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| Student ID Number: | 2 | | 0 | 1 | 2 | 3 | 2 | 1 | 6 | 4 |
| Student Name | Ben D’souza | | | | | | | | | |
| Module Code: | LUBS3303 | | | | | | | | | |
| Programme of Study: | Economics (Industrial) BSc | | | | | | | | | |
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| Title: | Big Tech’s Dominance: An Empirical Investigation Into the Role of Personal Data Accumulation on Big Tech’s High Market Shares in the Digital Economy. | | | | | | | | | |
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Big Tech’s Dominance: An Empirical Investigation Into the Role of Personal Data Accumulation on Big Tech’s High Market Shares in the Digital Economy.

Ben D’souza

The digital economy has become highly concentrated so that instead of numerous firms competing within markets, a few Big Tech firms compete to control entire markets. The purpose of this dissertation is to explore the factors that have led to this dominance, with a particular emphasis on the role of personal data accumulation. We review the existing literature to establish the features that have facilitated the growing market shares of Big Tech companies. This includes a discussion of economies of scale and scope, network effects and default coverage. This paper seeks to advance the existing literature by assembling new data with which we can test these features. Using this data we investigate the relationship between personal data collection and the market share of Big Tech companies across the digital economy.

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1. **Introduction**

Internet usage has increased considerably over the past decade (Statista, 2022a). Alongside this, advances in computation power and data storage have facilitated the accumulation of growing hoards of personal data by a select few technology firms (Brynjolfsson and McAfee, 2012). These companies, whom we label ‘Big Tech’, have generated high market shares across numerous markets within the digital economy and achieved global success. For instance, Alphabet have a rich bank of personal data, market capitalisation of $1.6 trillion and dominant market shares in several digital markets (Ycharts, 2022). An emerging area of the academic literature aims to understand the features that have led to the growing market power of Big Tech within select digital markets, although no consensus has been established on their overall effect on the digital economy. The first objective of this paper is therefore to take a broader approach to understand how Big Tech firms have grown to dominate the digital economy. The second objective of the paper is targeted more specifically at personal data to understand to what extent personal data accumulation has facilitated Big Tech’s success.

To answer these two questions this paper applies ordinary least squares (OLS) estimation to a cross-sectional dataset. This method allows us to establish both the joint effects of the relevant features of the digital economy on Big Tech’s market shares, as well as the role of personal data more specifically. In order to apply OLS it is necessary to collect data with which to model each variable. We collect our own data to model the degree of personal data collection in terms of the heterogeneity of the data collected. Privacy policies as published by Big Tech firms are important not only to source this data but also in providing an insight into Big Tech’s perspective on personal data.

The remainder of the dissertation is structured as follows. First, we provide background into Big Tech, the digital economy and our incentives for studying them. This is followed by a literature review which is split into two sections. The first section assesses the literature on personal data and its use by Big Tech. The second section seeks to contextualise our understanding of personal data use in the digital economy by establishing the other features which have contributed to Big Tech’s dominance. In this section we introduce variables such as network effects, economies of scale (EOS) and scope, and default coverage. Next follows our methodology section, which explains our empirical approach and describes the methods used to overcome data availability issues. Finally, our results section includes an interpretation of the OLS coefficients. From this we show that EOS, personal data collection and default coverage contribute positively to higher market shares, although EOS exhibit a non-linear trend. We end with an evaluation of the paper’s limitations and suggestions for further improvement.

* 1. Motivation

Since 2012, average daily internet use has increased from 83 minutes to 192 minutes (Statista, 2022a), whilst the number of internet users has increased from 34% of the global population to 63% in 2021 (ITU, 2022). Alongside improvements in computation power and data storage, this has facilitated increased personal data collection (Durand and Milberg, 2020). The European Union’s General Data Protection Regulation (GDPR) is widely used by the companies in this study and defines personal data as any information relating to an identifiable, natural person (European Commission, 2022). New digital industries have emerged which incorporate personal data into their business model.

The digital economy encompasses economic activity that is dependent on or enhanced by the use of digital inputs (OECD, 2022). Markets within the digital economy are digital markets. Haucap and Heimeshoff (2014) show that digital markets such as online search and social media are highly concentrated. These main beneficiaries are a group of companies collectively labelled ‘Big Tech’, which consists of Alphabet, Apple, Amazon, Meta and Microsoft. Despite varying business models, the common ground between these companies is that they have established dominant positions across a range of digital markets (Moore and Tambini, 2021). This paper focuses on Alphabet as a case study for Big Tech, making only limited reference to the other members.

Big Tech have established their dominance in not just a single digital market, but across many linked services (Petite and Teece, 2021). Figure 1 indicates the vast extent of consumer facing product markets in which Alphabet compete. Importantly, Alphabet have a dominant market share in many of the markets in which they compete, as is shown in Table 1. Moreover, in those markets in which Alphabet’s market share is large, but not dominant, the largest firm is another member of Big Tech.

**Figure 1:** Alphabet Products

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| **Table 1 – Global Market Shares in 2021** | | | |
| **Market** | **Alphabet Product** | **Market Share** | **Dominant Firm** |
| Search Engines | Google Search | 92.00% | Alphabet |
| Mobile OS | Android | 71.60% | Alphabet |
| Digital Mapping | Google Maps | 70.00% | Alphabet |
| Browsers | Google Chrome | 62.78% | Alphabet |
| Digital Advertising | Google AdSense | 44.30% | Alphabet |
| Email | Gmail | 36.50% | Apple |
| Smart Speaker | Google Home | 20.50% | Amazon |
| Cloud | Google Cloud | 10.00% | Amazon |

Source: Digiday, 2022; Statcounter, 2022a; 2022b; 2022c; Statista, 2021a; 2021b; 2022b; Verto, 2021

1. **Literature Review**

Although both personal data accumulation and Big Tech’s dominance have been a growing focus for economists, the depth and variety of academic research on these topics remains limited. This is partly because they are new phenomena, so research does not extend far beyond the last decade. Studies have emerged which repurpose traditional academic concepts and fit them within the context of the digital economy (Colangelo and Maggiolino, 2018; Evans and Schmalensee, 2010). However, whilst these papers may be grounded in strong economic theory, they often lack robust empirical support. This can be attributed to the limited availability of data with which concepts such as personal data accumulation can be measured. Nonetheless, the contributions of these studies are still substantial in that they have established theoretical groundwork which can be tested empirically by future papers. However, the lack of empirical evidence causes us to turn to reports from regulators to supplement findings in the academic literature. Although their data remains unpublished, the perspective of regulators is of particular interest due to their unique access to internal company data from Big Tech. To further supplement the academic literature we find it necessary to provide additional evidence from privacy policies. This information is useful for both evaluating and reinforcing key arguments in the literature.

2.1. Global Approach

Regional borders and other geographical barriers are largely irrelevant for digital markets, meaning that they typically become concentrated worldwide, rather than on a narrower national scale (Digital Competition Expert Panel, 2019). For this reason, I examine digital markets from the global perspective within which Big Tech operate, although there may be some nuances between countries.

2.2. Economic Advantages From Personal Data

2.2.1 Service Improvements from Personal Data

Personal data can be categorised as an intangible asset (Birch et al., 2021; Manikas et al., 2019; Nolin, 2020). That is, an identifiable non-monetary asset without material substance (International Accounting Standards Board, 2014). Itami and Roehl (1987) claim that intangible assets are often the best source of competitive advantage that firms can sustain over time because they are vital for adapting to technological change. Despite this claim, there is limited insight into how personal data is valued by those in demand of it (technology companies). To compensate for this many scholars survey the supply side (internet users) to understand how they value personal data. This is the approach taken by Spiekermann and Korunovska (2017) who survey 1269 social media users and show that people value their own data more highly because they are aware it provides value to the companies collecting their data. This finding is supported by several other studies which survey user attitudes to personal data collection (Carrascal et al., 2013; Staiano et al., 2014). This approach lacks robust evidence on how and why the companies collecting personal data value their asset, and instead relies on speculation from users. However, we can gain some insight into the firm’s perspective by investigating their privacy policies. GDPR requires that privacy policies include justifications for processing personal data. (Information Commissioner’s Office, 2018). Table 2 shows that the two most common justifications are for data analysis and to make improvements to the company’s services. All five Big Tech companies perform data analysis on users’ data, as well as 97.62% of the other services studied. This supports the consumer perspective that personal data holds value because of how it is processed by the companies who collect it.

