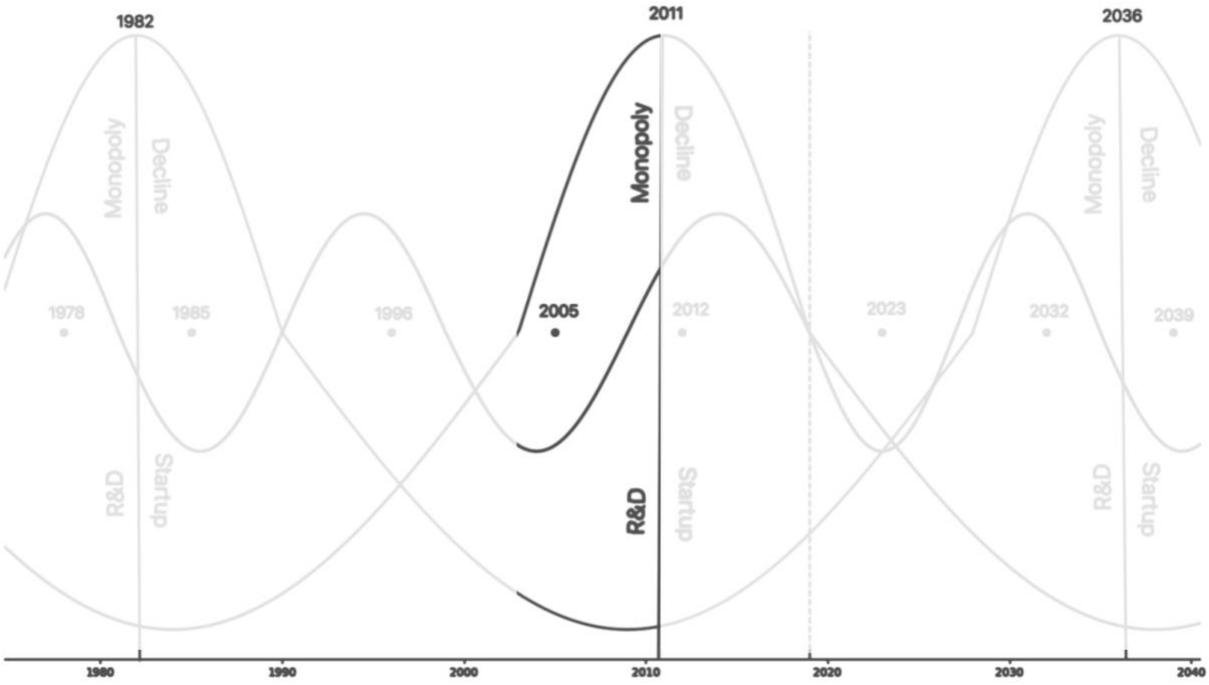


Figure 6: Monopoly Phase

They're usually just a handful of them that survive up to this point. They usually have good products and an important market share. The monopolies of the previous cycle have already declined, or are on the process of becoming irrelevant (as we will see in the decline phase). According to our model, the passage from an emerging startup to a monopoly usually takes shorter amount of time than it did during the startup period, as more capital becomes available, so does the price of acquiring users becomes cheaper for them. They attract more talents, more investors, more users, and more importantly they stabilize their business. They become the heavy poles of the technology sector, and they become those that dictate the direction of the market.

Competitions are usually wiped out easily as they are flexible enough to move, and have enough capital to buy or contain them. Their product is stable but not obsolete yet, updates are still being pushed and users experience is at its peak because

they're on the verge to profitability, which will have a reverse effect on its product line.

As they have more weight in the sector, other startups and smaller companies usually orbit around them, following their direction, their technology, their processes, and they rely on them through the services and products they offer. This creates what we previously called *"economic relativity"*.

On the other side, research is at its infancy, and mostly the two most important innovations (that will make them irrelevant in the last kuznets cycle) happen here. The monopolies usually play a crucial role in funding those research projects, that without them couldn't exist. Yet, strangely enough they don't act accordingly to play a role in sustaining themselves.

My hypothesis is that it is in the fundamental structure of corporations that makes them unable to mold and change. Perhaps this structure itself isn't the right one. As we saw previously in the last cycle, Google have survived the major shift of Smartphone revolution in 2005 due to its adaptability in creating smaller companies within its holding and acquiring companies that will face the new revolution without it changing its original product line. They acquired YouTube and Android, which both played a role in staying relevant in the web 2.0 and the Smartphone era. But under their nose, AlexNet of 2012 came out of their research companies. Yet they did not react. OpenAI was formed on that innovation, by the same people who contributed to it.

