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Digital technology, GAFA companies and the changing business world: growth trends in the ethereal economy 20 years later

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Abstract. Taking a historical perspective, we analyze the economic growth of GAFA companies, and how they fit into the indicators that measure global human development. We explore the limits of growth -assuming that economic growth is inherent to good economic performance- by studying these cases, which are relevant insofar as they lead global economic growth in the new digital-based ("ethereal") economy. Our methodological approach contrasts the growth patterns of GAFA companies with general human growth parameters. This case-to-global study finds clear trends, suggesting that the ethereal economy is constrained only by the limits of human growth.

Keywords. GAFA, *Big Data*, linear trend, ethereal economy, digital companies, growth

1. Introduction

At the end of the 20th century, the world changed due to the digital revolution, and today we are still adapting to this new lifestyle. Due to its profound implication in all areas of economic activities, the so-called ethereal economy---based mainly on technological innovation in information-related products and data management---, is now a major source of economic development in the world. In 2018, the share of economic sectors in the global gross domestic product was 61.2% in Services, 27.81% in Industry and 4% in Agriculture (Plecher, 2020). Although the influence of the Information Technology (IT) in Industry is also relevant, the Services sector---predominant in the explained distribution---, is increasingly dependent on IT and data management. In relation to the services sector, for example, global growth in 2018 for IT related aspects was estimated in 4.5%, including Data Center Systems, Enterprise Software, Devices, IT Services and Communications Services, what gives an idea of the rapid development of this field (Gartner 2018, see also Makada et al. 2019). Concerning digital-based companies, in 2017 the top ten corporations by market capitalization in the world were Apple (>\$900bn), Amazon, Alphabet/Google, Microsoft (all >\$700bn), Facebook (GAFA companies + Microshoft), Alibaba, Berkshire Hathaway, Tencent (around \$500bn), before JPMorgan Chase and ExxonMobil (both <\$400bn) (Mikau, 2019). Already in 2016, GAFA companies appeared in the US market capitalization ranking in the first, second, fourth and fifth positions

(Schrader, 2017; p.57, Fig.3). This prominence continues to this day (Stoller, 2018), and Chinese counterparts---the so-called BAT companies---are also in the leading group of the global economy (Murphy et al., 2020).

Many economic indicators can be used to show the influence of digital technology on the global business world. The number of companies with more than ten employees with a website in all OECD countries in 2019 was over 80% (OECD stats, 2019). In fact, the adoption of digital technologies has become a real wall for the development of countries: those that have implemented new technologies in strategic areas of development---retail, the insurance industry, finance, education, health, transportation and logistics, and tourism---are the ones exhibiting exponential economic growth (Ferezin, 2019). In some of these areas---for example, FinTech---the adoption of some specific technologies such as blockchain has produced a total disruption with respect to the traditional way of doing things (El-Masri, 2019).

Thus, the objective of this paper is to study the economic growth of GAFA companies as prototypes of the ethereal economy, comparing it with some natural indicators of human development. Our intention is to analyze the limits of the growth of the global liberal economy through a case study of the evolution of some development indicators of GAFA companies. Although the diversity in the way technological innovation products are commercialized is enormous---small local development companies, free lancers, IT departments of large non-internet based companies---, we can accept as a working hypothesis that the so-called GAFA companies are good representatives of how the new economic world is developing, taking into account their leading role in the global economy. As Murphy et al. explain in relation to the current situation, companies based on digital platforms are leading---and indeed dominating---the business world: “Currently the global oligopoly consist of Google, Apple, Facebook, Amazon (‘GAFA’) and Baidu, Alibaba, Tencent/WeChat, (‘BAT’) plus more regional or local business platforms” (Murphy et al. 2020). In just a few years they have been at the forefront of the world economy, changing the classic structures of the market, distribution and services, and even employment. They are almost entirely service companies, which do not produce consumer goods---with notable exceptions---, and have incorporated changes in the way they offer the products and services they market, becoming powerful companies that have enabled them to influence a global change in the economy of nations (Schrader, 2017; Part I,2). This makes their analysis, from the economic point of view, of great interest to understand the keys to the current economic evolution of the planet.

Therefore, although the systematic analysis of the GAFA companies is interesting by itself, to do it is not the purpose of this work. The main objective of the present paper is to propose some arguments to analyze how the economic growth based on the digital innovation---that is, the so called “ethereal economy”--- follows the mathematical rule that is supposed to provide the essential paradigm of the global economy: exponential growth of the economies is the motor of the current liberal worldwide dominating framework. After the advent of digital business, this model seems to need a thorough overhaul. Some alternatives to this basic framework have already been proposed. Among them, although it was published 12 years ago, the analysis developed in Newman and Dale's 2008 paper seems to remain current and updated. Essentially, the authors propose in this work that the growth of the new economy would follow the pattern of evolutionary ecology, with stable periods and moments of great change. In times of crisis, such as the one we are experiencing now with the covid-19 pandemic, economic structures automatically adapt to the new situation (see for example Kraus et al. 2020). For example, in the present case it seems that the ethereal economy could benefit from the need to satisfy the consumption requirements of a population conditioned to stay at home, forcing

companies to modify their marketing strategies (Wang et al. 2020), among other changes that this new situation may force, concerning corporate social responsibility, consumer ethics and the basic philosophy of marketing (He and Harris, 2020). The general argument behind the idea of the impossibility of exponential economic growth is based on the facts of the Earth's finite nature, the impossibility of an ever-increasing world population and the need to preserve the natural environment for human survival. These obvious requirements were, however, questioned by some authors, and indeed some of them argue that innovation in science and technology could improve the efficiency of our use of nature in a green economy, and therefore there are no fixed limits to economic growth (Vollebergh and Kernfert, 2005; Columbo, 2001). Thus, innovation seems to be the key to endless growth, even if we think of a material-based economy. Today, abstract concepts such as "innovation products" can be concretized in a few elements that synthesize a large number of new innovative business drivers: artificial intelligence (AI) applied to Big Data, which concentrates the necessary innovation in relation to digital business, defines one of the main vectors of development. Indeed, as pointed out by Kaplan and Haenlein, "many have described big data as the new oil and, in that logic, AI companies will probably be the utility providers of the future, transforming data into information similar to how classical utilities transform oil into energy"; the rapid rise of the GAFAM (GAFA + Microsoft) in the US and BAT (Baidu, Alibaba, and Tencent) in China and their market domination is mainly based in the use of this new technology (Kaplan and Haenlein, 2020).

