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The Metaverse: technology, financing and economics

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Abstract

This article critically discusses several issues regarding the unfolding of the Metaverse concept. Through the analysis of several sources, it demonstrates the rise of the Metaverse myth, as well as the innovation activities that are ongoing regarding the development of the technologies involved and the actual financial evolution of those companies, or funds, that are related to the Metaverse. Finally, it investigates some of the business model innovations and those that are expected to emerge, while comparing the Metaverse with the present status of the Internet. The conclusions suggest possible lines of analysis for future research.

Keywords

Metaverse, patents, business models, financing, technology

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1. Introduction

More than thirty years have passed since Neal Stephenson both coined the term and offered the conception of there being a Metaverse, in the science-fiction book "Snow Crash" (Stephenson, 1992) but only in the last few years are we finally seeing serious attempts to realise it. The first appearances to a large public date back to 2003, with the launch of the virtual world of Second Life. In the following years the concept evolved, primarily in the gaming sector (Cao, 2022), and it has further accelerated over the last decade, thanks to the improvements in the relevant technologies and the spread of new ones: Artificial Intelligence (AI), Virtual Reality (VR), Augmented Reality (AR), edge computing, etc.

In the meantime, the Metaverse concept started to spill-over beyond the gaming sectors. Several factors have contributed to this evolution, of course, including the new technological improvements, but also the advent of a series of related innovations in the appropriability and transaction of virtual assets. Blockchains, cryptocurrencies and Non-Fungible-Tokens (NFT), together with the push of the covid-19 pandemic, showed the importance and feasibility of transferral activities in a virtual world. Finally, the huge bet placed on the Metaverse by Facebook, a major Big Tech, which has even changed its name to Meta so as to explicitly signal its commitment, additionally accelerated the development, the investments in, and the awareness of, the Metaverse. Facebook not only changed its company's name but also bet more than $10 billion on the development of the Metaverse in 2021 alone (Floridi, 2021; Kraus et al., 2022).

Today, many of the most influential companies around the globe are investing significant amounts of capital to build their own visions of the Metaverse, by also acquiring smaller companies that are considered to be at the frontier of the technology. Microsoft, for example, has recently announced its intention to acquire Activision Blizzard, a major video game developer, for nearly $70 billion. The transaction is under severe review by the EU, UK and USA[1], and other jurisdictions, showing the attention of the regulatory authorities. Many other industrial and financial players are realizing, or announcing, new initiatives.

Nonetheless, the concept of the Metaverse is very far from being understood well, and its realization is far from being achieved. There are many issues, ones that have partially already been faced for Internet 2.0, but that will be amplified by the new immersive world of Internet 3.0, which is supposed to be going to host and embody the Metaverse. Furthermore, if the Metaverse proceeds as has widely been expected, it will present not only technological, but also social, legal and economic challenges. Pivotal themes of acting in the Metaverse will most likely be related to digital identities, ethical issues, content moderation, competition, data protection and privacy, among others. The evolution of the Metaverse will require the combination of many digital technologies (AI, VR, AR, Brain Computer Interface-BCI, etc.) which are still partially in the development phase. Despite the large investments in the Metaverse (acquisition of companies, investments in infrastructure, etc.), as well as the example of first realizations (acquisition of virtual real estate, adoption of cryptocurrencies and implementations of content on the existing pioneers Metaverses) we are still on a roller coaster, both as a perception of real achievements (Dwivedi et al., 2022) and due to the volatility of investment values in the financial markets (Vidal-Tomás, 2022).

The literature has, until now, devoted some attention to the technical characteristics of the Metaverse (Dwivedi, 2022) and has proposed different definitions (Sparkes, 2021; Ball 2022), but the economic perspective, the actual diffusion of the technology and the actual status of Metaverse's possible business model, are still understudied. This article will critically review some of these issues, attempting to understand the actual situation in the different sectors, examining the interest shown and the investments made, and also summarizing some of the Business Models Innovations (BMI) that have emerged so far in the different areas that are connected to the Metaverse.

1 The US Federal Trade Commission is seeking to block this acquisition, see https://www.ftc.gov/news-events/news/press-releases/2022/12/ftc-seeks-block-microsoft-corps-acquisition-activision-blizzard-inc

The rest of the paper is organized as follows: Section 2 revises some of the commonly proposed definitions of the Metaverse. Section 3 presents the evolution of the interest in the Metaverse by looking at different sources (books, internet searches, scientific publications), thus confronting the rise of the Metaverse myth. Section 4 explores the innovation required to achieve the Metaverse by examining the evolution of the patents on the key technologies that are fundamental for the future development of the field. Section 5 illustrates the financial markets' assessment of the investments in the Metaverse, and the actual value of the assets owned in some of the Metaverses that already exist. Section 6 attempts to compare the Metaverse concept with the present status of the Internet. To this purpose, some of the business models which the players are developing are combined in the different layers that are necessary to achieve the Metaverse. Section 7 concludes the paper.

2. The Metaverse: definitions and use expectations

The ground-breaking novelty represented by the Metaverse is evident from the variety of imaginative definitions of it that can be found in both the tech-related press and the academic literature.2 The Metaverse has been defined in many ways, as a product or a service, as a place, and even as a moment in time. The author and investor, Matthew Ball, in a seminal book on the topic (Ball, 2022), refined his own often-quoted definition by describing the Metaverse as "A massively scaled and interoperable network of real-time rendered 3D virtual worlds that can be experienced synchronously and persistently by an effectively unlimited number of users with an individual sense of presence, and with continuity of data, such as identity, history, entitlements, objects, communications, and payments." This definition emphasises, among the Metaverse's core attributes, interoperability, synchronicity and persistence. The Metaverse has also been described as a place in which users can connect, interact, and transfer themselves and their belongings across multiple digital locations. More recently, the start-up entrepreneur, Shaan Puri, came up with a time definition of the Metaverse: the moment in which our digital lives – our online identities, experiences, relationships, and assets – become more meaningful to us than our physical ones. This perspective puts the focus on the human experience, making the transition to the Metaverse a sociological shift instead of, or in addition to, a technological one.

More simply, we will refer to the Metaverse as a three-dimensional virtual world where an unlimited number of avatars (digital reproductions of persons) engage in social, political, economic and cultural activities.

Adopting an analytical approach, the Metaverse must be analysed in terms of its three main components: hardware, software and content (Park and Kim, 2022). Hardware, in the Metaverse, is essential to provide the immersive experience but, at the moment, its inadequacy is a major limitation on enjoying the Metaverse in a satisfactory way; the critical issue is related to latency (the time it takes for data to travel from one point to another of the network and back), which plays a decisive role in defining the quality of human interactions. Probably, a maximum latency that is close to about 10 milliseconds is key for the smooth functioning of the Metaverse. Firstly, there are the physical limits, the speed of light to cover distances: even considering that well-designed fiber networks today may allow speeds that are in the right range, low latency requires the speed's performance to be sustained throughout the network connecting users to the cloud, and many elements are not sufficiently fast. Besides the speed of the connection, other hardware components, including head-mounted displays (HMD), are most important in order to get the sense of immersion in a completely virtual world, hand-based input devices, non-hand-based input devices (based on eye-tracking, head tracking, voice inputs and so on) and motion input devices all contribute to the quality of the experience.

2 Park and Kim (2022) report 54 different definitions of the Metaverse that have been presented in the recent academic literature.

As for the software, the input collected by the hardware needs to be processed by software so as to create the models that represent the virtual environment. There are five different types of software that are essential for the Metaverse: Scene and Object Recognition (the process of recognizing the size, shape, position, brightness and colours of objects, according to distance); Scene and Object Generation (which may either be related to the real world or to an entirely imaginary or hard-to-reach environment); Sound and Speech Recognition (fundamental for communication among avatars); Sound and Speech Synthesis (which gives the user a sense of immersion); Motion Rendering (to make the Metaverse realistic, elements such as body language, facial expression, hand movements, etc., all need to be rendered with a high quality).

Finally, the third key component of the Metaverse is content: users are expected to create large amounts of multimedia and text content through their avatars, these entities and their relationships are used to organize events which are combined to form a scenario. Scenario generation, scenario population and scenario evaluation are types of important content components in the Metaverse.

The complexity of the technical architecture, briefly described above, shows that the Metaverse, even in its infancy, aims to offer an experience that is quite different from the previous elementary examples of virtual reality (such as Second Life). However, this ambition presents many challenges (Park and Kim, 2022) and potential side effects for users today, and these are still partially unknown. Anyway, there is little doubt that digital technology has, in the last two decades, made great steps forward and can today enable a more immersive experience, the possibility to easily access the Metaverse at anytime and from anywhere, thanks to mobile devices, and a deeper bond with real life, for example, by allowing the trading of virtual objects and the use of virtual currencies.