Schumpeter states that the monopolies are temporary during the Kundratiev cycle.

The monopoly phase, according to our model, lasts for 13 years. During that period the product line stabilizes, the company becomes profitable, and usually goes public. As profitable as it becomes, the product line worsens over time. Revenue becomes more important than the user experience. On the other hand, users start complaining through intrusive advertisements or high prices or low-quality features or undesired changes…etc. We call that phenomenon "*customer's prison*", because the monopoly holds total power over the market. They know you have nowhere to go. They are the only provider, and during this phase, they have the upper hand to take the decision that fits the corporation's bottom line rather than the customer's. In a capitalist system, it's both good and bad. It's good for the present and bad for the future. On one hand it creates a stability in the market where employment flourish, prices stagnate, productivity increase, and most importantly GDPs affected positively. However, this can't go on forever, as market

volatility cools off as well as investor's capital who move on to other sectors, and only stable low risk companies are on the table. The latter requires a medium to long term commitment that most investors are unwilling to make. As it creates a stability of employment, it creates a tension of investment, that will explode within the first sign of optimism with the next cycle.

This dynamic happens as an equilibrium driving the market towards stability. Even the instability that we observe is itself a search for equilibrium that is certainly going to be reached in the future.

Phase 4: Decline

The products and services provided by monopolies deteriorate over time. That is a rule! However good this might seem for entrepreneurs; they are ready to do anything to stay monopolies. Political lobbying, vexatious litigation (legal bullying), employee raiding … whatever tool within their hands to stay in the game.

As we have seen before, the *decline phase* of the current cycle goes alongside the *startup phase* of the next cycle. As the startups capture their momentum, they present alternatives to the monopolies deteriorating products, steal their customer base, and most importantly their market share that reflects directly on both their stock prices and their revenue. After all the initial responses either through acquisitions offers, litigations, marketing new lines of products that usually don't exist, they find themselves in the point where they should present a competing product. Because investors fuel the market through high-risk capital, that capital that have been kept within low-risk ventures during the monopoly phase, the startups are ready to innovate from all sides to capture a part of the market share, especially from the monopoly's side because it's there where customers already are.

At this point, the monopolies either embrace the threat and get to competition with these growing startups, or they decide to ignore, which happens quiet often.

Example; Apple is one of the companies that ignored the threat of Artificial Intelligence on their line of products. As a hardware company, selling smartphone and computers, and innovating in new lines such as VR Headsets, they see themselves safe from the threat of AI startups that are growing today. However, what they fail to see is that most of the technological revolutions (or the Juglar innovation cycles), are hardware revolutions and not software. Every technological

revolution happens on the hardware level. Either in presenting a new hardware (and the software that goes with it), or a software that uses the hardware in a different way like the Web 2.0 revolution in 1995, that made people use the preestablished lines of network and websites hosted on each network…etc. It was more of a mathematical problem of networks, rather than a software one. (we will talk about the Juglar innovation cycles later).

In other words, Apple is not in the safe zone. They are the first ones who will be directly attacked by the existing innovation that happened in 2023. It is not mainstream yet, and is only known within the research cycles. This innovation that is certainly building upon the 2012 AlexNet revolution, and is certainly hardware level, will be attacking the smartphones and computers directly, building upon them and becoming a platform that will host all the previous revolutions. This way, they will be competing with their long-standing monopoly for the last 20 years.

On the counter part of those monopolies that chose to ignore the threat, others chose to compete, which costs them dearly. Employees are pressured to release products within a short time, even though the startups had a long time in harnessing their vision, their products and more importantly their engineering skills in making the research real. The startups are closer to the market than big tech monopolies. Customers can have talk to the founder directly, which doesn't happen on the monopoly side. So, these engineers in big tech, under the pressure of making something they barely understand because the monopoly's core products are different. Also pressuring research teams, they fund into publishing results, which is not how researchers work. Every resource is used within its maximum capacity to achieve the goal to go-to-market even this late.

Within all this chaos, they are obliged to use their financial resources within their maximum capacity as well. Including cutting unnecessary costs. They close locations, they layoff teams that are deemed unnecessary, they merge startups under their control, sometimes they change entire divisions core mission to solely compete with the startups. When we talk about billions in motion directed towards one goal, to compete with startups who still must raise funds, we are talking about results. This is what IBM did in 1980, what Microsoft did in 1995, Meta in 2012, and Google in 2022.

