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Patents and the business strategies of digital platforms: A comparative analysis of the patent portfolios of large digital platforms

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Patents and the business strategies of digital platforms:

A comparative analysis of the patent portfolios of large digital platforms

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Abstract

Recent years have recorded a growth in the number of patent applications filed by digital platforms. This paper argues that by profiling these patent portfolios, we can obtain insightful patterns on platforms' business and innovation strategies. For this purpose, we build a dataset of over 380,000 patent applications filed at least by one of ten large US and Chinese digital platforms between 1986 and 2024. A significant rise in patent activity has taken shape since 2012, largely due to an impressive number of applications filed by Chinese platforms. Platforms tend to patent alone and concentrate their patenting activity on computer technology and electric communication, with machine learning being an overarching theme. However, some platforms like Apple pursue the development of a diversified patent portfolio, while others build one more specialized and aligned with their core business. Additionally, platform applications receive a significant number of citations, despite a skewed distribution which is only slightly challenged by Apple. Finally, applications by Chinese platforms have a more limited international protection when compared to their American counterparts, as attested by their patent family sizes.

Keywords: patents, digital platforms, portfolio, China

1. Introduction

Intellectual property rights have become central in the digital age, not only for protection and innovation purposes, but also as means for market power. Firms in the Information and communication technologies (ICT) sector, for example, now adopt different patenting strategies to better gain competitive advantage and achieve a stronger financial performance (Shaikh & Singhal, 2019). This shift results from a commodification of knowledge (Lamoreaux & Sokoloff, 1996), with intellectual property rights acting simultaneous as an incentive for inventors, who would otherwise need a large R&D investment, and as costs for firms, through the payment of licensing fees to apply the knowledge protected by these rights (Brüggemann et al., 2016; Kogler, 2015).

Digital platforms are at the heart of this transformation. Rikap & Lundvall (2022) argue that, whether through the co-authorship of scientific publications or the development of large patent portfolios by acquiring AI and cloud computing startups, these firms have a strategy of knowledge absorption within their ecosystems. To capitalize on this knowledge accumulation, platforms turn to property rights like patents, which have a newfound exchangeable feature. This is evident in high capital intensity industries (telecommunications, software), whose interdependent innovation chain makes firms unable to proceed with product or service development without the access to prior knowledge now increasingly commodified through property rights (Rikap & Durand, 2023).

Reports on patenting activity show an increasing number of patent applications in software, neural networks, cloud computing and artificial intelligence, particularly machine learning, with the primary acquirers being tech digital platforms (Webb et al., 2018). Previous literature has addressed how these platforms are engaging in a shared path of high-profile portfolios in AI or natural language processing though with different strategies (Rikap & Lundvall, 2021; Rikap, 2024).

This work performs a thorough review of more than 380,000 patent applications from the most valuable digital platforms with considerable market shares in ICT and investment in R&D. We consider seven American platforms (Amazon, Apple, Facebook/Meta, Google/Alphabet, Microsoft, Netflix and Twitter) and three Chinese ones (Alibaba, ByteDance and Tencent). We combine techniques from bibliometrics and econometrics to profile platform patent portfolios, assessing aspects related to quality, technological specialization and breadth, geographic distribution, collaboration openness and identify potential shifts through time. This work aims to expand the comprehension on platform patenting activity spanning from the late 1970s to 2024, being the first to perform a comparative analysis of portfolios held by US and Chinese platforms. Hence, we intend to answer the following research question: How do the patent portfolios held by US and Chinese digital platforms differ and what trends do they signal in the ICT sector? The answers bring insights on the chronological evolution of platform patenting, not only specialization and collaboration patterns but also on the growing technological rivalry between the US and China, namely on leadership across different ICT subfields.

Our findings show an active engagement by platforms in patent activity, filing in more applications, particularly in the period between 2012 and 2020. Alibaba and Tencent are now ranking together with Microsoft and Google as the platforms with the largest patent applications portfolio, somehow balancing the total number between American and Chinese platforms. For the most part, platforms patent alone and concentrate in specific areas, namely in computing and electric communications patent subsections, and topics like machine learning. However,

they have differences in their profile, with some platforms opting for a more diversified portfolio while others are more prone to areas close to their core business. Apple is a clear standout not only due to its diversified portfolio but from the high level of citations received. Finally, despite the growth in number of applications, Chinese platforms' patents are still marked by low citation levels and a great share of patents with small family sizes, which signals that quality remains an aspect on development.

This article is structured as follows. Section 2 discusses the role of patents within the digital economy paradigm, outlining how large digital platforms make a strategic use of their patent portfolio. Section 3 proceeds with the data collection and methodological set-up, while Section 4 presents the major findings from the analysis of the patent portfolios of the selected large digital platforms. Section 5 provides a discussion of the results. Finally, Section 6 presents conclusions.

2. Literature Review

2.1. Patenting and intellectual property rights in the digital economy

Patenting has become a key instrument in high-tech industries. There has been an exponential growth in patent applications, particularly in ICT fields like digital communications and computer technology, as well as electrical machinery and medical technology, while traditional patent-intensive areas such as pharmaceuticals and semiconductors display lower growth rates (WIPO, 2024b).

The surge is partially explained by the incremental and overlapping nature of digital technologies, which require the incorporation of prior knowledge to develop patents (Ouyang et al., 2022). Institutionally, additional factors weigh in, the international alignment of intellectual property rights, the fact that ICT industries are characterized by a significant R&D investment, which has a small but significant elasticity with patent output, or strategic government backing through subsidies (Danguy et al., 2014; Eberhardt et al., 2016; Fink et al., 2015).

Despite this, increasing patenting or robust intellectual property rights regimes are not consensually considered in literature as drivers of technological innovation (Boldrin & Levine, 2008, 2013; Hall, 2025; Moser, 2016). Prevalent in ICT fields, patent races have been found to lead firms, whether they lose or win, to conduct more follow-on research, making the evidence inconclusive (Hong, 2024; Thompson & Kuhn, 2020). Instead, patents are understood as a key mechanism for protecting inventors and potential knowledge disseminators (Moser, 2013), with innovation occurring despite them, rather than because of them.

In fundamental sectors to the digital economy, intellectual property rights can act as a barrier to technological advancement. The case of the software sector is illustrative, faced with threats of litigation by large firms ("*patent trolls*") or the progressive narrow scope of eligibility, startups often choose not to pursue patents since the risk of infringement is too high (Appel et al., 2019; Karakashian, 2015). Indeed, patents on software are a frequent source of conflict between companies, given the potential vagueness of what is effectively granted (Duhigg & Lohr, 2012).

The abuse of intellectual property rights may strain innovation in the digital economy in the short term by deterring knowledge, which translates into high sunk costs that may or may not be mitigated with the returns obtained from granted patents (Chen & Wu, 2022; Heinecke, 2015). In fact, only a minority of small firms in ICT are found to apply for patents, which, despite initial challenges of operating in an intensive R&D market, can result in an upgrade in firm size and

market share (Exadaktylos et al., 2024). Thus, patents fulfil their intent of affirming a firm's value and ensuring appropriate returns, while protecting intellectual property (Gambardella, 2021).

However, there are other problems regarding patenting in the digital economy besides the mentioned *trolls* or patent thickets - where newcomers must get through overlapping bundles of patents to proceed with their inventions (Comino et al., 2019). Another important barrier are patent holdups, in which owners demand disproportionate high royalties by enforcing their patents, typically SPEs (standard essential patents), against other firm's products (Galetovic et al., 2015; Shapiro & Lemley, 2019). To address these issues, corporations, most notably in ICT, frequently resort to cross licensing agreements and patent pooling, reducing transactional and operational costs while minimizing the risk of litigation (Barnett, 2016; Nikolic & Galli, 2022).

Corporations can adopt different patent strategies. In the competitive environment of digital economy, firms are more likely to pursue a strategy with relative openness, exchanging intellectual property with other patent owners. At the same time, if the subject matter concerns their core technology, they may favour a defensive approach like fencing (Cappelli et al., 2023).

In addition, a firm may be influenced by the nature of its country's patent regime. High tech industries are geographically clustered, with leading firms being conglomerated particularly in strategic areas of the US and China (Mo et al., 2020; Moretti, 2021; Wang & Lin, 2008; Zandiatashbar & Hamidi, 2022). In this regard, it is important to stress the relevance of differences between the promotion of strict intellectual property rights by the US and China's seemingly broader stance in their protection and enforcement, which have led to mutual accusations (Peter, 2022; Raustiala, 2020; Shu & Shen, 2021).

Naturally, patents are not the only method of protecting intellectual property rights. Most critiques of patenting in the digital economy concern the potential harms made to innovation and the costs and difficulties faced by small firms in applying for patents, despite being the majority (Boudreau et al., 2022). Copyrights, secrecy or trade secrets can be reliable alternatives to patents in the ICT sector. For example, in machine learning, where the main concern is the protection of datasets, firms can opt by non-disclosure agreements and develop internally their technologies rather than patenting (Jin, 2017). Thus, firms must consider their products' specific features and development procedures to find the most suitable intellectual property protection method.

2.2. Trends in patent portfolios of large digital platforms

Large US digital platforms like Amazon, Apple, Facebook, Google or Microsoft, often grouped as Big Tech, GAFAM or FAANGs (including Netflix), along with Chinese competitors such as Alibaba and Tencent are increasingly invested in the development of patent portfolios. A surge in patent applications by these firms in the past decade, on par with the overall trend, confirms platforms' strategic pursuit, despite a considerable number of technology patents ultimately going unused (Jemala, 2021).

This tactic can be interpreted in light of platforms' financialization model, in part characterized by an increasing accumulation of goodwill and other intangible assets (patents, copyrights, trademarks) (Fernandez et al., 2020). At the same time, platforms are expanding into emerging markets and developing new technologies, namely in healthcare and financial services (Armstrong et al., 2020; Barwise & Watkins, 2018; Ozalp et al., 2022). Described in literature as a co-evolution process, the entry of one digital platform into a new sector prompts others to follow, almost in a defensive fashion to avoid falling behind (Gómez-Uranga et al., 2014). Hence,

platforms hold large patent portfolios not only to have a competitive advantage beyond the ICT sector, but also as a consequence of business diversification (Bae, 2025).

Two other factors play in the surge of patent applications by digital platforms, namely the acquisitions of startups and investment in R&D.

The acquisition of corporations translates into the transference of their patents to platforms, which poses a problem to the innovation-competition market dynamics. On one hand, there is evidence that, in the long run, the number of applications by acquired firms tends to drop after the business deal, particularly in the context of killer acquisitions, which refer to the acquisition of potential competitors (Kang, 2024). On the other hand, citations of the acquired firms' patents usually increase after the merger, indicating a possible enhancement of the matter at hand (Barsy & Gautier, 2024). Therefore, platforms may leverage patents' potential, and the acquisitions of startups does not imply the dearth of innovation.

Platforms invest heavily in R&D (Klinge et al., 2023; Mendonça et al., 2024) with Google (Alphabet) and Facebook (Meta) accounting for three-quarters of the total increase in R&D spending within the software sector, while Alibaba and Tencent averaged an investment of €8b in 2022 (Bonaglia et al., 2024). A concrete outcome of this foray into research is the growing number of scientific publications, most of which coauthored by academic researchers (Damásio et al., 2023). This collaborative approach contrasts with patents, another result of this investment, where platforms are generally the sole applicant and the number of co-applicants is residual (Rikap & Lundvall, 2022).

When conducting a study on the differences between platform strategies in their AI portfolio, Rikap (2024) corroborates a knowledge concentration paradigm, that, nevertheless, includes some nuances. According to Rikap, Microsoft and Google have some openness to external knowledge in the process, namely to AI startups and high-ranking universities, though both platforms control the innovation chain. Standing in direct contrast with Amazon, that prefers non-disclosure agreements with the same collaborative stakeholders (academia and startups), and with Facebook, whose corporate approach prioritizes the development of its own business applications (Metaverse) and foundational technologies.

Artificial intelligence, its domains and techniques are undeniably the focus of platform patent portfolios, given that they compete as top assignees on emerging subfields like pattern recognition, deep learning, natural language processing, data mining and cloud computing (Abadi & Pecht, 2020; Devarapalli et al., 2015; Petrova, 2021). Literature stresses this aspect, often at the expense of a broader analysis of the portfolios themselves. This AI-focus is not exclusive to platforms, academia, particularly American and Japanese universities, has also shifted toward more patents and research on AI technologies to the detriment of others fields (Fujii & Managi, 2018).

Machine learning is the standout area of patenting activity in AI, comprising 40% of all patents within the field and appearing in 89% of fillings, largely due to the exponential rise of deep learning whose use rose 175% between 2013 and 2016 (WIPO, 2019). Unsurprisingly, given their large collections of data and cloud infrastructures, platforms engage heavily in patenting in ML (Omarova et al., 2024; Schuhmacher et al., 2023; Webb et al., 2018), allowing them to develop applications in multiple sectors such as healthcare (recognition systems). Again, Rikap & Lundvall (2021), when examining Amazon and Microsoft's patent portfolios, identified an increasing move towards deep learning and deep neural networks, which they relate to the development of cloud services and data processing and storage procedures.