By collecting and analysing usage data, firms can improve their services by making them more efficient, discovering bugs, and identifying trends for popular features. Applying observations from personal data analysis allows firms to make better strategic decisions (World Bank, 2021a). Colangelo and Maggiolino (2018) show that by offering a higher quality service, firms can attract more users to their platform, who in turn generate more personal data for the firm to capture and further improve their services. This process manifests itself as a positive feedback loop as depicted in Figure 2. Processing personal data thus allows firms to continually improve and adjust their services. Unable to fully benefit from this feedback loop, Pasquale (2013) argues that new entrants are thus unable to provide services of comparable quality to incumbents. However, the age of this study may be a concern, as Chiou and Tucker (2017) note that quick shifts of industry dynamics in the digital economy may cause older theory and datasets to be outdated and return obsolete results.

**Figure 2:** Personal Data Feedback Loop

Source: Produced by author

The benefits from personal data may be particularly important when performing less common tasks. For example, Google may benefit from its greater number of users (and thus personal data) when fulfilling rare search queries (CMA, 2020a). Although the CMA have access to internal data and studies from Big Tech, this does include data on less common searches and so their claim requires further inspection. Shafi and Ali (2019) provide the required supporting evidence by testing the precision of search results for physical sciences topics. They find that Google return the most accurate results. However, their results are based on a sample of just 15 queries, which represents only a tiny fraction of the millions of searches that search engines perform daily. Although other studies suffer from similarly small sample sizes, they too find that Google outperforms its competitors (Goutam and Dwivedi, 2012; Lewandowski, 2015). However, some scholars dispute that the greater precision of Google’s search results is due to its access to a larger bank of user data. Rather, Varian (2006) places an emphasis on the efficacy of Google’s search algorithm. It must be noted that Varian is Google’s chief economist, and whilst this gives him a unique insight into the operation of the search engine, it also creates an incentive to underemphasise the role of personal data accumulation. However, the superiority of Google’s algorithms has been acknowledged by its competitors in search, including Microsoft (CMA, 2020b). Yet, this view neglects the importance of data in developing and fine-tuning algorithms. Tucker (2010) outlines one such method in which platforms run different versions of an algorithm simultaneously and collect data on how users interact with the service to determine the superior algorithm. In Google’s case, search engines also access user data to determine the most popular sites and therefore those which should be updated most regularly by its indexing technologies (House of Representatives, 2020).

2.2.2 Personalisation

Winter et al. (2021) use a survey of 936 individuals to show that using personal data to customise a service for each user can increase engagement by up to 2.52%. This process is known as personalisation, to which the survey indicates a positive response. There is evidence to support this from the firm’s perspective as Table 2 shows that personalisation is implemented by Big Tech and 92.86% of the other firms studied. The main benefit to personalisation is that it can help to retain customers because more personalised content increases the cost of switching to another service (Chellappa and Sin, 2005; Rubinfield and Gal, 2017; Zarifis et al., 2021). For example, YouTube Music store each user’s payment details for monthly billing. To switch to another streaming service the user has to enter these payment details again, and loses access to their own playlists as well as the personalised ones developed by the YouTube algorithm (Morris, 2015). Furthermore, Li and Unger (2012) show that perceived quality improvements from personalisation can offset privacy concerns. As with much of the literature, their approach uses a survey from which they achieve a response rate of only 40%. However, the demographic breakdown shows that responses were relatively evenly distributed between people of different ages, gender, and years of internet experience. Furthermore, a report by Ofcom (2019) found that 70% of YouTube views are driven by recommendations, which suggests that consumers rely heavily on recommended content.

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| **Table 2 – Reasons for Personal Data Processing** | | | | | | |
| **Justification** | **Meta** | **Amazon** | **Apple** | **Alphabet** | **Microsoft** | **Percentage of Other Companies** |
| Legal obligations | Yes | Yes | Yes | Yes | Yes | 90.48 |
| Consumer’s interest | Yes | Yes | Yes | Yes | Yes | 61.9 |
| Innovation | Yes | No | No | Yes | Yes | 21.43 |
| Improvements | Yes | Yes | Yes | Yes | Yes | 97.62 |
| Personalisation | Yes | Yes | Yes | Yes | Yes | 92.86 |
| Profitability | Yes | No | No | No | No | 0 |
| Communicate with user | Yes | Yes | Yes | Yes | Yes | 90.48 |
| Fulfil transactions | Yes | Yes | Yes | Yes | Yes | 85.71 |
| Data analysis | Yes | Yes | Yes | Yes | Yes | 97.62 |

Source: Company Privacy Policies

However, Edlin and Harris (2013) find that switching costs to consumers in digital platforms are largely mitigated by the possibility for multi-homing. That is, the ability to have accounts on multiple platforms simultaneously. Additionally, several members of Big Tech including Google and Facebook claim to have compensated for their advantage by creating a ‘Download Your Information’ tool for users to transfer their data to competitors (Bowles, 2020). However, this may meet reluctance from consumers because of the time and effort required to transfer their data. Alongside increased convenience and switching costs, Manorot (2019) finds a positive relationship between personalisation and consumer trust. One reason for this may be that consumers perceive higher quality when experiencing more relevant content. The consequent increased customer retention may be particularly important for online platforms because acquiring a new customer costs on average ten times as much as retaining one (Karimi et al., 2001). Personalisation also attracts advertisers because it allows them to market their goods to the users who are most likely to purchase them (CCIA, 2019). This is supported by a Google study which showed that advertisers’ revenue fell by up to 65% when they were unable to personalise their campaign (CMA, 2019). Although Google may have some incentive to distort the results of their study, their findings are supported by similar results in the literature (Aguirre et al., 015; CMA, 2020b; Kim and Han, 2014). Adomavicius and Tuzhilin (2005) found that personalisation is more effective in the digital economy than in an offline setting because of the ease of accumulating personal data.

2.2.3 Personal Data Volume and Heterogeneity

Despite a general reluctance to publicly admit the value of personal data, on occasion Big Tech have confessed to its importance. For example, Microsoft stated their lack of access to user’s location data as a barrier to the success of their search engine, Bing (CMA, 2020b). Microsoft explain that they are unable to match Google’s level of personalisation without access to a comparable volume of location data in order to provide localised search results. More generally, Esteve (2017) suggests that the common goal for companies collecting personal data is to generate a profit. This is supported by Facebook’s (2022a) privacy policy where they claim that processing personal data is necessary to run a profitable service. Despite this assertion, Table 2 shows that Facebook are the only company studied who claim that their profits are contingent on personal data collection. Nonetheless it is still a significant admission considering it comes from the sixth highest valued company in the world in 2021 with a market cap of $870 billion (Statista, 2021c).

Bleier et al. (2020) posit that personal data becomes more valuable as more of it is produced. The first reason for this is that greater volumes of personal data can allow firms to develop more refined insights. This hypothesis is supported by several studies on personal data volume and algorithm performance (Kumar, 2019; Tucker, 2010). However, there is a split in the literature as Chiou and Tucker (2017) show that increasing volumes of historical personal data do not improve the performance of search engines. This distinction may suggest that accumulating large volumes of personal data is only effective if that data is recent. The second reason given by Bleier et al. (2020) is that personal data becomes more valuable when a greater variety of data is collected because combining multifarious data points allows firms to develop new insights into consumer behaviour. Although this claim lacks empirical support, it is worth some consideration because it offers a new method of measuring personal data collection based on heterogeneity. Rubinfield and Gal (2017) also find that the value of data is linked to the heterogeneity of data collected. The Federal Supreme Court acknowledged this in 2020 when they ruled that Meta must stop merging user data across its platforms (World Bank. 2021b). Admittedly their decision was based on a privacy perspective, however if combining data across Meta’s services offers such detailed insights into consumers that they infringe on their privacy, it follows that these insights are beyond the capabilities of a single platform. As such, the economic benefits from personal data are expected to be amplified by greater heterogeneity.

