Same Old, Same Old in the App Economy: Predicting the Effects of Article 6c of the European Commission Proposal for a Digital Markets Act on the iOS App Ecosystem

by

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Dedication

This thesis is dedicated to my mother, Ruth Wolkersdorf. Without her endless love, support, and sacrifices I would not have become the person I am today. I thank her for her advice, her patience and, most of all, for always understanding me.

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1 Introduction

In early 2019, the Swedish music streaming service Spotify launched a media campaign against American tech giant Apple. In line with the campaign's slogan, "Time To Play Fair," Spotify is raising a series of accusations against Apple that center around alleged tendencies to monopolize the music streaming market. At the same time, Spotify lodged a complaint with the European Commission (hereafter, the Commission) concerning Apple's potentially anti-competitive behavior. Spotify argues that Apple uses the terms of conditions of the App Store to impede upon the Swedish music streaming giant's competitive potential to the advantage of Apple's own music streaming service, Apple Music, by charging a 30% fee on Spotify subscriptions purchased through the App Store and forbidding Spotify to promote subscriptions to their service through other channels.

In August 2020, Epic Games filed a lawsuit against Apple for similar reasons. One of the world's largest game developers, Epic Games offered a mobile version of their most popular game, *Fortnite,* for free download through the App Store. The game is financed through in-app purchases of digital items, such as cosmetic character modifications. After Epic Games introduced a payment method in their mobile version of *Fortnite*, which bypassed payment through the App Store and was instead processed directly through Epic Games, Apple removed the app from the store. As a result, Epic Games sued Apple in the United States, arguing that the amount of time users spend on *Fortnite* on iOS devices had dropped by more than 60%.

In December of that year, Cydia (an alternative app store for software-modified iPhones and iPads) also filed a lawsuit against Apple, alleging that the tech giant abused their dominance over iOS app distribution by using anti-competitive tactics to freeze out alternative app stores from the company's operating system. Apple's terms and conditions do not allow third-party app stores to be downloaded from the App Store itself, citing security concerns. Cydia, to date, works only on devices that have been jailbroken — a form of software modification that is counteracted by operating system updates and requires some expertise to install.

The amplification of lawsuits targeting Apple's conduct in the app economy indicates an emerging pattern of resistance against the tech giant's hold over this section of the industry. While the aforementioned investigations in the US and the EU have yet to be concluded, on

December 15, 2020, the EU Commissioner for Competition, Margarethe Vestager, introduced the Digital Markets Act (DMA), which touches upon the exact issue at stake. The DMA's proposal complements the EU's digital antitrust regime with a set of ex-ante provisions for very large online platforms, so-called gatekeepers. Among other provisions, the DMA would require Apple to allow third-party apps and app stores to be sideloaded (downloading an app from the web or transferring it from the PC on the mobile phone without using an app store) onto the device (Article 6c DMA). Advocates of the proposal argue that app downloads that do not run through Apple's servers, along with the availability of alternative app stores, would erode the dominant position of the App Store and thereby set prices and spur innovative competition from which the end user could benefit. Developers could then evade the 30% commission fee that Apple collects for providing a spot on the App Store and for handling in-app purchases. Additionally, consumers would have greater freedom to choose where, when, and how they purchase apps: more competition, choice, innovation, and quality.

However, it remains unclear whether Apple users would actually adopt alternative means to download and whether new alternatives to the App Store would actually be utilized. A report by the Directorate General for Connected Networks, Content, and Technology (DG CNECT) and the EU's Joint Research Centre (JRC) have remarked that because of network effects around dominant app stores, the results of the DMA's provisions could be limited (Cabral et al., 2021). Network effects refer to the added value a user of a platform receives when another user from the same or other side of a market joins. In app stores, consumers benefit from an increasing number of developers in the market because they provide a growing selection of apps and stimulate competition. Similarly, developers benefit from more users who could potentially buy their apps. In theory, these network effects lead to high barriers to entry for alternative app stores and diminish competitors' ability to scale. Considering the economic literature on the characteristics unique to digital markets, such as network effects, lock-in, and economies of scale, an actual switch of consumers to alternative distribution channels is questionable.

Evidence from behavioral economics casts further doubt on the hopes of the advocates of the DMA. For example, the status-quo bias refers to the emotional preference for the status quo. Empirically proven again and again, the theory implies for Apple that as long as it ships its iPhones and iPads with the App Store preinstalled, theirs will remain the standard app store.

Building upon previously published literature, this thesis seeks to answer the question of whether Article 6c DMA can create a more competitive and fairer environment for app

developers by encouraging European Apple users to employ distribution channels other than the App Store and thereby counter market forces such as network effects.

Because users of the Android operating system can already make use of alternative app stores and payment options, Android's own app store, the Play Store serves as a well-suited case study to predict whether Apple users will actually adopt alternatives to the App Store. Based on the literature review, I argue that even if Apple opens up its operating system, the network effects and status-quo bias will prevent Apple users from switching. With a survey among Android users from the European Economic Area, I test whether network effects in the mobile operating systems are in fact strong enough to prevent mobile phone and tablet users from seeking alternative app distribution systems. The results and empirical knowledge generated are used to evaluate the theoretical assumptions.

The theoretical framework provides the reader an overview of the distinct characteristics of digital markets and app stores. After establishing that the two dominant app stores, Google's Play Store and Apple's App Store, are two-sided markets with strong indirect network effects, special attention will be paid to the closely interlinked concepts of network effects, status-quo bias and consumer lock-in. The theoretical framework allows us to assume that because of strong network effects, mobile phone users stick to the dominant app store even if alternatives exist.

After elaborating on potential barriers to store-switching or resorting to sideloading in the theoretical chapter of the thesis, the empirical chapter analyzes the actual switching behavior. Since Android users can already use alternative app stores, Google's Play Store is treated as a case study on which to base expectations of how the dynamics in the Apple ecosystem may change after the DMA comes into force. At first sight, alternative app stores on Android OS seem to be underrepresented because most apps are exclusively distributed through the Play Store. However, no study in this field provides clear data the extent to which users of the Android operating system employ alternative means of download. With the help of a survey conducted among Android users, their download behavior will be analyzed; the survey asked 249 Android users whether they had installed apps through sideloading, a practice referring to the installation of apps downloaded from websites other than the Play Store or transferred from the PC onto the device. Respondents were prompted to explain why they had or had not practiced sideloading. A subsequent question probed Android users' engagement with alternative app stores. While a number of alternatives to the Play Store exist, a gap in the research remains concerning the extent to which Android users actually apply these options.

As such, survey respondents were asked to specify why or why not they have made use of alternative app stores.

With its survey of the determinants of Android users' acceptance of alternative app stores and other means of app download, this thesis provides a first assessment of the potential impact of the expected regulatory change of the DMA for Apple users. This assessment offers an important insight as to whether "business users who depend on gatekeepers to offer their services in the single market" will indeed "have a fairer business environment", as the Commission (2020) states, or whether the proposal will benefit only a small number of app developers that already enjoy an entrenched position in the market.

2 Competition in Digital Markets

We live in a rapidly digitalized world in which economic activities are expected to shift increasingly to digital markets. The COVID-19 pandemic has only accelerated this process by driving many aspects of life online. While people were confined at home, many traditional ways of doing business struggled, and as such, new models emerged, and trends solidified. Many developments that digitalize society and make life easier are beneficial: For example, families can maintain contact over long distances through various means of online communications, and official business can be done from home thanks to an increasing number of e-government solutions. Additionally, travel has been facilitated by a plethora of mobile navigation apps.

However, digitization also creates problems. Workers fear that their jobs could be replaced by artificial intelligence, and data protection concerns grow as data theft proliferates. Anxiety is also increasing that big online platforms, so-called gatekeepers, will abuse their market dominance for their own sake and at the expense of consumers.

In fact, with few predominantly American companies dominating the sector, the digital market in Europe is highly centralized. Of the five biggest companies in the world by market capitalization, four are digital companies that also operate within the EU: Apple, Alphabet (the parent company of Google), Amazon and Microsoft (Statista, 2020). With Facebook coming in seventh place, the Big 5, also called GAFAM (Google, Amazon, Facebook, Apple, Microsoft), are complete.

Most Europeans depend on gatekeepers to control key channels of communication and distribution. Apple and Android (Google) dominate the operating system market on mobile devices by covering 99% of the market share (StatCounter, 2021). Microsoft and Apple are the undisputed incumbents on the market for desktop operating systems, reaching 94% of the European market share together, while in Germany the turnover of online shopping giant Amazon is almost five times greater than that of the second ranked online retailer Otto Group (StatCounter, 2021; EHI, 2020). Inarguably, Facebook dominates online social media platforms, especially since its recent acquisition of Instagram.

The emergence of a few key digital players with massive user bases within a short time has raised serious concerns among competition authorities and has led economists to study the characteristics that lead to winner-takes-all dynamics in two- or multi-sided markets. Here, the term “digital markets” is commonly used as an umbrella term to describe sectors concentrating

on digital technologies (e.g., communication, information technology and data processing) and embracing the trade of information services or goods through electronic commerce (Capobianco & Nyeso, 2017; OECD, 2012). According to Eisenmann et al. (2006), Sun and Tse (2007) and Kouris and Kleer (2012), four distinct conditions follow from the two-sided market theory and lead to strong concentration in digital markets:

1. High indirect network effects
2. High multi-homing costs
3. High direct network effects
4. Minimal platform differentiation

In the following sections, I summaries the dominant themes that have been discussed. Building on the insights gathered in this chapter, I determine in Chapter 3, dealing with competition in the mobile app store ecosystem, whether these conditions are present within the app store ecosystem.