Similarly, generative AI was another subfield that rose to prominence, representing already 6% of AI patent publications. Tencent, Alibaba, Google, ByteDance and Microsoft are, in that order, among the largest patent owners in this domain, with Chinese platforms, in particular, experiencing a great growth between 2014 and 2023 in number of patents hold (Lee et al., 2024). This brings forth another relevant aspect again – the rivalry between US and Chinese platforms. China's strategy of gradual reduction of external dependence and strong R&D investment has been successful in challenging US hegemony in key areas like AI, cloud computing or 5G, placing China at the top of key high-tech industries and leading in AI patent citations (Allison et al., 2021; Melnik, 2019).

3. Methodology

3.1. Research Design

This paper employs a basic bibliometric approach for the patent dataset's analysis. Patent bibliometrics is akin to bibliometric analysis on scientific literature, making use of key elements such as firm/country productivity, inventor/applicant productivity or citation impact (Narin, 1994). Though there are some differences, since instead of a category of the journal where the scientific publication appears, patents have an international designed technological field. Similarly, if a publication undergoes peer review, the patent application has the average 18 months period from filing to publication. In citations there is an even greater contrast in purpose, where publication citations are mostly to acknowledge the source of information, patent citations are to signal the invention novelty (Criscuolo & Verspagen, 2008; Meyer, 2000).

Both analyses share the stylized fact of a highly skewed distribution where there is a small number of high-impact patents and a large number of limited impact ones (Narin & Hamilton, 1996). Hence, an effective analysis must be able to make use of all available variables since patent count alone can lead to misleading conclusions on innovation activity.

Our analysis encompasses two data types: structured that includes patent classifications, applicant names, jurisdictions and number of citations, while unstructured data corresponds to patent titles and abstracts (Abbas et al., 2014). To analyse the later, we adopted a methodological framework based on text mining, partly inspired by Kim et al. (2019).

First, in the text processing stage, we converted all text to lowercase, removed punctuation and numbers, and then applied tokenization. Some lemmatization was needed to standardize terms and guarantee consistency. For filtering terms, we used the stopwords list developed by van Rijsbergen (1979), which was more extensive than alternatives like the USPTO (USPTO) or the NLTK stopwords list (Bird et al., 2009). Note that, subsequently, we add manually other verbs and nouns that compromised the analysis to the list. Afterwards, we used term-frequency to filter remaining unnecessary terms. Finally, we obtained the bigrams, removing generic boilerplate terms as "*user data*" or "*comprises steps*".

3.2. Data treatment

Our analysis is limited to patent applications and does not include other patent document types, specifically granted patents. Applications provide a written description of the invention to be submitted for approval to the patent office and may be subject to modifications, while patents already meet all the needed requirements. Therefore, although not leading automatically to the granting of a patent, applications are an important source of information on technology development (Duening et al., 2021; Pasimeni & Georgakaki, 2020).

This work compiles all patent applications filed by the ten digital platforms studied available in "The Lens.org" database. Lens is a free and open-access resource comprising patent and scholarly data from four key sources: European Patent Office (EPO), IP Australia, United States Patent and Trademark Office (USPTO) and the World Intellectual Property Organization (WIPO), that has become a benchmark in patent analytics (Jefferson et al., 2019; Oldham, 2022). The database provides information on patent families, categories, citation patterns, geographic jurisdictions, among other relevant variables (Jefferson et al., 2018). Lens was chosen given the international scope of this work, which covers both American and Chinese platforms, as well as for its advanced search features.

To the best of our knowledge, this is the first comprehensive analysis of both Chinese and American patent portfolios. For instance, the work by Rikap (2024) and Rikap & Lundvall (2021) focused only on Microsoft, Google, Amazon and Facebook, with a particular emphasis on their AI portfolios.

The ten digital platforms studied were selected given their dominance in the ICT sector on basis of their worldwide financial value in market capitalization, market share, investment in R&D, worldwide operation and leadership in key subfields such as artificial intelligence and cloud computing (Acs et al., 2020; Gawer, 2022; van der Vlist et al., 2024). These internet-based corporations wield an unmatched influence over the path of digital markets such as social media, ecommerce, digital advertising or mobile applications (Evans, 2016; Parker et al., 2020), and even to the socio-economic context due to the crucial relevance of data analytics in the present economy (Saura García, 2024).

Data was collected from The Lens database by conducting the following queries in the "Applicants" field: "Alibaba", "Amazon", "Apple", "ByteDance", "Facebook" and "Meta", "Google" and "Alphabet", "Microsoft", "Netflix", "Tencent", "Twitter". In addition to the parent company, we considered all their valid subsidiaries and disregard all companies with similar names but unrelated to platforms, obtaining a total number of 633,305 patents.

Figure 1 describes the data-collection protocol. All observations were considered from the foundation dates of each platform to 2024, with the current year being excluded since it is incomplete. Then, we applied a filter in the "Document Type" field to limit the results to "Patent Applications" and remove all other forms like "Granted Patents" or "Limited Patents", ending up with 389,324 patents. Information extracted included the patent title, abstract, applicants, classification categories, jurisdiction, application and publication dates.

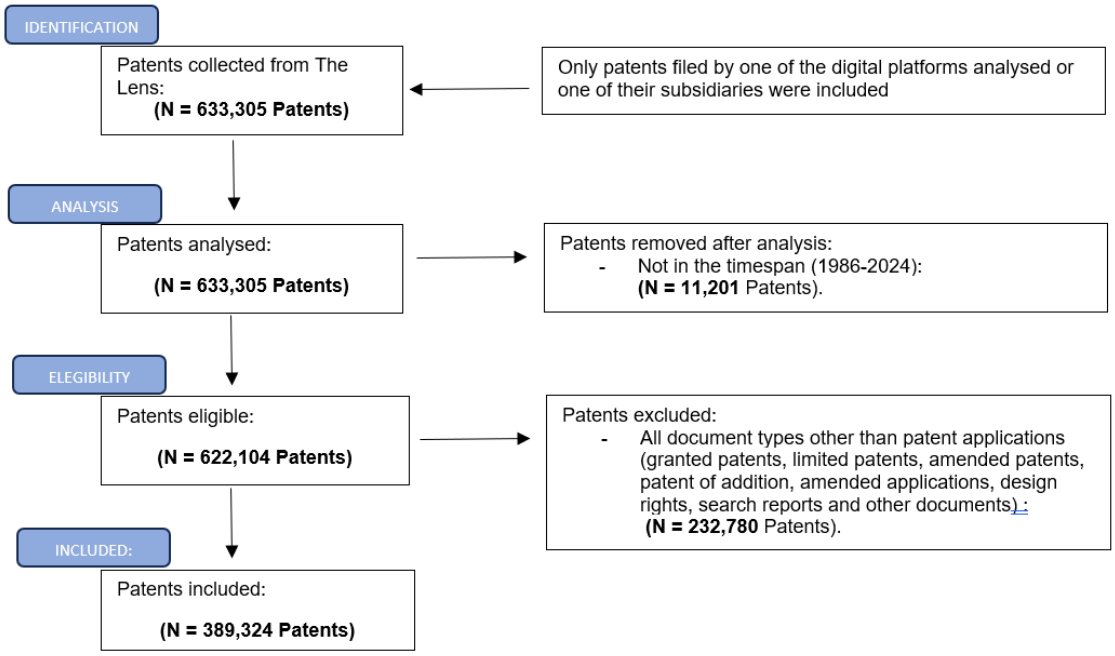

Figure 1 – Data collection procedures

Some standardization of applicant names was required, whether corporations or academic institutions. For example, the following iterations: “Google Inc”, “Google LLC” or “Google Ltd” all refer to the same entity. The same reasoning was applied to all applicants in the analysis.

Finally, Lens provides three types of patent categorization: CPC (Cooperative Patent Classification), IPCR (International Patent Classification – reformed version) and US classification codes. Since our analysis includes both American and Chinese platforms, we chose IPCR as it provides a broader and more consistent international coverage. The US or CPC classification systems are only applied by the EPO and the USPTO, hence they do not safeguard the same comprehensive coverage of Chinese applications. Nonetheless, CPC has been considered in literature to offer a slightly more extensive and detailed technological taxonomy (Chae & Gim, 2019; Lee & Hsiang, 2020).

3.3. Empirical Strategy

First, to analyse the growth dynamics of platform applications, we had to obtain the periodical distribution. Hence, to divide our dataset in cohesive time periods, we used Bai-Perron tests, a well-known technique that identifies multiple structural breaks in a time series (Bai & Perron, 1998, 2003). The resulting division was read under external events, namely the corporate history of platforms and patent publication dynamics.

Having discussed the choice of IPCR, it is important to state we are only going to use the sections and subsections of the patent codes. The section is the first letter of the code, often serving as a broad umbrella category of the patent field like “A - Human necessities”, “C - Chemistry, metallurgy” or “G - Physics”. As for the subsection or class, which is represented by the first three digits of the code, it provides further context on the domain of the patent like “A01 - Agriculture; Forestry; Animal Husbandry; Hunting; Trapping; Fishing" or “E02 - Hydraulic Engineering; Foundations; Soil Shifting”. Remaining divisions of the code go further in detail, providing more insight on patent specificities. Therefore, since our aim is to profile and single out the main differences between platform portfolios, we limit our analysis to subsections.

For thematic analysis we also employed two indicators: the Revealed Technology Advantage (RTA) Index and the Hirschman-Herfindahl Index (HHI), both granting insight on innovation through patent data (Confraria et al., 2024).

RTA is a specialized indicator used to assess a country's technological development stage, by measuring the level of a firm or country's patenting activity in a given technological domain (Chen, 2011; Khramova et al., 2013). We calculated as such:

$$RTA_{p,s} = \frac{(\frac{Patent\ count_{p,s}}{Total\ patents_p})}{(\frac{Total\ patents_p}{Total\ patents})}$$

where:

- p is a platform
- s is a patent IPCR subsection,
- $Total\ patents$ are the applications from all platforms

HHI is calculated by summing the squares of patent subsections shares, usually for a company or country, to obtain the level of concentration of technological activity and, consequently, the degree of diversification. As such, if in this case a platform has all its patent applications under only one technological field it will have a HHI equal to 1, indicating a highly concentrated portfolio, while a HHI closer to 0 suggests a more diversified one (Chen & Chang, 2010; Jeong & Yoon, 2017). We used the following formula:

$$HHI_{p,s} = \sum_{s=1}^{N} \left((\frac{n_{p,s}}{n_p} \right)^2$$

where:

- p is a platform
- s is a patent IPCR subsection,
- N is the total number of subsections a platform is active

Finally, we assessed quality through the number of citations received and the size of patent family. Citations provide insight in the technological impact of a patent and can help locate highly influential patents in a particular scientific field (Jürgens & Herrero-Solana, 2017). A patent's family size indicates the number of jurisdictions in which the patent sought international protection (Harhoff et al., 2003). It shows the international relevance of a patent and is typically higher for key patents like standard essential ones (Baron & Delcamp, 2012).

4. Results

4.1. Platform patent surge

Platform patent activity is characterized by a persistent growth with some fluctuations. The applied Bai-Perron tests suggest the presence of statistically significant breaks, which point to three different growth stages in the number of patent applications filed by digital platforms as shown in figure 2. The first phase, up to 2004 and when some platforms were not established yet was marked by a slow linear growth. In the second stage, between 2005 and 2011, there is a significant though inconsistent rise, reaching nearly 10,000 applications per year. It is only in the third period, comprising 2012 to 2020, that a surge in patent activity occurs, growing from 10,000 to over 30,000 applications, in a clear display of platforms' burgeoning interest on patents.

Finally, the number of patent applications peaks in 2021, followed by a decrease in the ensuing more recent years which could be in part associated with the general patent publication delay, as it takes on average 18 months for an application to get published (Hegde et al., 2023).