2.3 Digital Economy Overview

2.3.1 Economies of Scope

The digital economy has become highly concentrated so that instead of numerous firms competing within markets, a few Big Tech firms compete to control entire markets (House of Representatives, 2020). Ciurak (2018) argues that SE are a significant contributing factor to this. SE exist when the sum of costs from producing numerous outputs individually exceeds the cost of producing these same products jointly (Curtis and Sarmiento, 2002). Although Ciurak (2018) makes his assertion on purely theoretical grounds, Figure 3 offers evidence to support his claim. The most frequently investigated practice in abuse of dominance cases in the digital economy is preferential treatment (World Bank, 2021b). This refers to using one platform or service to unfairly promote another. For example, in the case of Matrimony.com Limited v Google (2012) CN0730, Google were found to display their own products first in search results. This is significant because the average clickthrough rate of the first search result is 34.35%, whilst for the second search result it is only 16.96% (European Commission v Google, 2017 AT.39740).

SE also exist when Big Tech firms combine multiple personal data sources from numerous digital markets to generate unique insights into consumer behaviour (Stucke and Grunes, 2015; Kumar, 2019). For example, Alphabet can combine in-depth consumer interests data from Google Search with information from its DoubleClick advertising service on the sites users access after leaving Google. From this they can generate insights not available to companies operating in just one of these markets (Harbour, 2007; Stucke and Grunes, 2015). In this way SE skew the benefits from personal data in favour of larger companies.

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Source: World Bank, 2021b

2.3.2 Network Effects

Network effects can be divided into two categories. Direct network effects (DNE) exist when the value of a service increases as the number of users increases (Katz and Shapiro, 1985). Haucap and Heimeshoff (2014) show that these effects are particularly prominent for communication services and social medias, such as Google Meet, where the number of people one can communicate with increases as the number of users increases. In contrast, indirect network effects (INE) exist when a greater number of users on one side of a platform attracts more users to the other side (Haucap and Heimeshoff, 2014). For example, a greater number of users makes Google Search more attractive to advertisers who have more prospective customers to whom they can market their product (CMA, 2020b). However, Lerner (2014) finds that the advantages of INE are only transitory because of the weak user demand for advertisers. This finding is supported by Manne and Wright (2011) who criticise the weak theoretical approach and lack of empirical evidence taken by those who advocate for INE.

DNE may create a positive feedback loop; as the number of users grows, the platform becomes more attractive to non-users because service quality is directly impacted by the size of the user base (Digital Competition Expert Panel, 2019). For Evans and Schmalensee (2010), the result is that online platforms need to reach a critical mass of users to establish themselves in the market. Without the required number of users, the substitutability of the entrant relative to the dominant platform will be low because this limits the ability of users to find their contacts (Colangelo and Maggiolino, 2018). However, Katz and Shapiro (1994) note that unique product attributes can attract consumers to a platform regardless of the network size. Furthermore, Haucap and Heimeshoff (2014) claim that, for platforms such as Google, DNE are weak because consumers do not care how many other users there are. Certainly, the prevalence of each feature may vary across the digital economy, with DNE being weaker in search than in social media.

Regardless of their strength, Stallkamp and Schotter (2018) show that DNE operate across borders, meaning that firms with a large global userbase can expand to new countries with relative ease. This was a key factor in informing the decision to take a global perspective in this paper. Admittedly, DNE may be stronger within groups of countries who speak the same language (Stallkamp and Schotter, 2018). This is because users may be outside of each other’s network if their language is a barrier to communication. However distinctions between countries are outside of the scope of this paper.

2.3.3 Default Coverage

In the context of digital markets, default positions refer to pre-installed software on new devices. It is an area already recognised by behavioural economists in pension savings, the medical sphere and health insurance (CMA, 2020b; Suri et al., 2013; Boonen et al., 2010; Czech, 2016). Zafiris et al. (2021) show that even when it takes little effort to change from the default, consumers often display inertia in switching to a new platform, and this effect may be stronger in digital markets where the service is free. This is supported by an Ofcom (2019) report which found that the ten most used apps were dominated by apps which come pre-installed on iOS and Android. Furthermore, Ofcom (2019) show that YouTube is used more on Android devices where it is pre-installed, than on iOS devices where it is not. The Ofcom report corrects for demographic differences between iOS and Android users globally by considering only UK smartphone holders, which is a more homogenous group. The value of default coverage was demonstrated by Alphabet’s $1.2 billion payment to Apple to make Google the default search engine on UK iPhones (Digital Competition Expert Panel, 2019). This is equivalent to over 17% of Google’s annual search revenue in the UK.

Despite the funds invested by Google to secure default positions, the returns from investment may vary. For example, in 2019 Google owned default positions in 94% of mobile search and 29% of desktop search, with market shares of 97% and 84% respectively (CMA, 2020b). In contrast, Bing owned default positions in 68% of desktop search and less than 1% of mobile search, resulting in market shares of 13% and 2% respectively. Clearly, despite greater default coverage in desktop search, Bing’s market share remains only a fraction of Google’s. One reason that Google’s default positions may appear more effective than Bing’s is because the smaller screen on mobile devices makes changing default settings more difficult (Digital Competition Expert Panel, 2019).

2.3.4 Economies of Scale

The CMA (2020a) notes that EOS for a rising number of users manifest in two ways in the digital economy. The first of which is through increased data accumulation facilitating more powerful algorithms. The second method is through the falling marginal cost of providing digital services to additional users, as is shown in Figure 4 (Morris, 2008). EOS in this instance occur because online platforms tend to have low marginal costs but high fixed costs. In addition, digital services tend to have limited distribution costs because information services can be delivered to any location for minimal additional cost (Stigler Center, 2019). Fixed costs typically include servers (House of Representatives, 2020), but once these are running, the cost of expanding to an additional user is minimal. Evans and Schmalensee (2010) find that digital firms may therefore initially require a large capital injection to compete with incumbents. An example of this is found in the search engine market. Developing a web index to return search results was cited by DuckDuckGo as an expense that smaller search engines cannot afford (European Commission v Google, 2017 AT.39740). Indeed, even larger search engines like Yahoo have stopped indexing. As such, only Bing and Google still perform their own web indexing, which they sell to the smaller search engines for them to run their own services. As such, even when Yahoo, DuckDuckGo, or any other search engine is used, Microsoft and Alphabet collect and analyse the data.

The CMA (2020a) also argue that algorithms become more precise when fed with additional user data. A Microsoft commissioned paper by He et al. (2017) supports this, showing that increasing volumes of user data can improve the accuracy of search results by up to 4%. Whilst this must be regarded with caution due to the possible incentives for Microsoft to distort the results, equally their findings cannot be ignored due to their unique access to vast amounts of data. Indeed, the study uses six months of queries for two major search engines to show that there are significant returns to increasing data accumulation. The results further show that these returns may diminish for higher volumes of data (He et al, 2017). The evidence supports the CMA’s (2020a) proposition that EOS exist in the digital economy for a rising number of users through falling costs and rising accuracy.

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Source: Drawn by author

1. **Methodology**

The remaining analysis focuses on Alphabet and their competitors within six digital markets. These are: search engines, browsers, social media, digital mapping, email clients and music streaming. Including multiple markets captures the effects of each variable on the digital economy, rather than on just one digital market in which some effects may be stronger and thus would be overemphasised in our results (Haucap and Heimeshoff, 2014). These specific markets were chosen because they are the ones most often referenced in the literature, and because low data availability made including other markets infeasible.