2.1 Multi-sided platforms

The business models employed by dominant players in the digital market are characterized by a prevalence of two- or multi-sided platforms (MSPs). The latter term was coined in the seminal works of Rochet and Tirole (2006, p. 645), who define MSPs as markets in which "one or several platforms enable interactions between end-users and try to get the two (or multiple) sides 'on board' by appropriately charging each side." MSPs have at least two distinct user groups that rely on the platform as an intermediator (OECD, 2018). Facebook, like Twitter and Instagram, is considered a MSP, as it connects users with other users but also with advertisers, content creators and so forth. Similarly, the ride-hailing app Uber connects drivers with personal users looking for a ride, while search engine Google connects personal users with website owners, advertisers and other user groups.

However, a job fair or a magazine is arguably an MSP, as each also connects different user groups. A job fair connects employers with employees, and magazines provide a platform for advertisers to reach readers and potential clients. However, academics have increasingly shifted to argue that indirect network effects and to a certain extent direct network effects are

the defining characteristic of multi-sided markets (Rochet & Tirole, 2006; Hagiu, 2007; Evans & Schmalensee, 2015). The two concepts are outlined below.

2.2 Indirect network effects

Indirect network effects were first discussed by Katz and Shapiro (1986). These authors define network effects as the utility an agent receives when a market member on the other side of the market enters. The main contribution of Rochet and Tirole (2006) is their emphasis on indirect network effects as a core characteristic of MSPs and the phenomenon of cross subsidization. According to Rochet and Tirole (2006), indirect network effects can be found in multi-sided markets, where an increasing number of users on one side benefit the agents on the other side of the market and vice versa, often with some degree of cross-subsidization. Cross-subsidization refers to the practice of charging (artificially) low prices to one side of the market by increasing the prices of the other (Rochet & Tirole, 2003).

Rochet and Tirole (2003) initially illustrated indirect network effects with the example of credit card markets. The authors demonstrate that credit card companies often resort to shifting only a small or negative share of the aggregate price for a credit card transaction to the consumer. By doing so, the credit card company incentivizes consumers to use a card belonging to their company, which in turn encourages merchants to accept credit cards by said company. The element of indirect network effects, commonly also referred to as indirect network externalities, in this case thus refers to the phenomenon that one side of the market (i.e., the merchant or the credit card holder) benefits when another agent joins: The consumer benefits from every additional merchant that accepts credit cards, while the merchant benefits from consumers who can shop in their store. Similar empirical investigations have been conducted by Rysman (2004) on the Yellow Pages phone books, Kaiser and Wright (2006) on magazines and Landsman and Stremersch (2011) on video gaming systems.

With the advent of the internet, the concept of indirect network effects found ever-increasing application because information and communication technologies, in particular, enable strong network effects (Jullien, 2006). This phenomenon relates to the commonality that ICT business models often include high fixed costs and extraordinarily low marginal costs (Jullien, 2006). Creating and maintaining the infrastructure for a social network or a digital marketplace is usually very expensive, as it is associated with high development, hosting and advertising costs, while adding users to either side of the market is not connected to considerable additional costs (Abdelkafi et al., 2019).

To enlist additional users, digital platforms usually decide to subsidize one side of the market when their side is of high value to the other side. Internet platforms therefore often offer their services to the private end user for free, while these externalities are internalized by the business user at the other side of the platform (Abdelkafi et al., 2019). The OECD (2018) has argued that this practice is common in subsidy-based relationships, which he contrasts with service-based relationships (in which the supply side provides a service to the demand side). Examples of service-based relationships include Uber, Amazon and AirBnb. Both the supply side and the demand side internalize the platform externalities and generate revenue by paying some sort of commission. In subsidy-based relationships, by contrast, "one side indirectly defrays [the] other side's costs of using the platform but does not offer an additional service that directly attracts users to that platform" (OECD, 2018, p. 190). Here, a subsidizer, usually an advertiser, bears the platform costs, while the core service is provided by the platform itself and offered for free to the user. Examples include Facebook, Instagram and Google Search.

2.3 Direct network effects

Next to indirect network effects, direct network externalities are also commonly found in digital platforms. Coined by the seminal work of Katz and Shapiro (1994), direct network effects (also called network externalities or economies of scale in consumption) comprise the incremental benefits experienced by existing users of a network for each new user entering that network. Put more simply, network effects refer to the phenomenon that an addition of users on one side of the market increases the appeal of the platform to other users on the same side, while the initial platform content of functionality becomes increasingly subordinated (Calvano & Polo, 2020). The pioneering analytic application of network effects by Jeffrey Rohlfs focused on inception of landline telephony in the United States. Rohlfs (1974) argues that the value of a telephone increases with the number of other phone users a telephone owner can reach with it. With the advent of social media platforms, study of network effects expanded as scholars demonstrated that the value of a social network for a user usually increases with the number of other users with whom they can interact (Boudreau & Jeppesen, 2015; Belleflamme & Peitz, 2018). Most social media platforms, including Facebook, Twitter, and Instagram, become interesting only if users can connect with other users. Users join Facebook because they know that their neighbor, classmate or family member is also on the platform (Øverby, 2018). In other digital sectors the link is subtler, yet similar dynamics can be identified. The number of users of a given search engine seems at first to be irrelevant. However, the accuracy of search results is directly related to the scale of operations by other users, as search engines

determine the relevance of results by factoring in how often they were clicked on by users searching for similar keywords (Calvano & Polo, 2020). Consequently, the quality of search results improves with the number of agents using a search engine. In this case, demand-driven dynamic economies of scale create what economists have called “network-like effects” (Calvano & Polo, 2020).

Both direct and indirect network effects can lead to strong degrees of market concentration and market tipping. According to Hagiu & Rothman (2016), once a platform reaches a critical mass of users on both sides, direct and indirect network effects apply, exponential growth follows and competitors face significant market entry barriers. For competitors, such barriers create a chicken-and-egg problem: if other agents within a network generate the most value for other agents, it becomes increasingly complicated for alternative platforms to compete with an incumbent (Evans & Schmalensee, 2015). Because direct and indirect network effects favor companies with large user bases, these markets are vulnerable to market tipping, a scenario in which the incumbent’s position becomes unassailable (Evans & Schmalensee, 2015).

2.4 Multi-homing

Whether companies can achieve market dominance through network effects depends on the ability of users to multi-home (Armstrong, 2006). Multi-homing refers to the situation in which a user joins more than one platform (Rochet & Tirole, 2003). In contrast, single-homing is defined as a scenario in which an agent uses only one platform (Rochet & Tirole, 2006). According to the German Federal Cartel Office (2021),

> multihoming on matching platforms can be a factor counteracting the self-reinforcing feedback loop effect as customers use several, possibly differentiated platforms in the market, which considerably reduces the lock-in effect possibly involved in network effects, particularly in direct network effects.

Conversely, the competition watchdog states that “the risk of tipping is greater in the case of single-homing activities on matching platforms or networks than in the case of multi-homing, because single-homing can result in suppliers competing for the market and, ultimately, monopolization” (German Federal Cartel Office, 2021).

Given that single-homing facilitates tipping, MSPs often take actions that raise switching costs, preventing users from multi-homing. The OECD points out that many ICT products are associated in particular with switching costs that discourage users from shifting to a competitor. Klemperer (1987) defines switching costs as the monetary or non-monetary disadvantages resulting from a change of business partner (Klemperer, 1987). He further differentiates transaction costs (e.g., the cost of closing a bank account), learning costs (associated with familiarization with a specific product) and "artificial" costs such as rewards card programs, and contract costs (Klemperer, 1987). Consequently, switching costs are not reduced to monetary means but can also be psychological, effort-based, or time-based (Grant, 2021). Once users face switching-costs that are too high, one speaks of "user lock-in."

2.5 Platform differentiation and homogeneity of the product

Relevant literature dictates that the degree of differentiation also features in market tipping. According to Bedre-Defolie and Nitsche (2020, p. 618),

> if platforms are differentiated in dimensions other than network effects (e.g. variety of products or services they offer; quality of match, interactions, or products; and better search or recommendation systems), even if all users on one side multi-home, users on the other side might still prefer to multi-home to benefit from other differentiating factors unrelated to network effects.

In some markets, consumer preferences are heterogenous enough to allow for product differentiation in terms of quality, safety, comfort, and price (Kouris & Kleer, 2012). Hence, platform differentiation can prevent tipping, and the more heterogeneous the user base, the less likely a market tip (Duch-Brown, 2017)

3 Competition in the Mobile App Store Ecosystem

Mobile operating systems and app stores inhibit key characteristics of digital markets and have raised serious concerns amongst antitrust authorities in Europe and elsewhere. This chapter provides a short overview of the mobile ecosystem market in Europe and expands upon the theoretical insights gained from the previous chapter by applying the concepts discussed to the incumbent mobile app stores of Apple and Google. Based on the four characteristics that facilitate market tipping, as described in the previous chapter, this chapter will demonstrates that the mobile app store ecosystem enforces strong "winner-takes-all" tendencies.

3.1 Market analysis

App Stores are digital storefronts for mobile applications ("apps"), through which app developers seeking to distribute their apps can reach end users intending to download said apps. Within the European Union, two companies dominate the mobile ecosystem: 71.22% of phones operating in Europe run on the Android operating system, developed by Google, and 28.33% run on Apple's iOS (Statista, 2021). Less than 1% use one of the remaining operating systems, such as Microsoft's discontinued Windows Phone or Samsung's Tizen OS (Statista, 2021).

Apple's iOS is not licensable to mobile phone manufacturers, such as so-called original equipment manufacturers (OEMs) such as Samsung, Huawei, or LG, while Google's business model is centered on the idea of allowing OEMs to install Android on their devices, often referred to as "off-the-shelf OS." All iOS devices manufactured after 2008, and most devices that run on Android, have an app store preinstalled that is provided and maintained by the developer of the operating systems: Apple's App Store for the former and Google's Play Store for the latter.