The central role of innovation in the new technologic world becomes even clearer if we focus on the new pattern we call the ethereal economy. In the quoted paper by Newman and Dale---and after an specific analysis of the limits to growth rate in these economies---, some relevant conclusions regarding the expected growth rates of global economy are presented. Ethereal economy do not depend on natural resources as much as classical industrial economy. It is based on technological innovation and the continuous increase of new features that the current trends indicate to be more ecological and sustainable, and no limits seem to be clearly fixed for the development, as far human creativity seems to have no limit and nature provides an inexhaustible energetic source. However, Newman and Dale suggest that innovation---due to its intrinsic characteristics, including the capacity of society to integrate new ideas--- cannot provide a uniform pattern of growth. Indeed, although innovation seems to have no limits, the growth of knowledge is a complex evolutionary process with a high uncertainty degree (Metcalf and Ramlogan, 2005). In general, innovation and technological breakthrough are different concepts, that are often confused, but the difference among them is crucial to understand that often scientific discoveries do no influence the technologic environment of the people as far as one could expect in view of its disruptive power. Some authors have called this effect the MAYA principle---the "most advanced yet acceptable" coined by Loewy, 1951---, that has become a useful tool for analysis of innovation trends (Ceballos, Hodges and Watchravesringkan, 2019; Hung and Chen, 2012). If an idea is too advanced, potential users could reject it by several reasons, including complexity of understanding or simply, fear (Harris, 2000).

This implies that a clear progression pattern cannot be expected: eventually, steady states could be reached and, depending on if we accept that global trends on the supporting fundamental agents of the economy---population, use of natural resources,...---will soon stop the exponential behavior to change to a logistic description (Jalas, 2002). The process of diffusion of new technological ideas and the adaptation to the daily use of people causes necessarily a delay in the growth. Only a limited amount of innovation can be absorbed by

society--- from the point of view of consumers, employment and other relevant issues ---, and this is the main constraint to economic growth (Bryndin, 2018; Teece, 2018). However, in the new world of the ethereal economy seems still possible to preserve an always increasing behavior of the capitalist economy, whence the ecological problems caused by the climatic change are solved in a reasonable time period (Gude, 2016, Lorek and Spangenberg, 2014). Sustainable economies based on the adoption of continuous technological innovation together with an active care of the ecological environment--- for example, balancing these terms by favouring a circular economy, Ghisellini et al 2016---, could provide a good perspective for the global economy (UNEP, 2011, Jovane et al. 2008, Seyfang and Haxeltine, 2012).

The mathematical description of these trends is difficult to fix. After 12 years of the analysis of Newman and Dale about the foreseeable evolution of the global economies, the progression of economic parameters are still under inspection. In this paper we are interested in the (qualitative) mathematical properties of these parameters. However, this study is not easy to design, as there are many variables and it is not clear how to achieve meaningful global indices that are sufficiently representative for the purpose of describing the main economic aspects of this major change. We have therefore made the methodological decision to move from macro analysis to a case-based approach. Consequently, we are not in a position to make a complete and systematic study, but only to provide some basic elements of analysis, which suggest the existence of some trends that could be analysed in more depth in subsequent studies.

2. GAF A companies as prototypes of the ethereal economy

The leading global companies in digital business---such as the GAF A companies---, rely on permanent technological innovation, improved management processes and advanced use of data, often personal data. In fact, one of the main differences between traditional companies and those of the digital era is represented by the concept of mass economies (Evans and Forth, 2015), which consists of the exploitation of Big Data that makes the rapid expansion of digital companies possible. This---sometimes questionable---use of data has allowed GAF A to become the largest technology companies in the market, forcing changes in business and other fundamental social aspects. In this section we will explain some of the keys of their business model, and which are the characteristics that make them to be the leaders as well as prototypes of the digital business world, trying to find some of the parameters that explain their increasing weight in the economy of the world. Our main idea is that, by examining these variables, we can provide some arguments for the issues presented in this paper, i.e. determining the mathematical nature of the development of today's information-based world economy.

Thus, we will briefly analyze the business model of the GAF A companies, how they work, and the positive and negative aspects in relation to the way these digital companies interact with the population. We will not go into some of the obvious aspects of these companies' success, such as the rapid deployment of their efficient freight distribution platforms, since, although they rely heavily on their ability to manage large data sets, they can be directly associated with more traditional business models, with which they share such logistical problems. We will focus on how they get the information they need to do their business and continue to grow at a very fast pace. We will pay special attention to the use these companies make of the data, trying to explain what their exploitation models are. The ultimate goal is to study the effects they have on today's society, what aspects of our daily lives they influence, and how they do so. Therefore, and in order to extrapolate the results to the global understanding of the information-based economic world, we carry out a study of the variables that influence the social and economic impact of these companies on the world economy.

Based on several specific studies on how the transformation of traditional businesses into digital businesses has been carried out---see for example, Berman, 2012, the paper by Tanda and Schena, 2018, for FinTech, and Ibarra et al. 2018, for manufacturing---, we have proposed the following fundamental differences that we find in GAFA companies compared to traditional ones. These differences are the systematic use of Big Data in business activities - both for the production of new products and for their commercialization-, the geographical distribution of companies (logistics centres), the extent of their social impact -variation in consumption habits, employment-, and the turnover with respect to other industries. This list of characteristics will allow us to analyze the limitations that they have or could have in the near future to develop their activity as they have been doing until now, that is, to what extent their business model is sustainable and their current mathematical description can be extrapolated.