All five Big Tech companies dominate multiple digital markets and rely on personal data as a necessary input. Nuances between the companies exist but are largely irrelevant to our research question. Indeed, despite considerable differences between Amazon’s e-commerce business, Alphabet’s internet search services and Meta’s social networking sites, the companies are grouped together in the literature because of their shared focus on personal data and their dominant positions in the digital economy (Birch et al., 2021; Moore and Tambini, 2021). The main differences between Big Tech are with regards to the markets within which they operate, and this is already accounted for by the inclusion of multiple digital markets. Indeed, including Alphabet’s competitors means that all of Big Tech are accounted for in our results because they all compete with Alphabet in at least one market. More broadly, Yin (2003) argues that case studies are appropriate for studying contemporary topics, for which the digital economy qualifies.

* 1. Data

The privacy policies listed on each company’s website were a vital data source. GDPR requires that companies inform users of the types of data that they collect (Information Commissioner’s Office, 2018). Using this I created an index of personal data categories to record the data each company collects. Privacy policies are expected to be reliable because firms are liable to fines of up to 4% of their total global turnover if they breach users’ right to be informed (Information Commissioner’s Office, 2018). Nonetheless each privacy policy was cross-checked to add further robustness to the data. The sources used for this were also made available by GDPR. That is, the right to download the data a company has collected about you (Information Commissioner’s Office, 2018). This data has been excluded from the paper for privacy reasons, however, the data that each platform held about me was found to be largely consistent with the reporting in their privacy policies. Some inconsistencies existed only where an application had not collected a data point that they typically do according to their privacy policy. This is easily explained, as platforms can only collect data they are given access to. For example, I have not purchased the premium services offered by YouTube, so they have not collected my payment information. In these instances the privacy policy was chosen as the preferred source of information. The final data was a count of the number of categories of data that each company collects. One potential limitation of this is that it attributes equal value to all forms of personal data. Further detail on the categories of personal data considered can be found in appendix B.

The second dataset I collected and compiled was to assess SE. I read through company investor reports and recorded whether they offered a product within each digital market. One difficulty with this is that the distinction between digital markets is often blurred (Porter and Heppelmann, 2014). For example, YouTube is not typically considered a social media, yet Facebook consider YouTube a competitor because a reduction in the time spent on one service is correlated with an increase in the time spent on the other (Bowles, 2020). The distinction between some digital markets may therefore be unclear. Nonetheless, the wide range of markets mitigates the impact of a particular service being deemed as part of one digital market where it could be included in another. Furthermore, the final data type was a count of the number of digital markets that each company operated in, so services were accounted for equally regardless of the market they compete in. For greater detail, the list of digital markets considered is shown in appendix D.

To account for default coverage I created a dichotomous dataset. I recorded 1 if a firm had default positions for 10% or more of the market, and 0 if they did not. The basis for placing search engines and browsers within one of these categories was a report by the CMA (2020c). For other services I used the market share of Android (Alphabet) and iOS (Apple) to categorise them (Statcounter, 2022a). This was viable because iOS and Android market shares are so dominant that services which come pre-installed on either OS surpass the 10% threshold. Similarly, Windows’ dominance as a desktop OS meant that pre-installed Microsoft services such as Edge also qualified as default services (Statcounter, 2022d; Statista, 2022c).

The remaining two independent variables, DNE and EOS, were measured using downloads and app ratings respectively. Downloads for the last month were taken from SensorTower (2022a; 2022b), with the exception of default Apple apps. These apps are automatically downloaded on all iPhones but are not available to download on other devices. As such, the number of downloads is equivalent to the number of iPhones purchased each month according to Apple’s (2021) annual report. EOS in digital markets occur for a rising number of users. The initial plan was therefore to model EOS using monthly active user (MAU) data. However, not all companies publish their MAU which led to data availability issues. Another proxy which can be used to measure the number of users is the number of app ratings (Bondaronek et al., 2019; Liu et al., 2015). The appropriateness of this measure was strengthened by its Pearson correlation coefficient of 0.86 with the available MAU data. The app ratings were compiled for each app from Apple’s App Store and Google’s Play Store, which constitute the main method of accessing each digital service (Roma and Ragaglia, 2016). Again, the number of citations required to include the ratings for each app is impractical, but these sources can be identified in the list of references.

Finally, the data for our dependent variable, market share, was sourced from Statcounter (2022b; 2022c; 2022e) for three digital markets: search engines, browsers and social media. Market share data for email, music streaming and digital mapping was sourced from Statista (2021a), Midia (2021) and Verto (2021) respectively. These sources were chosen for their robust methodology. For example, Statcounter’s tracking code is installed in over 2 million websites across a range of geographies (Statcounter, 2022f). The data is also adjusted to remove bot activity and therefore offers an accurate representation of global market share. Each source’s robust methodology makes them sufficiently interchangeable, however it is worth noting that the most appropriate measure of market share differs for distinct digital markets. For example, data on paid subscribers more accurately reflects market share for music streaming services whilst search engine data can be computed from the number of page referrals. This difference in methodology is not expected to have a notable impact on results.

* 1. Empirical Specification

A cross-sectional model was chosen for this study because cross-sectional studies allow for investigation of data at a specific point in time (Wooldridge, 2013). This fits the design of our dataset, whereas data availability issues for previous periods would make implementing a panel model difficult. As the dominance of Big Tech in the digital economy is a relatively new phenomenon and is yet to be studied extensively (Moore and Tambini, 2021), a cross-sectional model is a good entry point for the formation of new hypotheses which can be built on by further research (Wang and Cheng, 2020). In particular, we estimate the following equation using OLS:

[1]

This allows us to investigate both the joint impact of the explanatory variables on market share, as well as the role of personal data more specifically (Wooldridge, 2013). The personal data index was used to create three binary categories: pd1, pd2 and pd3. These signified companies who collected between 5 and 12 data points, 13 and 15 data points and greater than 15 data points respectively. Applying this method allowed the number of observations to be divided evenly between the categories. The expectation is that pd3, signifying firms who collect the most data, would have a positive coefficient. A similar approach was taken for SE, which were divided into 4 categories with an even distribution of observations. As such, scope4, categorising the firms who operate in the most digital markets is also expected to have a positive coefficient. The same is true for default2 – the products with default coverage. DNE, as measured by downloads, should again have a positive coefficient. The decision was taken to transform downloads by taking the natural log. One advantage of this is that it can help to correct for skewed data where outliers may be present (Wooldridge, 2013). Our dependent variable market accounts for the market share of each company in their respective market. The error term captures all other influences on the dependent variable which are not accounted for by the explanatory variables (Wooldridge, 2013).

The justification for the use of the rating variable and its square is illustrated in Figure 5 which suggests a non-linear relationship between market and ratings. The literature indicates that economies of scale help to grow market share and thus the coefficient for ratings is expected to be positive, although there may be diminishing returns to scale. However, the non-linear trend in ratings suggest that the square of ratings may return a negative coefficient.

**Figure 5:** Scatterplot of Ratings and Market Share

Chart, line chart, scatter chart

Description automatically generated

Source: Author's own computation

The normality of the data is an important condition for further statistical analysis. The central limit theorem dictates that sample data is approximately normal when the sample size is large (Navidi, 2021). Although only a rule of thumb, a sample size greater than 30 would constitute a sufficiently large sample size in this case (Navidi, 2021). As our dataset contains only 37 observations this condition is narrowly met and thus further confirmation is preferrable. The graphical interpretation shown in Figure 6, which plots a standard normal probability against the distribution of our error terms, suggest a roughly normal distribution (University of Utah, 2022). Nonetheless a more robust check is desirable. This is available in the form of the Shapiro Wilk test, which sets the null hypothesis that the data follows a normal distribution and is suitable for our sample size (Yazici and Yolocan, 2021). The p-value of 0.087 generated by the test is greater than our critical value of 0.05, meaning that we fail to reject the null hypothesis at the 5% level and our data can be treated as normal.