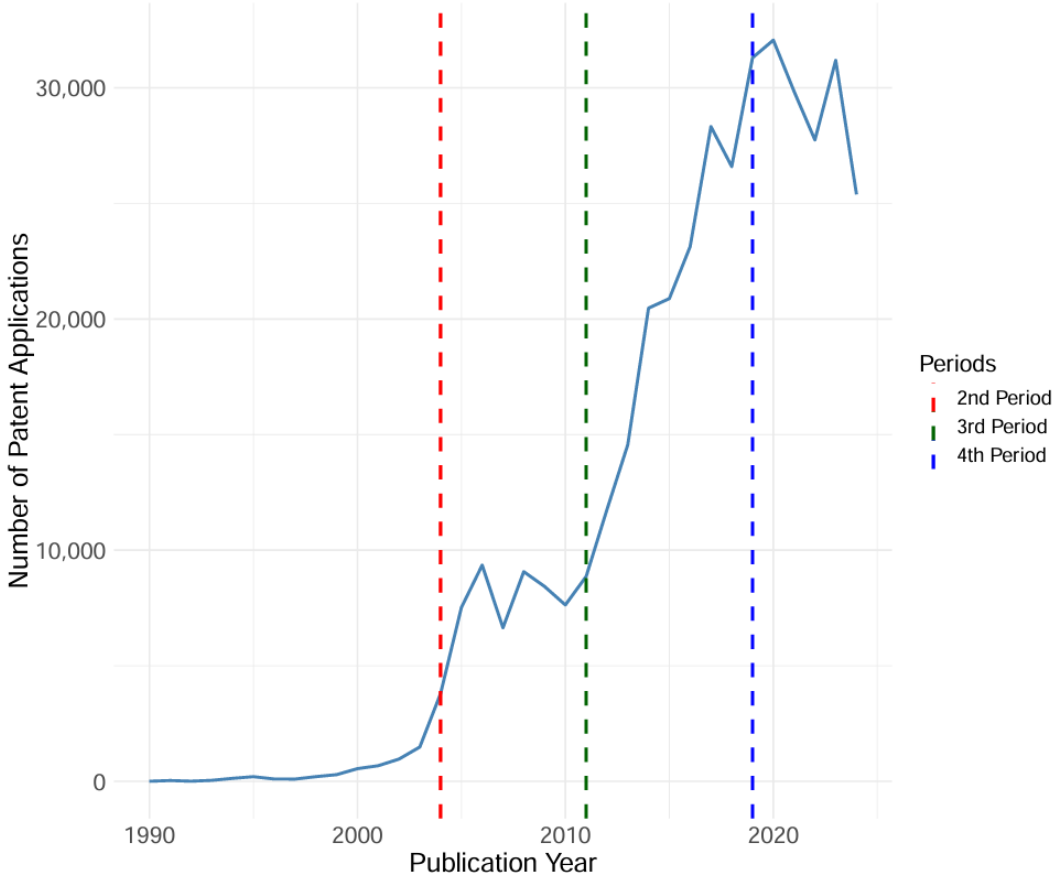

Figure 2 – Platform patent applications per year

Separately, platforms reveal discernible differences in growth trends as observed in Figure 3. Google, Alibaba and Tencent have a somewhat identical surge in the period between 2011 to 2019, echoing the overall tendency seen in Figure 1, while Microsoft and Apple appear to stagnate during the same period. These two latter companies were the clear leaders, particularly Microsoft, until this great surge, which gradually lifted the former group to the lead. In fact, from 2011 onwards, Microsoft fluctuated between 5,000 to 7,500 applications per year and Apple between 1,500 to 2,500. In contrast, from under 1,000 applications in 2011, Google achieved near 6,000 applications in 2019, while both Alibaba and Tencent surpassed the 7,000's threshold.

Other platforms like Amazon, Facebook, Netflix and Twitter exhibit a similar small and linear growth behaviour to Apple, with Facebook even slightly surpassing Apple after 2020. The only platform in this lower-rank group to exhibit an exponential growth is ByteDance, whose peak in 2021 surpassed 3,000 patent applications.

Therefore, the bulk of platform patent activity arises from the surge in Google, Tencent and Alibaba, as well as the large application portfolio from Microsoft, despite its stagnant growth. To further study the relevance of Chinese platforms in this shift, Figure 4 shows how until 2017 they were, from a significant difference, mimicking the growth of American platforms. However, whereas American platforms began to decline in patent application by 2018, their Chinese

counterparts' exponential rise permitted them to match the US platforms in number of applications in 2019 and even surpass them by 2020.

Exponential growth by Chinese platforms can be contextualized in light of an overall patent surge in China, which became the leader in patent fillings in 2011 and in international patent applications by 2019 (WIPO, 2020). Driven by a combined effort that included a steady investment in R&D, large foreign direct investment and government patent subsidies, this surge in Chinese patent activity is nevertheless met with a degree of scepticism, since a large share of the resulting patents is considered as presenting low quality (Chen & Zhang, 2019). Moreover, China trails developed economies in patent quality metrics like invention quality, document quality or quality for the commercialization, and has a very low granted patents to patent applications ratio, standing at just 30% in 2019 (He, 2021; Song & Li, 2014).

Therefore, despite not targeting Chinese platforms specifically, literature confirms a tendency in Chinese patenting to favour quantity over quality, which may explain the growth burst in Alibaba, ByteDance and Tencent. Some authors argue still other reasons, namely patenting as a guarantee for external or third-party financing and contracts or as a strategy of rapprochement to secure government funding (Cheng et al., 2025; She et al., 2019).

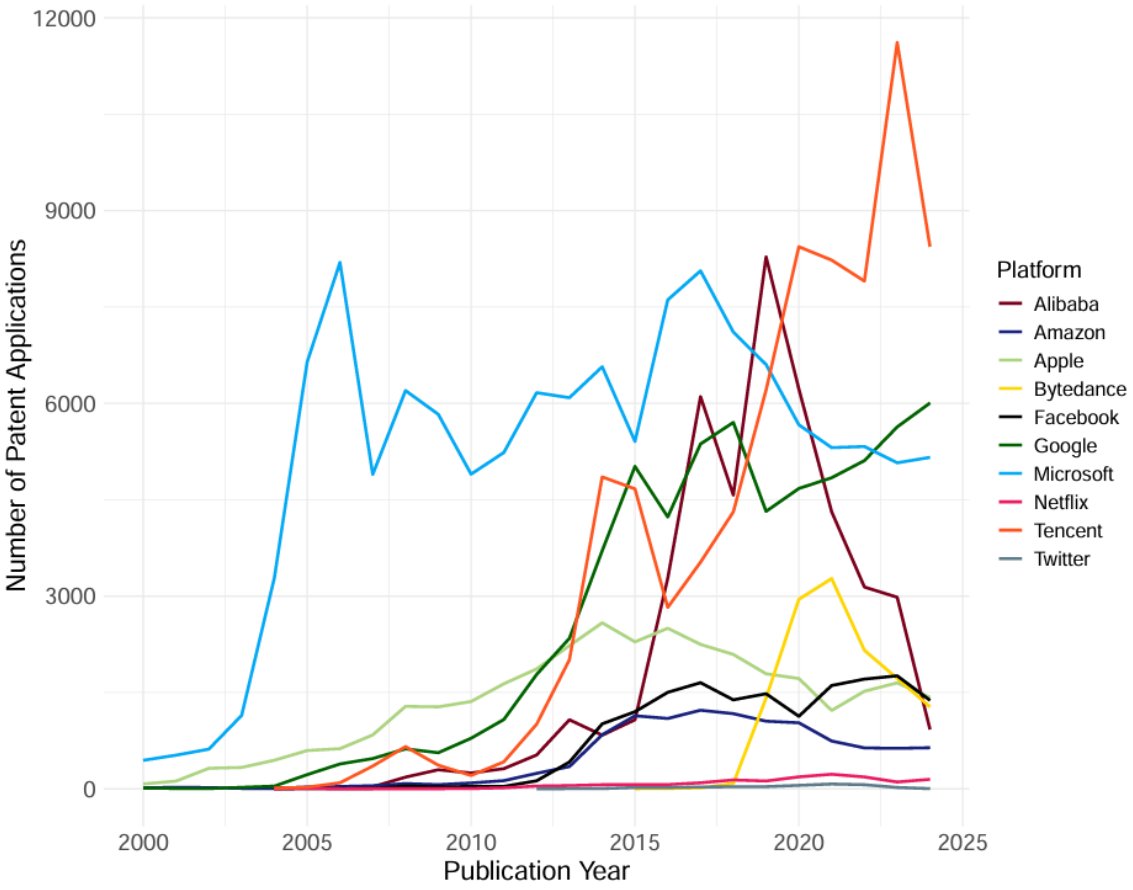

Figure 3 – Patent applications per platform

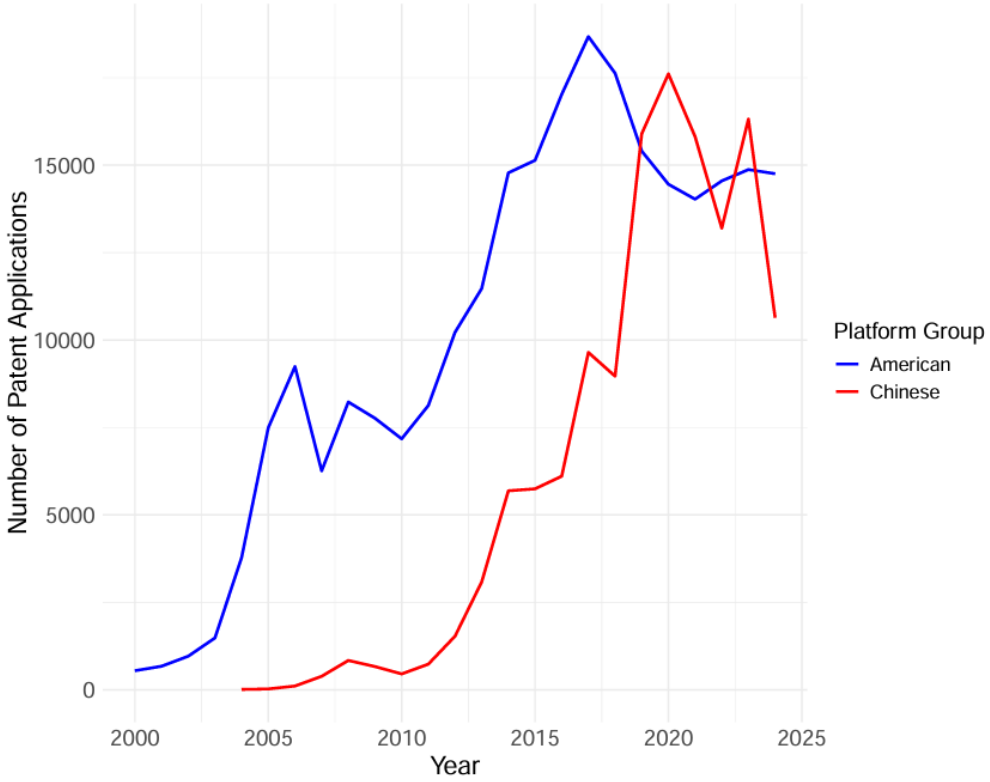

Figure 4 – Patent applications per platform group

4.2. Applicant Dynamics

The geographical distribution of platform patent applications reflects the US-China rivalry, with the two countries being the standout jurisdictions in filing activity, both exceeding the 100,000 applications, as seen in Figure 5. Although China has surpassed the US in total number of applications (Hu et al., 2017), in our platform's filed subset the US is still ahead . Nevertheless, the jurisdiction distribution mirrors some broader global tendencies like the growing preponderance of Asia (WIPO, 2024b). Note that besides China, the offices of South Korea, Japan and Hong Kong rank in the top 10 jurisdictions for platform filings.

American platforms have a much more internationally diversified filing strategy than their Chinese counterparts, with applications filed through the USPTO accounting for 47% of American platforms' total, while filings in the CNIPA (China National Intellectual Property Administration) represent 65% of the total for Chinese platforms. The trade-off between the two countries is balanced, with Chinese platforms filing 11% of total through the USPTO and American platforms filing 10% of total through the CNIPA, with this last value nearing 18% if we included other Asian countries (Japan, South Korea, Hong Kong, Israel, Philippines and India).

Figure 5 also shows a significant number of applications filed through WIPO, over 50,000. Almost of half of these applications were filed after 2019, coinciding with the global surge, particularly in more recent years, in the use of the Patent Cooperation System (PCT) and number of published PCT applications, which were prompted by the innovation growth in certain technological sectors like ICT (WIPO, 2024a). The preference for a PCT application may be attached to a resulting higher-quality innovation recognition, since they are more likely to be approved by different patent offices, helping to justify the surge in recent years (Zhao, 2022).

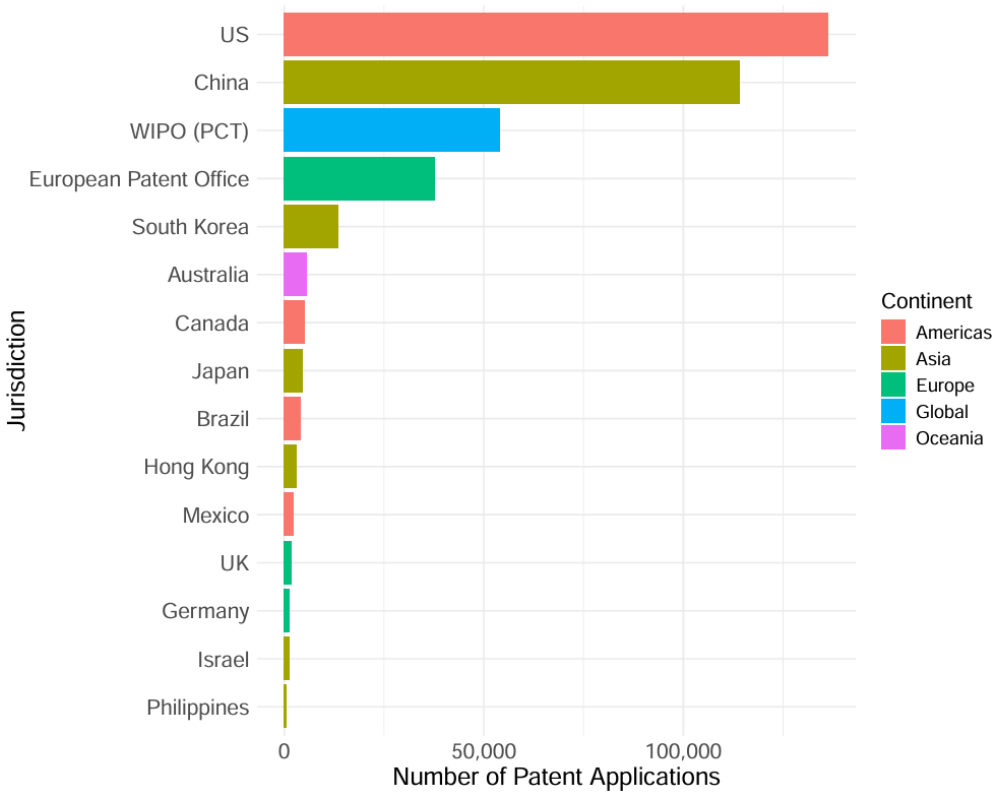

Figure 5 – Patent applications per filing office

Our results partially confirm the leaning identified in Rikap & Lundvall (2022), that digital platforms typically patent alone or with workers as co-applicants. Figure 6 presents the share of applications filed solely by platforms, which confirms high shares of sole patenting and reinforces a certain propensity for knowledge monopolization discussed in literature (Safadi & Watson, 2023). The only exception to the rule seems to be Apple, for while the Chinese platforms and Facebook file over 90% of applications independently, Apple does not exceed the 40% level.