Most of the data needed to carry out this study have been extracted from the reports that the companies themselves have provided, published in books and journal articles, mostly in the scientific field. We focus on the overall growth pattern, and on the growth data of GAFA companies. Most of the information can be found (and has been extracted) in (from) *statista*. As for the studies on these large companies, in addition to the scientific documents we cite, our specific sources are the works of Evans and Forth, economists and members of the Boston Consulting Group; the MIT Technology Review by Martin Giles; the paper by Miguel de Bustos and Casado del Río, 2016, economists and data analysts, who provide some insights to help understand the local point of view on the implementation of GAFA companies; and the official documents of the European Commission. In addition, other secondary sources of lesser interest have been used to substantiate our claims.

The driving force behind the GAFA companies' business model is to bring content/product providers into contact with end consumers (such as YouTube). In addition, they currently produce their own content and sell it through their own platforms (such as Amazon Prime), so that they can compete with companies like Netflix or HBO, which until now were the largest in the sector. In less than twenty years, GAFA companies have managed to outperform companies that were pioneers in the field of communications in the rankings of market capitalisation. On the other hand, they have a much smaller number of employees. This is due to the type of activities they carry out, since thanks to ICTs it is much easier for them to create and distribute than for other more traditional companies. Amazon would be the exception: due to its large logistics system, it needs to have a high number of workers compared to Google, Apple or Facebook.

One of the important factors common to these companies is internationalization. All of them have a large part of their business in countries other than the one they come from, which is not usual in more traditional communication groups. This has been made possible by the increased use of the internet and new technologies. Internet use has grown from 1.1 billion users in 2005 to 4.131 billion users in 2019, and continues to grow as we can see in Figure 1. (All statistics in this section have been found in *statista*.) From 2018 to 2019 the figure increased by 100 million new users.

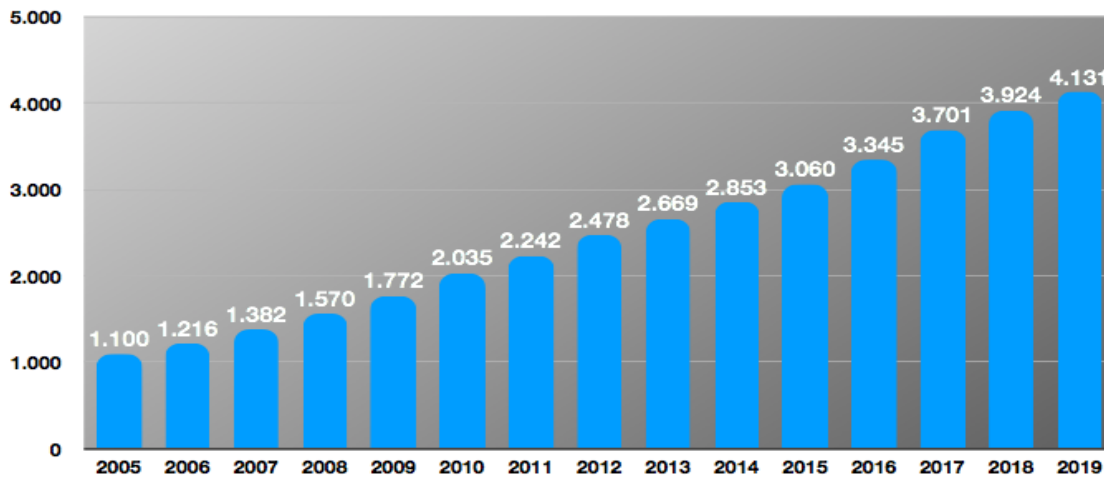


Figure 1. Number of Internet users in the world between 2005-2019 (million). Source: Own elaboration. Data taken from Johnson, 2021.

Google began with the idea of being an Internet search engine, but due to its fame and good performance, they decided to implement Google Adwords (currently Google Ads), their tool for creating advertisements on Google, from where they obtained most of their profits (Szymanski, 2018). From then on, they started to implement other marketing strategies to get new clients based on the "addiction" to their services (addiction in the sense of creating a dependency of the users towards the tools and services they offer). The vast majority of the products generated have followed the same scheme: create a free service to gradually add features and then charge for them, leaving the "free" part with very little profit. Thus, one of Google's most relevant strategies is to allow access to different tools free of charge for the user, which has led to an exponential increase in the number of customers and results in the great success of the company (Green et al. 2020). Thanks to Google Ads, it is possible for private companies to position their advertising on Google practically free of charge, and manage their ads as they wish, investing more or less according to their interest. Another facility provided by Google--as do other companies such as Facebook or Twitter--is the fact that users have a unique identifier--user and password--to connect to different websites, thanks to Google Connect. This is possible in exchange for some private information, which users enter on these websites. This is how these companies collect a large amount of private data, which at the end of the day is the "gold" of the new economy of the ethereal. On the other hand, access to any of Google's products ends up producing a dependency on all of its products, resulting in "The Winner Takes it All" effect (van der Aalst et al., 2019). Thus, forcing customers to accept the whole "Google package" has become a source of legal problems with the legislation of many countries (Barwise and Watkins, 2018; Coyle, 2018). As a relevant example, the European Union, has been developing legal tools to fight against certain abusive practices with respect to the privacy of its customers for years (European Commission, 2019). This is one of the fronts of social and legal action against these companies, which, together with some practices to defend their monopolistic situation (Clemons and Madhani, 2010), has been a source of strong criticism about their actions all over the world (see Newman, 2014). In short, users pay for the use of these services with the data they provide: mobility, hobbies and health data, among others. In the new ethereal economy, data is the most valuable resource, as it allows GAFA companies to built new successful products following different business models (Conrad, 2018,

Klous and Wielaard, 2016, Hartmann et al. 2016). Regulation of the use of the main resources of these firms (Data+AI) is then imperative for the future of the global economy to prevent excessive concentration in the AI space (Podszun, 2019).