**Figure 6:** Distribution of Errors

Chart, scatter chart

Description automatically generated

Source: Author's own computation

1. **Results**
   1. Interpreting the results

Applying the methodology as explained above returned the regression results shown in Table 3 when computed in Stata. For personal data we observe a positive coefficient of 17.966 for pd3. Essentially, companies who collect the most data (more than 15 data points) are expected to have a 17.966% higher market share than companies who collect less data but otherwise operate the same. This finding is significant at the 10% level and is consistent with the literature; companies who collect more personal data can generate a competitive advantage and increase their market share. The coefficient for EOS, as measured by ratings, somewhat aligns with the theory discussed in section 2.3.4 and is significant at the 1% level. One additional rating is expected to initially increase market share by 0.00000131%. The small magnitude of this coefficient may be explained by the large mean of 17100000 ratings. This means that one additional rating is only a tiny percentage increase and would thus be expected to have a modest impact. Interpreted together, the positive coefficient for ratings and the -9.43e-15 coefficient for the square of ratings suggest a concave relationship between ratings and market share as shown in Figure 5. Each additional rating reduces the slope of ratings by -9.43e-15. This partially supports the analysis of He et al. (2017) as they find evidence of diminishing returns to scale, but not decreasing returns to scale. Our results suggest that diminishing returns to scale extend beyond just the search engine market studied by He et al. (2017) to the rest of the digital economy. Decreasing returns to scale were not anticipated by the literature, although their prevalence in brick-and-mortar markets (McAfee and McMillan, 1990) suggests that it is feasible they are present in some form in the digital economy. As before, there are unfortunately no comparable econometric studies for us to compare with the coefficients.

|  |  |
| --- | --- |
| Table 3 - Results | |
| Dependent Variable: Market Share | |
| Explanatory Variables | Coefficients (1) |
| PD2 |  |
| PD3 |  |
| Scope2 |  |
| Scope3 |  |
| Scope4 |  |
| ln(downloads) |  |
| Ratings | \*\*\* |
| Ratings2 | \*\*\* |
| Default | \*\*\* |
| \* indicates statistical significance at the 10% level (p<0.1)  \*\*\* indicates statistical significance at the 1% level (p<0.01) | |

Source: Author's own computation

|  |  |
| --- | --- |
| Table 4 - Overall Model Fit | |
| Prob > F | 0.0001 |
| R-squared | 0.6832 |
| Adjusted R-squared | 0.5776 |
| Number of observations | 37 |

Source: Author's own computation

The results for default coverage are consistent with the literature and are significant at the 1% level. The coefficient of 25.79 indicates that firms who have at least 10% default coverage are expected to have a 25.79% higher market share than a firm that does not, ceteris paribus. Furthermore, this coefficient is significant at the 1% level. However, SE do not behave as expected in that the coefficient is both negative and statistically insignificant. The cause of this result is likely the high correlation coefficient of 0.72 between our scope and default variables, which raises the issue of imperfect multicollinearity. Although imperfect multicollinearity does not violate any OLS assumptions, it does mean that the coefficient on one or both correlated variables will have an imprecise estimate. The theoretical reason behind the high correlation is straightforward. Companies with a larger scope generally included companies who sold their own hardware. Capturing a significant proportion of the market share for smartphones allows companies such as Apple and Google to hold default coverage for products such as Apple Maps and Gmail which come pre-installed on all iOS and Android devices respectively (House of Representatives, 2020).

Finally, DNE, as measured by app downloads return an insignificant result. As highlighted in section 2.2, there is no consensus within the literature on the significance of DNE on the overall digital economy. Our results support the claims of Haucap and Heimeshoff (2014), who dismiss the importance of network effects on the digital economy but stress their greater relevance within select digital markets. The strength of network effects in social media may thus be dampened by their triviality to other digital markets.

Despite a lack of empirical work for us to draw comparison to, the overall measures of the model suggest that our results do explain Big Tech’s dominance. The value suggests that 68.32% of the variance in the dependent variable can be explained by our model. However, systematically overestimates the amount of variance explained by the model (Karch, 2020). Instead, we can use the adjusted , for which a value of 0.5776 indicates that 57.76% of the variation in market share can be explained by our explanatory variables. The F-statistic also pertains to the overall model fit, whilst its associated p-value of 0.0001 tells us that we can reject the null hypothesis that all of the coefficients are equal to zero (Kremelberg, 2011).

* 1. Summary of Findings

This paper sought to answer two questions: (1) how have Big Tech firms achieved high market shares in the digital economy? And (2) to what extent has personal data facilitated this? The results have been somewhat effective in answering question (1). The adjusted R-squared value of 0.5776 showed that 57.76% of the variation in market share could be explained jointly by our explanatory variables. More specifically, we showed the contributions of EOS, personal data collection and default coverage for growing market share in the digital economy. Whilst the coefficients for these three variables mostly aligned with the relevant theory, this was not the case for the remaining two variables. That being said, there are explanations for the divergence of both coefficients from the expectations of the literature. The unusual result for SE can be explained by the imperfect multicollinearity between SE and default coverage. For network effects, most of the literature focuses on social networks. Our broader focus on the digital economy may therefore suggest that these effects are less prevalent outside of select digital markets. As for question (2), the positive coefficient on PD3 indicates that firms who collect a greater variety of personal data have generally higher market shares.

4.3 Limitations

As mentioned in section 3.1, we account for personal data collection by attributing an equal weight to all types of personal information collected. The effect of one company collecting a user’s name is therefore equal to another company collecting their biometric information. However, it is likely that some forms of personal data are more valuable. Unfortunately, which categories of personal data this may entail is not clear. Initial consideration may suggest that data which is more scarce, or collected by fewer companies is more valuable. However, the user’s name is collected by all the companies studied and yet it retains its value over time because their name is unlikely to change. In contrast, user interests are collected by fewer companies but are liable to change overtime and may therefore ‘expire’ after a given point. To add further complexity, the value of personal data is largely dependent on the insights that can be generated from it (Nuccio and Guerzoni, 2018; Tucker, 2010) and so even a single category of personal data may differ in value for different companies and markets. As such, further research is required to construct a framework of the value scale of personal data.

Furthermore, it is difficult to establish a causal relationship using OLS because the explanatory variables and the dependent variable are observed within the same period (Wang and Cheng, 2020). Indeed, as shown by Figure 2, the role of personal data collection is expected to be self-perpetuating.

1. **Conclusion**

The objectives of this paper were bifurcate. The first was to understand how Big Tech firms have generated such high market shares in the digital economy. The second was to discern the role of personal data in achieving high market shares. The first step in answering these questions was a literature review to establish the key features behind Big Tech’s success. From this we established five key features of the digital economy, although limited empirical evidence mandated a heavy reliance on theoretical concepts. Our analysis focused on Alphabet’s operations within the digital economy to achieve our first objective. Studying Alphabet and their competitors across six digital markets allowed us to draw conclusions which could be applied to the digital economy more broadly. This approach differs from most of the literature which focuses its analysis on just one digital market.

To achieve our objectives we applied OLS estimation as described in the methodology section. This required us to collect data from several online sources. The most notable data sources were privacy policies, from which we created an index of the categories of data that each company collects. Using the index, we took a novel approach to fulfilling our second objective by modelling personal data accumulation based on the heterogeneity of data points collected. Applying the approach outlined in the methodology section we showed that firms who collect a greater variety of personal data categories are expected to have higher market shares within the digital economy. The results for our other variables produced mixed evidence, with EOS and default coverage being the only other variables to contribute positively to market share. However, decreasing returns to scale for an increasing number of users was not anticipated by the literature. Nor was the insignificance of SE and DNE as implied by our results. Whilst both results are at odds with the conclusions drawn from the literature, they may be explained by the details of our methodology. Imperfect multicollinearity between SE and default coverage meant that the coefficients on both variables may be imprecisely estimated. DNE are studied most often for social networks; the inclusion of multiple digital markets may therefore reduce their influence. We might therefore hypothesise that network effects are less prevalent for the rest of the digital economy, although analysis of network effects specifically within less studied digital markets is necessary to confirm this. Our empirical findings were subject to limitations which were mostly influenced by data availability issues. The use of cross-sectional data, for example, limits the strength of any conclusions we can draw from our results. However, we were able to overcome some of the issues of data unavailability, not least by collecting our own data and taking a new approach by modelling personal data in terms of its heterogeneity.