Android OEMs can theoretically choose whether they install Google software next to the operating system with the application suite "Google Mobile Services" (GMS). GMS is a collection of apps developed by Google such as the Google Play, the internet browser Google Chrome or Google's video sharing platform YouTube. While OEMs must obtain a license fee to pre-install GMS on an Android device, Google does not charge a fee for this service (Google, 2021). To receive a license, an OEM must sign a Mobile Application Distribution Agreement (MADA). While certain individual clauses exist, the key points of the agreement are similar for all OEMs (Edelman & Geradin, 2016). The agreement rules that OEMs are required to not pre-install apps that compete against the GMS suite, meaning that smartphone manufacturers cannot install their own app store, video sharing service or map application. Furthermore,

“Google requires that these preinstalled apps be prominent, with certain apps presented at least on the panel immediately adjacent to the Default Home Screen and others no more than one level below the phone top.” (Edelman & Geradin, 2016, p. 165) A second Anti-Fragmentation Agreement (AFA) hinders OEMs from using the Android OS as a baseline to develop a competing operating system (Edelman & Geradin, 2016).

While manufacturers are not required to accept the aforementioned terms to manufacture devices that run on Android, very few OEMs opt out of installing the GMS suite. According to Edelman and Geradin (2016, p. 167), “if a manufacturer offers bare Android, it need not preload any specific Google app, but in that case the device cannot include any Google app including those that are expected by the vast majority of users and are necessary for commercial success.” The authors state that “to get even a single Google app, including the Play Store that provides access to others’ apps, the device manufacturer must sign the MADA and the AFA, committing to preload a full suite of Google apps, accepting Google’s other requirements and promising not to use modified versions of Android on any devices they sell” (Edelman & Geradin, 2016, p. 167). Because Google Apps such as the Play Store, Google Maps or YouTube provide key value to the phone, the option to not install the GSM suite does not reflect the commercial reality of the smartphone market. Edelman and Geradin (2016) highlight the difficulties these companies face. According to the two authors, Amazon — which distributed its “Fire Phone” without the GMS suite but with its own apps pre-installed such as the Amazon App Store — was harshly criticized by reviews for not including Google apps. Additionally, Android users that switched from a “normal” Android version to the bare version running on the Fire Phone complained that they were not able to recognize prior app purchases because the device lacked Google’s Play Store (Edelman & Geradin, 2016). A more recent example includes the Chinese technology giant Huawei, which was unable to maintain a Google GMS license because the US government had designated the company a national security threat. After Google was forced to cease cooperation with the Chinese OEM, overseas smartphone sales declined by 27% (Jonnalagadda, 2020). Consequently, the vast majority of phones distributed in Europe come with either Apple’s App Store or Google’s Play Store pre-installed.

3.2 Winner-takes-all dynamics in the mobile app ecosystem

The strong dominance of the two prominent operating systems is inherently linked to network effects generated by the respective app stores. While mobile operating systems can be considered a multi-sided market, app stores are usually described as a two-sided market with strong indirect network effects. This section provides insights into the market forces at stake in the mobile app store ecosystem for both the Google and Apple app platform, based on the factors outlined in the previous chapter.

3.2.1 App stores as two-sided markets

Apple's App Store can be considered a two-sided market in which one side is composed of application publishers and the other side of app store users. As of 2019, there were roughly 2.8 million app developers for the iOS operating system (Business of Apps, 2021). By partaking in the Apple Developer Program, developers can access the Apple Software Developer Kit, composed of tools such as Xcode (a development environment supporting the programming languages Swift, Objective-C, C, and C++), an iOS emulator (a testing environment for apps), TestFlight (a beta program to test apps currently under development using real beta tester) and more (Apple, 2021).

Google provides a similar array of tools for its 750,000 app publishers. The developer software suite Android Studio includes a visual layout editor, an emulator, and a code editor supporting the programming languages Kotlin, Java, C and C++ (Google, 2021).

Before submitting an app, both Apple and Google review every app for compliance with the company's strict terms and conditions and check the source code for possible security issues. Developers whose apps have been admitted to the app store can then determine their sales price on the App Store and the prices of in-app purchases (iAPs). In-app purchases can be used to offer digital goods or services, but not physical goods (Apple, 2021). For example, digital coins for a racing game can be purchased through in-app purchases on both platforms, but airplane tickets or warehouse orders cannot be purchased through the in-app purchasing system.

Both Apple and Google charge a 15% commission on app store purchases and in-app purchases for developers earning up to US$ 1 million per calendar year in revenue from app store sales and in-app purchases (Apple 2021, Google 2021). If publishers earn more than $1 million, a 30% commission is taken (Apple 2021, Google 2021). On Android, many publishers do not use Google's in-app purchasing system, whereas on Apple, in app-purchases are not

only more commonplace, but the enforcement of in-app purchase rules is also considerably stricter, with a bar on developers from distributing in-app purchases through their own payment system (Munson, 2020). Google, however, has announced a crackdown on apps that bill customers directly and will implement an updated billing system by September 2021, thereby following Apple in disallowing app developers to bill through their own payment system (Munson, 2020)

The other side of the two-sided market is composed of Apple products or Android users who are seeking to download an app. By introducing a 15–30% commission on app purchases and in-app purchases, the app stores designate prices that encourage groups on each side of the market to join for the benefit of access to each other (Rochet & Tirole, 2004; Evans & Schmalensee, 2007). The defining feature of app stores in the context of competition theory is that they can solve indirect network externalities by reducing transaction costs and facilitating value by creating exchanges between app developers and users (Müller et al., 2011).

3.2.2 Direct network effects in mobile operating systems and app stores

A strong level of indirect network effects, as compared to a lesser degree of direct network effects, can be observed in the app economy. Both Apple and Google exploit these effects to increase the value of their products and operating systems.

Direct network effects in the app economy can occur because high numbers of other users on the same side of the market positively influences each users' ability to share apps or use messaging apps available only on one platform. A prominent example direct network effects includes the controversial app *Clubhouse*, which is now available only on Apple products such as iPhones and iPads and not on Android devices.

On the developer's side, negative direct network effects are at stake. With almost two-million apps on the App Store and nearly three-million apps on the Play Store, the visibility of individual apps increasingly diminishes with each developer that publishes an app on an app store, according to Kouris and Kleer (2012).

While extensive literature on this topic has not yet been published, the existence of positive network effects on the user side and negative direct network effects on the supply side can be assumed. Although definitive studies on this topic are yet to be conducted, Kouris and Kleer (2012) theorize that indirect network effects contribute considerably to market tipping in the mobile app store ecosystem than do direct network effects.

3.2.3 Indirect network effects in mobile operating systems and app stores

A strong degree of indirect network effects can be identified within the mobile app ecosystem on both Android and iOS. On mobile operating systems, an end user of an app store benefits from numerous app developers due to the choice of apps and competition on the other end of the market. On the contrary, developers are attracted by an increasing number of possible customers for their apps on the other side of the market. An app developer is typically the one defraying the other side's costs by the Commission the app store operator charges, while the mobile phone can use the app store for no additional charges.

Many studies confirm the existence of indirect network effects generated by mobile app stores. In 2015, Campbell-Kelly et al. presented a comprehensive analysis of mobile operating systems in the context of multi-sided market theory. The authors define mobile operating systems as MSPs that serve a variety of stakeholders, including consumers, mobile phone manufacturers, advertisers, network operators, and app developers, and they apply multi-side platform theory to capture why specific mobile operating systems caught momentum (Campbell-Kelly et al., 2015). Their study finds that the success of Apple's iOS operating system was initially grounded in the fundamentally superior features of the handset, while later-on, Apple could sustain momentum by "innovating steadily in terms of operating-system software and handset design, and, second, by attracting third-party developers via the App Store" (Campbell-Kelly et al., 2015, p. 730). The authors stress that the early availability of developers willing to develop apps for the iPhone (and later the iPad) positively impacted the phone's popularity among users on the other side of the market, showing the existence of indirect network effects within the App Store.

A study by Garcia-Swartz and Garcia-Vicente (2015) confirms the findings of Campbell-Kelly and directly correlates the number of apps available on the iPhone and the number of sales of iOS devices. Roma and Ragaglia's (2016) survey results confirm this estimation, finding that the number of apps available in the app stores — and therefore the number of developers on one side of the market — is a decisive factor for customers opting for a device with the respective operating system and the auxiliary app store. The study found that "consumers derive higher utility from the presence of a higher number of developers in the app stores as they have a larger product variety available for purchase" (Roma & Ragaglia, 2016, p. 181). Roma and Ragaglia conclude that indirect network effects in Apple's App Store and Google's Play Store are among the main reasons Google and Apple became the two dominant players in the mobile OS ecosystem. This conclusion is supported by Mui (2013), who argues

that both Google's Android and Apple's iOS have reached dominance in the mobile sector through indirect network effects that led to high barriers to entry for potential competitors.

Holzer and Ondrus (2011) have considered at network effects in mobile operating systems from an app developer's perspective. They argue that the closed nature of Google's Play Store created centralized portals amplifying indirect network effects, as they provided each side an overview over the other (Holzer & Ondrus, 2011, p. 55).

Unsurprisingly, Apple identified the chicken-and-egg problem of network effects in terms of reaching a critical mass to activate a positive feedback loop early-on. Four months before the launch of the iPhone 3G and the opening of the App Store in July 2008, Apple released a free iPhone Software Development Kit (SDK), enabling developer companies to program their own native applications for the iPhone's iOS operating system (Tewari & Sareen, 2014). This early focus on getting app developers to commit suggests that Apple understood from the beginning that indirect network effects can boost phone sales.

Interestingly, the absence of indirect network effects can subsequently lead also to the absence of direct network effects. As Cornell (2020) identifies, when app developers are reluctant to develop apps for a device because of the number of users on the other side of the market, other users are disinclined to switch from an operating system that has plenty of apps available to an operating system with fewer apps, as they would then be unable to communicate with other operating systems due to the absence of relevant apps.