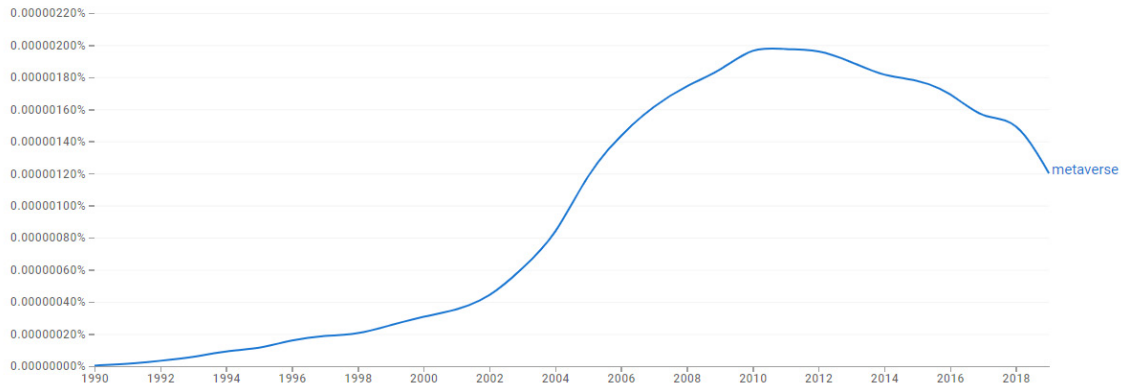
However, the satisfaction of the huge interest that has been shown in the Metaverse is strictly linked to the necessary technical improvements and the richness of the user cases that are expected. These innovations promise to modify our lives, our culture and the way we interact: the Metaverse is expected to change the education systems (immersive education), to increase the opportunities for meeting, both for work and private purposes; to induce changes in the healthcare system, (leading to multimodal medical information standards, medical and social data fusion, telemedicine and online health management, Chen and Zhang, 2022); to increase transparency in the assessment of second hand markets and the quality of products. Almost all sectors that can benefit from a direct, even if virtual, engagement of users may be affected and changed but, after all, as in many profound innovations, we can’t predict today how many different uses may actually emerge in the future.

3. The Metaverse: hype and studies

The term Metaverse is not that new, as has already been recalled, it was introduced in the book “Snow Crash”, which described the immersive and pervasive virtual reality to which the hero of the novel continuously retreated in the face of a truly disappointing real world (Stephenson, 1992). However, the concept of the Metaverse has only quite recently become a topic of frequent discussion and general press articles. In the scientific literature, the topic of the Metaverse has been around for a while, but an acceleration of this has become evident in the last year.

Figure 1 shows the presence of the concept of the Metaverse in books published from 1992 to 2019, the last year available. The data clearly show a peak of interest in the concept between 2008 and 2012, followed by a certain decline in the years that have followed.

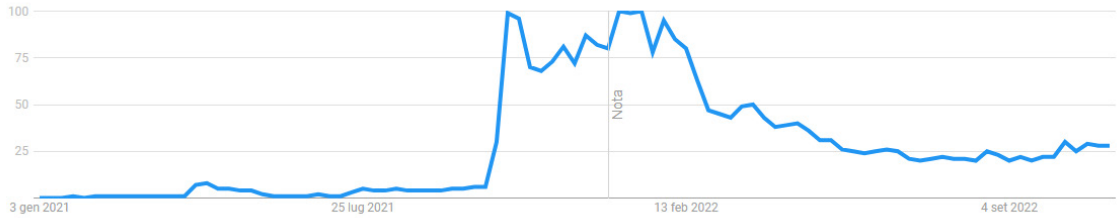
Figure 1. Book usage of the Metaverse topic (1992-2019)



Source: Google Ngram Viewer; extracted on 11-11-2022.

However, as shown in Figure 2, which presents the search trend on Google for the word Metaverse, in the last two years, a new acceleration of interest is evident. Between January and October 2021, searches for the concept were relatively low in number, but, at the end of October, 2021, when Mark Zuckerberg announced the change in his company's name, from Facebook to Meta, the interest in the term "Metaverse" increased dramatically. After a few montHs, by February 2022, such searches showed a decline, but still settled at much higher values than in October 2021. Probably, this increasing trend means that the idea of the Metaverse has finally reached wider recognition. The concept is no longer limited to specialists, or to those persons who are directly involved in the development of the technology but has become a topic that is of interest to the general public.

Figure 2. Metaverse search trend (Jan 2021 - Nov 2022)



Source: Google Trends; extracted on 11-11-2022

On the other hand, the scientific interest in the Metaverse has been growing quite constantly, particularly in the last few years (Abbate et al., 2022) and more than 500 scientific papers have been published on the topic.[3] There is the predominance of computer sciences, engineering and telecommunications publications, leaving to the social sciences approximately the remaining 10-15% (Figure 3). This means that, from the point of view of technology experts, the interest in the Metaverse has been running high for several years,[4] while the interest from the social sciences has started to rise only more recently.

3 ISI Web of Science search based on the word "Metaverse" using topic as search criteria in all scientific fields (06 Dec 2022).

4 Notice that these are ISI publications on scientific journals. This means that the research has undergone a peer review process before being published. One can thus expect that papers published in, say, 2022, had most likely been being prepared for at least a couple of years.

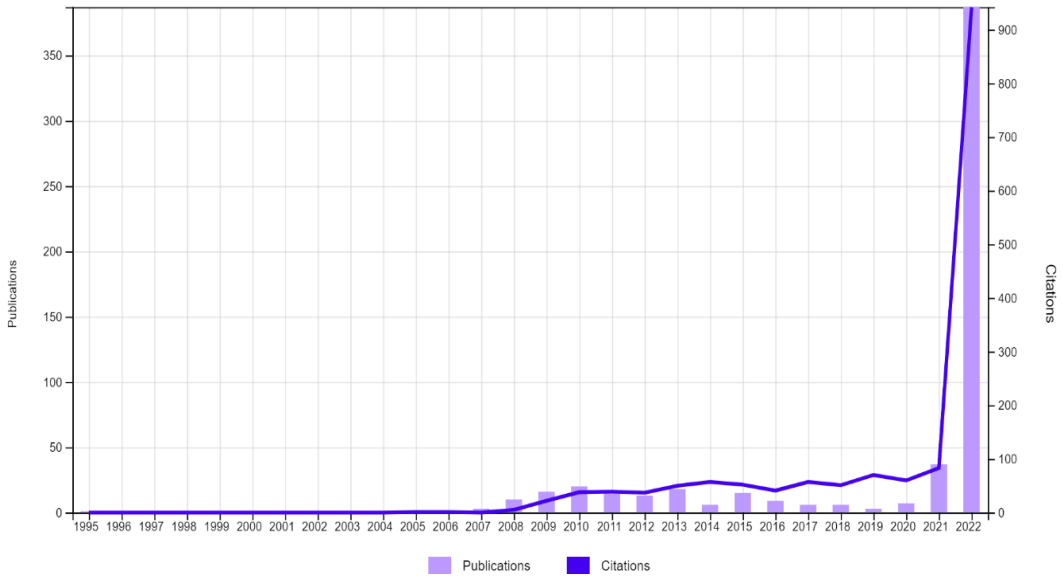
FIgure 4 shows the rising trend in the yearly number of scientific publications, particularly from 2008, but also the spike during the last year, with more than 380 papers published in 2022 alone (more than the overall number of publications from 1995 to 2020). Citations for articles with the topic Metaverse, another important indicator of scientific attention, also show a value greater than 900 for the year 2022, which is more than nine times the value recorded in the previous year.

In synthesis, while it is likely that some form of hype is today surrounding the concept of the Metaverse, the scientific community has been working on the theme for several years, with an evident acceleration in 2022.

Figure 3. Scientific publications divided by topic

Source: ISI Web of Science.

Figure 4. Yearly evolution of scientific publications and citations



Source: ISI Web of Science.