1. **Appendices**

Appendix A: Full Dataset

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Table 5 – Final Data Used for Computation** | | | | | | |
| **Service** | **Market Share** | **Downloads** | **Ratings** | **Count of Personal Data Categories Collected** | **Count of Digital Markets Operated In** | **Default Coverage** |
| Google Search | 92 | 6200000 | 23252488 | 16 | 24 | 1 |
| Bing | 2.97 | 140000 | 230250 | 15 | 18 | 1 |
| Yahoo | 1.51 | 40000 | 44060 | 11 | 4 | 0 |
| Baidu | 1.18 | 2000000 | 23943 | 13 | 12 | 0 |
| Yandex | 1.06 | 1300000 | 1479151 | 11 | 12 | 0 |
| Google Chrome | 62.78 | 7600000 | 37793643 | 16 | 24 | 1 |
| Safari | 19.3 | 17100000 | 351 | 12 | 19 | 1 |
| Firefox | 4.21 | 2700000 | 4438136 | 5 | 5 | 0 |
| Edge | 4.06 | 1900000 | 468593 | 15 | 18 | 1 |
| Samsung Internet | 2.77 | 400000 | 4911550 | 6 | 16 | 0 |
| Opera | 2.26 | 6500000 | 4068247 | 8 | 7 | 0 |
| UC Web | 0.86 | 3000000 | 22127424 | 8 | 8 | 0 |
| Gmail | 36.5 | 8600000 | 11202561 | 15 | 24 | 1 |
| Apple Devices Client | 34.1 | 17100000 | 5300 | 13 | 24 | 1 |
| Apple Mail | 16.6 | 17100000 | 564 | 12 | 19 | 1 |
| Outlook | 7 | 5000000 | 8445537 | 15 | 18 | 0 |
| Yahoo Mail | 2.7 | 1600000 | 6354027 | 11 | 4 | 0 |
| Samsung Mail | 0.6 | 30000 | 2104709 | 14 | 16 | 0 |
| YouTube Music | 8 | 6000000 | 3714032 | 15 | 24 | 1 |
| Apple Music | 15 | 17100000 | 481596 | 13 | 19 | 1 |
| Spotify | 31 | 28000000 | 29597957 | 13 | 1 | 0 |
| Amazon Music | 13 | 9000000 | 2741388 | 13 | 15 | 0 |
| Tencent Music | 13 | 1005000 | 57637 | 9 | 13 | 0 |
| Deezer | 2 | 1400000 | 2873089 | 12 | 5 | 0 |
| Yandex Music | 2 | 900000 | 905483 | 11 | 12 | 0 |
| YouTube | 6.35 | 18000000 | 139646597 | 15 | 24 | 1 |
| Facebook | 73.12 | 57000000 | 126550328 | 24 | 9 | 0 |
| Twitter | 7.44 | 16600000 | 20538812 | 17 | 3 | 0 |
| Pinterest | 6.16 | 14400000 | 9426138 | 12 | 1 | 0 |
| Instagram | 5.28 | 55000000 | 137058282 | 24 | 9 | 0 |
| Reddit | 0.79 | 5000000 | 2753183 | 15 | 3 | 0 |
| Tumblr | 0.28 | 600000 | 3678428 | 13 | 5 | 0 |
| Google Maps | 70 | 10400000 | 15978167 | 16 | 24 | 1 |
| Google Earth | 2 | 5000000 | 2853071 | 16 | 24 | 0 |
| Waze | 17 | 5000000 | 8627040 | 16 | 24 | 0 |
| Apple Maps | 16 | 17100000 | 787 | 13 | 19 | 1 |
| Mapquest | 1 | 110000 | 8554 | 8 | 5 | 0 |

Appendix B: Categories of Personal Data

|  |
| --- |
| **Table 6 –Personal Data Categories Considered in the Index** |
| **Category** |
| Email |
| Name |
| Age |
| Gender |
| Sexual Orientation |
| Race |
| Religion |
| Location |
| Address |
| Employment Status |
| Pet Ownership |
| Phone Number |
| Device type |
| Interests |
| Bank Account Details |
| Salary |
| Social Media Profiles |
| Health Information |
| Facial Recognition |
| Environment Recognition |
| Product Recognition |
| Contacts |
| Voice Recognition |
| Camera Roll |
| Languages |

The full index of personal data collected by each company is too large to display in this format but can be found [here](https://github.com/bendsouza2/Dissertation-Appendix-B/blob/master/personal_data_index.csv).

Appendix C – Privacy Policies

|  |  |
| --- | --- |
| **Table 7 – Privacy Policy Sources** | |
| **App/Service** | **Source** |
| Google Search | Google, 2022a |
| Bing | Microsoft, 2022a |
| Yahoo | Yahoo, 2021 |
| Baidu | Baidu, 2022a |
| Yandex | Yandex, 2022a |
| Google Chrome | Google, 2022a |
| Safari | Apple, 2022a |
| Firefox | Mozilla, 2022a |
| Edge | Microsoft, 2022a |
| Samsung Internet | Samsung Developers, 2018 |
| Opera | Opera, 2021 |
| UC Browser | Alibaba, 2020 |
| Gmail | Google, 2022a |
| Apple Devices Client | Apple, 2022a |
| Apple Mail Privacy | Apple, 2022a |
| Outlook | Microsoft, 2022a |
| Yahoo Mail | Yahoo, 2021 |
| Samsung Mail | Samsung, 2022a |
| YouTube Music | Google, 2022a |
| Apple Music | Apple, 2022b |
| Spotify | Spotify, 2021 |
| Amazon Music | Amazon, 2022a |
| Tencent Music | Tencent Music Entertainment, 2021 |
| Deezer | Deezer, 2021 |
| Yandex Music | Yandex, 2022a |
| YouTube | Google, 2022a |
| Facebook | Facebook, 2022a |
| Twitter | Twitter, 2021 |
| Pinterest | Pinterest, 2022a |
| Instagram | Instagram, 2021 |
| Reddit | Reddit, 2021 |
| Tumblr | Tumblr, 2021 |
| Google Maps | Google, 2022a |
| Google Earth | Google, 2022a |
| Waze | Waze, 2020 |
| Apple Maps | Apple, 2022c |
| MapQuest | System1, 2020 |