Yet IBM didn't win over its market share even though its product disrupted the market and popped up the bubble. They were the catalysis of an economical selection where only the strongest startups survived, who have the unfair

advantage and go away with it, can attract better skills, and thus better equipped for this new cycle than they are. The same happened for Microsoft

It's exactly at this vulnerable moment where litigations for previous practices hit them. Anti-competitive, ethical, privacy …etc. Either the court judge they split the monopoly or discontinue products (ex; Microsoft), which leaves room for the startups to flourish and become monopolies, or sometimes they chose to split the themselves, like IBM did. In all cases monopolies don't usually die. They decline, but they don't die. They become irrelevant in the new world, but they usually stay public and have investors, and go on with their business, but always you can see them try to get back on track. With every technological cycle, those *legacy monopolies* play a sort of a nuisance to other current monopolies, either by leveraging their voice through unsubstantial marketing to weaken them, like the case of Microsoft trying to push the market towards their *"Marojana Chip 1"* that is somehow the first quantum processor, within the heart of the AI race. It's obvious there is no market for it, it's not commercial, the entire world's AI is built upon GPUs, and a decade long of code written on that, and billions of computers already implemented with that. It's obviously absurd the launch will not lead to any sort of impact. It will only take the attention away from the monopolies racing towards dominance of the current AI cycle.

Another example of a long-lasting tech monopoly is AT&T. They were responsible for creating the Unix, the transistor, the C language, the information theory responsible for all sorts of communication … etc. According to our model, they were the ones that lasted from the 40s to the late 60s, until IBM came after them. They have been divided following an antitrust in 1984 to 8 companies that still exist today. Monopolies never die, because the technologies themselves as we previously proved, are encapsulated within each other, and their services never go out of business, they will always be needed within the next cycles after new innovations encapsulate previous ones, and the next one and the next after it and so on.

10. The Innovation Cycles

Innovation have been proven to follow a cycle. Schumpeter expressed that the Juglar cycles are tied to innovation. But no accurate details were presented in the literature. Our attempt in our model, is to close it within an accurate precise range. A definite date where innovation happens. The Juglar cycle when formed in a particular pattern {11; 9; 7}, it accurately determines the dates where innovative

research happen. It coincides with it happening within the range of half a kuznets cycle {16, 18, 20}.

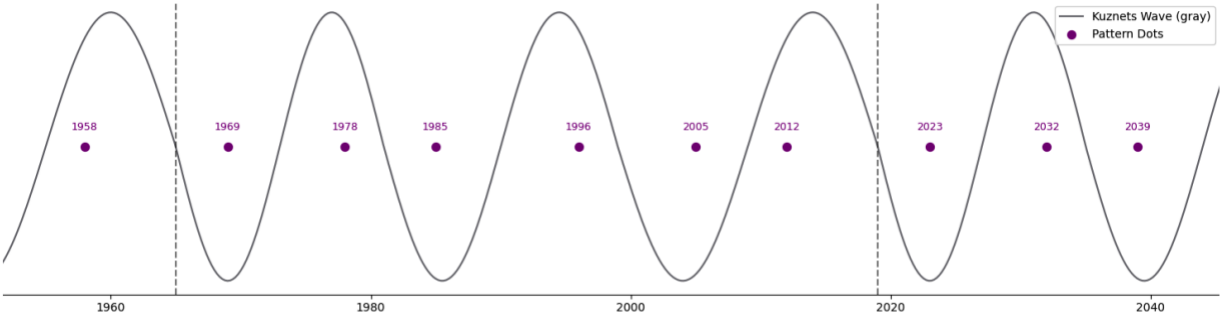


Figure 7: Innovation Cycles (Juglar)

Every date in our model determines a particular technologically innovative event, that creates a platform for startup to emerge around it and form a wave that would compete directly with the pre-established monopolies. These events are only known within the technological community, yet as startups emerge, these concepts and researches become mainstream and get different names.

Most of the concepts related to innovation have been described previously, like the encapsulation principle where each innovation that impacts the next one encapsulates in it all the ones before it, not directly but acts as a platform where products can be built encapsulating them all. So, if you're at the year 2000 for example, and sitting at a computer browsing the web, you can clearly identify each of those technological innovation that impacted the direction of the tech sector that led to that. We do not omit the importance of other groundbreaking research, however the definitive dates we provide, are the dates where an innovative event happen that influences the direction the market takes for the Kuznets cycle after it.