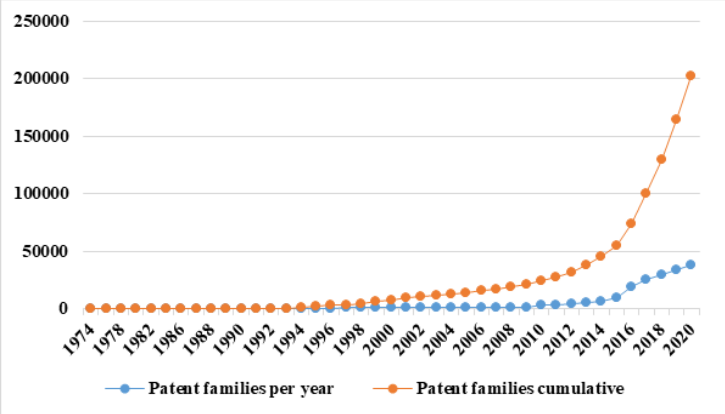
4. The Metaverse: innovation and patents

Another method of assessing the present interest and investment in the Metaverse, is through the examination of developments in related innovations. The most common way to investigate innovation is by the analysis of the trends in patents. In this case, we will explore the evolution of the patents that are related to the most important of the technologies that are the foundation of the Metaverse. A limitation of this method is that a large amount of the Metaverse's development is achieved through computer programming improvements and these kinds of innovations normally are not found in the public domain. However, advancements in AR, VR and BCI, all considered among the most important of these technologies, which might favour the future massive adoption of the Metaverse, are normally patented innovations. A second limitation of the approach relates to the fact that the economic literature is still debating whether identifying patents is the best way to measure innovation. Notwithstanding the reasonable caveat that patents do not account for all the innovations produced, they are recognised as a reasonable proxy for innovation, at least at the aggregate level (Acs et al., 2002; Burhan et al., 2017).

For the moment, we explore how these innovations translate in terms of the number of patents,[5] conscious that this remains a rough measure of the attention and investment that are devoted to these crucial technologies. The less known of the relevant technologies, brain-computer interface (BCI), shows an overall number of patents that is slightly over 5.300, while augmented reality (AR) has just over 136.000, and virtual reality (VR) approximately 183.000. By simply using the keyword "metaverse" we add "only" another 1.540 patents. Running the search again, considering all the technologies together (to avoid double counting,) we found an overall result of 241.567 patents.

Figure 5 shows that this patenting activity has shown a significant growth year on year: from 1.888 patents in 2009, to 3.096 in 2010, to 9.832 patents in 2015, 19.419 in 2016, until it reached a peak of 38.395 in 2020.

Figure 5. Patent Families AR, VR, BCI, Metavese

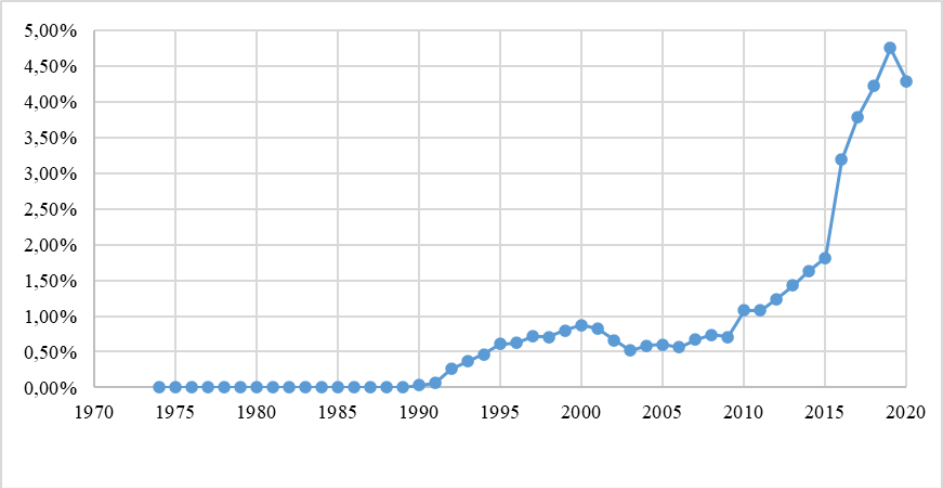


Source: Our elaboration on Espacenet data.

Of course, it is a well-known fact that, in the last twenty years, many kinds of patents have shown important growth but, for the technologies examined here (AR, VR, BCI, Metaverse) the growth in the last 5 years looks significantly more pronounced than does the average. In the period from 2015 to the 2020, the number of patents that are in some way related to the Metaverse showed an increase approximately three times higher than the increase recorded for other technologies, bringing these technologies to grow in number from 1,5% to 4,5% of the total (Figure 6).

5 The simple count of patents is not a refined measure of the development of a technology (Parcu et al., 2022). However, the aim here is not to compare countries 'or companies' developments, but only to roughly understand the evolution of a certain technology over time, and the acceleration more recently. For this simple purpose, patent counting may be an acceptable proxy.

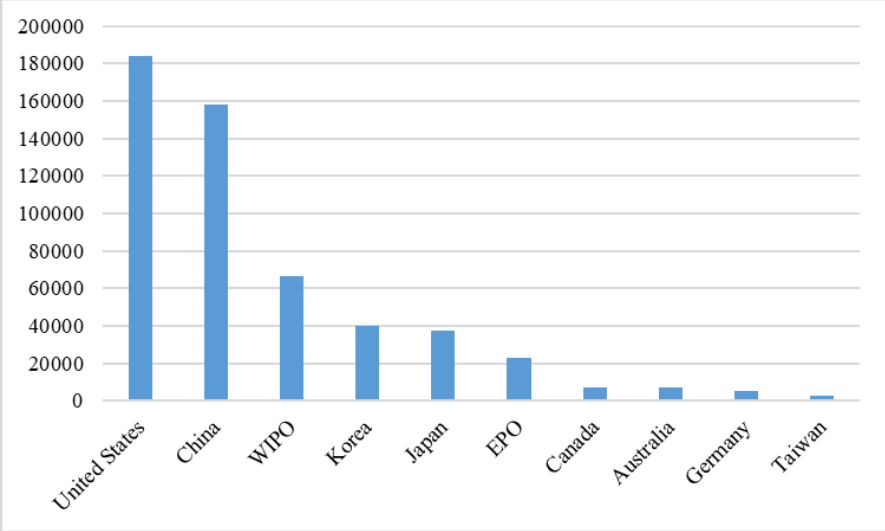
Figure 6. Percentage of Metaverse (AR, VR, BCI) patents on all patents



Source: Our elaboration of Espacenet data.

Another aspect that might be considered is if these technologies are protected by the companies that produced them and that hold the related patents, the results are shown in (Figure 7). With more than 180.000 patents, the United States is by far the first country, closely followed by China, with just under 160.000 patents. The other main repositories are quite a lot smaller: WIPO has counted approximately 66.000 patents, Korea 40.000, Japan 37.000 and EPO 23.000.

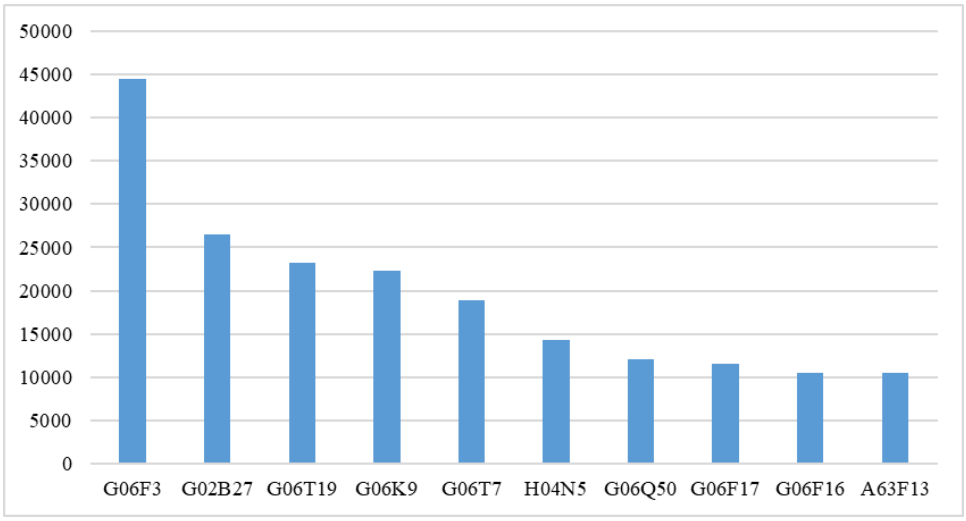
Figure 7. Office where the patent was published



Source: Our elaboration of the Espacenet data.