While network effects mean that competing app stores could technically reach substantial scale in a relatively short period of time, they also imply that any successful app store must solve the chicken-and-egg dilemma that all platforms face during their initial stages (Bostoen & Mandrescu, 2020; Rochet & Tirole, 2003). The failure of the Windows Mobile operating system illustrates that solving the problem is difficult. The operating system developed by Microsoft gained much praise by the press and the tech scene during its launch phase (Cornell, 2020). Despite offering technically well-equipped phones competitively priced, as compared to Apple devices, this operating system did not grow and survive. Cornell (2020) explains that with the absence of direct and indirect network effects, "developers were reluctant to develop a Windows Phone version because the number of users of Windows Phone was too small compared to iOS and Android" and that "the existing iOS and Android users also did not want to switch to Windows Phone because they could not communicate with other iOS and Android users due to the lack of apps."

In conclusion, indirect network effects, and to a certain extent direct network effects, considerably supported the entrenchment of the two dominant mobile operating system providers, Google and Apple, from other competing operating systems.

The ACM study (2019, p. 39) argues that the app store has become the "central controller of the architecture that navigates and allocates supply and demand." Consequently, "for both Apple and Google, control over the App Store is essential to guarantee the value of the ecosystem, to prevent fragmentation, and to offer third-party app developers opportunities for innovation." (ACM, 2019, p. 39)

3.2.4 App store multi-homing

The previous section has demonstrated that the availability of a well-stocked app store can generate indirect network effects so strongly for a mobile operating system that other operating systems experience significant barriers to entry, leading to an effectively tipped mobile operating system market in Europe. Control over app stores is essential to guarantee the value of the operating system. While strong network effects can themselves lead to the avoidance of multi-homing, both Apple and Android employ strategies further preventing multi-homing. The following chapters outline the two strategies employed by Google and Apple to maintain control over the app ecosystem on their operating systems, predominantly driven by efforts to reduce multi-homing via app distribution systems. Based on the findings of ACM (2018) on competition in mobile app stores, Sections 3.2.4.1–2 outline how the possibilities for multi-homing in the app ecosystem are restricted for app developers and smartphone users to varying degrees on both Android and iOS.

3.2.4.1 Developer multi-homing

According to the ACM (2018), multi-homing in the app ecosystem can occur on both sides of the two-sided market. First, a developer could decide to multi-home by publishing its apps on multiple distribution platforms. Here two levels of multi-homing exist: App developers can generally distribute their apps on multiple operating systems, most commonly for iOS and Android.

Whether developers are multi-homing on different operating systems has been researched thoroughly. A study by Hyrynsalmi et al. (2012) demonstrates that few publishers (6.8%) opt for a multi-homing publishing strategy by distributing their app on multiple operating systems. A follow up study by the same researcher, Hyrynsalmi et al. (2016), cemented the results of their earlier study, finding in addition that app developers of particularly

popular apps opt to multi-home more frequently. The authors explain this dynamic as a result of the costs associated with porting an app to other operating systems, which smaller app developers often cannot bear (Hyrynsalmi et al., 2016). By running their operating systems on incompatible coding languages, both Google and iOS have introduced considerable hurdles to multi-home for app developers. This finding is further amplified by the mobile app stores study conducted by AMC, which found that "app providers indicate platform-incompatibility as a serious threat for the app-economy, and state that they wish they only had to develop one app instead of two" (2018, p. 52).

The second level of multi-homing is the provision of an app through sideloading. According to the ACM study (2019, p.4), "sideloading refers to the installation of apps on a smartphone without using the app store." Most commonly, this practice occurs through the downloading of an app through a browser or transfer of an app from a PC to a phone. According to ACM (2019), developers often opt not to distribute their apps through a different digital environment, due to the lack of discoverability. This preference is illustrated by the app *Fortnite*, a very popular multiplayer shooting game, which lost a total of 41% download numbers when Android removed it from the Play Store (ACM, 2019). According to the ACM study (2019, p. 48), "only consumers who are already familiar with an app and are willing to look for it outside the Play Store will sideload it." Further, it reports that app stores are an important channel because "around one half of app downloads concern apps that consumers would not have known or downloaded otherwise" (ACM, 2019, p. 22). The ACM study indicates that sideloading is a feasible method of app distribution only for app developers who "already have a high brand awareness and established user bases" (ACM, 2019, p. 49).

Additionally, this is a feasible option only for Android app developers, because Apple actively hinders iPhone and Apple users from being able to install applications outside the App Store.

3.2.4.2 User multi-homing

On the end-user side of the market, again, also two levels of multi-homing exist. According to ACM (2018, p. 51), "the lower level of multihoming can refer to the use of one or more app stores, and the higher level can refer to the use of one or more app-ecosystems." In practice, this means that for the higher level, users must own two or more mobile phones running different operating systems, each of which cannot run the apps developed for the other(s). High-level end-user multi-homing imposes considerable switching costs. Such

switching costs to access other operating systems and their proprietary operating system include the price of the new phone and also costs incurred by re-downloading apps, learning costs associated with becoming accustomed to the new operating system interface and costs associated with the lack of compatibility with other devices, the latter being especially relevant when switching from Apple to Android (AMC, 2018).

The lower level of multi-homing materializes in users installing two or more app stores in addition to the proprietary app store or by installing apps on the phone through sideloading. Apple counteracts end-user multi-homing with software barriers that hinder users from jailbreaking their devices. Within the Apple ecosystem, users can install only third-party app stores or sideload by "jailbreaking" their device, a modification that removes Apple's software settings that restrict the installation of third-party apps. Apple views this practice as a violation of the end-user agreement and patches software vulnerabilities that developers of jailbreaking solutions exploit (ACM, 2018). Jailbreaking requires considerable digital literacy and is therefore feasible for only a limited number of users (AMC, 2018). This requirement complicates low-level end-user multi-homing considerably and renders it infeasible for most users (ACM, 2019). Apple users are effectively locked to the App Store by not only network effects but also technical restrictions.

On Android, users can install third-party apps by sideloading without considerable software restrictions from Google. While Android warns the user of possible harmful content that can be downloaded from the internet with a banner popping up when a user tries to install a third-party app, users still can download and install an APK file (the app file format for Android).

Yet, lock-in effects are also observable on the Android platform. The literature suggests that by exploiting the status-quo bias, Google can lock users into using the Play Store without software restrictions because most Android phones come with the Play Store pre-installed (Bostoen & Mandrescu, 2020). Such preinstallations, according to Bostoen and Mandrescu (2020, p. 20), "make solving the chicken and egg problem more difficult since it requires overcoming the status quo bias of consumers." The status-quo bias was established by Samuelson and Zeckhauser (1988). The theory holds that people generally prefer to a previously established option (Samuelson & Zeckhauser, 1988). The Stigler Report, a multidisciplinary inquiry on how to address the competition issues raised by big tech, argues that digital platforms can rely on a number of consumer biases, such as the status-quo bias, to bind consumers to their platforms, thus making "switching to alternatives more difficult than

imagined by lay intuition" (Morton et al., 2019, p. 95). Following the literature on status-quo bias, by shipping Android devices with the Play Store pre-installed, Google creates a choice architecture that makes it difficult to opt out. A report by the Commission (2018) affirms this indication. The Commission (2018) bases their findings on empirical evidence generated through a through a comparison of search queries conducted on smartphones running the Android and the Windows Phone Operating System. On Android systems, which had a Google Search app preinstalled, and with the proprietary browser Chrome pre-configured with Google Search, "more than 95% of all search queries were made via Google Search," while "on Windows Mobile devices (Google Search and Chrome are not pre-installed) less than 25% of all search queries were made via Google Search." (European Commission, 2018) More than 75% of search queries happened on Microsoft's Bing search engine, which is pre-installed on Windows Mobile devices" (European Commission, 2018). Based on these findings, the Commission argued in 2018 that pre-installation can create status-quo bias and found that "users do not download competing apps in numbers that can offset the significant commercial advantage derived through pre-installation."

We can see that developers and users experience much lock-in within the app store ecosystems of Apple and Android. On each platform, users must bear significant switching costs if they shift operating systems. iPhone and iPad users are restricted by Apple's sideloading and hard stance against alternative app stores. For Android users, network effects and status-quo bias are likely to discourage them from making use of other means than the Google Play Store. In return, app developers hesitate to distribute apps through alternative app stores because of the lack of discoverability. The literature suggests that Google and Apple use different strategies to lock users and developers into their app store ecosystem, but each has a similarly high degree of lock-in.

3.2.5 App store differentiation

The theory on product differentiation suggests that if different app store features are desired, niche building for alternative app stores might exist. According to Kleer and Kouris (2012), within the app store ecosystem "on the users' side, there are different customer segments: there are, for instance, business customers with preference for security, very high quality, and ability to pay for it on the one hand; on the other hand, there are budgeters who are not willing to pay much, and nerds who want the opportunity to adjust apps as they wish, etc." On the developer side, differences exist in terms of the motives (Kleer & Kouris, 2012). In theory, opportunities for niche-building in the app store ecosystem have been identified.

However, because of the aforementioned dynamics of the market, it seems unlikely that alternative distribution methods overcome the chicken-and-egg problem.

4 The Digital Markets Act

Various large online platforms have been addressed with antitrust proceedings in the European Union within the last years. In 2008 and 2013, Microsoft was fined €860 million and €561 million, respectively, for anticompetitive behavior in the company's operating system, Windows (Jochum, 2018). In the period from 2017 to 2020 the Commission fined search engine giant Google €8.21 billion for abuse of its dominant market position in the core business segments of advertisement (AdSense), commerce (Shopping) and operating system (Android) (Mrohs, 2020). Despite these numerous antitrust proceedings against various large enterprises in the digital sector, the opinion that anti-competitive practices of these companies are only inadequately addressed by EU antitrust has been voiced at increasing frequency in recent years (Schöning et al., 2020).

As a response to these calls, in late January 2020, the Commission announced the Digital Services Act (DSA) and an adjacent DMA (Commission, 2020). The former seeks to shift responsibility to flag and remove illegal digital content, ranging from hate speech to counterfeit goods, to the platform operators. The latter aims to counteract the abuse of dominance of large platforms in the digital market by introducing a set of obligations for the so-called gatekeepers.

The intention to regulate dominant online platforms was first announced in the 2019 Commission communication "Shaping Europe's digital future," which was followed by two public consultations on the need for a new competition tool (European Parliament, 2021).