Virtually all consumers who use Amazon are satisfied with the service. It took seven years to achieve these results in user perception before it became profitable (Galloway, 2017). One of the products that made many customers loyal was its recommendation system. By analyzing customers' purchase data and what they visited on the web, it suggested recommendations that were very appropriate to their profile. This was really novel when they incorporated it, and then it has been imitated by many of the e-commerce companies on the Internet. Over the last ten years, Facebook has been one of the largest social networks in the world. (Ugander, 2011). This gives it an added value and produces the "herd effect", which is based on the fact that a social network becomes more attractive the more users it has. For customers, a social network with few users is of little use, as they will not be able to contact or obtain information about most of the people they are interested in (Wong, 2012). If it has many users, this works the other way around, and therefore the power that the brand has in the market is much greater. In certain social sectors it was accepted that if you wanted to be "connected" with the world, you need to have a Facebook. This has advantages and disadvantages, since on the one hand it facilitates communication, but it forces companies to pay to be in contact with their public account (Baek et al. 2011, Hollenbaugh et al. 2014). Finally, Apple is a leader in innovation and technology, offering its consumers products at high prices compared to the competition, but of very good quality and with good service, which generates that the customers have confidence in the company and continue choosing it (Fawzy and Olson, 2018). They offer very "closed" products---Apple do not allow any kind of software modification---which are not designed for expert people, but for people with basic knowledge who only want to use their functionalities in the simplest way possible.

GAF A companies use the information that users enter into their applications/ platforms/ webs, so these companies are no longer based solely on billing and profit (Dominici, 2020). The commitment and the treatment to the client becomes one of the most important factors for the correct operation of these companies. The creation of a "unique experience", which generates a "hook" for users based on new ways of commercialization, offering for example integrated services covering several needs at the same time (Thépot, 2019). Subsequently, the company can measure, account for and analyse the actions of customers in order to design strategies to keep them consuming. The aim is to create an environment or "ecosystem" for companies and users to interact in the way that best suits them (both parties obtaining the best result as far as possible), which facilitates the purchasing process and therefore increases the companies' profits. Among other consequences, this favours the monopolistic imposition of GAF A companies, which generates structural problems in the new global economic world (Stucke, 2018, Miguel de Bustos and Casado del Río, 2016, Nooren et al., 2018).

Advertising from external companies on their platforms represented for Facebook a turnover of 16.624 million dollars of its turnover in the second quarter of 2019, with a total turnover of 16.886 million dollars. This represent more than 90% of the total turnover of the company (Figure 2), a very high percentage.

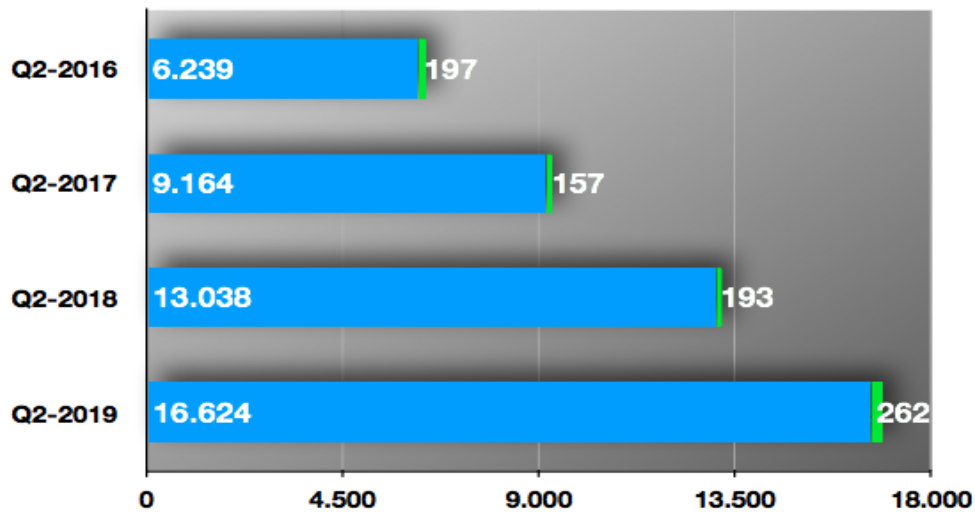


Figure 2 Facebook billing Q2 2016 to Q2 2019. Advertisements in blue, rest in green. Source: Own elaboration. Data extracted from Facebook 2017, 2018, 2019,

Thus, Facebook (along with Instagram and WhatsApp), has been able to derive much of its revenue from third-party advertising, but doing so in a way that is not too invasive for users, giving the user a personalized advertising experience that is usually perceived positively. Each time a user registers, they give access to all their personal data such as names, surnames, addresses, friends, use of free time and hobbies, and so the databases continue to grow. For Alphabet (Google), advertising represented 83.3% of its net income in 2019 (Data taken from Company Reports; Statista 2019). In general, GAFA's business model is based on the information we produce, which is used to offer other companies a space on their platforms to advertise. Consequently, the profits of GAFA depend entirely on the use of the Internet by their potential customers, and they are forced to change the consumer habits---from traditional to digital commerce---to ensure their success. It is therefore logical to expect that, as Internet use increases, the benefits of GAFA will increase.

In summary, the GAFA companies share some fundamental characteristics, such as the systematic use of customers' personal data and Big Data (Talia, 2019; Ch.2), an adaptation to the needs of those users that is highly appreciated, and the achievement of monopolistic situations that greatly favour those companies, and that are sustained by the behaviour of those same customers (Batat, 2019; Ch.1). Of course, the use of the ITCs is other of their main characteristics. Except in the case of the Apple devices, the products marketed by GAFA companies are intangible---Amazon do not sell the goods, mainly sells the managements of goods---, being therefore a clear example of the economy of the ethereal. Also, the strategic importance of the strong distribution platforms that these companies have built, is evident (Gawer, 2014; Boudreau, 2010).