The list is as follow starting from 1924:

- 1924; de Broglie matter-wave thesis. Which influenced the development of cathode research directly, electron tunneling and energy distribution.
- 1930; Zworykin's iconoscope patent. Which laid the foundation for Electronic TV.
- 1942; Harvard's Mark I at IBM's Endicott labs was completed. It used switches, relays and punched tape to automate calculations.

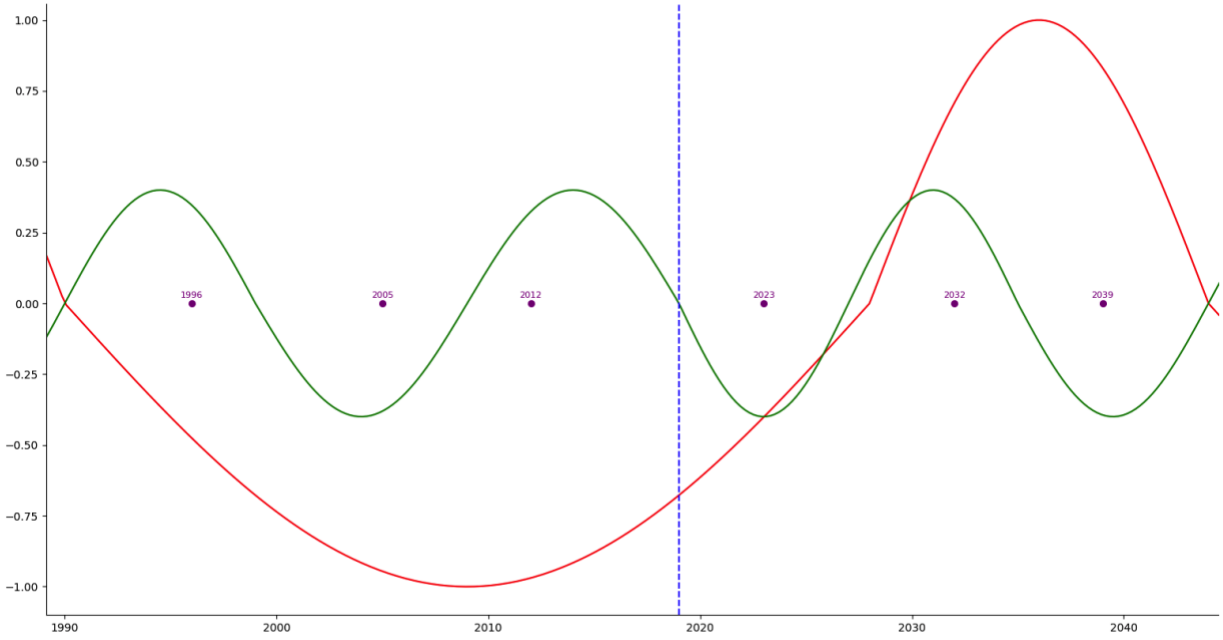
- 1951; UNIVAC I, the first commercial general-purpose electronic computer was delivered to the US Census Bureau.
- 1958; Jack Kilby at Texas Instruments demonstrating the first integrated circuit. Combining multiple electronic components into a single semiconductor chip.
- 1969; ARPANET first packet sent, which led the foundation of the modern internet, using minicomputers with integrated circuits.
- 1978; Intel announced the 8086, its first 16-bit microprocessor, which introduced the x86 architecture. By the 1980s it was de facto standard for CPUs.
- 1985; NSFNET, a high-speed backbone connecting supercomputing centers across the US was launched. By 1990s, 85% of US internet traffic was passing through it, and played a huge role in the Internet explosion in that era.
- 1996; W3C published XML 1.0 draft, which was the foundation for web 2.0 revolution, where most websites were relying on APIs, RSS feeds and SOAP web services.
- 2005; Google acquiring Android, which produced the first open-source OS for mobile, based on Linux. That will later on become the most-used OS in the world.
- 2012; AlexNet was created by Alex Krihevsky, by demonstrating that deep convolutional networks, trained with GPUs could vastly outperform classical methods. Which will be the starter for the AI explosion later.
- 2023; O-RAN nGRG report. Outlining the AI-RAN technology, that will be like GSM towers for AI, where phones and available devices could use AI processing units faster and cheaper.