Chapter 4 first introduces the reader to the term "gatekeeper," which the DMA addresses, along with the provisions of the proposal. After that, I will concentrate on Article 6c, which concerns the conduct of app stores and the dominant operating system providers.

4.1 Gatekeepers

The provisions outlined in the DMA target "core platform services" with a gatekeeping position, meaning that they exert "significant impact on the internal market, operate one or more important gateways to customers and enjoy or are expected to enjoy an entrenched and durable position in their operations" (European Commission, 2020, p. 2).

Core platform services refer to "online intermediation services (incl. e-commerce marketplaces, app stores and online intermediation services in other sectors like mobility, transport or energy), online search engines, social networking or video sharing platform

services, number-independent interpersonal electronic communication services, operating systems, cloud services and advertising services [...]" (European Commission, 2020, p. 2). According to the Commission's definition, a core platform service has more than 45 million monthly active users from the EU and has more than 10,000 yearly active business users established in the Union (European Commission, 2020, p. 2).

Article 3 of the DMA defines the quantitative criteria for designating a gatekeeper. In order to qualify for the position of a gatekeeper, an undertaking must

(1) "achieve an annual EEA turnover equal to or above EUR 6.5 billion in the last three financial years" or have a market capitalization or the equivalent fair market value of EUR 65 billion or above

(2) have "more than 45 million monthly active end users" and "more than 10,000 active business users"

(European Commission, 2020, p. 37)

Companies that meet the threshold criteria for gatekeepers are obliged to notify the Commission thereof within three months of satisfying the criteria and disclose relevant information to the Commission, which then designates the platform as a gatekeeper within 60 days (European Commission, 2020).

Caffara and Scott-Morton (2020) demonstrate that the aforementioned criteria might capture digital players beyond only the Big Five (Google, Amazon, Facebook, Apple, Microsoft), such as software developers SAP and Oracle, as well as the cloud computing platforms Amazon Web Services (AWS) and Amazon Azure. Conversely, according to Caffara and Scott-Morton (2020), other intermediary platforms such as Twitter, AirBnB and Zoom do not meet the criteria, while services such as video-sharing social network TikTok, accommodation booking platform Booking.com and videoconferencing application Zoom seem to be at the brink of meeting the characteristics (Caffara & Scott-Morton).

The Commission recognizes that online platforms can be effective gatekeepers without matching the quantitative criteria outlined in Article 3 by introducing an alternative method of determination called "market investigation" (European Commission, 2020). A market investigation allows the commission to consider *dynamic parameters* such as a platform's entry barriers, user lock-in effects, the presence of strong network effects or data-driven advantages.

This generous flexibility in determining the gatekeeper status of a platform puts a much broader array of companies within the scope of the DMA (de Meese et al., 2021).

4.1.1 Gatekeeper obligations

When gatekeeping platforms offering core platform services meet the quantitative criteria outlined by Article 3 or when a market investigation qualitatively determines the gatekeeping role of a platform, core platform providers must comply with ex-ante regulation in the form of a set of prohibitive and affirmative obligations. Article 5 differentiates between universal obligations that apply with no further qualification and a much more exhaustive schedule of obligations that may be further specified (European Commission, 2020; Caffara & Scott-Morton, 2021).

Articles 5a–6i of the proposal provide a definitive list of misconduct that must be omitted by gatekeepers, identified pursuant to Article 3. The below table provides a compressed overview of the prohibitive and affirmative obligations with which core platform services in a gatekeeping position must comply.

Gatekeeper obligations without further specification

Prohibitive	**Affirmative**
Article 5a: "**Refrain from combining personal data sourced from core platform services with other personal data** [offered by the same gatekeeper] [...]"	*Article 5b:* "**Allow business users to offer the same products or services** to end users **through third party online intermediation services** at prices or conditions that are different from those offered through the online intermediation services of the gatekeeper [...]"
Article 5d: "[...] **refrain from** preventing or **restricting business users from raising issues with any relevant public authority** relating to any practice of gatekeepers [...]"	*Article 5c:* "[...] **allow end users to access and use**, **through the core platform services of the gatekeeper, content, subscriptions, features or other items by using the software application of a business user**, where these items have been acquired by the end users from the relevant business user **without using the core platform services of the gatekeeper** [...]"

Article 5e: "[...] **refrain from requiring business users to use**, offer or interoperate with an **identification service of the gatekeeper** in the context of services offered by the business users using the core platform services of that gatekeeper [...]"	*Article 5g:* "[...] **provide advertisers and publishers** to which it supplies advertising services, upon their request, **with information concerning the price paid by the advertiser and publisher, as well as the amount or remuneration paid to the publisher** [...]"
Article 5f: "[...] **refrain from requiring business users or end users** to subscribe to or **register with any other core platform services** [...] **as a condition to access, sign up** or register to any of their core platform services [...]"	

(own illustration based on Article 5 DMA)

Gatekeeper obligations susceptible to further specification

Prohibitive	**Affirmative**
Article 6a: "[...] **refrain from using, in competition with business users, any data not publicly available, which is generated through activities by those business users**, including by the end users of these business users, of its core platform services or provided by those business users of its core platform services or by the end users of these business users [...]"	*Article 6b:* "[...] **allow end users to uninstall any pre-installed software applications** on its core platform service [...]"
Article 6d: "[...] **refrain from treating more favourably in ranking services and products offered by the gatekeeper itself** or by any third party belonging to the same undertaking compared to similar services or products of third party and apply fair and nondiscriminatory conditions to such ranking	*Article 6c:* "[...] **allow the installation and effective use of third party software applications or software application stores** using, or interoperating with, operating systems of that gatekeeper and allow these software applications or software application stores to be accessed by means other than the

[...]"	core platform services of that gatekeeper [...]"
Article 6e: "[...] **refrain from technically restricting the ability of end users to switch between and subscribe to different software applications and services** to be accessed using the operating system of the gatekeeper services of that gatekeeper [...]"	*Article 6f:* "[...] **allow business users** and providers of ancillary services **access to and interoperability with the same operating system, hardware or software features that are available or used in the provision by the gatekeeper** of any ancillary services [...]"
	Article 6g: "[...] **provide advertisers and publishers, upon their request and free of charge, with access to the performance measuring tools of the gatekeeper** and the information necessary for advertisers and publishers to carry out their own independent verification of the ad inventory [...]"
	Article 6h: "[...] **provide effective portability of data generated through the activity of a business user or end user** and shall, in particular, provide tools for end users to facilitate the exercise of data portability, [...], including by the provision of continuous and real-time access [...]"
	Article 6i: "[...] **provide business users, or third parties authorised by a business user, free of charge, with effective, high-quality, continuous and real-time access and use of aggregated or non-aggregated data**, **that is provided for or generated** in the context of the use of the relevant core platform services **by those business users and the end users engaging with the products or services provided by those business users** [...]"

(own illustration based on Article 6 DMA)

4.2 Literature on the Digital Markets Act

Due to the novelty of the DMA, little literature has been published on the issue. Presently, the most prominent analysis of the DMA proposal is that of Cristina Caffara and Fiona Scott-Morton (2021) for the Centre for Economic Policy Research (CEPR). While the authors applaud the DMA for the progress it has created, their paper critiques the DMA's definition of gatekeepers, alleging that it fails to take into account the business model of the respective companies it seeks to regulate (Caffara & Scott-Morton, 2021). Economists argue that the Commission has selected a one-size-fits-all-approach to platform services that inherently differ. The business models, according to Caffara and Scott-Morton (2021) differ systemically in terms of "the type of economies of scale they rely on," "the type and direction of network effects (direct/indirect, one/both directions)" and "the potential for multihoming (on one or both sides)." According to the scholars, these distinctions matter because they directly determine the entry strategy of potential competitors and therefore also the defense strategy of incumbents (Caffara & Scott-Morton, 2021). Hence, the authors are skeptical as to whether the fairly specific obligations determined by the Commission apply to all gatekeeper platforms in the EU and call for a more flexible approach to determine whether a company has gatekeeper status.

Meredith Broadbent (2020) bases her criticism on the numerous leaks of the proposal that were published by various media outlets in late 2020. She criticizes the DMA as poorly-fitting the rapidly evolving dynamics of the digital market, in which "Schumpeterian" creative destruction causes temporary monopolies to be displaced by one another through innovation (Broadbent, 2020). According to Broadbent (2020), the ex-ante rules prescribed by the DMA fail to comply with established antitrust proceedings leading to companies being unable "to offer evidence in defense of an allegation of dominant behavior" anymore. Furthermore, Broadbent (2020) criticizes that the DMA obligations are difficult to enforce and specifically threaten American companies, significantly hurting transatlantic trade relations.

4.3 The Digital Markets Act and app stores

One of the main focuses of the DMA is on the alleged anti-competitive behavior of app store operators. Apple fulfills the DMA criteria of a gatekeeper because its annual EEA turnover is above €6.5 billion in the last three financial years, and the App Store qualifies as a "core platform service" because it has more than 45 million monthly active users from the EU and more than 10,000 yearly active business users established in the Union (Rothman, 2019).

According to Statista, in 2020, Apple posted a turnover of €56 billion. Simultaneously, there are more than 160 million iPhone users alone, qualifying the App Store as the iPhones proprietary app store as a core platform service (StatCounter, 2020)

Even though app stores have been called the prime example of multi-sided markets and despite that various provisions of the DMA can directly be assigned to alleged misconduct in Apple's App Store, little commentary has been offered on the provisions that seek to regulate anti-competitive misconduct in app stores (Bostoen 2020). Article 6c is of particular relevance for Apple. Article 6c would oblige Apple to "allow the installation and effective use of third party software applications or software application stores using, or interoperating with, operating systems of that gatekeeper and allow these software applications or software application stores to be accessed by means other than the core platform services of that gatekeeper" (European Commission, 2020).