Apple's differentiated profile may not come from a more collaborative approach. Though Apple is well-known for promoting cross-licensing agreements (Liu et al., 2024), the company is also highly protective of its intellectual property and market position, acquiring more patents to further consolidate its leadership (Chang et al., 2014). It can be argued that akin to its technology transfer strategy, where Apple incorporates external content in its products and services (Lee & Kim, 2017), the company promotes a knowledge transfer dynamic within its ecosystem by acquiring companies and their patent portfolios (Patel, 2020).

Figure 7 shows the top external co-applicants in platform patent filings, the majority of which are multinational corporations in telecommunications, computer software and semiconductors such as Intel, Nortel Networks or Motorola. The substantial number of applications with Intel should not come as a surprise, given that it is among the largest patent assignees in the fields of software, smartphones, machine learning and semiconductors (Webb et al., 2018). More importantly, Apple's acquisition of Intel's smartphone modem division translated in the transfer of a significant part of Intel's patents (Strauss & Yang, 2024), which may further explain the value in Figure 6.

Similarly, the top reflects some key alliances in platform industrial strategies. Infineon Technologies is a key supplier of baseband chips for Apple's electronic devices and

semiconductors (Grimes & Sun, 2016; Liang, 2016), while Alibaba and Tencent pursue collaborations with Tsinghua University that forge networks in energy or information technology supported on academic research to foster innovation (Krishna et al., 2025).

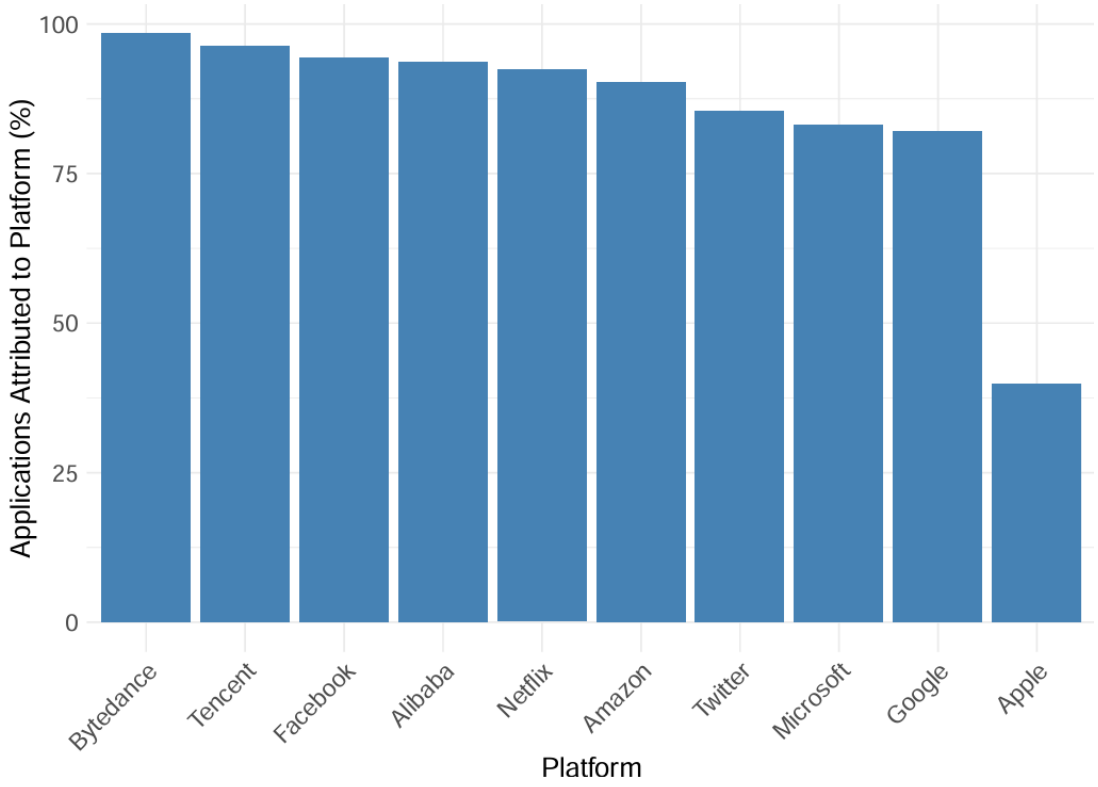

Figure 6 – Share of Applications Attributed to Platforms Only (%)

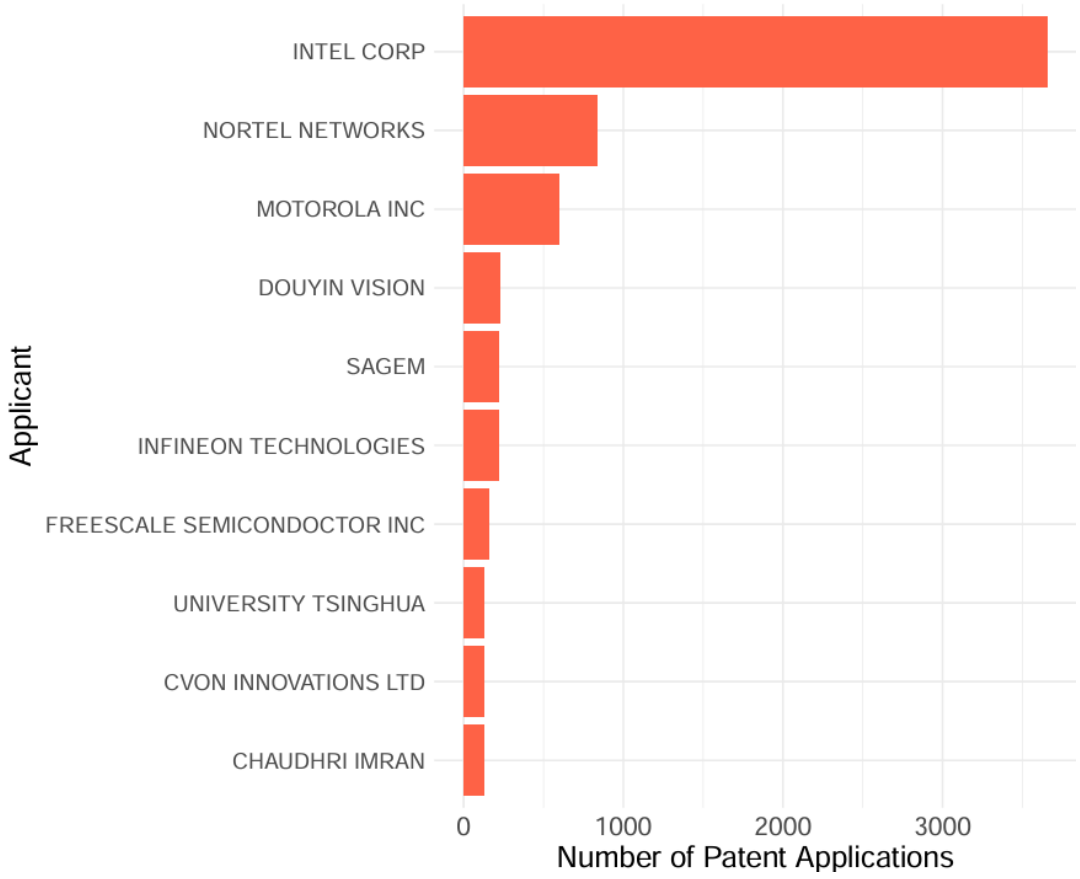

Figure 7 – Top 10 External Applicants

4.3. Portfolio Profile

Although digital platforms have a vast array of scientific interests, publishing from agriculture to computer science-themed journals and investing in areas beyond their business core like medicine, their patent portfolios are more specialized and have a narrower scope. In Figure 8, we divided patent applications according to IPCR's main section, i.e. the first digit in the classification code. Platform filings concentrate on "G – Physics" and "H – Electricity", with remaining categories exhibiting residual values, a trend already observed in Barsy & Gautier's (2024) study of GAFAM's acquisitions and innovation.

For further insight, we looked in the IPCR subsection classification, where there is another concentration trend in the categories "G06 – Computing; Calculating; Counting" and "H04 – Electric Communication Technique". G06 encompasses computing devices (optical, digital, analogue, hybrid arrangements), data processing systems and methods, and image data processing. H04 comprehends different communication devices (telephones, microphones, speakers, televisions) and systems and methods (broadcasting, multiplexing, digital data transmission, wireless networks, encryption) (Tamenaga, 1980).

Historically, these patent classes have remained among the most significant in the USPTO, the SIPO (former designation of CNIPA), as well as the EPO, the JPO (Japanese Patent Office) and the KIPO (Korean Intellectual Property Office), showing very strong growth rates from the early 2000s onwards (de Oliveira Lages, 2016). Hence, platforms are once again in line with overall patent trends.