Figure 8 present the most common technologies represented. The largest number of patents is recorded under the IPC class G06F (ELECTRIC DIGITAL DATA PROCESSING), with a cumulative number of approximately 80.000 patents, the second group is the class G06T (IMAGE DATA PROCESSING OR GENERATION, IN GENERAL), with a total number of 40.000 patents. Other relevant technologies are those related to the class G02B (OPTICAL ELEMENTS, SYSTEMS, OR APPARATUS), with more than 25.000 patents, G06K (RECOGNITION OF DATA; PRESENTATION OF DATA; RECORD CARRIERS; HANDLING RECORD CARRIERS), with 23.000 patents, H04N (PICTORIAL COMMUNICATION), with close to 15.000 patents, and A63F13 (VIDEO GAMES), with about 10.000 patents.

Figure 8. 10 most frequent IPC technologies

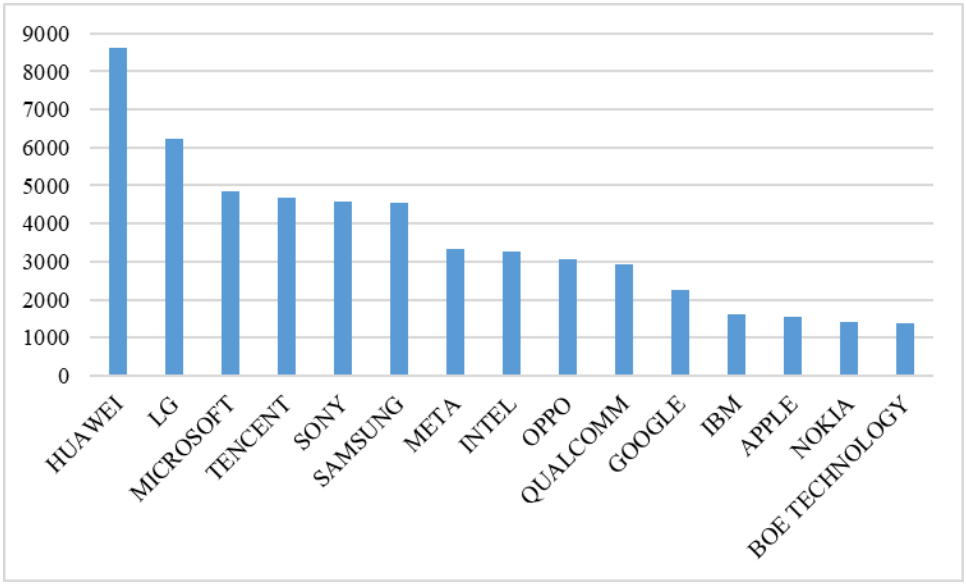


Source: Our elaboration of the Espacenet data.

After this first general analysis, it would seem to be interesting to explore which the companies that hold the largest number of patents in these key technologies are, so as to obtain a first indication of the relevant players in this field.

Figure 9 presents the 15 companies that hold the largest numbers of patent portfolios in relation to these technologies. The first place, with more than 8.600 patents, is held by Huawei, followed by LG, with more than 6.000 patents, Microsoft, Tencent, Sony and Samsung follow, all in a range from 4.500 to 4.800 patents, and then Meta, Intel, Oppo and Qualcomm, which each record between 2.950 and 3.300 patents, Google has slightly more than 2.000, and the last group comprises IBM, Apple, Nokia and BOE, who are all in the range 1.400 and 1.600 patents.

Figure 9. 15 Companies with the most patents

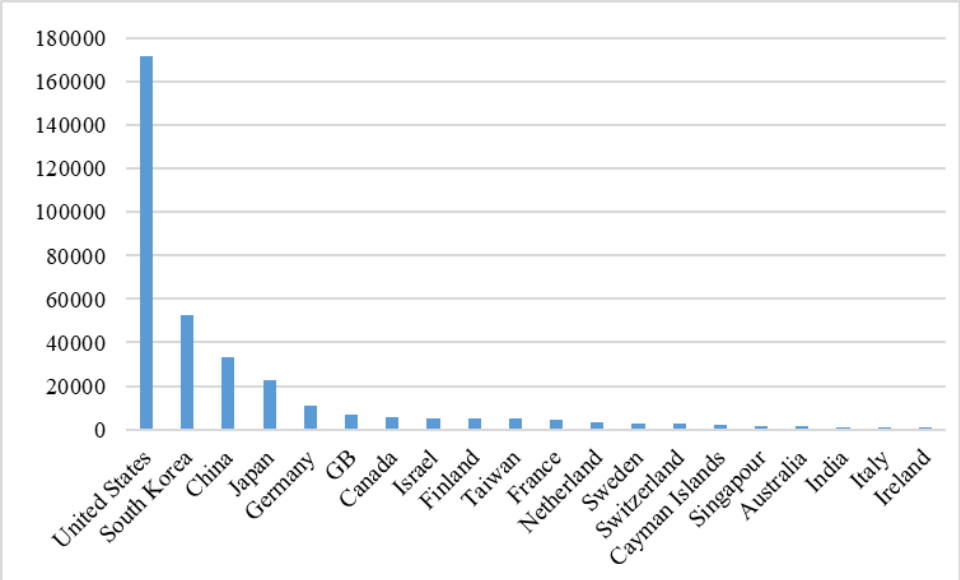


Source: Our elaboration of the Espacenet data.

The list of patent holders, unsurprisingly, includes many of the most innovative technology companies and also many of the Big Techs. The strong participation of the technology companies, which usually patent their inventions and licence them to implementers, and the Big Techs, which usually keep their innovation within their controlled platforms, is an interesting signal of the present uncertainty about the Metaverse's future technological configuration.

Figure 10 shows the predominance of patent applicants from the United States (170.000 patents), and, with respect to the other countries of the world, there is a result that appears to be in contrast with the fact that five of the six largest patent-holding companies are not American. The second position is covered by South Korea (52.000), followed by China (33.000) and Japan (23.000).

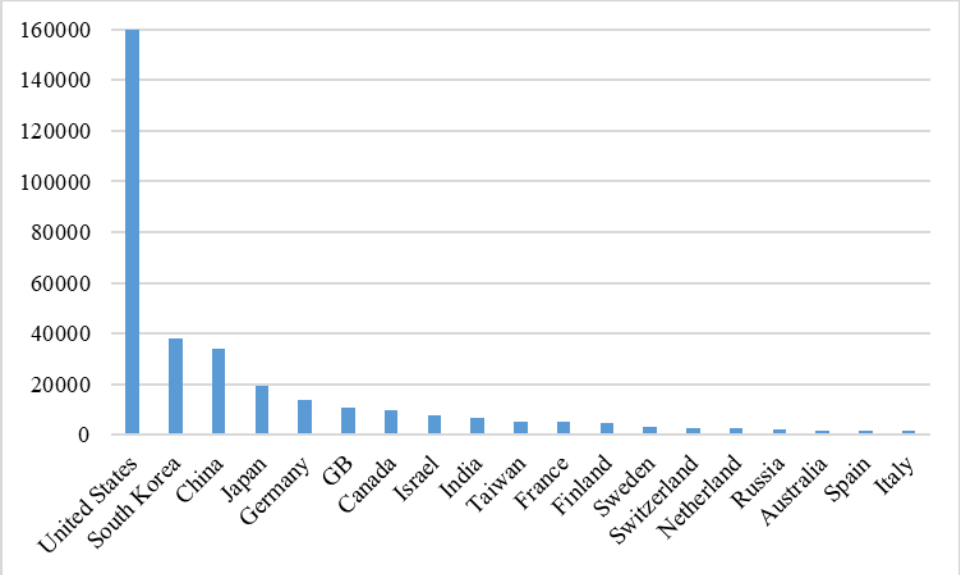
Figure 10. Country of the applicant (20 most frequent)



Source: Our elaboration of the Espacenet data.

A similar picture is presented in Figure 11, which classifies patents by using the country of residence of their inventors. Again, the predominance of the US inventors in patenting technologies that are related to the Metaverse is clear.

Figure 11. Country of residence of the inventors (20 most frequent)



Source: Our elaboration of the Espacenet data.

Finally, after this rapid rise in patent numbers, thus witnessing vibrant innovation activity, it remains unclear why the effective use of many of these technologies for the Metaverse seems still to be struggling to achieve widespread adoption, except, of course, in the gaming industry.

However, it may help to recall that some of the previous major technological innovations (computers, internet) also struggled for many years before attaining general use and reaching their first million users. In this respect, some studies claim that three of the key technologies for the Metaverse, VR, AR and BCI, are all still far from the slope of productivity that is the moment when there is mass diffusion among users.