The provision would effectively force Apple to employ a regime similar to that of Google and allow sideloading of apps and third-party app stores. As outlined earlier, Apple prohibits its users through software restrictions to install apps through other app stores or by directly downloading them from websites and locking its users and developers in.

The only commentary on the Article stems from a report from a panel of economic experts of the JRC. The report argues that "the Article 6(c) obligation to allow third-party app stores in the OS opens the possibility for price and quality competition between app stores. App stores with lower entry and aftermarket prices might attract more app developers and apps and erode the dominant position of the […] Apple App store" (Cabral et al., 2021). However, the report argues, "network effects around the dominant stores may however reduce the effectiveness of price competition" (Cabral et al., 2021). The latter argument aligns with the theoretical insights described before.

4.4 Summary and research question

Based on the theoretical insights gained in the theoretical chapters, it can be doubted whether the forced opening of the Apple ecosystem to sideloading and alternative app stores will lead to an increased contestability of the App Store and whether developers will consider other distribution methods to be feasible. The theoretical chapters have demonstrated that strong network effects, the status-quo bias and to some extent direct network effects led the two companies to an entrenched position on the mobile OS market and to a high degree of user lock-in. While the two dominant smartphone OS operators, Apple and Google, both rely on market phenomena such as network effects, Apple further increases user lock-in by technically restricting multi-homing. Google instead relies on market phenomena exclusively to lock in Play Store users. The DMA and Article 6c will force Apple to employ a policy similar to that of Android, which will allow sideloading and the use of third-party app stores. To assess whether the DMA will achieve its goal of increasing the contestability of app stores and create pressure on unfair conditions in app stores, Chapter 5 tests the following hypothesis and answers the subsequent research question.

Hypothesis: Because of a high degree of user lock-in in Google's Play Store, predominantly informed by network effects and the status-quo bias, Android users are unlikely to multi-home on app stores even though there are no technical restrictions for such behavior.

Research Question: To what extent can Article 6c DMA create a more competitive and fairer environment for app developers by encouraging European Apple users to employ distribution channels other than the App Store and thereby counter market forces such as network effects.

Because Android allows users to sideload, Android users provide for an excellent case study to estimate what user behavior can be expected from Apple users when Apple opens its operating system to sideloading and alternative app stores. To answer the main research question, a number of sub-research questions (SRQs) have been formulated:

SRQ1: To what extent does Google's reliance on market phenomena such as network effects and the status-quo bias lock users into the Play Store?

The empirical chapter has also demonstrated that discoverability is central to app developers and that "only users who are already familiar with an app and willing to look for it outside the Play Store will sideload it." (ACM, 2019, p. 48). To achieve the DMA's second policy goal of enabling app developers to use alternative distribution channels effectively, it is crucial to determine whether Play Store users multi-home through sideloading or through an alternative app store, prompting SRQ2.

SRQ2: Do Android users more often rely on sideloading or alternative app stores to capitalize on app store multi-homing?

To gain further insights into the market dynamics of a mobile app store ecosystems, the final SRQ probes the motives of app store users to multi-home or not.

SRQ3: What are the reasons Android users employ alternative app stores or not?

5 Methodology

To predict whether Apple users will use alternative app stores or will install apps through sideloading, this thesis investigates the extent to which Android users use app distribution channels other than Google's Play Store now through a survey of Android users. This chapter describes the study's research methodology, providing its delimitations, target population, survey design, data analysis, limitations, reliability, and ethical considerations. The survey aimed to evaluate the theoretical assumptions and the resulting hypothesis, thereby deriving conclusions on the probable effects of the DMA on the Apple ecosystem.

5.1 Delimitation

The survey targeted citizens and residents with an Android device in the European Economic Area (EEA). The EEA consists of the 27 Member States of the European Union and the three European Economic Area states (Iceland, Liechtenstein and Norway). These countries were selected because of EU competition policies; consequently, the DMA, when in force, targets the whole EEA and not only Member States of the EU. The DMA comes in the legislative form of a regulation and, according to the Article 288 Treaty on the Functioning of the EU, would be "binding in its entirety and directly applicable in all Member States." Furthermore, only Android users were allowed to participate in the survey, because the research focuses on Android users' engagement with alternative app distribution channels to the Google Play Store.

The survey was deliberately designed not to target Apple users because of difficulties arising from the hypothetical bias. The hypothetical bias occurs when respondents report unrealistic values or behavior predominantly in stated preference surveys (Buckell et al., 2020). According to Buckell et al. (2020), hypothetical bias connects to factors such as the non-binding character of stated preference settings. Because this survey was conducted entirely online, respondents would find themselves far removed from the actual setting in which they would make decisions in the real world (Buckell et al., 2020). Additionally, in hypothetical settings, respondents tend to answer surveys strategically (Buckell et al., 2020).

5.2 Target population

The target population refers to the entire population considered qualified for data analysis. In the survey, Android users of all ages from the European Economic Area were considered qualified.

Android users were selected as the target audience because the survey aims to discern to what extent Android users employ alternative app stores and sideloading. Because Apple users cannot presently make use of these practices, this population was excluded from the sample. Other operating system users, such as Symbian OS or Windows Phone, were not included because they represent only a marginal share of all phone and tablet users in the EU. In fact, 68.82% of Europeans use an Android device, while only 30.41% use an Apple device (Statcounter, 2021). Respondents whose survey response indicated that they were not using an Android or lived outside the EEA were directed to the end of the survey and were not statistically considered.

According to the Commission (2020), 72% of the EU-27 population used a mobile phone with internet connection in 2019. If a similar mobile device penetration also applies to the three other countries belonging to the EEA, which has a total population of 520 million inhabitants, around 374 million mobile phone users in the EEA can be expected. The mobile operating system market share of Android is at 68.86%. Applying this percentage to the EEA, one could expect 258 million Android users in the EEA. The sample size is 273 with a confidence level of 85% and a margin of error of 5%. With 231 successfully respondents, the survey fell short to that number by 42 responses.

5.3 Survey design

Provided in English and German, the survey was distributed through a variety of channels to reach the target audience. The survey begins with a brief introductory text on the nature of the research. Respondents were made aware that the survey was the central data collection tool for this research. To minimize the likelihood of strategic answering, no information was provided on the hypothesis developed in the theoretical framework of the thesis.

The survey was conducted in the form of an analytical cross-sectional study with a questionnaire containing 15 questions in total. Respondents who qualified for the survey were asked 12 multiple-choice questions and two Likert-scale questions. The questions were organized in two thematic blocks.

The first block asked for general information about the responders. After respondents were asked to indicate whether they were citizens of the EEA and users of a device running the Android operating systems, they were given the opportunity to identify their preferred gender identity, with the options male, female, transgender female, transgender female, gender variant/non-conforming and other, but respondents could refrain from answering this question. The next question asked about the age of the respondents. Respondents could choose between ages 0–17, 18–25, 26–35, 36–45, 46–55, 56–65 and 65 and older, but could also refrain from providing this data. The age of the respondents allows for important conclusions regarding demographically different effects of the legislation and enables to predict whether the impact of the legislation will change when the number of younger, and possibly more IT-literate members of society, grows. Similarly, the following questions that gave the option to disclose the education level allow one to draw conclusions regarding the impact on different shares of society divided by their educational background. IT-literacy was queried through two Likert scales in which respondents could express their confidence in operating technology.

The second block interviewed the respondents about their actual switching behavior. Respondents could indicate whether they had used a means of app installation other than the Play Store. First, the survey inquired whether respondents had ever made use of "sideloading." Sideloading was defined as the installation of apps through the browser or through file transfer from the PC, but not through an app store. Respondents who answered affirmatively were asked why they had sideloaded and were presented four answer options: First, respondents could indicate that they wanted to install an app that was not available on the Play Store. It can be expected that users sideload apps for a variety of reasons, predominantly to circumvent geo-blocking of apps and to redeem apps that were removed from the app store or that did not comply with Google's terms and conditions. The second option was sideloading to receive an app for free that was paid on the app store. The third was sideloading for privacy concerns, and the final option allowed respondents to provide their own reasons for sideloading. Users could provide multiple answers.

Respondents who indicated that they had not made use of sideloading were also offered four answer options: first, that they did not feel the need to sideload; second, that they were unaware it was possible; third, that they had security concerns; and fourth, that they had an independent reason, which they were then asked specify.

Consecutively, respondents were asked whether they had ever downloaded an app through an app store other than Google's Play Store. When a positive answer was given,

respondents had five options for response: first, that they used an alternative app store to download an app unavailable on the Play Store; second, that they downloaded an app for free through an alternative app store that was paid on the Play Store; third, that they wanted to download an app at a cheaper price than on the Play Store; fourth, that they made use of an alternative app store because their device was shipped with it; and finally, that they had their own reason and what it was.

If respondents indicated that they had not used an alternative app store on their Android device, four options were presented: first, that they did not feel the need; second, that they were unaware of any alternative app store; third, that they did not know how to use an alternative app store; fourth, that technical problems hindered them from downloading a necessary app; fifth, that security concerns prevented them from sideloading; and finally, that they had a reason of their own and what it was.

5.4 Data analysis

Following a simple frequency distribution, a chi-squared test was conducted, followed by a cross tabulation of relevant associations.

5.4.1 Frequency distribution

First, a simple frequency distribution was constructed to categorize and summarize the survey data. A frequency distribution is a tabular representation of the data. It serves to oversee the data conveniently and draw conclusions based on the visual representation. The frequency distribution was visualized in the form of tables, pie charts, bar charts and column charts.

5.4.2 Chi-squared test

A chi-squared test was run to test the statistically significant association between categorical variables, to check whether the demographic variables (Gender, Age, Education, Screen Time, technological literacy) correspond to the two means of multi-homing.

According to Pearson (1900), two assumptions must be passed. First, the two tested variables must be either ordinal or nominal, meaning that they cannot be ranked in any meaningful order. Second, the variables should have two or more categorical and independent groups. Both assumptions were met. All variables are measured on a nominal level, and all variables have two or more categories.

Consequently, 12 chi square tests were run, centering on the following hypotheses.