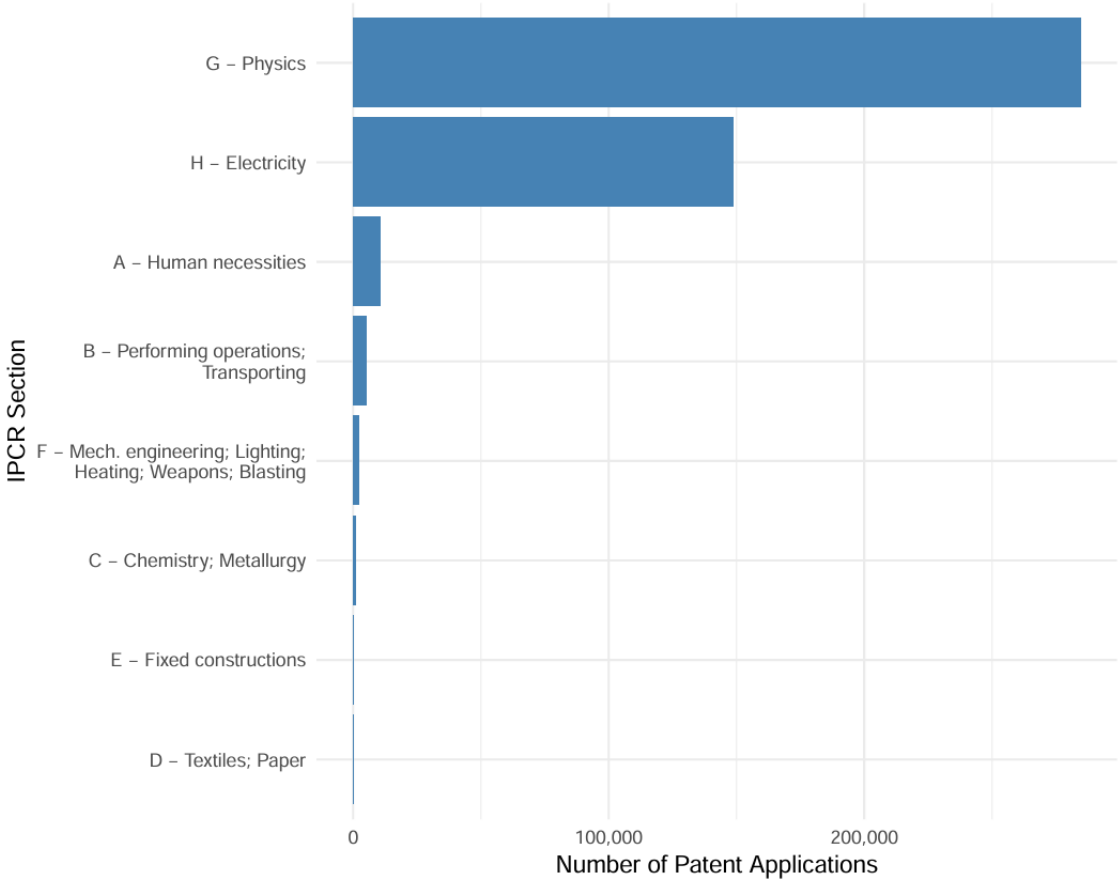

Figure 8 – Applications by main IPCR Section

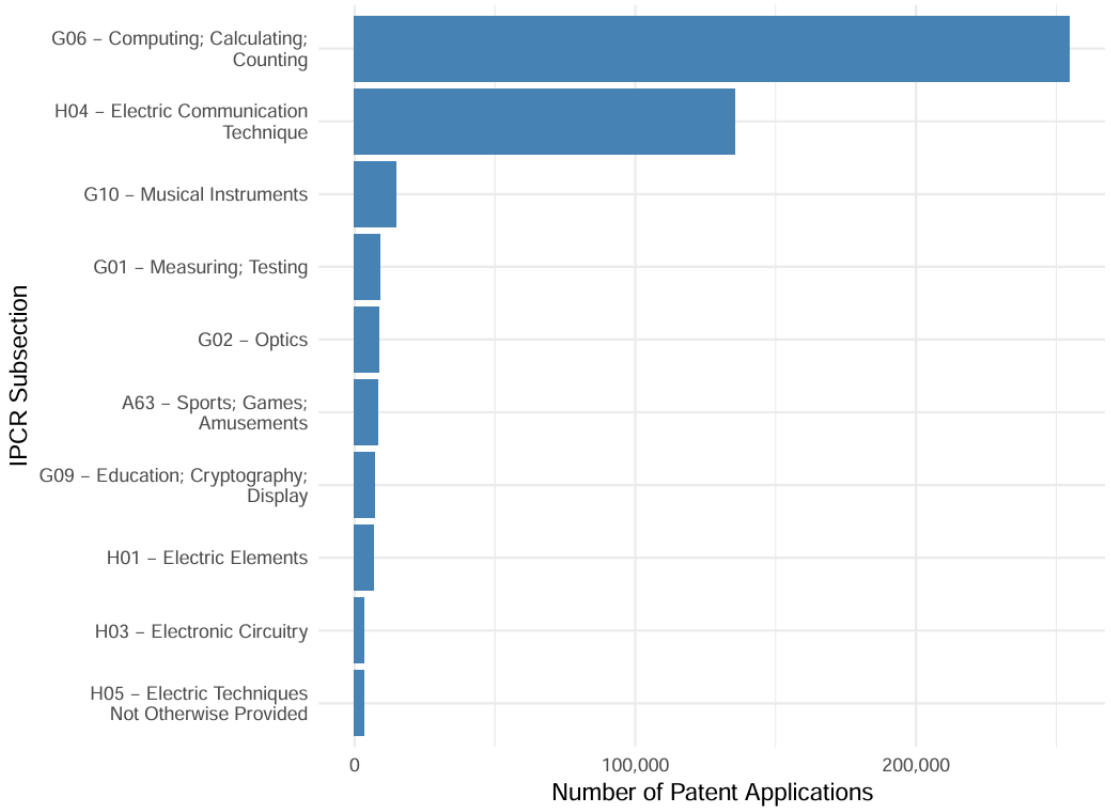

Figure 9 – Top 10 IPCR Subsections

For a more thorough understanding of platform applications, we conducted a bigram analysis of the patents' abstracts (see Appendix). There is a preponderance of artificial intelligence and machine learning related terms across all platforms, particularly the ones with the largest portfolio like Microsoft and Google. Recurring bigrams like "data storage", "learning model" or "training data" prove how platforms attach great relevance to data treatment, which is crucial for the development of "neural network" algorithms (Rikap & Lundvall, 2022), another repeated observed term. Hence, abstracts confirm machine learning as the cornerstone of platform innovation particularly since it allows a more efficient use of information available in social networks (Attaran & Deb, 2018).

Apart from machine learning, abstracts also focus on "cloud computing", "speech recognition", and communication technologies, the latter reflecting the prominence of the H04 class in applications. Note that platforms have a significant number of acquisitions on the communications sector (Gautier & Maitry, 2024), incorporating the attached patents in their portfolios.

Platforms with a smaller portfolio, such as Netflix and Twitter, show bigrams closer to their core business, thus diverging from the broader trend of machine learning oriented abstracts. Apple, another exception, is focused on wireless communications, with the observed terms also conveying a closeness to the firm's products such as "touch screen" and "touch sensor".

Figures 10 and 11 allow a clearer distinction of the platform portfolios, by presenting the RTA values for the G – Physics and H – Electricity subclasses, respectively. Almost all platforms exhibit at least one subclass where they have a relative higher level of specialization than average. Apple and Google have a higher level of technological advantage in a broader range of subclasses than

other platforms. Apple has a strong showing in “G09 – Educating; Cryptography; Display; Advertising; Seals”, “G11 – Information Storage”, “H01 – Basic Electric Elements”, “H02 – Generation, Conversion or Distribution of Electric Power” and “H03 – Basic Electronic Circuitry”, while Google is more specialized in “ G08 – Signalling”, “H05 – Electric Techniques (not otherwise provided for)”, and “H10 – Semiconductor devices”. In contrast, Chinese platforms do not register high RTA values in general, except in the two subsections G06 and H04 where there was already a great concentration of activity by many platforms. Other platforms have similarly a narrow scope of specialization like Netflix with G11 and Microsoft with H03 and H10. Therefore, not all platforms pursue a diversification strategy in patent application like Google and Apple.

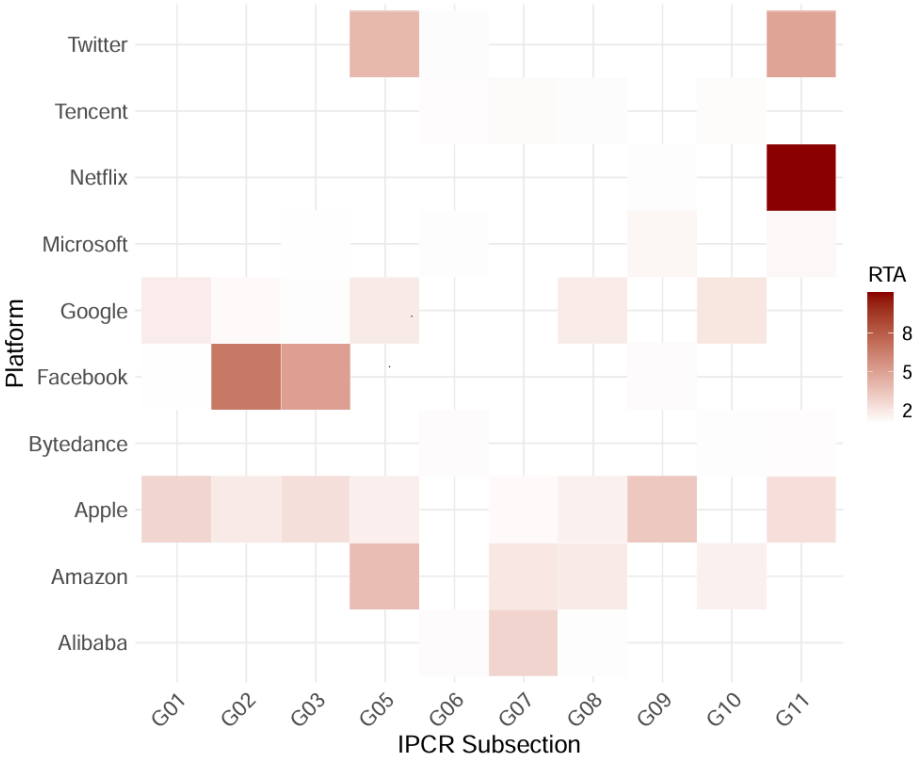

Figure 10 – RTA Index by Platform in Section G (Physics)

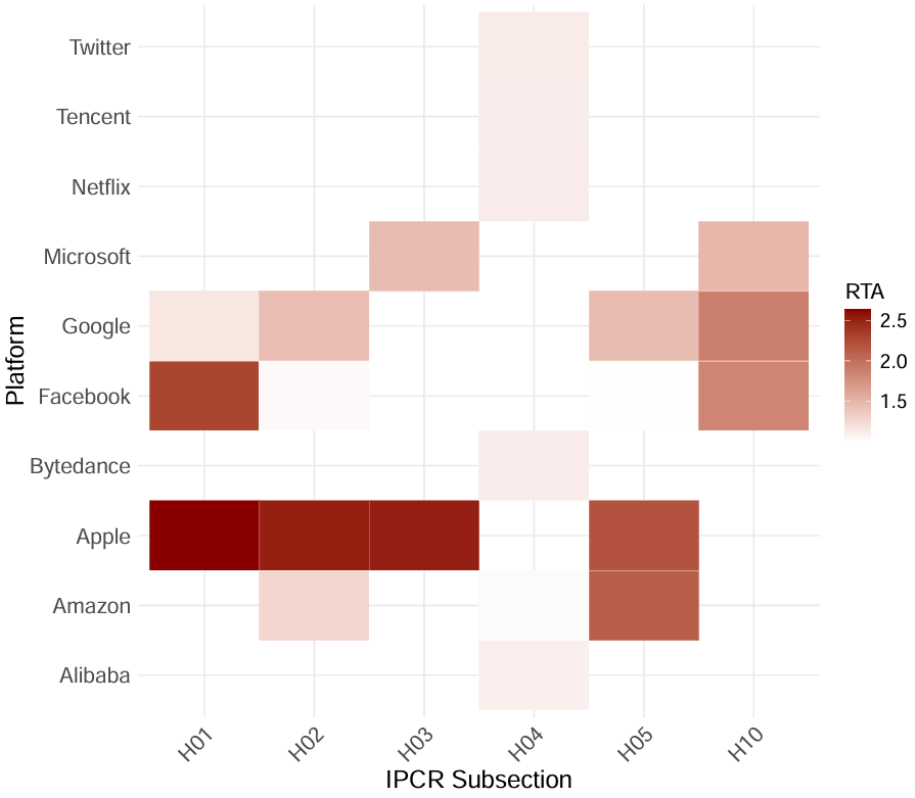

Figure 11 – RTA Index by Platform in Section H (Electricity)

To conclude on differences between platform profiles and strategies, we calculated the Herfindahl-Hirschman Index using patent subsection frequency, as shown in Table 1. Apple confirms its status as the platform with the most diversified portfolio with a HHI inferior to 0.4, while Microsoft, along with platforms with the smaller portfolio like Netflix and Twitter, has a more concentrated one. Nevertheless, most platforms show a HHI level close to 0.5 which suggests a balance between diversification and specialization.

HHI by Platform and SubSection	
Platform	HHI
Alibaba	0.660
Amazon	0.562
Apple	0.382
Bytedance	0.530
Facebook	0.533
Google	0.561
Microsoft	0.686
Netflix	0.684
Tencent	0.516
Twitter	0.871

Table 1 – Herfindahl-Hirschman Index by Platform (IPCR Subsection Level)

4.4. Patent Quality

Altogether, platform applications have a considerable number of citations. Table 2 shows the total number received by the periods identified through the Bai-Perron tests in section 4.1. Most platforms were in an earlier stage of development in the first and second periods, hence the overall small number of citations apart from Apple and Microsoft, the two oldest companies. From 2012 to 2020, all platforms except Microsoft register a solid growth. Finally, the low values in the last period can be justified by the time recent applications take to build up citations.

Individually, Apple has a remarkable number of citations received proportionate to its number of applications. Note that as a technological diversified portfolio usually leads to the development of better products and services (Lin et al., 2006), the high level of citations received may be associated with the company's diversified portfolio as discussed earlier. At the same time, the growth in citations received by the Chinese platform group between the second and third periods matches their rise in application volume.

Table 3 shows citations divided by range to identify if platforms have highly influential applications or whether their portfolios are predominantly constituted by moderately cited patents. Platforms do not avoid the general skewed citation distribution found in bibliometric studies (Bornmann, L., & Leydesdorff, 2017), with 67% of all applications having receiving between one to five citations and around 4% receiving more than fifty citations.

Apple is again the group's outlier, displaying an impressive 6% of applications with more than one hundred citations, 8% with more than fifty citations and only 38% under five citations, which translates in a highly sought and regarded patent portfolio. On the other hand, Chinese platforms have a higher proportion of low-cited patents, as well as the smaller platforms (Netflix and Twitter) and, more surprisingly so, Google and Facebook. Lastly, Microsoft and Amazon have a skewed distribution close to the average, with the highest share of more cited patents after Apple.