Appendix D: Economies of Scope

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Table 8 – Scope of Other Markets Competed in by Search Engines** | | | | | |
| **Product Market** | **Google Search** | **Bing** | **Yahoo** | **Baidu** | **Yandex** |
| Search Engines | Google | Bing | Yahoo Search | Baidu | Yandex |
| Browser | Chrome | Edge | 0 | 0 | Yandex Browser |
| Cloud Services | Google Cloud | Azure | 0 | Baidu Wangpan | Yandex Cloud |
| Headphones | 0 | Surface Headphones 2 | 0 | 0 | 0 |
| Tablet | 0 | Surface Go | 0 | 0 | 0 |
| Smartphone | Pixel | Surface Duo 2 | 0 | 0 | 0 |
| PC | Chromebook | Surface Laptop 4 | 0 | 0 | 0 |
| Smart Speaker/Voice Assistant | Google Home | Cortana | 0 | Baidu DuerOS | Alisa |
| Smart Wearables | FitBit | 0 | 0 | 0 | 0 |
| Maps | Google Maps | Bing Maps | 0 | Baidu Maps | Yandex Maps |
| Email | Gmail | Outlook | Yahoo Mail | 0 | Yandex Mail |
| App Store | Google Play | Amazon App Store | 0 | 0 | 0 |
| Social Media | YouTube | LinkedIn | 0 | Baidu Space | 0 |
| Broadband | Google Fiber | 0 | 0 | 0 | 0 |
| Cyber Security | Chronicle | 0 | 0 | Baidu Safety Center | |
| Online Advertising | AdSense | Microsoft Advertising | 0 | MediaGo | Yandex Direct |
| Smart Home Devices | Nest | 0 | 0 | 0 | 0 |
| Video Entertainment | Android TV | 0 | 0 | Baidu Movies | 0 |
| Other Apps | Google Docs | Microsoft Word | Yahoo Weather | Haokan | Yandex Navigator |
| OS | Android | Windows | 0 | 0 | 0 |
| VR/AR | Cardboard | HoloLens 2 | 0 | 0 | 0 |
| Video Meeting Software | Google Meet | Microsoft Teams | 0 | 0 | Yandex Telemost |
| Gaming | Stadia | Activision | 0 | Baidu Games | 0 |
| Payment Services | Google Pay | 0 | 0 | Baidu Wallet | 0 |
| ecommerce | Google Shopping | 0 | Yahoo Shopping | Baidu Youa | Yandex Market |
| Music Streaming | YouTube Music | 0 | 0 | 0 | Yandex Music |
| Source | Google, 2022b | Microsoft, 2022b | Yahoo, 2022 | Baidu, 2022b | Yandex, 2022b |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Table 9 – Scope of Other Markets Competed in by Browsers** | | | | | | | |
| **Product Market** | **Google Chrome** | **Safari** | **Firefox** | **Edge** | **Samsung Internet** | **Opera** | **UC Browser** |
| Search Engines | Google | 0 | 0 | Bing | 0 | 0 | 0 |
| Browser | Chrome | Safari | Firefox | Edge | Samsung Internet | Opera | UC Browser |
| Cloud Services | Google Cloud | iCloud | 0 | Azure | Samsung Cloud | 0 | Alibaba Cloud |
| Headphones | 0 | Air Pods | 0 | Surface Headphones 2 | Galaxy Buds 2 | 0 | 0 |
| Tablet | 0 | iPad | 0 | Surface Go | Galaxy Tab S8 | 0 | 0 |
| Smartphone | Pixel | iPhone | 0 | Surface Duo 2 | Galaxy S22 Ultra | 0 | 0 |
| PC | Chromebook | MacBook Air | 0 | Surface Laptop 4 | Galaxy Book2 Pro | 0 | 0 |
| Smart Speaker/Voice Assistant | Google Home | Home Pod | 0 | Cortana | Bixby | 0 | 0 |
| Smart Wearables | FitBit | Apple Watch | 0 | 0 | Galaxy Watch4 | 0 | 0 |
| Maps | Google Maps | Apple Maps | 0 | Bing Maps | 0 | 0 | 0 |
| Email | Gmail | Mail | Thunderbird | Outlook | Samsung Mail | 0 | 0 |
| App Store | Google Play | App Store | 0 | Amazon App Store | Galaxy Store | 0 | 0 |
| Social Media | YouTube | 0 | 0 | LinkedIn | Penup | Hype | 0 |
| Broadband | Google Fiber | 0 | 0 | 0 | 0 | 0 | 0 |
| Cyber Security | Chronicle | 0 | Firefox Monitor | 0 | 0 | 0 | 0 |
| Online Advertising | AdSense | Apple Search Ads | 0 | Microsoft Advertising | 0 | 0 | Alibaba |
| Smart Home Devices | Nest | 0 | 0 | 0 | SmartThings Hub |  | 0 |
| Video Entertainment | Android TV | Apple TV | 0 | 0 | 0 | Loomi | Youku |
| Other Apps | Google Docs | Find My | Mozilla VPN | Microsoft Word | Samsung Health | Apex Football | Alibaba.com |
| OS | Android | iOS | 0 | Windows | Samsung DeX | 0 | 0 |
| VR/AR | Cardboard | 0 | 0 | HoloLens 2 | 0 | 0 | 0 |
| Video Meeting Software | Google Meet | FaceTime | Hubs | Microsoft Teams | 0 | 0 | DingTalk |
| Gaming | Stadia | Apple Arcade | 0 | Activision | Game Launcher | GameMaker Studio 2 | 0 |
| Payment Services | Google Pay | Apple Pay | 0 | 0 | Samsung Pay | Dify | Alipay |
| ecommerce | Google Shopping | 0 | 0 | 0 | 0 | 0 | Taobao |
| Music Streaming | YouTube Music | Apple Music | 0 | 0 | 0 | 0 | 0 |
| Source | Google, 2022b | Apple, 2022d | Mozilla, 2022b | Microsoft, 2022b | Samsung, 2022b | Opera, 2022 | Alibaba, 2022 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Table 10 – Scope of Other Markets Competed in by Email Clients** | | | | | | |
| **Product Market** | **Gmail** | **Apple Mail** | **Apple Devices Client** | **Outlook** | **Yahoo Mail** | **Samsung Mail** |
| Search Engines | Google | 0 | 0 | Bing | Yahoo Search | 0 |
| Browser | Chrome | Safari | Safari | Edge | 0 | Samsung Internet |
| Cloud Services | Google Cloud | iCloud | iCloud | Azure | 0 | Samsung Cloud |
| Headphones | 0 | Air Pods | Air Pods | Surface Headphones | 0 | Galaxy Buds 2 |
| Tablet | 0 | iPad | iPad | Surface Go | 0 | Galaxy Tab S8 |
| Smartphone | Pixel | iPhone | iPhone | Surface Duo 2 | 0 | Galaxy S22 Ultra |
| PC | Chromebook | MacBook Air | MacBook Air | Surface Laptop 4 | 0 | Galaxy Book2 Pro |
| Smart Speaker/Voice Assistant | Google Home | Home Pod | Home Pod | Cortana | 0 | Bixby |
| Smart Wearables | FitBit | Apple Watch | Apple Watch | 0 | 0 | Galaxy Watch4 |
| Maps | Google Maps | Apple Maps | Apple Maps | Bing Maps | 0 | 0 |
| Email | Gmail | Mail | Mail | Outlook | Yahoo Mail | Samsung Mail |
| App Store | Google Play | App Store | App Store | Amazon App Store | 0 | Galaxy Store |
| Social Media | YouTube | 0 | 0 | LinkedIn | 0 | Penup |
| Broadband | Google Fiber | 0 | 0 | 0 | 0 | 0 |
| Cyber Security | Chronicle | 0 | 0 | 0 | 0 | 0 |
| Online Advertising | AdSense | Apple Search Ads | Apple Search Ads | Microsoft Advertising | 0 | 0 |
| Smart Home Devices | Nest | 0 | 0 | 0 | 0 | SmartThings Hub |
| Video Entertainment | Android TV | Apple TV | Apple TV | 0 | 0 | 0 |
| Other Apps | Google Docs | Find My | Find My | Microsoft Word | Yahoo Weather | Samsung Health |
| OS | Android | iOS | iOS | Windows | 0 | Samsung DeX |
| VR/AR | Cardboard | 0 | 0 | HoloLens 2 | 0 | 0 |
| Video Meeting Software | Google Meet | FaceTime | FaceTime | Microsoft Teams | 0 | 0 |
| Gaming | Stadia | Apple Arcade | Apple Arcade | Activision | 0 | Game Launcher |
| Payment Services | Google Pay | Apple Pay | Apple Pay | 0 | 0 | Samsung Pay |
| ecommerce | Google Shopping | 0 | 0 | 0 | Yahoo Shopping | 0 |
| Music Streaming | YouTube Music | Apple Music | Apple Music | 0 | 0 | 0 |
| Source | Google, 2022b | Apple, 2022d | Apple, 2022d | Microsoft, 2022b | Yahoo, 2022 | Samsung, 2022b |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Table 11 – Scope of Other Markets Competed in by Music Streaming Services** | | | | | | | |
| **Product Market** | **YouTube Music** | **Apple Music** | **Spotify** | **Amazon Music** | **Tencent Music** | **Deezer** | **Yandex Music** |
| Search Engines | Google | 0 | 0 | 0 | Sogou | 0 | Yandex |
| Browser | Chrome | Safari | 0 | Amazon Silk | QQ | 0 | Yandex Browser |
| Cloud Services | Google Cloud | iCloud | 0 | AWS | Tencent Cloud | 0 | Yandex Cloud |
| Headphones | 0 | Air Pods | 0 | 0 | 0 | 0 | 0 |
| Tablet | 0 | iPad | 0 | Kindle | 0 | 0 | 0 |
| Smartphone | Pixel | iPhone | 0 | 0 | 0 | 0 | 0 |
| PC | Chromebook | Macbook Air | 0 | 0 | 0 | 0 | 0 |
| Smart Speaker/Voice Assistant | Google Home | Home Pod | 0 | Amazon Echo | 0 | 0 | Alisa |
| Smart Wearables | FitBit | Apple Watch | 0 | 0 | 0 | 0 | 0 |
| Maps | Google Maps | Apple Maps | 0 | 0 | Tencent Maps | 0 | Yandex Maps |
| Email | Gmail | Mail | 0 | 0 | QQMail | 0 | Yandex Mail |
| App Store | Google Play | App Store | 0 | Amazon Appstore | Tencent Appstore | 0 | 0 |
| Social Media | YouTube | 0 | 0 | 0 | WeChat | 0 | 0 |
| Broadband | Google Fiber | 0 | 0 | 0 | 0 | Ice Group | 0 |
| Cyber Security | Chronicle | 0 | 0 | 0 | 0 | 0 |  |
| Online Advertising | AdSense | Apple Search Ads | 0 | Amazon DSP | 0 | 0 | Yandex Direct |
| Smart Home Devices | Nest | 0 | 0 | Ring | 0 | 0 | 0 |
| Video Entertainment | Android TV | Apple TV | 0 | Twitch | Tencent Video | Sport 5 | 0 |
| Other Apps | Google Docs | Find My | 0 | IMDb | Tencent News | Dazn | Yandex Navigator |
| OS | Android | iOS | 0 | Fire OS | 0 | 0 | 0 |
| VR/AR | Cardboard | 0 | 0 | 0 | 0 | 0 | 0 |
| Video Meeting Software | Google Meet | FaceTime | 0 | Amazon Chime | 0 | 0 | Yandex Telemost |
| Gaming | Stadia | Apple Arcade | 0 | Amazon Luna | Riot Games | 0 | 0 |
| Payment Services | Google Pay | Apple Pay | 0 | Amazon Pay | TenPay | 0 | 0 |
| ecommerce | Google Shopping | 0 | 0 | Amazon | JD.com | Zalando SE | Yandex Market |
| Music Streaming | YouTube Music | Apple Music | Spotify | Amazon Music | Tencent Music | Deezer | Yandex Music |
| Source | Google, 2022b | Apple, 2022d | Spotify, 2022 | Amazon, 2022b | Tencent, 2022 | Access, 2021 | Yandex, 2022b |