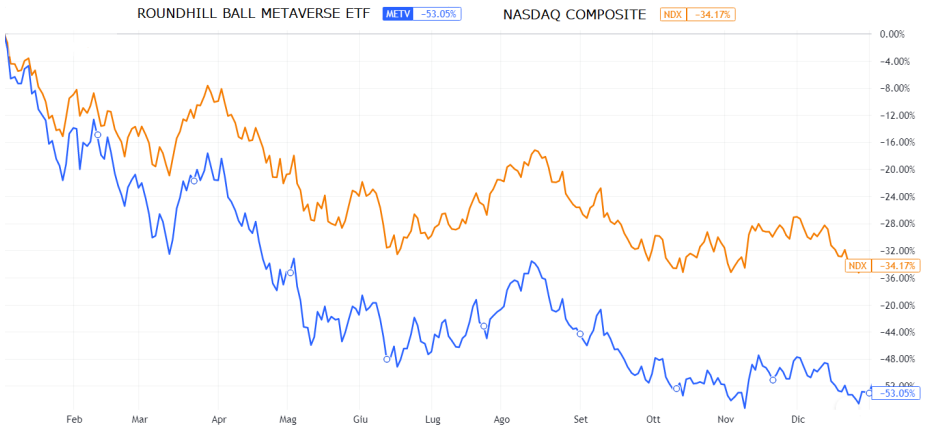
5. The Metaverse: financial investment

As briefly outlined in the introduction, the economic interest, in terms of the investments that are in some way directed at the Metaverse, is increasing considerably. The relevant acquisitions that have already been completed (Oculus VR), or that are in progress (Activision Blizzard), amount to several billions of dollars. Direct investment by many different companies brings the overall amount of funds to well beyond the large investment of the $10 Billions of Facebook/META, in 2021. Moreover, many of these investments were purely financial in nature, rather than the investors having actual input into the products.

However, when considering the ETF instruments that are related to the Metaverse (Vidal-Tomás, 2022), it is quite clear that the recent performance of these investments, is not positive. In general, all these financial investments showed a loss that was greater than 50% in 2022. The largest, and most known, ETF, investing in the Metaverse, Roundhill Ball Metaverse ETF[6], counting on an initial value of Assets Under Management (AUM) of over $850 million, lost approximately 53%. The fund's assets are composed of 24% by gaming platforms, 17.5% by cloud solutions, 17.5% by computing components, and 11.5% by social networks. Even if compared to the general decrease in the value of the financial market over the same period, the comparative loss remains about 20% higher (see Figure 12). In the last year, other ETFs, or portfolios, that have also focused on the Metaverse, have shown similarly negative performances (eToro Metaverse Life Smart Portfolio lost 65%; Evolve Metaverse ETF 55%, etc.).

6 https://www.roundhillinvestments.com/etf/metv/

Figure 12. Nasdaq Index and Roundhill Ball Metaverse ETF comparison: Year 2022



Source: Our elaboration

Following the same, purely financial, perspective, the best-known company that has decided to bet strongly on the Metaverse, Meta, has also not been rewarded by the financial markets. Meta has recently demonstrated very negative performances, with a loss of shares' value that was close to 63% during the year 2022 (Figure 13). Meta recently announced that, for the first time in its history, it would be making a staff reduction of approximately 13% of its workforce (Financial Times, 2022).

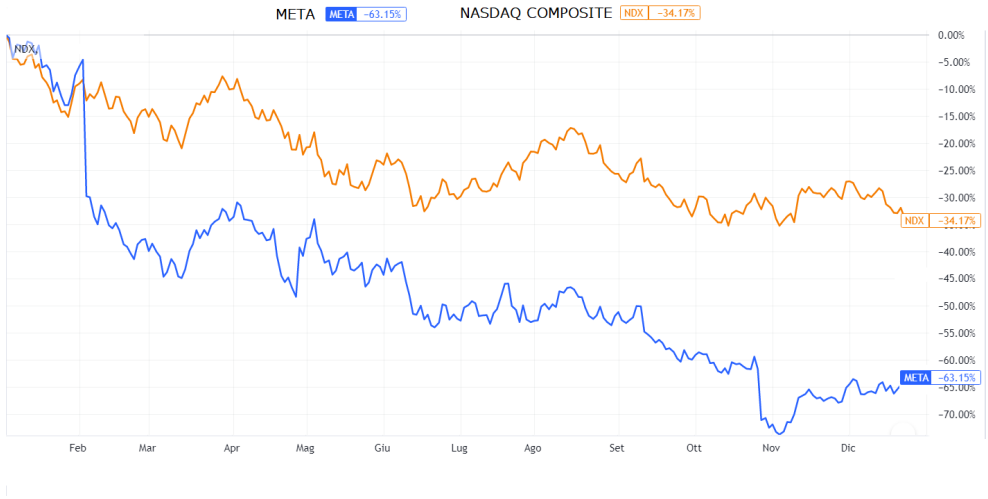
Another relevant market that may give us some idea of the high interest and opportunities that investors foresee in relation to the Metaverse concept, is the virtual real estate, an area that is strictly related to certain cryptocurrencies which are connected to a specific Metaverse. The most important decentralized[7] Metaverses, all built on the Ethereum blockchain, are Decentraland, with the cryptocurrency Mana (which has a market capitalization of $950 million), Sandbox, with the cryptocurrency Sand (market capitalization of $930 million), and Axie Infinity (AXS market, with a capitalization of $690 million), which is a Metaverse that is more gaming-oriented than the other two[8]. These three metaverses together, in 2021, accounted, through virtual land sales, for more than $500 million, with single pieces of virtual land being sold for over $4 million.[9] At the end of November 2021, the market capitalization of the three cryptocurrencies just cited, in total, was over $20 billion (Mana 9.1, Sand 6.2 and AXS 8.6).

7 The main difference between centralized and decentralized Metaverses is that the former maintains control and authority, in terms of decision-making, planning, security, appropriability of earnings, etc., while a Decentralized Metaverse refers to a system in which the control and authority is distributed amongst the users. Of course, different degrees of centralization that fall between a fully centralized Metaverse and a fully decentralized one, are possible. One of the clearest examples is Decentraland, which is completely decentralized and based on the blockchain Ethereum. Its decentralization is represented by an autonomous organization of control: Decentralized Autonomous Organization (DAO), which are composed of the participants of this Metaverse, who can vote and freely redesign the policies of Decentraland.

8 It is a mixed world based on a game that is strongly related to the cryptocurrency NFT's acquisition, as well as to land ownership in the Metaverse (in November 2021, a piece of virtual land was sold for the record price of $2.3 million).

9 The highest price paid for a single acquisition is $5 million, in what is quite an unknown Metaverse platform, TCG, but several lots of virtual land, with prices ranging from $2 to $4 million, were sold on Sandbox, Decentraland and Axie Infinity.

Figure 13 Nasdaq and Meta comparison year 2022



Source: Our elaboration

Despite the strong investments that we have underscored, and the hype that the Metaverse concept has enjoyed during the last year, the news has recently claimed that “in the Metaverse there is nobody”, a claim that is not completely true. Following the most recent statistics, there are at present more than 400 million monthly unique users, but they are divided among many different Metaverses, with a great predominance of the gaming ones (Roblox, with more than 200 million, Minecraft, with 160 million, and Fortnite, with 80 million). This also has consequences for the average age of those users, who are largely younger than 18 years old (Metaversed, 2022), and who are thus often unable to make transactions, buy land, and/or to spend easily. However, this skewed age profile can also be interpreted as being good news for the future of the Metaverse concept.

The prevalence of gaming platforms leaves a few users who are dispersed sparsely among the many different non-gaming platforms. While estimates may vary, according to the different sources, the ranges vary between the 200.000 monthly users of Horizon World, to the 40-50.000 at Sandbox and Decentraland. These, for the moment, appear to be numbers that may allow for limited interaction, and may thus justify the impression of empty worlds.

These data, in conjunction with the economic and geopolitical events that have hit the world since the beginning of 2022, have led the financial values of Metaverse companies (particularly those that are non-gaming oriented), into the very problematic period we have described. Nevertheless, the key issue relating to the low usage of Metaverses other than those for gaming purposes, remains. There are many different explanations, first, it appears that there are still too many technological hurdles that mean that the user-experience is not fully enjoyable. One of these is the technological discussion around the challenge of latency, which we introduced above. In addition, there is the high price of the most advanced instruments, which are able, today to allow for a “complete” and immersive experience (i.e., the “professional” VR or AR devices). The best devices have list prices higher than $1.000 (HTC Vive Focus 3 and Meta Quest Pro), while VR devices that are expected to come from Apple in 2023 will probably be priced in a price range that is between $2-3.000. These prices appear to be far too high for mass consumption.[10]

10 Even if there are devices at lower prices, some of which cost even less than $100 (e.g., the Sony PlayStation VR), these are commonly used only for gaming, leaving, once again, few possibilities for those who are interested in the non-gaming Metaverse(s).