Platform	1986-2004	2005-2011	2012-2020	2021-2024
Alibaba	-	10,952	175,147	15,387
Amazon	941	4,294	112,763	5,842
Apple	49,346	423,210	510,482	25,551
Bytedance	-	-	19,736	16,501
Facebook	-	3,457	78,250	9,592
Google	2,237	68,092	363,505	20,704
Microsoft	131,391	918,687	559,239	22,886
Netflix	1	58	5,020	390
Tencent	95	20,639	279,829	44,888
Twitter	-	-	2,909	177

Table 2 –Citations received by applications per platform

Citations Received (Range)	Alibaba	Amazon	Apple	Bytedance	Facebook	Google	Microsoft	Netflix	Tencent	Twitter	All (%)
<5	70.3	67.0	38.9	82.0	76.3	77.0	64.3	85.5	69.4	79.0	67.1
5-10	17.6	12.6	14.9	12.0	10.4	9.4	11.1	7.5	17.7	7.6	13.2
11-50	11.6	15.1	31.6	5.6	11.4	10.6	18.2	5.4	12.6	9.8	15.5
51-100	0.4	3.4	8.1	0.3	1.3	1.8	4.1	1.2	0.3	1.7	2.6
>100	0.1	2.0	6.6	0.0	0.6	1.2	2.3	0.4	0.1	2.0	1.6

Table 3 –Citations by range

Finally, we looked at the distribution of simple and extended family sizes of platform applications, as seen in Figures 12 and 13 The results mirror the skewed distribution of citations, with most applications being part of small patent families. Again, Apple stands out as the platform with more applications with larger families, holding the highest share of families over 50 members. However, in the second largest family size category (11-50 members), whether simple or extended, it is Netflix and Twitter that have the largest shares. Hence, the platforms with the smallest and least diversified portfolio also have a relatively large share of patents with broad international protection.

Chinese platforms stand as the companies with the largest share of small families, either simple or extended, with Alibaba and Tencent having almost two-thirds of patents with families under five elements. Bytedance differs somewhat from the other Chinese companies by also holding the highest share of the largest family size category after Apple, as well as presenting family size distributions of the 11 to 50 members range in line with the other American platforms. Therefore, it can be said that Bytedance is pursuing a broad internation patent protection, a path from which Alibaba and Tencent are still far.

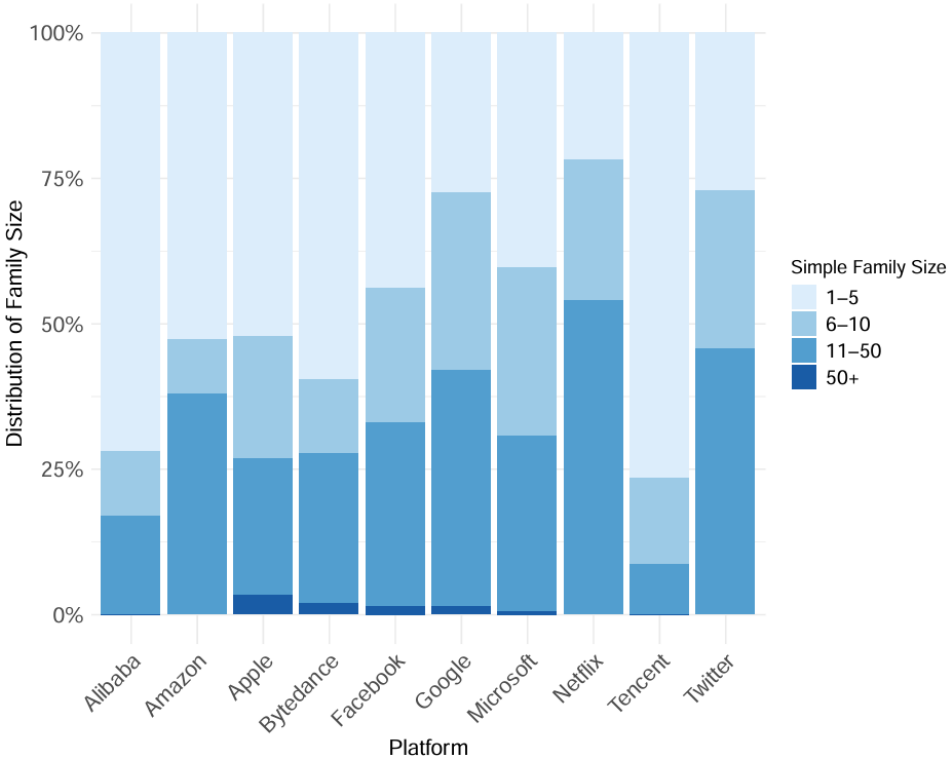

Figure 12 – Distribution of Applications by Simple Family Size Across Platforms

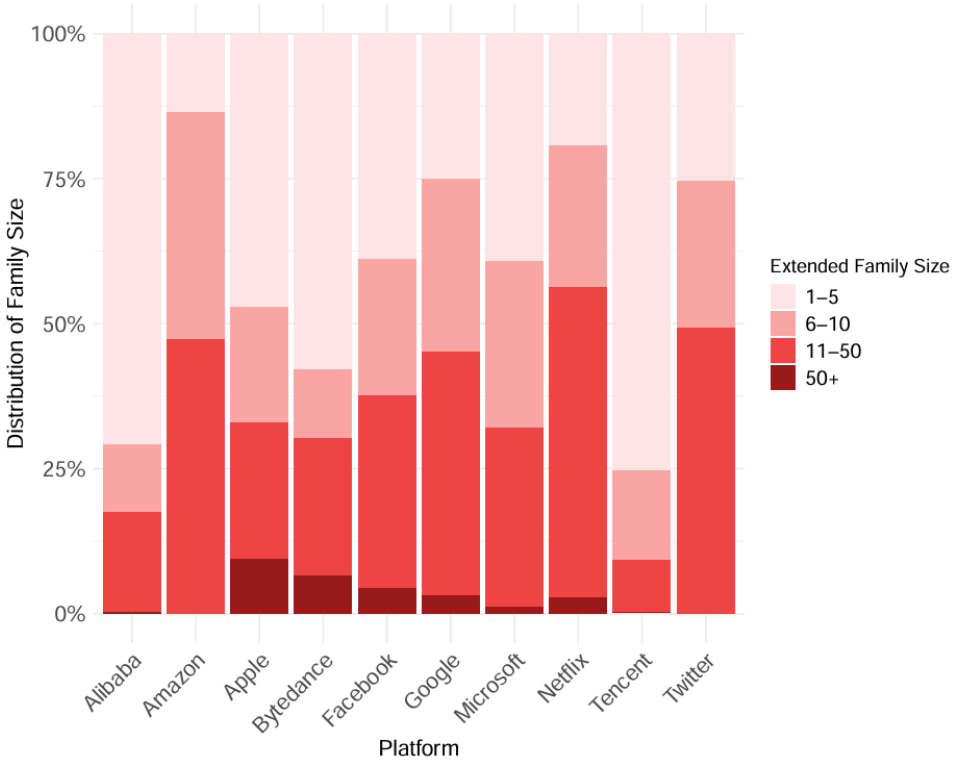

Figure 13 – Distribution of Applications by Extended Family Size Across Platforms

5. Discussion

The patent applications of digital platforms display patterns that mirror broader tendencies within patenting activity. The concentration of applications in two IPCR categories: G06 and H04 shows that platforms move in the most dynamic of subsection groups, where other key technology multinationals like Samsung, Huawei, IBM or LG also patent the most (de Oliveira Lages, 2016). Taking into account the broad scope of platforms' activity in every aspect of the digital economy from infrastructures (telecommunications, software) to digital media would naturally lead to an investment in patent development particularly in the mentioned subsections (de Bustos & Izquierdo-Castillo, 2019). As a result, platforms are benefiting from a central position, given their omnipresence in information and communication technologies, which does not allow them to overlook intellectual property.

This concentration in specific technological sectors in their patenting profiles differs slightly from their approach in scientific publishing. Platforms exhibit marginal application values in patent sections outside the sections of "G – Physics" and "H – Electricity", which constitute the bulk of their portfolios. When co-authoring scientific papers, platforms show proportionately more openness to more topics even that secondary, like social sciences, in their heterogeneous research agenda (Mendonça et al., 2023; Verhoef et al., 2021). At the same time, this scientific research that leads to publications is largely developed in collaboration with academia, while patenting activity is usually conducted by platforms themselves solely.

These findings confirm the diagnostic by Rikap & Lundvall (2022) which argues that though willing to promote scientific collaborations platforms rarely co-own patents. Pointing to a knowledge predation paradigm, these authors stress how platforms are building intellectual monopolies then fuelled by machine learning. Platforms made a standard practice of acquiring

patent portfolios through the acquisitions of companies (WIPO, 2019), hence intellectual property comes both as a motif and consequence of their business strategy. However, there are some nuances concerning platform patenting behaviour. For example, Apple has a significant contingent of applications where strategic partners like Infineon and, for a long time, Intel, are co-applicants. This may suggest that Apple has a reliable knowledge transfer ecosystem, in which the company does not need sole co-ownership. Establishing not necessarily a collaborative model for Apple remains the figurehead, but an innovation chain within a platform ecosystem.

The case of Chinese platforms stands in contrast with Apple, displaying large shares of solely owned applications. In addition, whereas Apple's applications receive an impressive number of citations, Chinese platforms' applications have a proportionate lower level. This must be interpreted considering the Chinese context in which patents co-signed by inventors, despite being a minority, are shown to be of higher quality (Jiang et al., 2019). Therefore, co-ownership of patents can be synonymous with a higher-quality outcome.

Another factor that we argue explains the observed quality of Apple's portfolio, not only due to high citations but also by the significant number of patents with large families, is the broad technological scope. Standing again in opposition to the portfolios of Chinese platforms, which do not present high specialization levels outside the G06 and H04 subsections. However, there is no significative evidence showing that diversification per se can lead to higher quality. Instead, diversification implies developing applications in different subsections potentially with different co-applicants, which extends the platform ecosystem. Thus, the development of a patent portfolio may contribute for a further expansion of digital platforms.

Finally, regarding the stylized fact of machine learning as a pillar of their patent portfolio. Faced with the amount of data in their ecosystems, platforms had inevitably to invest in machine learning to potentiate that resource. Furthermore, machine learning offers a solution to a variety of areas from medical diagnosis to forecasting electrical demand or security surveillance, which induced platforms to develop cloud-based services (Attaran & Deb, 2018). For all these reasons it is unsurprising that platforms continue to have so many applications on machine learning, for it allies innovation with an efficient business management (Hamed Vares et al., 2024).

6. Conclusion

Platforms are increasingly filing in patent applications. This work identified different growth stages, with a notable rise between 2012 and 2020 led particularly by Alibaba and Tencent, that overcame traditional leaders like Microsoft and Google in number of applications. Furthermore, the sum of Chinese platform activity matches the one by American counterparts in more recent years. However, when observing citations received levels Chinese platforms are still lagging, presenting a proportionate lower level and a residual number of highly cited patents. Therefore, in what is a common pattern in Chinese patents (Boeing & Mueller, 2019; Fisch et al., 2017), Chinese platforms still struggle to obtain a higher appreciation through citations.

Thematically, platform applications are concentrated in computer technology and electric communications patent subsections. As expected, applications also reflect an interest in machine learning with the topics of neural networks and data storage being of significant relevance across all platforms. We single out Apple as the platform with the most diversified patent portfolio, given that it presents high levels of specialization in more than one or two subsections, contrasting with Chinese platforms or Netflix and Twitter that have a narrower scope. An argument is made that platforms have different strategies regarding portfolio composition, with

some preferring to develop and fill applications closer to their core business, while others extend to more areas.

Our findings reinforce the observations of previous literature that platforms tend to patent alone. Apple was the exception to this rule, presenting a much lower share of applications filed independently. However, we discuss that this could be the result of the company's acquisitions strategy, particularly when looking at the top external co-applicants like Intel. One can also suggest the presence of co-applicants as a direct result of the platform's alliance policies, for example Alibaba and Tencent have a small but significant number of applications filed with Tsinghua University, a strategic partner.

A diversified portfolio seems to garner more citations, while a more concentrated one can reflect a focus on core business areas by the platform. Thus, regulatory entities can look at the scope of a platform's portfolio to better understand the market position of a given platform in different sectors, potentially allowing to anticipate moves to other markets. Another relevant debate matter is the relation between acquisitions and patent portfolios, platforms can be taking advantage of their position to further consolidate their dominance, in this case through intellectual property.

Our results only considered patent applications and not granted patents. As such, this work does not provide an absolutely accurate outline of platforms' patenting activity, especially when considering that some applications do not result in granted patents. Other limitations relate to the methodological choices taken, like the use of IPCR classification subsections.

This work showed how platforms have considerable patent application portfolios. Through a bibliometric assessment we were able to take some conclusions regarding their business strategies, namely how platforms' acquisition strategy may have repercussions on market dynamics, reinforcing their position through an expansion of their intellectual property portfolios. Further research must look at possible imbalances caused by this acquisition strategy and to understand the extent to which patent portfolios hold by platforms result from such acquisitions.