Null Hypothesis H_01: There is no statistically significant association between app sideloading and the demographic categorical variables (gender, age, education level, screen time, technological literacy, enthusiasm for technologies).

Alternative Hypothesis H_11: There is statistically significant association between “Side load an app” and categorical variables “sideloading of apps” and the demographic categorical variables (gender, age, education level, screen time, technological literacy, enthusiasm for technologies).

Null Hypthesis H_02: There is not statistically significant association between the “use of an alternative app store” and the categorical variables (gender, age, education level, screen time, technological literacy, enthusiasm for technologies).

Alternative Hypothesis H_12: There is statistically significant association between the "use of an alternative app store" and categorical variables (gender, age, education level, screen time, technological literacy, enthusiasm for technologies).

By running the chi-square test, the chi square value and the *p*-values were provided by SPSS. The null hypotheses were rejected if $p \leq .05$. The respective *p* was noted in a table together with the respective variables. Based on the association, cross tabulations were presented to derive further insights.

6 Results

This chapter presents the results of the study conducted among Android users. The chapter first offers a preliminary analysis of the sample's demographic information. It then presents the findings on sideloading and the use of alternative app stores, alongside graphical representations of the significant associations.

6.1 Preliminary analysis

A total of 231 respondents successfully answered the survey. Table 1 provides an overview over the distribution of demographic variables in the sample. The following figures illustrate the distributions.

Variables	*N*	%
Gender		
Female	97	39%
Male	126	50.60%
Transgender Female	1	0.40%
Transgender Male	1	0.40%
Other	1	0.40%
Prefer not to say	5	2%
Age		
0–17	4	1.60%
18–25	71	28.50%
26–35	60	24.10%
36–45	33	13.30%
46–55	32	12.90%
56–65	27	10.80%
66+	4	1.60%
Highest education level		
Secondary Education	31	12.40%
Vocational Education	50	20.10%
Undergraduate Education (Bachelor's or equivalent)	82	32.90%
Postgraduate Education (Master's, PhD or equivalent)	58	23.30%
Prefer not to say	10	4%

Table 1: Frequency distribution of demographic variables

The frequency distribution analysis shows that half of the sample was male (55%), followed by 42% female. Two percent preferred to not indicate their gender, while one

respondent (0.4%) each indicated being transgender male, transgender female, or belonging to the “other” category.

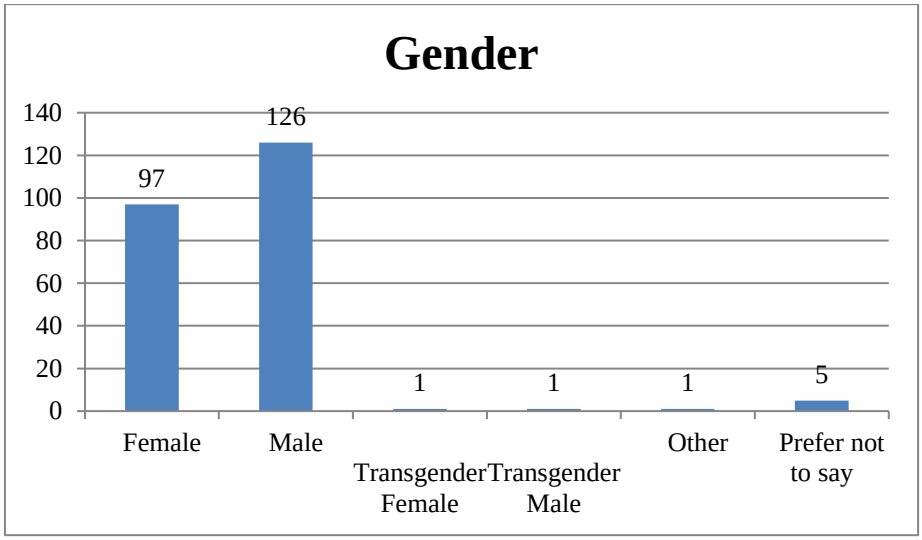

Figure 1: Gender distribution

In terms of age, 29% of the respondents were 18–25, 24% were 26–35, 13% were 36–45, 13% were 46–55, and 11% were 56–65. Few respondents of 0–17 or over 66 answered the survey.

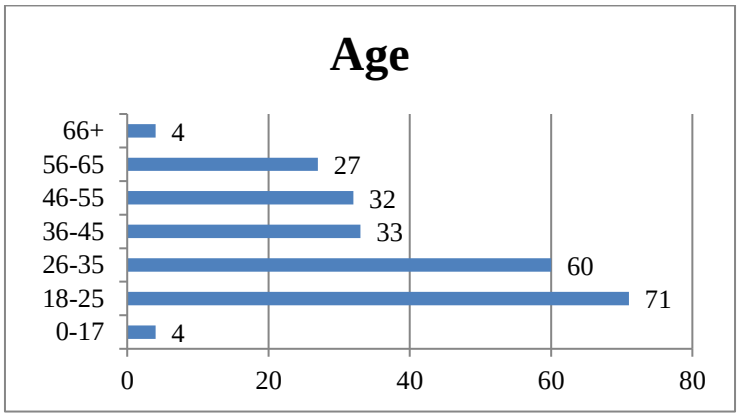

Figure 2: Age distribution

Regarding education level, most respondents (33%) indicated that they had completed an undergraduate education, while 23% had completed postgraduate education and 20% had completed vocational education. Twelve percent of respondents had completed only their secondary education.

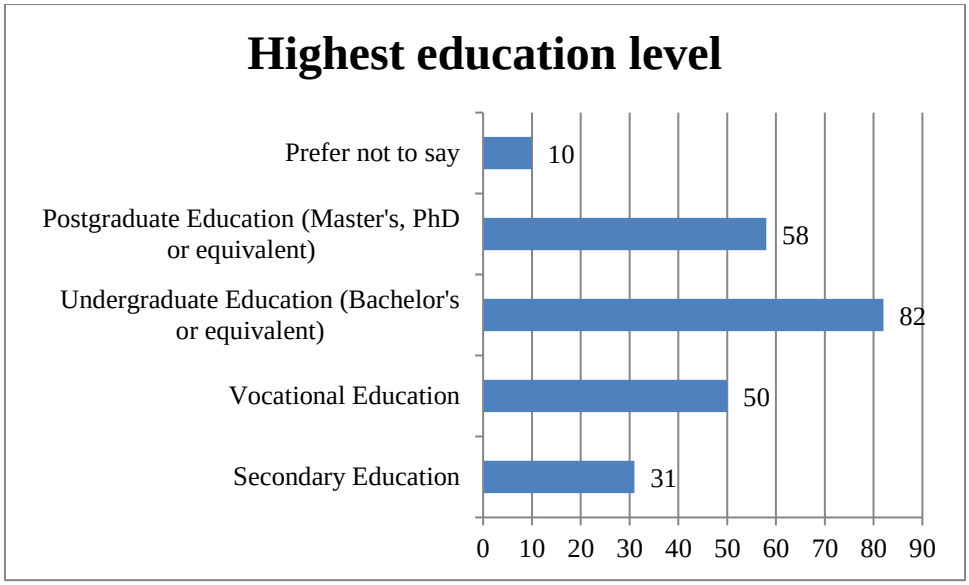

Figure 3: Education level

Respondents were very positive regarding how well they handle technology without assistance and how enthusiastic they are about new technologies. Nearly three-quarters of respondents positively reported, in varying degrees of agreement, that they were "enthusiastic about new technologies." Similarly, more than 70% were confident handling new technology without assistance.

Variables	*N*	%
Screen time		
0–60 min	37	14.90%
1–2 h	68	27.30%
3–4	76	30.50%
4–5 h	35	14.10%
6–7 h	12	4.80%
Prefer not to say	3	1.20%
Enthusiastic for new technologies		
Strongly agree	56	22.50%
Agree	61	24.50%
Somewhat agree	63	25.30%
Neither agree nor disagree	20	8%
Strongly disagree	2	0.80%
Somewhat disagree	23	9.20%
Disagree	5	2%

Variables	*N*	%
Handle technologies without assistance		
Strongly agree	79	31.70%
Agree	76	30.50%
Somewhat agree	30	12%
Neither agree nor disagree	15	6%
Strongly disagree	3	1.20%
Somewhat disagree	18	7.20%
Disagree	9	3.60%

Table 2: Technology usage

6.2 Use of sideloading and alternative app stores

The most striking result to emerge from the gathered data is that more than 50% of all respondents have made use of sideloading. This finding contradicts the hypothesis established in the methodology chapter, which expected a significantly lower share of respondents to employ distribution channels other than the Google Play Store.

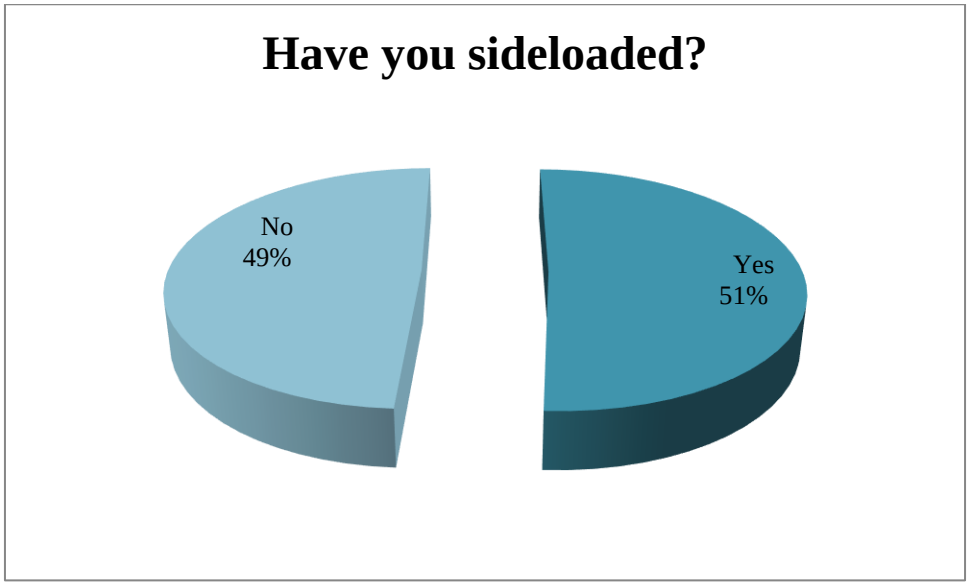

Figure 4: Sideloading

Respondents reasons differed. More than 80% of those who had sideloaded wanted to install an app unavailable on the app store. More than 30% wanted to receive an app for free that was paid on the Play Store. Eleven percent sideloaded for privacy reasons, while 12% stated “other.”