11. What can startups learn from this?

The reason I wrote this report and started this investigation was to create a macroeconomic model so that startups can benefit from it. On one hand it explains the dynamics surrounding the technological sector, and in the other hand, to offer a map of clarity regarding the direction to take.

There is no way we can predict or accurately forecast the next technology. However, we can for certainty say where the direction is going to take us, because the next technology that is going to lead the market, will encapsulate the ones

before it. By understanding the principles, the dates, and technologies, we can know the right leading project when we see it.

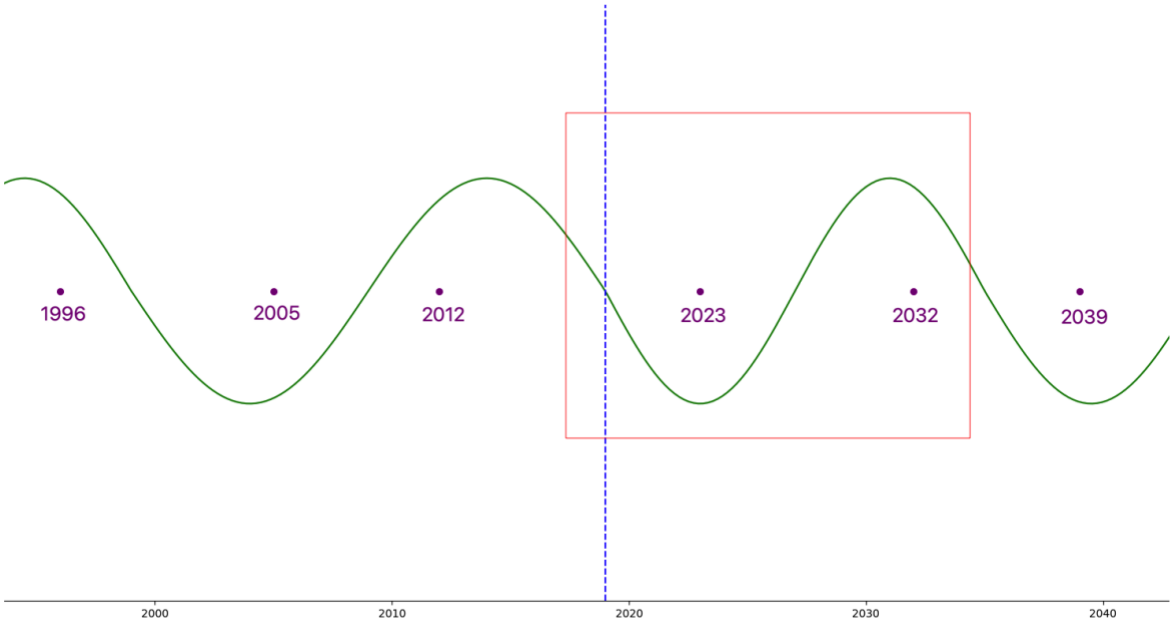


This is the current Kundratiev wave. Against what is already known in the economical literature, our proposed model is that the Kundratiev cycle (the red wave) started in 1990. It is what we might call “The Intelligence Age”. The “Information Age” ended in 2019, yet as we explained before, the cycles overlap because research of the era starts when monopolies were already formed. So, research in “The Intelligence Age” started in 1990, yet results have only been achieved around the year ~ 2008. After that we saw several early startups implementing that research and harnessing it to produce even more results and early prototypes. DeepMind is an example of that, founded in 2010. According to Stanford AI Index repots, 600 AI startups were created by 2017. Those are the early startups that were interested in the technology and the next monopolies are going to be companies from that era. After 2017 to 2025, International Finance Forum states that over 55,000 AI startups were launched.

Most of these companies are feeding on the high-risk capital available in the market. By the next downturn of the cycle, most of them will disappear and only those will strong business models will sustain.

According to the model, by 2025, the monopolies are getting forged already, which are possibly Google through its DeepMind, OpenAI and Anthropic. In 2023, a research have been published which will amplify the effect of AI on the current available technology in the market, perhaps on mobile and smaller devices, perhaps on network, perhaps both making AI mobiles possible. My guess is AI-RAN technology, which will become as a hub adopting 5G/6G that distributes the AI processing power everywhere just like GSM. This will open the possibility perhaps for the next cycle to adopt VR technologies based on AI, and only they could be useful, like the AI glasses.