Overall, the success of the ethereal economy is producing a profound social change whose limits appear to be only the general limits of information technology.

3. Calculations

We have designed an easy mathematical procedure to estimate the growth patterns of GAFA companies. We have chosen a linear model for the comparison between growth rates, based on Pearson's correlation of the variables, finding strong evidence of the goodness of the

linearity assumption. The set of variables that we have chosen as a sample of the total evolution of the growth of these Internet-dependent companies---and other closely related enterprises---show a significant linear behaviour (Figure 3).

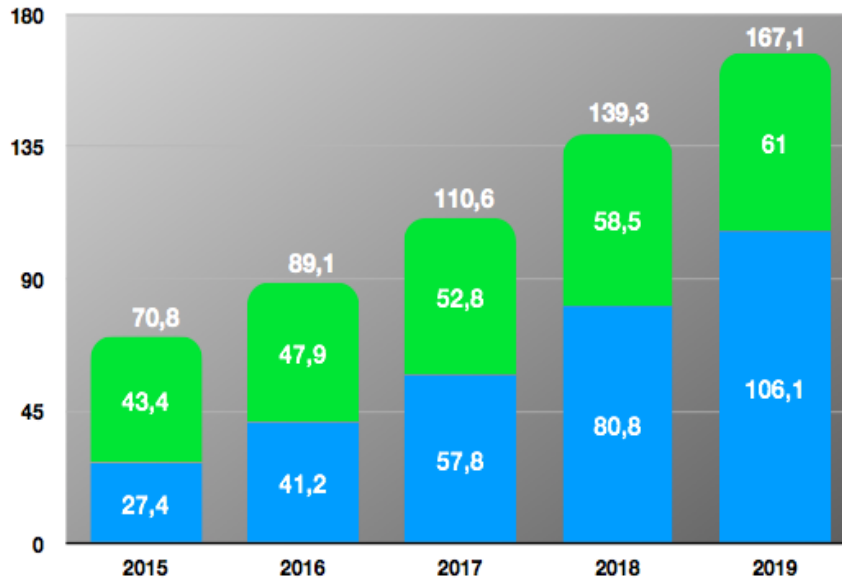


Figure 3. Number of paid subscribers to Netflix worldwide between 2015 and 2019. USA (blue), rest of the world (green). Source: Own elaboration. Data taken from Stoll 2021.

As an objective model, and taking into account that the companies we consider have a global implementation, we chose to describe the system through two basic variables of human growth. We can assume that the growth of the set of potential consumers can be described by the number of Internet users worldwide and the number of inhabitants in the world. Data are taken from the year 2005 to the year 2019. We find a strong Pearson correlation between the variables Internet Users and World Population (0.9977). Thus, we can assume that there is a linear dependence among both variables. It seems reasonable to suppose that the number of Internet Users can be written as a function of the World Population. If we try a linear mode as suggested by the data---see Figure 4---, we indeed find a good results, fitting data to the linear function

$$Internet_Users = 2.643122 * World_Population - 16246.489322.$$

Calculations have been performed with R. We have used “cor” for the Pearson correlation, “lsfit” for the least square fitting, and advanced commands for the plots.

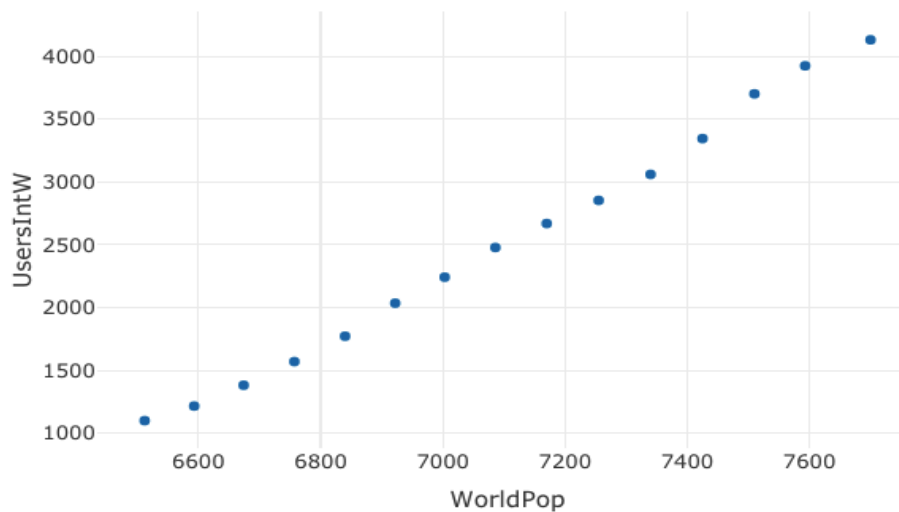


Figure 4. Dependence of the Internet Users vs World Population. *Source: Own elaboration. Data taken from Plecher 2, 2021 and Johnson, 2021.*

This basic model implies that the number of users increases with the numbers of inhabitants, but there is not a fixed rate $0 < R < 1$ of the world population that uses internet in such a way that the increment of 100 inhabitants in the world implies $100 * R$ more internet users. The relation is linear, but there is a big gap at the beginning, what can be seen from the big independent term - **16246.489322**. More adequately, the model means that after a gap of almost 6147 million inhabitants (the result of the equation $2.643122 * \text{World_Population} - 16246.489322 = 0$), we get the constant rate

$$\Delta(\text{Internet_Users}) / \Delta(\text{Word_Population}) = 2.643.$$

This clearly shows that the model does not indicate the rate of population of the world that uses internet, but simply that there is a great increase in the number of internet users with the time, much more than the increment of inhabitants in the world. No limit to this clear trend is observed, so we have to conclude that this is currently the pattern.

Linear dependence is also found for World Population and Internet Users as dependent variables and Year as independent variable. The representations in Figure 5 show these trends.