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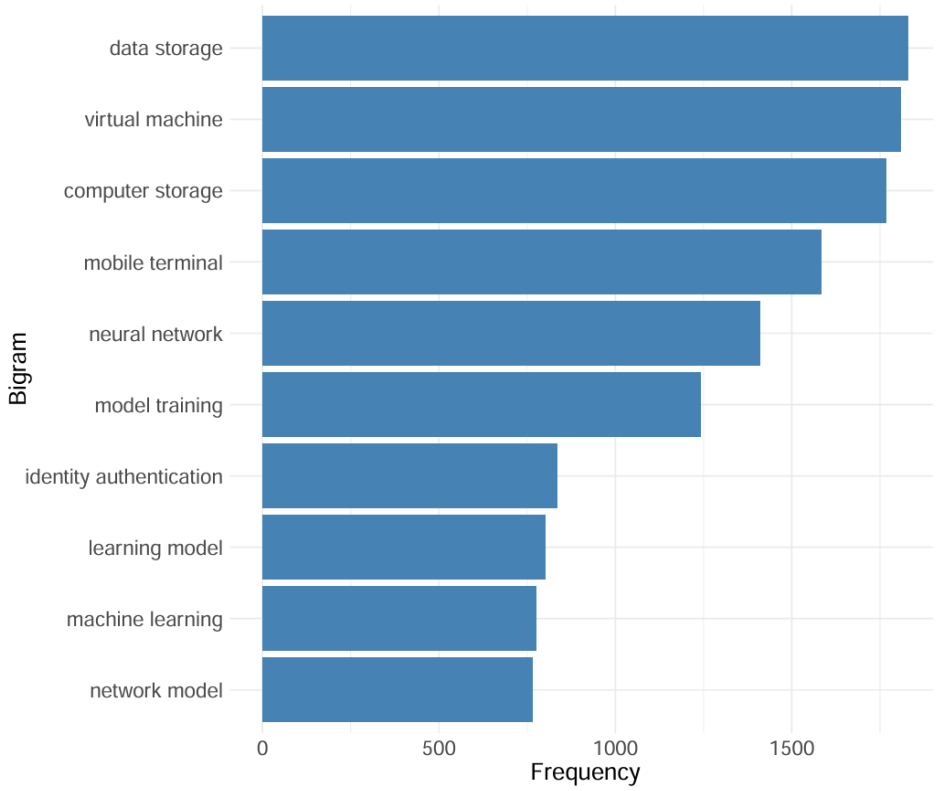
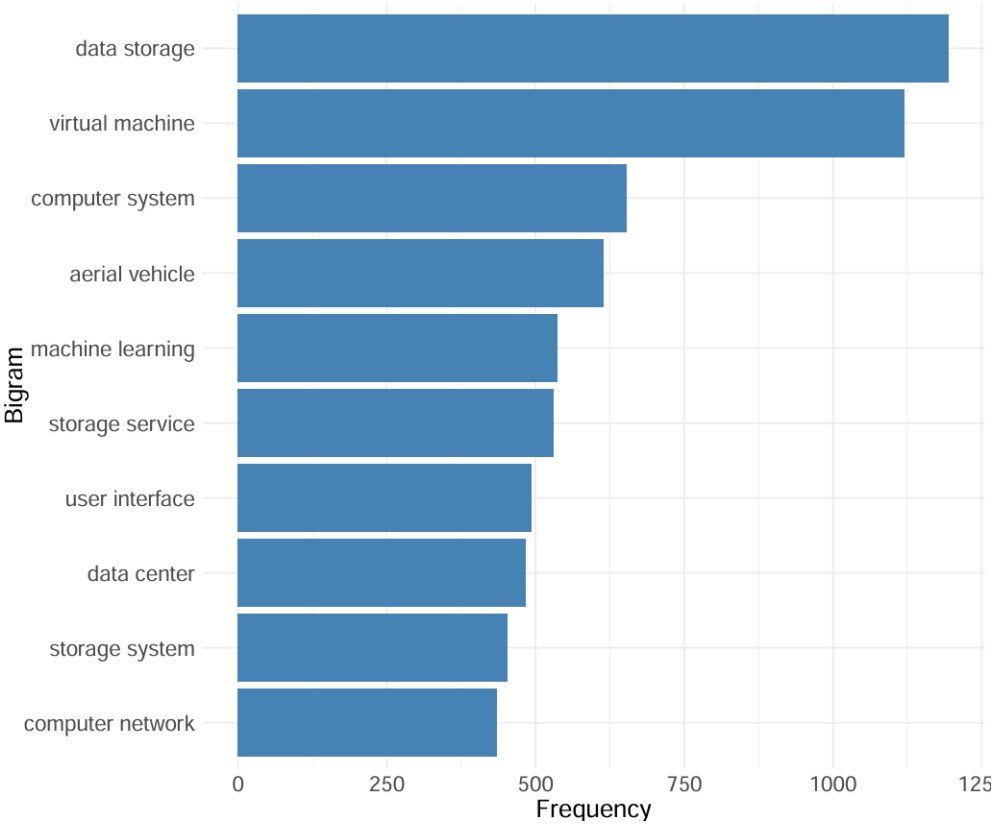
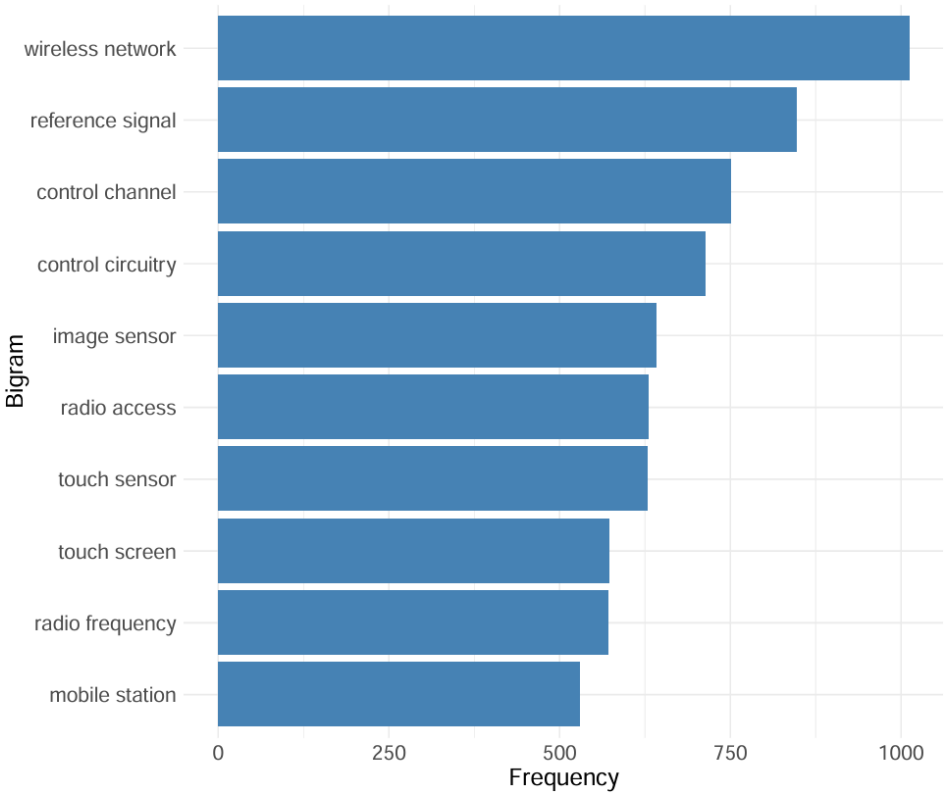
Appendix



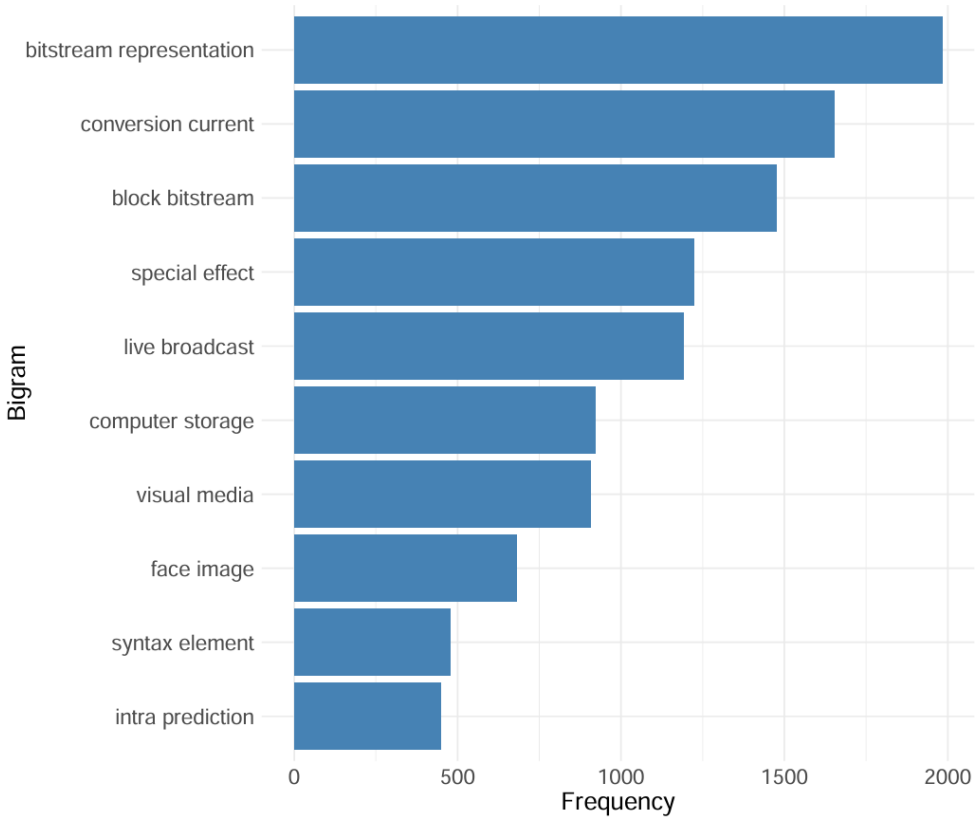
Appendix A.1 Top 10 Bigrams from Alibaba's patent applications



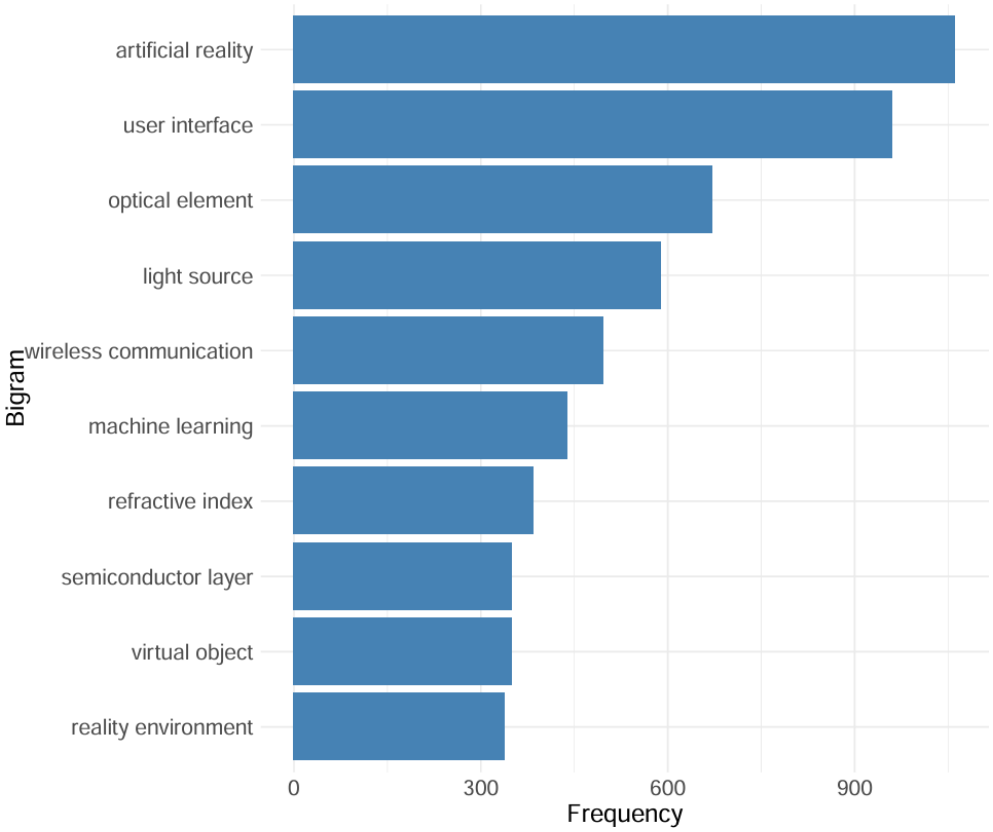
Appendix A.2 Top 10 Bigrams from Amazon's patent applications