As we said, the technological progress is almost always hardware. So the next big cycle will not be an LLM model or a mathematical theory or a platform. It is a hardware technology that amplifies the AI models and opens a platform for the web 2.0 to become web 3.0, instead of static exchange of data, it will be a dynamic exchange of data that changes, like the example we provided before about Spotify for AI curated songs that appear new after each refresh, that's a possibility for web 3.0 that might happen after the current kuznets cycle ends.



The red rectangle is where we are. We are on the ascension phase of the cycle. It is a good time to be an AI startup. However exciting easy investment might seem, most AI startups funded after 2019 will be dead after 2030. According to our model, that date will be go alongside the forming of monopolies, which makes sense because they're established and every competing product, every technology

that does not follow the direction they dictate will simply lose traction and will be seen as out of context. The “economic relativity” principle as we explained before.

For now, the best move for small to medium startups is to stay tight around the soon-to-be-monopolies, but be ready for a world with technologies such as AI-RAN that will soon be commercial, mostly after 2030 and lead by the monopolies in question. Softbank with OpenAI already in huge investment says everything we need to know about that.

After 2030, according to the model, a recession will take place. Monopolies will be formed, huge lay-offs, products will be discontinued, locations closed …etc. So for tech engineers, will be to establish their place in either big companies or startups on the rise, as the recruiting will be tight after that. It would be a good idea to start preparing for AI interviews, regarding the theories, the practices, the experience regarding that will be needed in 5 years after the monopolies and their orbiters are all in place.

Aspiring startups without strong business models, made for a world with AI-RAN technology, they might have a hard time to find any funding from 2030 to 2040. There is always room for businesses aiming for long-term commitment, but startups do not play the long-term game.

However, those starting their projects today, should get on the wave of the 2023 technology (AI RAN, web 3.0 in the sense of dynamic exchange of data rather than static, innovative platforms that embrace AI on mobile and other devices such as VR Glasses, AR headsets, apps, or frameworks for Apple Vision Pro …etc). Those Because the wave of LLMs and classical AI as we know it, have already established its monopolies, and most of the projects created today will be obsolete. We must face it that Cursor AI, ChatGPT, ElevenLabs … will be here for the next 10 years, and most definitely they are in their final format, and we as users, are experiencing the best experience in this cycle. By the time they reach profitability, their products will deteriorate.

Yet it will be a good time to be a tech researcher, because the research cycle of the next kundratiev cycle have just started in 2019. There is a lot of room to explore and most certainly not a lot of competition for a world of dynamic content, and most certainly the technologies affecting them directly, of course building upon artificial intelligence, and of course, not software, but always hardware related.

12. Probability of startup success in our model

We will use our model to deduce the percentage of failure among startups. As we will focus on Juglar cycles (the short-term cycles of 11 years, 9 years, 7 years) on which the innovation happen. As we explained, the Kuznets {16, 18, 20} are responsible for the market shifts either in turning startups into monopolies, or pushing monopolies to decline.

To calculate the probability of success, we have first to divide the kuznets into 3 parts:

- Depression: years 0 to 16 (16 years)
- Ascension: years 16 to 34 (18 years) – where we assume startup success is possible/probable.
- Expansion: years 34 to 54 (20 years) –where monopolies dominate, leading to probable startup failure.

The Juglar cycles start 7 years prior to the kuznets cycle beginning. Mapping the Juglar cycles of innovation, that are responsible for forming startups, to the kuznets cycles, that are responsible for market shifts we find as follow. The window of success of startups as we explained before in the model, is within the ascension (startup phase), as monopolies take over (expansion) the startups are no longer within the possibility of success and we don't count it:

- (1) 11-year Juglar (year -7 to 4)
  - Falls in the depression phase
  - Years of success (ascension): 0
  - ***Probability of success: 0%***
- (2) 9-year Juglar (4 to 13)
  - Falls entirely in depression phase.
  - Years of success (ascension): 0
  - ***Probability of success: 0%***
- (3) 7-year Juglar (13 to 20)
  - Falls in depression: 13-16
  - Falls in ascension: 16-20
  - Years of success (ascension): 4
  - ***Probability of success: 57.14%***
- (4) 11-year Juglar (20 to 31)
  - Falls entirely in ascension phase (16 to 34)
  - Years of success: 11

    - ***Probability of success: 100%***
- (5) 9-year Juglar (31 to 40)
    - Falls in ascension (31 to 34)
    - Falls in expansion (34 to 40)
    - Years of success: 3
    - ***Probability of success: 33.33%***
- (6) 7-year Juglar (40 to 47)
    - Falls entirely within the Expansion (34 to 54)
    - Years of success: 0
    - ***Probability of success: 0%***

The 4th cycle is where most startups have better chance to survive, while at the beginning of each kundratiev cycle (54 year) as well as in the end, they have the lower chance to survive.