6. The Metaverse: business models

The discussion on the emerging Business Models (BM), and on the Business Models' Innovation (BMI), is made complex by the fact that, as was true in the past for many new technologies (Web 2.0, IoT, etc.), these are not fully formed, and will emerge with the development, use and practical improvements. Companies and venture capitalists therefore have to speculate in regard to the opportunities, interactions and possibilities which are currently unclear, and often difficult to anticipate.

However, despite all these uncertainties, the financial fallbacks that we previously mentioned, and the less than enthusiastic impressions reported by many commentators, the Metaverse is clearly attracting relevant economic interests from many different perspectives (Narin, 2021).

A brief glance at Figure 14, below,[11] shows that the market map of the Metaverse builders is populated by different kinds of companies that belong to a variety of industries, such as telecoms, semiconductor, cloud, gaming, etc. In this phase of development, one can find both technological start-ups and consolidated digital giants. Big techs are apparently following different strategies, from Microsoft, which is attempting to acquire gaming companies (e.g., Activision Blizzard), to Facebook/META, which is investing in the creation of its own Metaverse (e.g., Horizon World) and acquiring companies that hold key technologies (e.g., Oculus VR), to Amazon and Google, which are mainly attempting to develop some of these technologies internally. However, Figure 14 shows how many other different companies have entered the race.

Besides the many companies that are contributing technologies and devices for the Metaverse, many others, which come from traditionally non-tech industries, are approaching the Metaverse, primarily as users. Among the key reasons for companies entering the Metaverse, one can start from branding and marketing (Rauschnabel, 2022): entering the Metaverse gives visibility to small companies (press, blog, social media, etc.) and even more visibility to big brands, as it may be considered to be a sort of novel advertising perspective (Kim, 2021; Taylor, 2022). In this respect, it is relevant to recall that many important consumer brands have already approached the Metavein the last few years (Coca-Cola, Gucci and Balenciaga, just to cite a few big names). These companies are already advertising, or selling their NFTs, in a variety of different Metaverses, creating their events, buying virtual land to build virtual branches or shops (Gucci on Roblox; Balenciaga on Fortnite, Nike in Decentraland, and Luis Vuitton, which recently released a game to find NFTs). Other examples include Atari, which has invested in buying land in The Sandbox and Decentraland, so as to allow visitors to play Atari-themed games; Adidas, which purchased land in The Sandbox, in order to fill its space with exclusive branded content and experiences, together with items for purchase. Recently, Nike has appeared on Roblox, and acquired one of the most renowned digital shoe markets: RTFKT. At the moment, the main reason to be present in the Metaverse, for these very well-known brands, is probably only to refresh and modernize their image, but this doesn't exclude the possibility that they may come to consider the NFT market for their products as being a truly profitable business for the future.

11 https://tech.co/news/metaverse-companies-whos-involved-whos-investing#giant

Figure 14. The market map

Source: Jon Radoff, Building the Metaverse, August 2022, available at: https://medium.com/building-the-metaverse market-map-of-the-metaverse-8ae0cde89696

A related possibility (and business opportunity) is to interpret the Metaverse as being the new frontier for online shopping, which is especially relevant for e-commerce platforms. The sellers may seek the possibility of presenting their physical products in a new, more complete and interactive way, to consumers, thus increasing both customers' loyalty and the demand for the products (Jeong et al., 2022). Virtual commerce applying immersive technologies, such as augmented and virtual reality, may shift consumer perception from a 2D product catalogue to a 3D experience of immersive reality, with the relevant incentives to shop online more, instead of physically visiting real stores.

Among the best understood, the BM of the gaming sector is at the forefront of the Metaverse. It is a sector that directly benefits from the best immersive experience in order to improve both the loyalty of the users and their willingness to invest in NFT since it is related to the game, a choice that is often linked to progress in the game and the improvement of the gamer's experience. This business model is not new, actually, it is already in use in many games, but what makes the difference is the pervasive use of a group of related instruments (cryptocurrencies, blockchains, smart contracts, etc.) that push gamers to increase the time they spend on the game, and their immersion in it, thus favouring their willingness to spend more.

Real estate, in the Metaverse, is already a reality, with the possibility of selling finished properties and virtual plots of lands, and thus the user can monetize their investments by either renting them or monetizing them through other forms of management.

Another sector that could be widely affected is tourism. This includes the replication of actual business models, but with the addition of new content through the Metaverse platforms, however many BMI, including Metaverse tourism, sustainable Metaverse tourism, together with, as Smart (2007) has proposed, AR, lifelogging, mirror worlds, and virtual worlds (Go and Kang, 2022; Koo et al., 2022; Gurosy et al., 2022).

Of course, we cannot avoid mentioning certain promising Metaverse applications that may really benefit society as a whole. In the first place, distance education could be significantly improved by a more immersive experience for students (Jeon, 2021; Tlili et al., 2022; Hirsh-Pasek et al., 2022) at all stages of study, from the elementary school to specializations at the University. In this case, the benefits for society are clear, but also the improvement in business models for private companies may result from the possibility of increasing fees with respect to standard online courses, lower expenditure for instructors' travel, as well as for premises, etc.

Another key example is in the health sector. Virtual reality can create new channels for the delivery of care, potentially lowering costs and improving services to patients. Among the tools, a telepresence, allowing people to be together virtually, even while they are far apart, digital twinning, and blockchain (related to patients' data management and exchange), are expected to become the most relevant applications.

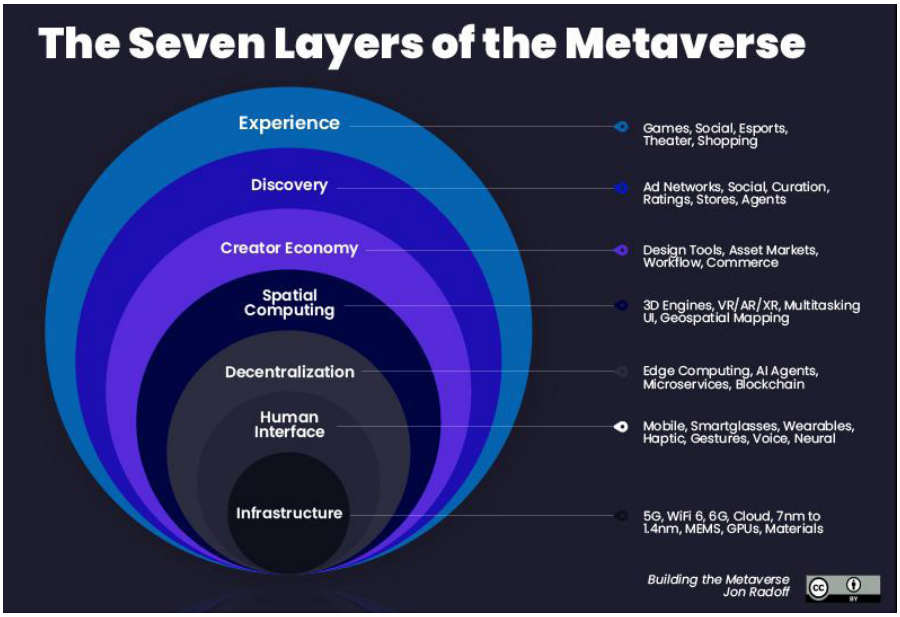
While many business opportunities are emerging, a variety of companies, as seen in Figure 15, are contributing to the building up of the Metaverse, and many others are betting on the possibilities of using it to develop their virtual/physical presence.

Figure 15 is a conceptualization that is quite consistently used to describe the Metaverse value chain, as it is perceived today. It proposes a classification around seven main clusters of activities[12] and, if read jointly with the market map seen in Figure 14, it might give the first idea of how companies, and especially the main technological companies, including the Big Techs, are presently positioning themselves in the Metaverse.