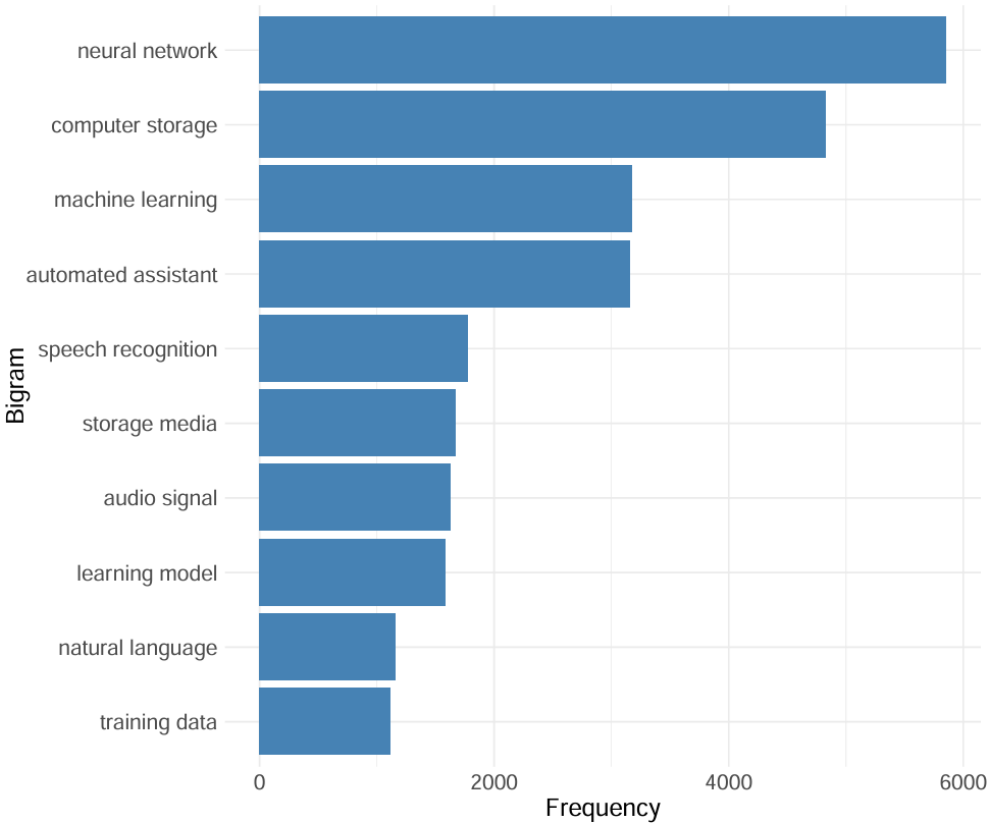
Appendix A.3 Top 10 Bigrams from Apple's patent applications



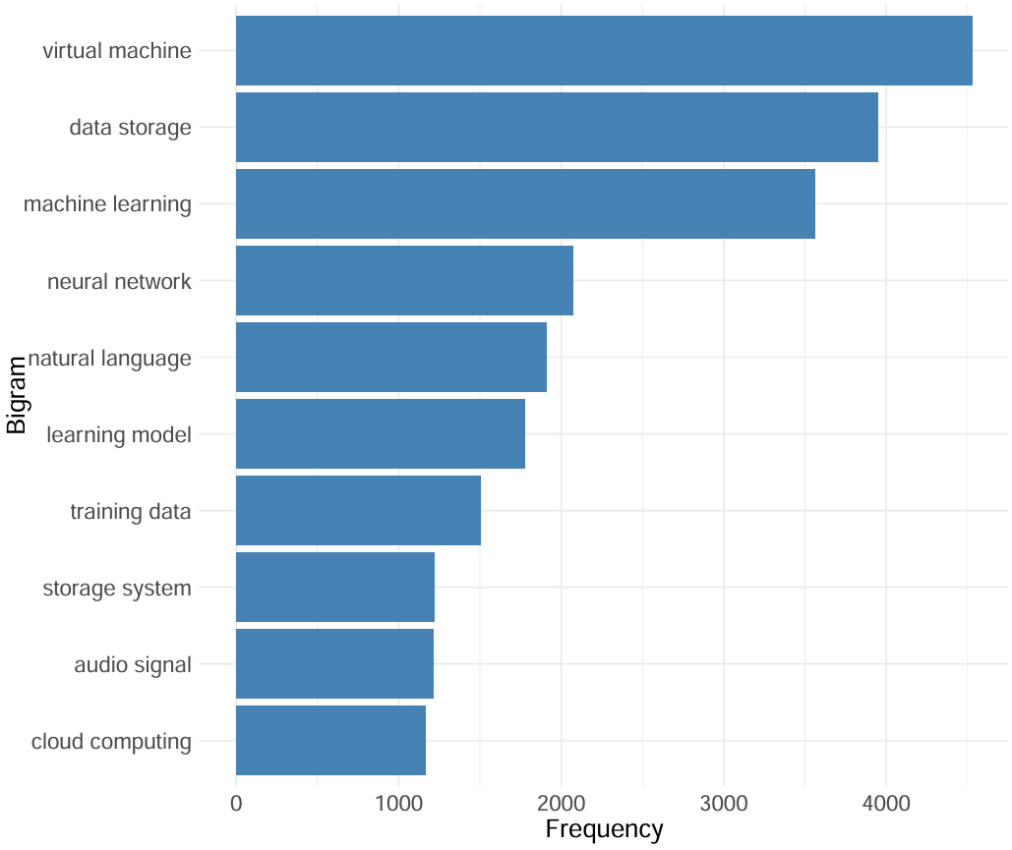
Appendix A.4 Top 10 Bigrams from Bytedance's patent applications



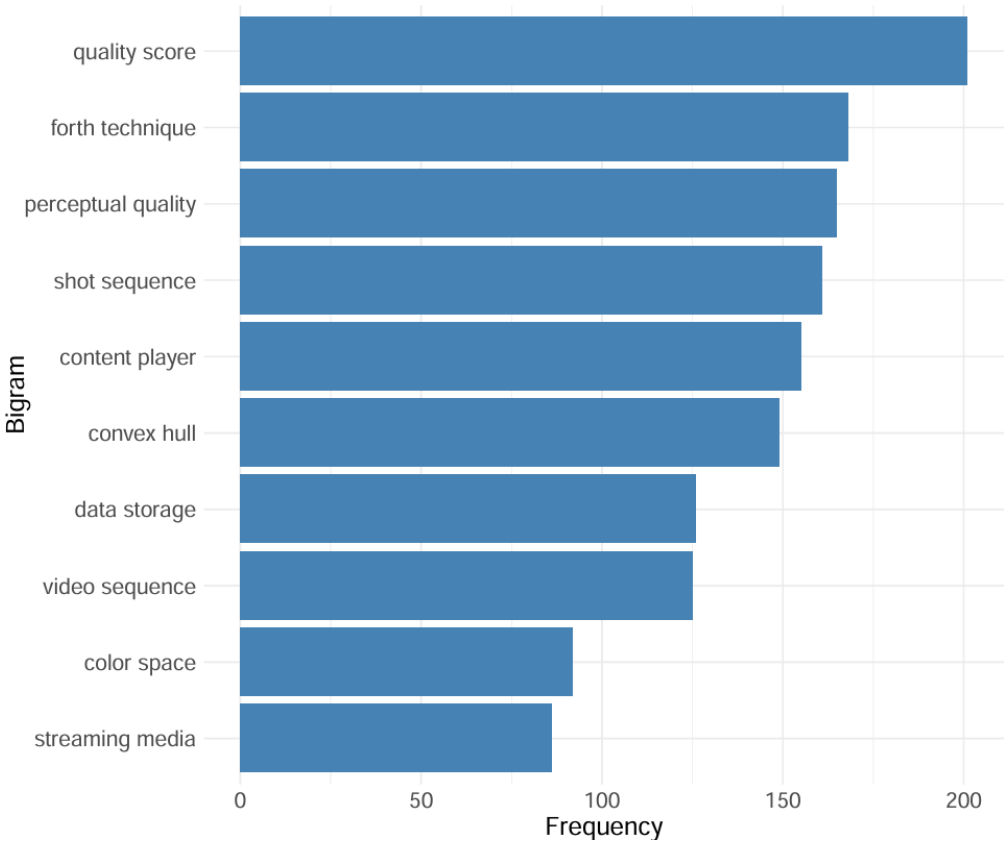
Appendix A.5 Top 10 Bigrams from Facebook's patent applications



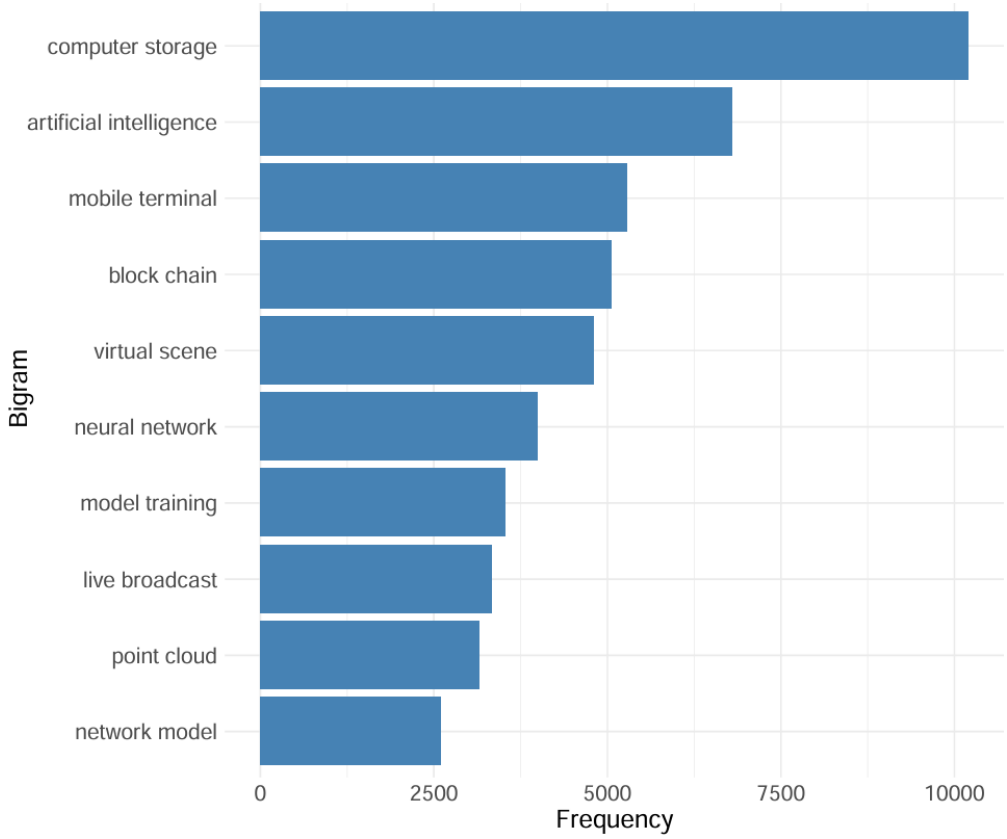
Appendix A.6 Top 10 Bigrams from Google's patent applications



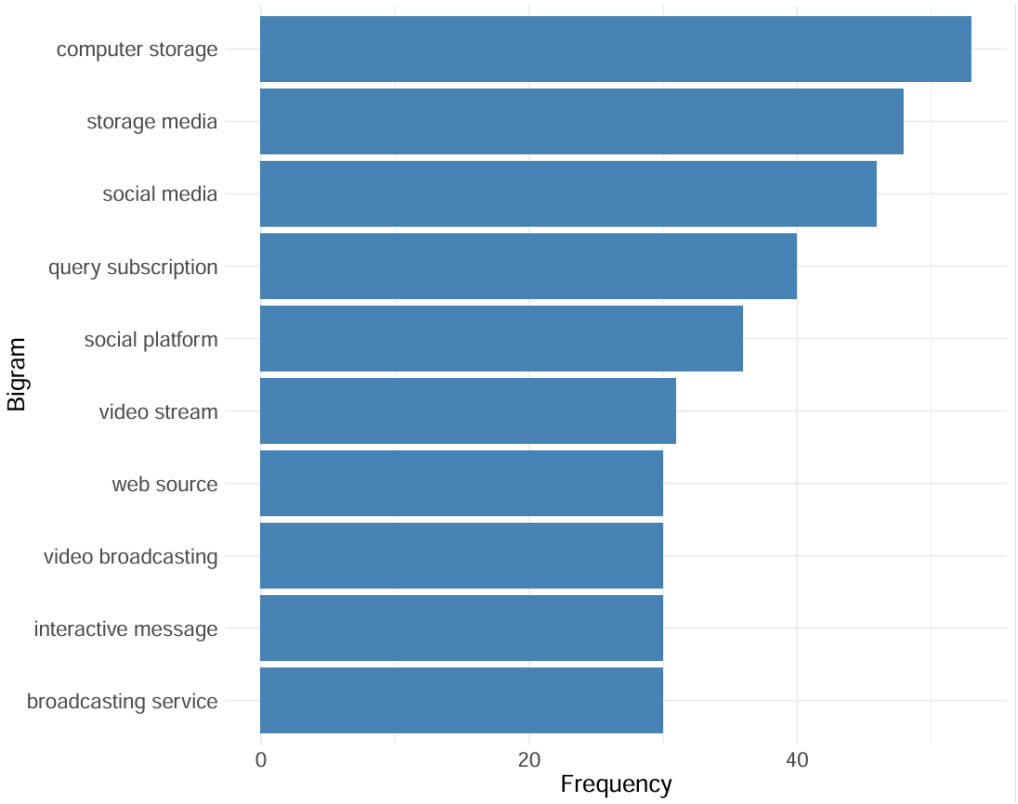
Appendix A.7 Top 10 Bigrams from Microsoft's patent applications



Appendix A.8 Top 10 Bigrams from Netflix's patent applications



Appendix A.9 Top 10 Bigrams from Tencent's patent applications



Appendix A.10 Top 10 Bigrams from Twitter's patent applications