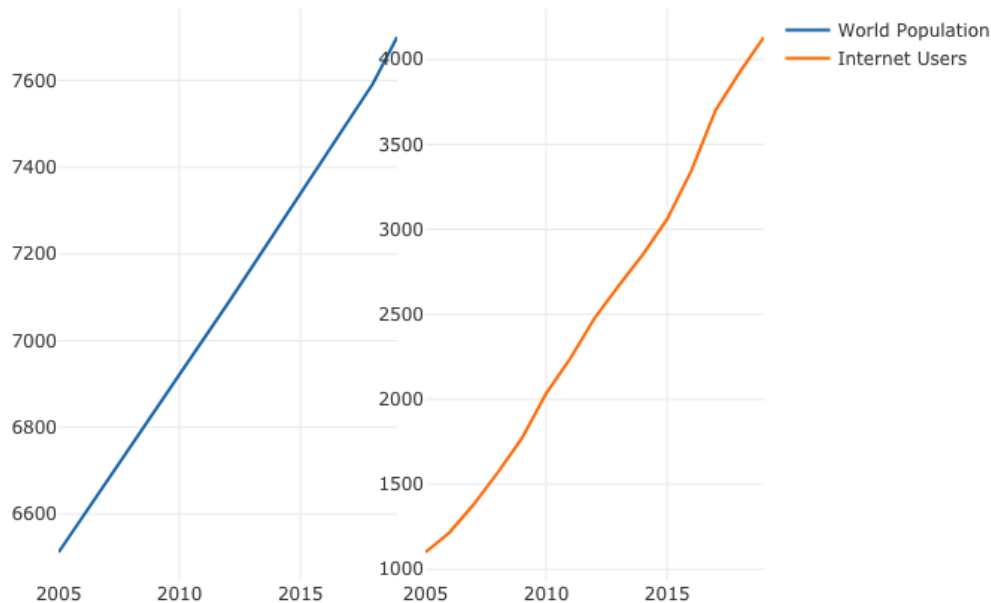


Figure 5. World population and global internet users (millions). *Source: Own elaboration. Data taken from Plecher 2, 2021 and Johnson, 2021.*

These quantities exhibit linear / weakly exponential growth (Figure 5), with a steep slope. Indeed, the mathematical shape of the curves can be assimilated to a linear function, and Pearson's correlation between Year and Internet Users worldwide gives the value of 0.9971. Year is also clearly correlated with the World Population: the correlation between both magnitudes is 0.9998, which means a very high coincidence rate and the adequacy of a linear model.

In 2005, there were about 1 billion Internet users; at that time, many analysts thought that the growing behaviour of Internet users was close to being stable, slowly becoming a logistic curve (Modis, 2005). Instead, the linear model we find now shows a continuous increase still: in 2019, there are approximately 4 billion users, four times more than in 2005. This behavior is similar to the world population growth.

4. Results. Growth patterns of GAF A corporations

After the analysis of how GAF A companies work, we return to the original question of the paper. As canonical examples of the ethereal economy, the GAF A show an increasing pattern of development. When Newman and Dales wrote their paper (2008), the direction of the world economy was not so clearly inclined towards ethereal products as today. The global economy may still follow the pattern of an ecological evolutionary process, as suggested by Newman and Dales---the equilibrium punctuated with exponential shoots, logistical growth and periods of stagnation---, but the growth of firms directly related to the ethereal economy exhibits linear or even exponential behavior.

Below are some concrete examples of growth behavior. As we have shown, the growth of the world's human population (Lutz et al., 2017) and the number of Internet users follow linear growth. Accordingly, the variables describing the growth of GAF A companies' products follow linear trends---with some variations probably associated with special situations---which would reinforce the hypothesis of a direct correlation of GAF A companies' growth with the world population in general, or with Internet users worldwide.

Therefore, the large increase in the number of Instagram users in recent years---as shown in Figure 6---is following a linear growth. The same trend can be seen in the daily number of Instagram stories, showing that both are successful products of the ethereal economy following linear patterns. The results are shown by month, starting in 2013 and 2016 respectively, and Pearson's coefficients are in these cases 0.9840 and 0.9938, again indicating a high correlation.

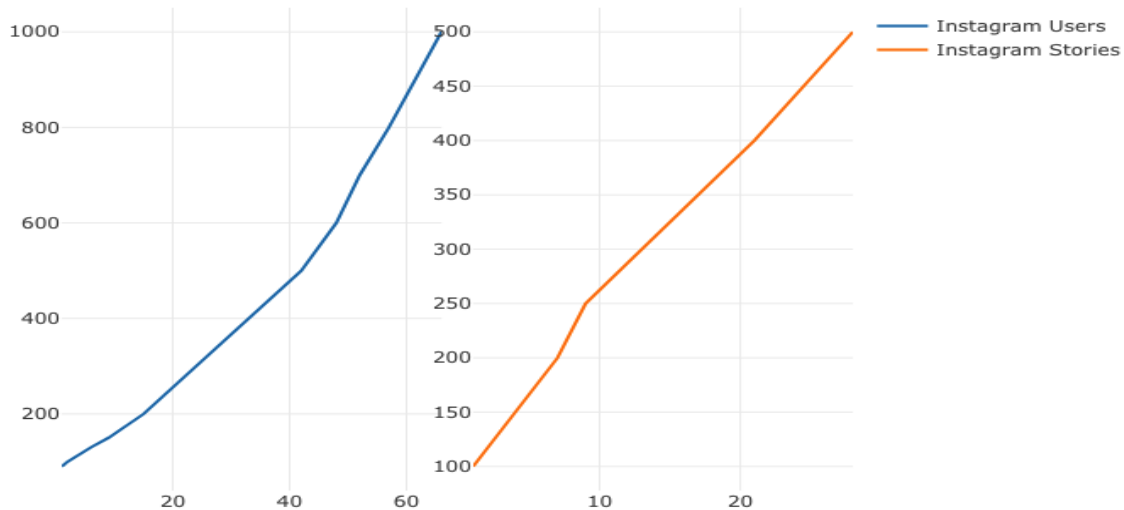


Figure 6. Instagram users (millions, vs months from January 2013), and daily Instagram stories (millions, vs months from October 2016). *Source: Own elaboration. Data taken from Tankovska, 2021 and Tankovska 2, 2021.*

For instance, Amazon Online Stores and Web Services have experienced an extraordinary growth that can be still considered as linear/almost exponential, as can be seen in Figure 7. Correlations are in these cases also high.