Starting from the bottom, the infrastructure layer includes the technologies and, in particular, the telecommunications networks and network components, that will make all the higher layers of the Metaverse possible. This basic layer includes fibre networks, WiFi, 5G, and beyond, cloud systems, semiconductors. According to some analysts, the Metaverse still requires revolutionary chip innovations, given that the devices needed to access and enjoy the experience need increasingly more powerful and tinier hardware (miniaturization). The presence, in this layer of the main global chipmakers, like Qualcomm, Samsung and Intel (to mention only a few of the market leaders) demonstrates both its centrality and its economic promise. In this layer, we obviously also find many established telecoms companies (like AT&T, DT, Verizon), and the powerful cloud divisions of the Big Techs (Microsoft Azure, Amazon AWS and Google Cloud), which are investing in, and contributing to, the technological development of the infrastructure. Among the companies in this layer, it is important to mention Nvidia, the world-leading Graphic Processing Unity (GPU) specialist company, which has a relevant role and, according to some analysts, is a potential candidate to become the Google of the next-generation of 3D Internet.

12 This was proposed by Jon Radoff in 2021, see https://medium.com/building-the-metaverse/the-metaverse-value-chain-afcf9e09e3a7

Figure 15. The Seven Layers of the Metaverse



The second layer from the bottom refers to the new instruments that are necessary to build the human interface with the Metaverse. With Internet 2.0, the screen of a pc or of a smartphone was a sufficient interface but, here, the Metaverse is truly different, and it requires more. There is the need for tools that are capable of being intermediaries between humans and the infrastructure in order to enable an immersive experience in the context of augmented and virtual reality applications. These tools may include all the wearable electronics that are in development, such as smart glasses, headsets, gloves, but clearly the research is also trying to discover and propose deeper, and probably more invasive, forms of man-machine connections. Companies, like Neuralink, MindMaze, BrainCo or Emotiv, are working on developing a direct interaction between the brain and the infrastructure of the Metaverse. In this layer, amongst other companies, all of the main videogame device companies (PlayStation, Xbox/Microsoft; Nintendo) and the Big Techs (Oculus/Meta, Apple) are also working to create the tools for human interaction with the Metaverse.

A third layer is identified through the concept of decentralization and relates to a vast area of technological innovation that should allow us to reach the full potential of the Metaverse by assuring a transparent, secure and traceable way to perform transactions and interactions. The development of technologies such as blockchain, crypto assets and Non-Fungible Tokens (NFTs) will certainly play a key role in the economy of the Metaverse. Trust in, and the safety of payments have long been a major issue for many activities on Internet 2.0, for example, for e-commerce. Many companies, often very new ones, are trying to develop automatic tools of trust chains that are embedded in the technology and that are beyond the control of traditional intermediaries.

The fourth layer, which is defined as Spatial computing, is probably the most challenging and innovative, and it is represented by the integration of traditional computing, which includes data and logic, with 3D locations, in order to develop the space in which user interfaces can be virtually located. It groups a large category of technologies that are related to the access to, and manipulation of, 3D spaces, and to augmenting the real world with more information and experience. Taken together, the two layers: Decentralization and Spatial Computing, include some of the most advanced technology companies, ones which are investing into the core, cutting edge technology of the representation of the Metaverse, including companies like Unity (a leader in 3D techs), Unreal, Niantic (a company born in Google, but later separated, that, among other things, has created Pokémon Go), Crucible, Ava Labs and others.

The last three layers of Figure 15, Creator Economy, Discovery and Experience are all close-to-the-user layers, where “content” plays the most important role. In the fifth layer, Creator Economy, all the technology that content creators use to craft the experiences that people may enjoy in the Metaverse, i.e., the combination of software and marketplaces that make it possible for creative people and teams to fill the Metaverse, are included. Companies like Roblox, Decentraland, Epic Games, ones that are either completely new or that come from the game industry, compete with the more well-known digital players, like Microsoft, Adobe, Shopify.

The sixth layer, which has been named Discovery, constitutes a vast ecosystem, presently one of the most lucrative for companies, that includes all the technologies through which, directly or indirectly, information and experiences that can be carried out within the Metaverse, are presented and offered to users. While search engines, curation, advertisements offer ways to discover content, products and experiences that are familiar to everyone on the Internet, in the Metaverse it is expected that further mechanisms may gain relevance. Among them, given the core value of social interaction, community-driven discovery that will enable the user to reach content will probably become a more effective means than the other, and presently the most common, forms of marketing. In this area, Big Techs, with a consolidated and powerful advertising BM, from Google to Facebook, will directly compete with the new inventors of content, from gamers to space creators, like Unity and Unreal. Nonetheless, in the future, community-driven discovery which exploits real-time presence features may lead the way if, as expected, the Metaverse fosters the transition from asynchronous social networking to real-time and collective social activities.

Finally, the seventh layer, which is named Experience, is the content layer in a more properly traditional sense. It includes everything that’s behind what the Metaverse is about, a technology that is expected to revolutionize a variety of human activities, including gaming, social interactions, shopping, entertainment, education and e-sports. Here, the competition is open to all content producers that aim at a market that is constituted from the attention and the time of the Metaversers. This is the realm of the present entertainment companies, from Netflix to YouTube, from connection companies like Zoom, for social media like Facebook, and that, today especially, but probably only at the start of the experience, is the domain of the gamer companies, from Fortnite, to Activision Blizzard, to Minecraft, and others.

In general, at the moment, we observe the five major Big Techs, the old GAFAM, apparently following different strategies in order to face the challenge that Internet 3.0 and the Metaverse pose to their specific areas of dominance in Internet 2.0. In the case of Apple, Tim Cook has recently declared that the company is betting on AR (augmented reality, in which virtual elements and images are superimposed onto the real world), thus attempting to confirm its primary role as a producer of sophisticated devices. In fact, Apple is reportedly developing an advanced AR/VR headset that may hit the market in 2023.

More radically, Meta, with the rebranding of the name of the company from Facebook, has made clear how seriously it takes the challenge of the Metaverse to its social media and advertising BM. The great plans of the company for the new technology, which span from the Oculus line of VR headsets to the creation of the Horizon Metaverse platform, are already in full development. Meta, in the previous classification of layers, is mainly located in the human interface (Oculus) and in the creator economy (Horizon World) but is also present in the discovery and experience layers.

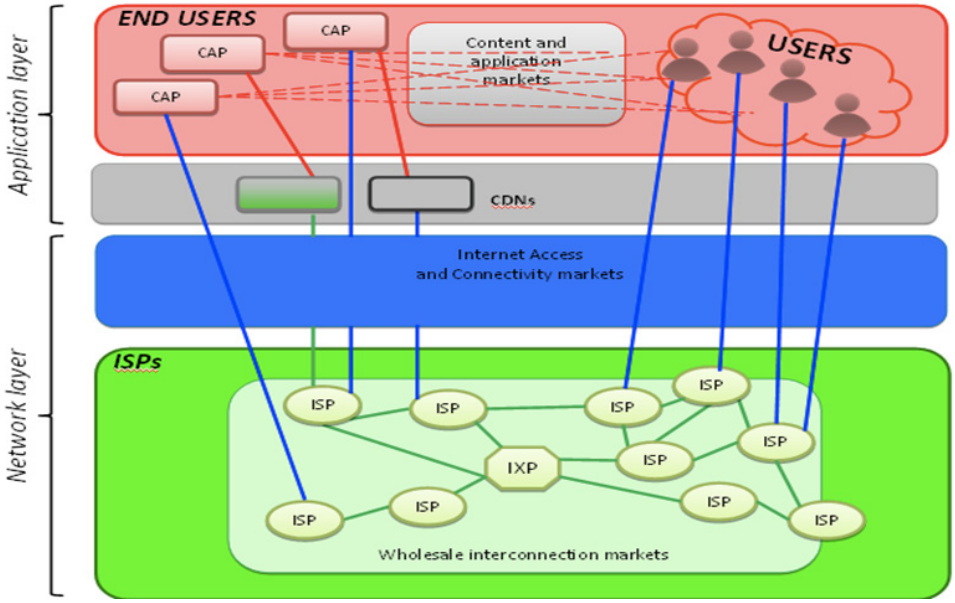
Microsoft is probably one of the few companies that seems to be investing transversally in all the seven layers: from infrastructure to experience, and that, at the same time, is attempting to escalate its presence with acquisitions of, for instance, Activision Blizzard (gaming) and AltspaceVR (social platform).

Somehow in between are Amazon and Google, whose plans for the Metaverse have not yet been openly explained. They both seem to be investing in the infrastructure layer (especially through their cloud business), but it is known that they have many other technological ongoing projects (Google, for example, in spatial computing with Google AI).

To make sense of the complex structure of the Metaverse's value chain, which we have previously described, we propose a comparison with our understanding of the Internet 2.0. Figure 16 shows a common representation of the Internet as a two-sided (or multisided) market. The key distinction is between a network layer and an application layer. However, the apparent simplicity is misleading, it is now clear that the affirmation of the Big Techs has created a reality composed of several differentiated silos, always in the form of multisided markets, all nested within the main Internet configuration.