If we accumulate, we find the probabilities result to:

- 11-year Juglar cycle (50%)
- 9-year Juglar cycle (16.67%)
- 7-year Juglar cycle (28.75%)

And the average of probability of success globally during the entire *Kundratiev cycle* result to: **33.33%** for the average of **9 years** per cycle.

That falls within the known percentage of startups success rate where only 30% of technology startups succeed within 10 years.

13. Appendix

Our Long Economic Cycle Model

Below is the code plotting the waves, the Red & Blue are our adapted Kundratiev long wave cycles. The green one is the adapted kuznets cycle, and the same for the purple dots that are the adapted Juglar's cycles.

```
## Adapted long wave kundratiev cycle

import numpy as np, matplotlib.pyplot as plt

start, cycle, repeats = 1911, 54, 3
T = 3
X = np.linspace(start, start + cycle * repeats, 800)
x = ((X - start) % cycle) / cycle * T
x2 = ((X - start + 29) % cycle) / cycle * T

cut = 38/54 * T
phi = lambda t: (t < cut) * (np.pi / cut * t) + (t >= cut) * (np.pi + np.pi / (T -
cut) * (t - cut))

seg1 = 16 / 54 * T
seg2 = 18 / 54 * T
seg3 = 20 / 54 * T

def psy(t):
    A = 0.4
    return (t < seg1) * (-A * np.sin(2 * np.pi * t / seg1)) + \
           ((t >= seg1) & (t < seg1 + seg2)) * (-A * np.sin(2 * np.pi * (t - seg1) /
seg2)) + \
           (t >= seg1 + seg2) * (-A * np.sin(2 * np.pi * (t - seg1 - seg2) / seg3))

plt.plot(X, -np.sin(phi(x)))
plt.plot(X, -np.sin(phi(x2)), 'r')
plt.plot(X, psy(x), 'g')

for i in range(1, repeats + 1):
    plt.axvline(start + i * cycle, color='blue', linestyle='--')

# Dots at END of each segment: 1906 + 11 → 1917, then +9 → 1926, then +7 → 1933, ...
pattern = [11, 9, 7]
dots = []
current = 1904
while current < X[-1]:
    for p in pattern:
        current += p
        if X[0] <= current <= X[-1]:
            dots.append(current)
        if current > X[-1]:
            break
```

```
plt.scatter(dots, [0]*len(dots), color='purple', s=30, zorder=5)

for d in dots:
    plt.text(d, 0.02, str(d), color='purple', fontsize=8, ha='center')

plt.xlabel("Year"); plt.show()
```

Mathematical Description

Below is the mathematical description for our adapted Kundratiev long cycles (blue and red wave), our adapted Kuznets medium cycles wave (green wave), and the adapted Juglar's innovation cycle wave (purple dots).

Let X be the input year.
Let Xref = 1911 be the primary reference year.
Let cycle = 54 be the length of one wave cycle.
Let T = 3 be the scaling factor for the internal time. Let A = 0.4 be the amplitude for the green wave.

Common Internal Phase Function $\phi(t)$

First, define the `cut` value:

$$\text{cut} = \frac{38}{54} \times T = \frac{38}{54} \times 3 = \frac{19}{9}$$

The function $\phi(t)$ is defined as:

$$\phi(t) = \begin{cases} \frac{9\pi}{19} t & \text{if } t < \frac{19}{9} \\ \pi + \frac{9\pi}{8} \left(t - \frac{19}{9}\right) & \text{if } t \geq \frac{19}{9} \end{cases}$$