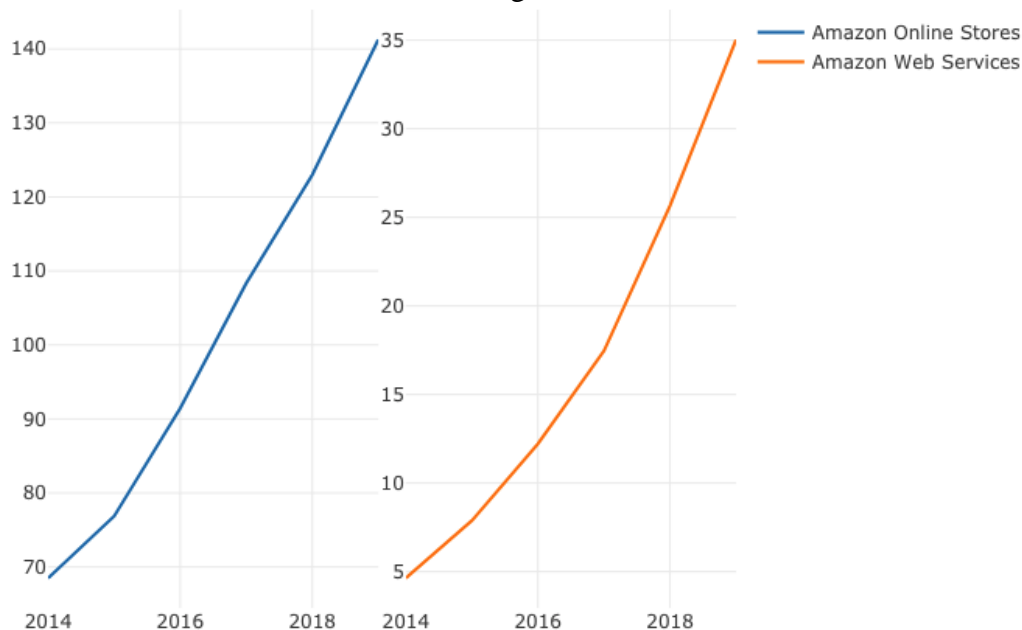


Figure 7. Amazon worldwide growth (Online Stores and Web Services) from 2014 to 2019 in billion U.S. dollars. *Source: Own elaboration. Data taken from Sabanoglu, 2021.*

The behavior of other variables in other companies are not so easy to describe. Regarding Apple, we find the following evolution (see Figure 8, right), that has a lot of local variation, although the overall description can be still considered as linear/weak exponential). Linear correlation is equal to 0.8678. In contrast, Google advertising business has a clear exponential growth, although smooth enough to still have a Pearson's correlation equal to 0.9477.

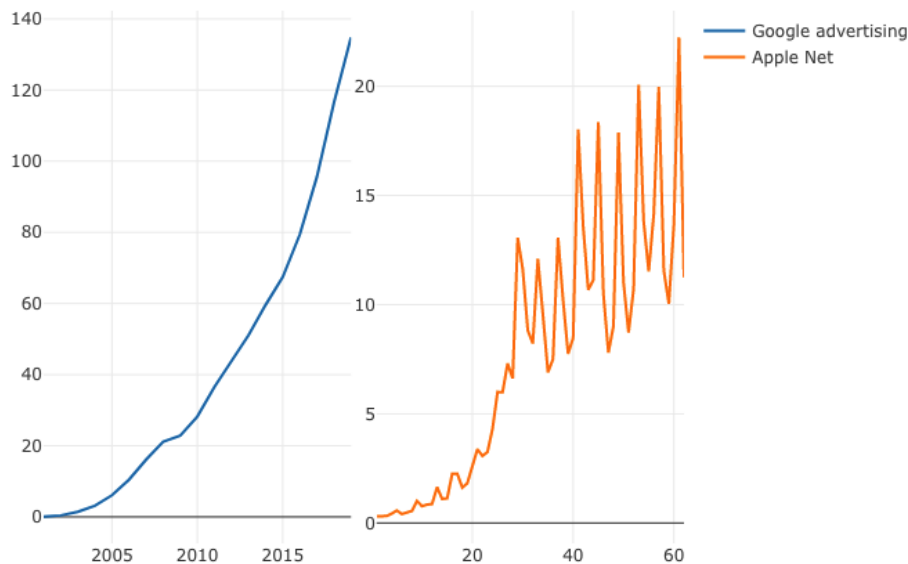


Figure 8 (Left) Advertising revenue of Google from 2001 to 2019 (in billion U.S. dollars). (Right) Apple's net income worldwide (quarters) from 1st quarter 2005 to 2nd quarter 2020 (in billion U.S. dollars). *Source: Own elaboration. Data taken from Johnson 2, 2021, and Statista Research Department, 2021.*