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| --- | --- | --- | --- | --- | --- | --- | --- |
| **Table 12 – Scope of Other Markets Competed in by Social Medias** | | | | | | | |
| **Product Market** | **YouTube** | **Facebook** | **Twitter** | **Pinterest** | **Instagram** | **Reddit** | **Tumblr** |
| Search Engines | Google | 0 | 0 | 0 | 0 | 0 | 0 |
| Browser | Chrome | 0 | 0 | 0 | 0 | 0 | 0 |
| Cloud Services | Google Cloud | 0 | 0 | 0 | 0 | 0 | Cloudup |
| Headphones | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tablet | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Smartphone | Pixel | 0 | 0 | 0 | 0 | 0 | 0 |
| PC | Chromebook | 0 | 0 | 0 | 0 | 0 | 0 |
| Smart Speaker/Voice Assistant | Google Home | 0 | 0 | 0 | 0 | 0 | 0 |
| Smart Wearables | FitBit | 0 | 0 | 0 | 0 | 0 | 0 |
| Maps | Google Maps | 0 | 0 | 0 | 0 | 0 | 0 |
| Email | Gmail | 0 | 0 | 0 | 0 | 0 | 0 |
| App Store | Google Play | 0 | 0 | 0 | 0 | 0 | 0 |
| Social Media | YouTube | Facebook | Twitter | Pinterest | Facebook | 0 | Tumblr |
| Broadband | Google Fiber | 0 | 0 | 0 | 0 | Charter Comms | 0 |
| Cyber Security | Chronicle | 0 | 0 | 0 | 0 | 0 | 0 |
| Online Advertising | AdSense | Facebook Ads | Tap Commerce | 0 | Facebook Ads | 0 | 0 |
| Smart Home Devices | Nest | 0 | 0 | 0 | 0 | 0 | 0 |
| Video Entertainment | Android TV | Facebook Gaming | 0 | 0 | Facebook Gaming | Discovery | VideoPress |
| Other Apps | Google Docs | Messenger | TweetDeck | 0 | Messenger | Vogue Magazine | Simplenote |
| OS | Android | 0 | 0 | 0 | 0 | 0 | 0 |
| VR/AR | Cardboard | Oculus | 0 | 0 | Oculus | 0 | 0 |
| Video Meeting Software | Google Meet | Facebook Portal | 0 | 0 | Facebook Portal | 0 | 0 |
| Gaming | Stadia | Facebook Gaming | 0 | 0 | Facebook Gaming | 0 | 0 |
| Payment Services | Google Pay | Facebook Pay | 0 | 0 | Facebook Pay | 0 | 0 |
| ecommerce | Google Shopping | Facebook Marketplace | 0 | 0 | Facebook Marketplace | 0 | Woo Commerce |
| Music Streaming | YouTube Music | 0 | 0 | 0 | 0 | 0 | 0 |
| Source | Google, 2022b | Facebook, 2022b | Twitter, 2022 | Pinterest, 2022b | Facebook, 2022b | Advance, 2022 | Automattic, 2022 |

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| --- | --- | --- | --- | --- | --- |
| **Table 13 – Scope of Other Markets Competed in by Digital Mapping Services** | | | | | |
| **Product Market** | **Google Maps** | **Google Earth** | **Waze** | **Apple Maps** | **Map Quest** |
| Search Engines | Google | Google | Google | 0 | StartPage |
| Browser | Chrome | Chrome | Chrome | Safari | Waterfox |
| Cloud Services | Google Cloud | Google Cloud | Google Cloud | iCloud | 0 |
| Headphones | 0 | 0 | 0 | Air Pods | 0 |
| Tablet | 0 | 0 | 0 | iPad | 0 |
| Smartphone | Pixel | Pixel | Pixel | iPhone | 0 |
| PC | Chromebook | Chromebook | Chromebook | MacBook Air | 0 |
| Smart Speaker/Voice Assistant | Google Home | Google Home | Google Home | Home Pod | 0 |
| Smart Wearables | FitBit | FitBit | FitBit | Apple Watch | 0 |
| Maps | Google Maps | Google Maps | Google Maps | Apple Maps | 0 |
| Email | Gmail | Gmail | Gmail | Mail | 0 |
| App Store | Google Play | Google Play | Google Play | App Store | 0 |
| Social Media | YouTube | YouTube | YouTube | 0 | 0 |
| Broadband | Google Fiber | Google Fiber | Google Fiber | 0 | 0 |
| Cyber Security | Chronicle | Chronicle | Chronicle | 0 | TotalAV |
| Online Advertising | AdSense | AdSense | AdSense | Apple Search Ads | |
| Smart Home Devices | Nest | Nest | Nest | 0 | 0 |
| Video Entertainment | Android TV | Android TV | Android TV | Apple TV | 0 |
| Other Apps | Google Docs | Google Docs | Google Docs | Find My | 0 |
| OS | Android | Android | Android | iOS | 0 |
| VR/AR | Cardboard | Cardboard | Cardboard | 0 | 0 |
| Video Meeting Software | Google Meet | Google Meet | Google Meet | FaceTime | 0 |
| Gaming | Stadia | Stadia | Stadia | Apple Arcade | 0 |
| Payment Services | Google Pay | Google Pay | Google Pay | Apple Pay | 0 |
| ecommerce | Google Shopping | Google Shopping | Google Shopping | 0 | CarsGenius |
| Music Streaming | YouTube Music | YouTube Music | YouTube Music | Apple Music | 0 |
| Source | Google, 2022b | Google, 2022b | Google, 2022b | Apple, 2022d | System1, 2022 |

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