Blue Wave Formula $W_{\textbf{blue}}(X)$

First, define the internal time variable $x_{\text{blue}}(X)$:

$$x_{\text{blue}}(X) = \frac{(X - X_{\text{ref}}) \pmod{54}}{54} \times 3$$

Then, the amplitude of the blue wave is:

$$W_{\text{blue}}(X) = -\sin\left(\phi\left(x_{\text{blue}}(X)\right)\right)$$

Red Wave Formula $W_{\mathbf{red}}(X)$

First, define the internal time variable $x_{\text{red}}(X)$:

$$x_{\text{red}}(X) = \frac{(X - X_{\text{ref}} + 29) \pmod{54}}{54} \times 3$$

Then, the amplitude of the red wave is:

$$W_{\text{red}}(X) = -\sin\left(\phi\left(x_{\text{red}}(X)\right)\right)$$

Green Wave Formula $W_{\mathbf{green}}(X)$

First, define the internal time variable $x_{\text{green}}(X)$, which is the same as $x_{\text{blue}}(X)$:

$$x_{\text{green}}(X) = \frac{(X - X_{\text{ref}}) \pmod{54}}{54} \times 3$$

Next, define the segment lengths for the $\psi(t)$ function:

$$\begin{aligned}
\text{seg1} &= \frac{16}{54} \times T = \frac{8}{9} \\
\text{seg2} &= \frac{18}{54} \times T = 1 \\
\text{seg3} &= \frac{20}{54} \times T = \frac{10}{9}
\end{aligned}$$

The $\psi(t)$ function is defined as:

$$\psi(t) = \begin{cases}
-A \sin\left(\frac{2\pi t}{\text{seg1}}\right) & \text{if } 0 \le t < \text{seg1} \\
-A \sin\left(\frac{2\pi (t - \text{seg1})}{\text{seg2}}\right) & \text{if } \text{seg1} \le t < \text{seg1} + \text{seg2} \\
-A \sin\left(\frac{2\pi (t - \text{seg1} - \text{seg2})}{\text{seg3}}\right) & \text{if } \text{seg1} + \text{seg2} \le t < T
\end{cases}$$

Substituting the calculated values for A, seg1, seg2, seg3, and T:

$$\psi(t) = \begin{cases}
-0.4 \sin\left(\frac{9\pi t}{4}\right) & \text{if } 0 \le t < \frac{8}{9} \\
-0.4 \sin\left(2\pi \left(t - \frac{8}{9}\right)\right) & \text{if } \frac{8}{9} \le t < \frac{17}{9} \\
-0.4 \sin\left(\frac{9\pi}{5} \left(t - \frac{17}{9}\right)\right) & \text{if } \frac{17}{9} \le t < 3
\end{cases}$$

Then, the amplitude of the green wave is:

$$W_{\text{green}}(X) = \psi\left(x_{\text{green}}(X)\right)$$

Purple Dots Formula D_k

Let k be the index of the dot, starting from $k = 1$.
Let $Y_{\text{initial\_relative}} = 1904$ be the absolute initial year for dot calculation.
Let $P = [p_1, p_2, p_3] = [11, 9, 7]$ be the pattern of increments.
Let $n_P = 3$ be the length of the pattern.
Let $\sum P = p_1 + p_2 + p_3 = 27$ be the sum of one full pattern cycle.
The year for the k-th purple dot, D_k, is given by:

$$D_k = Y_{\text{initial\_relative}} + \left\lfloor \frac{k-1}{n_P} \right\rfloor \times \left(\sum_{j=1}^{n_P} p_j \right) + \sum_{j=1}^{(k-1) \pmod{n_P}+1} p_j$$

Substituting the numerical values:

$$D_k = 1904 + \left\lfloor \frac{k-1}{3} \right\rfloor \times 27 + \begin{cases} 11 & \text{if } (k-1) \pmod 3 = 0 \\ 20 & \text{if } (k-1) \pmod 3 = 1 \\ 27 & \text{if } (k-1) \pmod 3 = 2 \end{cases}$$

The y-coordinate for all purple dots is 0.

Definitions

- ***Economic selection:*** is the market dynamic process of filtering the startups that doesn't have a strong business foundation.
- ***Revolutionary technology:*** is a technology that influences the market direction, and becomes the central technology of the era.
- ***Innovation:*** is the process of discovering new methodologies, or technologies that have the potential to disrupt the current market order.
- **Encapsulation of technology:** the process where a new technology holds within its formation the previous innovations that disrupted the market in previous cycles.
- **Kundratiev cycle:** long term cycle that last 54 years.
- **Kuznets cycle:** medium cycle that last respectively {16 years; 18 years; 20 years}. It describes the market fluctuation, and the forming of both monopolies and new disruptive periods.
- **Juglar cycle:** short term cycle that last respectively {11 years; 9 years; 7 years;}. It starts 7 years before the Kundratiev cycle, and it describes the dates of innovations that influences the market direction.