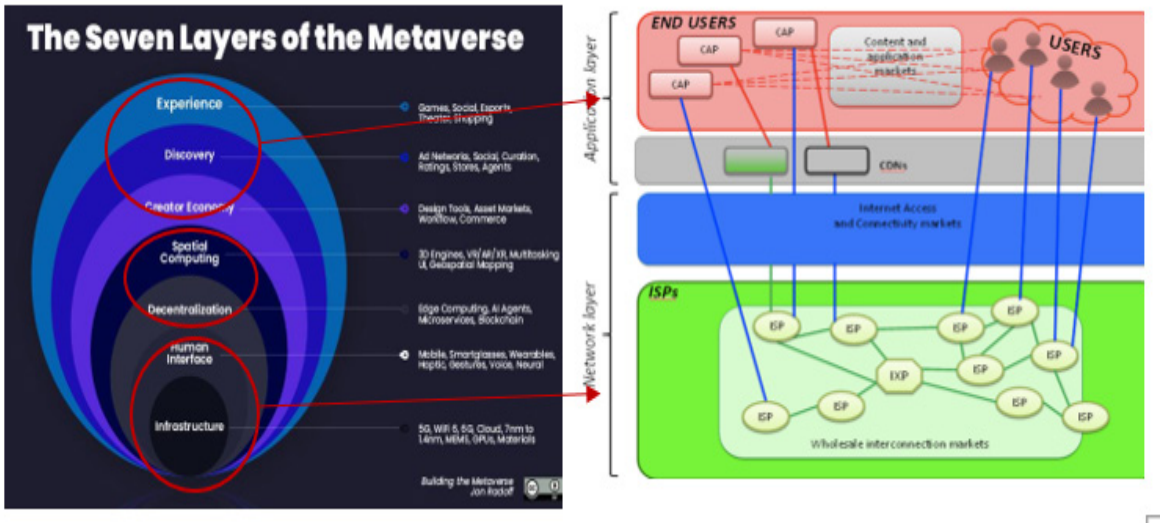
The different roles of network operators, content providers and users, remain relatively clear, but they are played in different market arrangements, like search, social media, e-commerce, and many others. We can therefore affirm that there still exists a unique Internet 2.0, but with different, and partially separated, realities, although more from an economic point of view than from a technological one.

Figure 16. The two layers of Web 2.0



If we simplify Figure 15 to make it comparable with Figure 16, we end up with a Metaverse composed of three macro-layers: one infrastructural (including the layers previously called Infrastructure and Human Interface), one including the cutting-edge software technologies (Spatial Computing and Decentralization), and the last one, which roughly relates to content (Creator Economy, Discovery and Experience).

Figure 17. The layers of the Metaverse compared with those of Internet 2.0



This simplified version of the Metaverse value chain corresponds to the two layers of Internet 2.0', as shown in Figure 17, with the two Infrastructure layers of the Metaverse being comparable to the network layer of Internet 2.0, and the three content macro-layer being comparable with that of application. In the present configuration, however, it is not easy to find an easy parallel for Decentralization and Spatial Computing.

If one tries to make sense of the vast list of powerful, but different, companies that are working to invent, build and manage the infrastructure of the Metaverse, and compare this to the infrastructure layer of the "traditional" Internet, it can be said that the technological challenge and the innovation of Internet 3.0 will probably reside much more in the infrastructure layer than the Internet previously did. On the other hand, by looking at the content-related layer of the Metaverse, this clearly corresponds to the traditional content layers of Internet 2.0, and we find, here, that almost all the key digital companies are involved, in one way or another, in their development. Of course, the finer classification into three distinct sub-layers that is used above, suggests the deeper complexity of Internet 3.0 content if we compare it to its predecessor. In this respect, the expectation of many technologists is that the Metaverse and Web3 will invert the Web 2.0' situation, in which content creation and distribution are mostly controlled by just a few tech giants, putting control back into the hands of the original creators by decentralizing distribution and encouraging interaction and interoperability instead.

In the middle of the Metaverse's conceptualization, the two layers: Decentralization and Spatial Computing, do not have clear correspondence to anything in Internet 2.0, representing the core of the new three-dimensional and decentralising challenge of Internet 3.0 and of the Metaverse to the present Internet.

This comparison is useful as a first step to addressing two of the present doubts regarding the Metaverse: will there be only one, or will there be a plurality of Metaverses, which are only partially able to communicate? The question is strictly connected to a second important one: will a centralized version of Internet 3.0 prevail, or will decentralization be a key characteristic of the Metaverse? The answers to these two questions, however, is not necessarily biunivocal. We may end up with decentralization and plurality, or centralization and unity – the latter is the hypothesis that there will be strong control of the virtual world by an all-powerful winning company, as proposed in certain dystopic representations of the Metaverse. However, it is also possible that we may end up with plurality and centralization, something closer to the present evolution of Internet 2.0. Clearly, the

targeted dream of many pioneers of the technology is a single, unique, but decentralized, Metaverse. A new world technological experiment in which a plurality of business models and possibilities may flourish continuously outside the control of a few powerful mega companies.

7. Conclusion

This article attempts to review several issues relating to the unfolding of the Metaverse concept. With this aim, it moves from a pluralistic observation point. First, it uses different explorative analysis tools to describe the diffusion of, and interest regarding, the Metaverse, starting from word searches, moving to patents and ending up with investments. Second, from a theoretical perspective, it moves from a simple definition of the Metaverse, attempting to guess probable evolutions with respect to the centralization/decentralization divide and the multiple/single Metaverse outcome. Moreover, it proposes an overview of the actual financial outcomes of the Metaverse, with special attention being paid to the strategy of the GAFAM. Finally, after a representation of the actual configuration of Internet 2.0, and the indications of the major differences within Internet 3.0, the paper offers a route that will allow us to analyse the new business models that the Metaverse promises.

Despite all its limitations, which are partially dependent on the novelty of the topic and partially on the exploratory nature of this work, this paper is an attempt to draw the attention of the social sciences to the Metaverse. It mainly aims to suggest possible lines of analysis for future research.

One of the most relevant issues that, in our view, will be discussed in the future, and which appears to be central to the development of the Metaverse, is the evolution towards either centralization or decentralization. A related issue is whether we are moving towards a single dominant Metaverse, or whether we will have many Metaverses, and in what form (few dominants and many niches, or many comparable and competing Metaverse projects).

From the technological perspective, one additional question that will emerge soon is whether we will be able to introduce a standardization process, as is true today for many ICT technologies. Interoperability will, most likely, be the key issue for the future of Internet 3.0. And, of course, there will also be the need to map the technological development from a regional perspective, carefully exploring, for example, the distance of Europe from the technological frontier of the development of key technologies for the Metaverse.

From the economic perspective, the discussion should, in our view, focus on identifying a series of clear business cases for the Metaverse. This question relates to the possible business models and to the profit opportunities that will emerge with the future development of the technology. Furthermore, the fair distribution of the financial burden for high speed/low latency connectivity infrastructures is a theme that is already being debated today, and which it is most likely, will be more relevant to the Metaverse. How to regulate economic exchanges in the virtual world(s) is also relevant from an economic point of view, particularly if we think that the very idea of “scarcity”, in this context, needs to be artificially created, since “objects” in the digital environment can be produced and multiplied at zero cost. There will also be the space for research that is related to privacy and security (will anonymity be allowed?), as well as on the wider impact that the Metaverse may have on real life in social and psychological terms.

To conclude, the main message of the paper, which has emerged from the comparison of Internet 2.0 and the Metaverse, is that the latter needs a more sophisticated infrastructure, technologies and devices in order to allow the user a truly satisfactory experience. These will require important financial resources and time in order to be developed, deployed and widely adopted. The present feeling that there is low quality and, sometimes, an absence of interesting content and interaction in the Metaverse, will be overcome only when the number of users has increased significantly, and this will happen only in the presence of a superior quality experience.

In our view, however, the actual technological hurdles and financial downs should not mislead: a more immersive Internet experience is just around the corner. When it does arrive, however, all the main critical issues with respect to Internet 2.0: privacy, identity, content moderation, market tipping, may come up again, only in a more radical manner. It is therefore important to understand and anticipate what is arriving, and especially be able to prepare what is necessary to avoid the possibility that the Metaverse will carry, with all its wonders, negative consequences for society, consumers and markets.

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