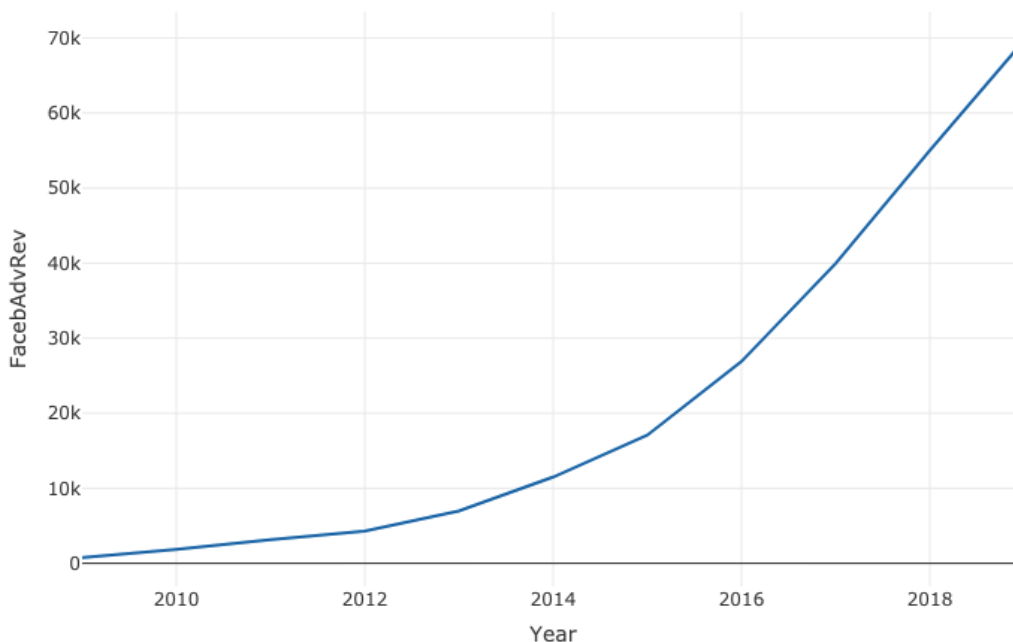


Figure 9. Facebook advertising revenue growth (billion U.S. dollars). *Source: Own elaboration. Data taken from Tankovska 3, 2021.*

Figure 9 shows the full time series of Facebook's evolution from the time it became an operational company until 2019. In this case, the exponential evolution is clear, although Pearson's correlation is still high, 0.9216. Netflix, which is also a standard representative of intangible asset-based businesses, experiences similar patterns. Figure 10 again shows linear/exponential growths, with correlations of 0.9946 for the American market and 0.9920 for the rest of the world.

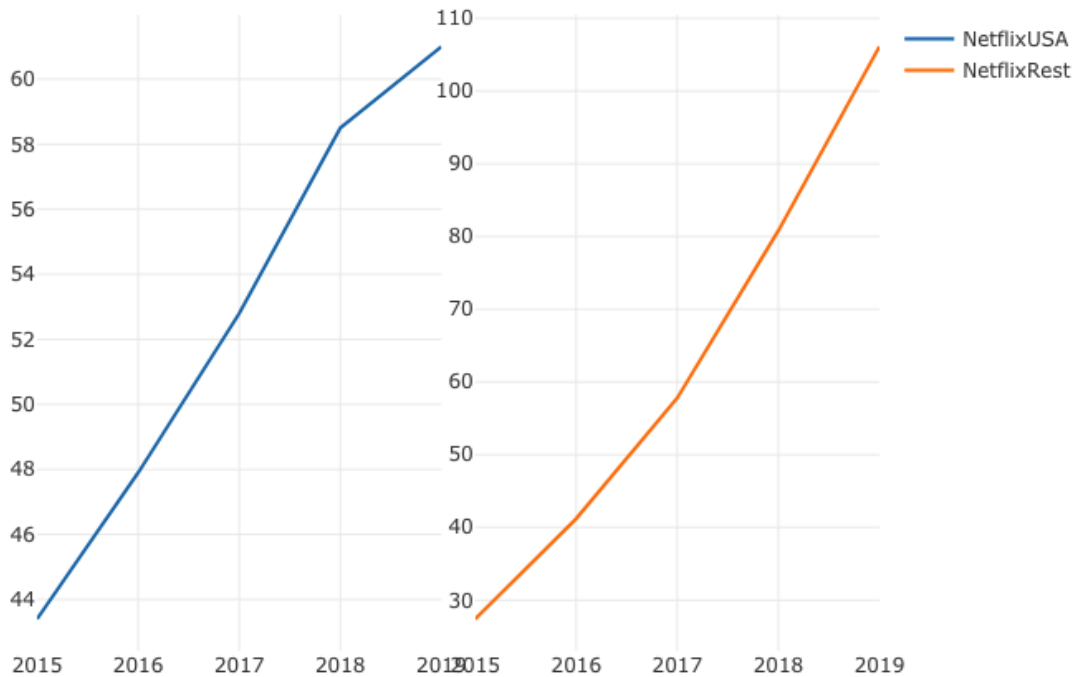


Figure 10. Netflix users (million). *Source: Own elaboration. Data taken from Stoll, 2021.*

The data provided are not intended to complete the full context of the emergence of GAFA companies in the world economy. However, we have chosen them as representatives of the growth pattern that GAFA companies exhibit today. From a quantitative point of view, they are clearly following a linear/exponential pattern, so they are growing at a high rate. Moreover, they follow the same growth pattern as the main world in terms of the variables chosen (internet users worldwide, world population).

6. Conclusions

Positive linear trends, even exponential ones, appear everywhere when the growth of GAFA companies is analysed. This is consistent with the linear models that follow the two global variables that describe the human/technological evolution we have chosen: the world population and the world's Internet users. The monopolistic policies imposed by the GAFA companies seem to be the way they survive, and the rapid increase of their profits and their position in the world market do not allow States to give a clear and fair legal answer, nor to design an adequate tax system.

In short, the great prospects for unlimited growth fuelled by the irruption of the economy of the ethereal seem to be confirmed from the quantitative point of view, but at the cost of leaving behind, perhaps definitively, certain aspects of social welfare previously

achieved. The ecological and social justice objectives that seemed to be more easily attainable with the economic shift towards structures based on the intangible, are far away. The global social challenge of the next few years will undoubtedly be to impose these objectives on companies in the ethereal economy, either through the market itself---individual consumer actions---or through legislation developed by nations

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