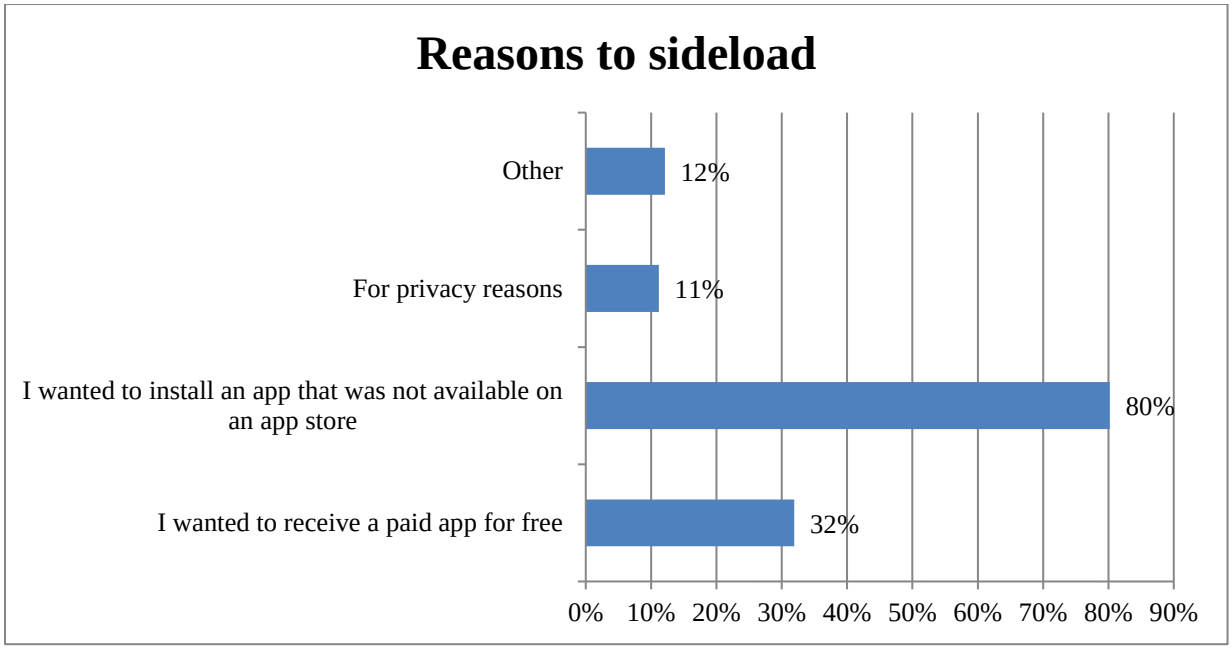

Figure 5: Reasons to sideload

Android users who have not sideloaded apps most commonly did not feel the need to (66%), while more than 40% indicated that they were unaware of this possibility. Around 20% of the sample had security concerns, while 3% stated another reason.

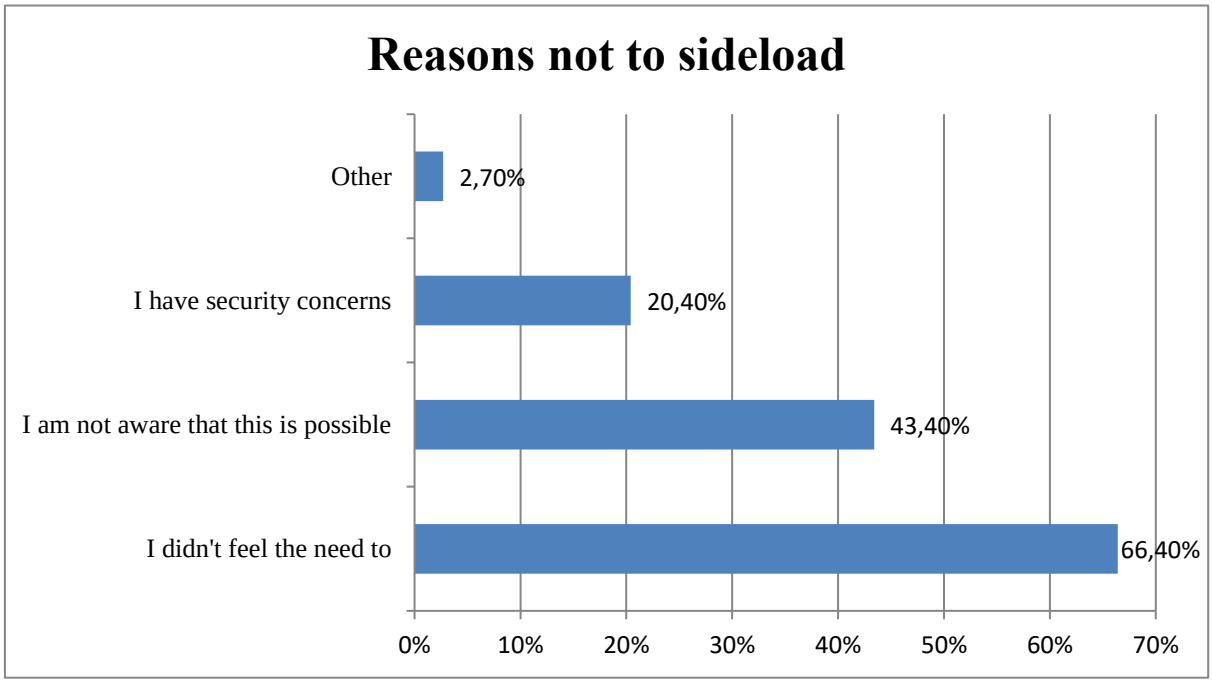

Figure 6: Reasons not to sideload

Conversely, the share of the sample that has made use of an alternative app store was significantly lower. Less than one-quarter (24.6%) of the sample surveyed indicated that they have ever made use of an alternative app store. This response supports the hypothesis

established in the methodological chapter that expected significantly fewer respondents to have utilized app stores alternative to the Google Play Store.

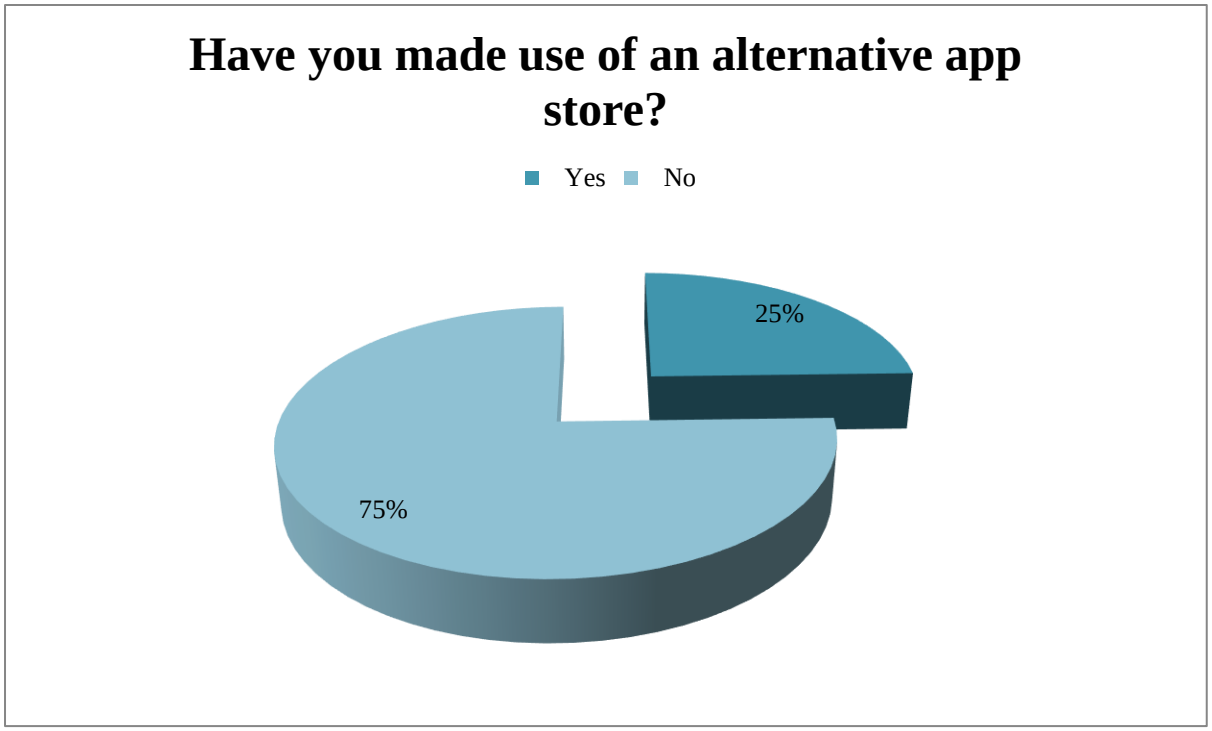

Figure 7: Alternative app store usage

The finding that most Android users do not use alternative app stores is further affirmed by the reasons alternative app stores were used. A large share (38%) made use of an alternative app store because the device was shipped with a different app store pre-installed. Thirty-six percent indicated that they downloaded an alternative app store because they sought to download an app unavailable on the Play Store, while 29% indicated that they wanted to download an app that was paid on Google's Play Store but available for free on an alternative store.

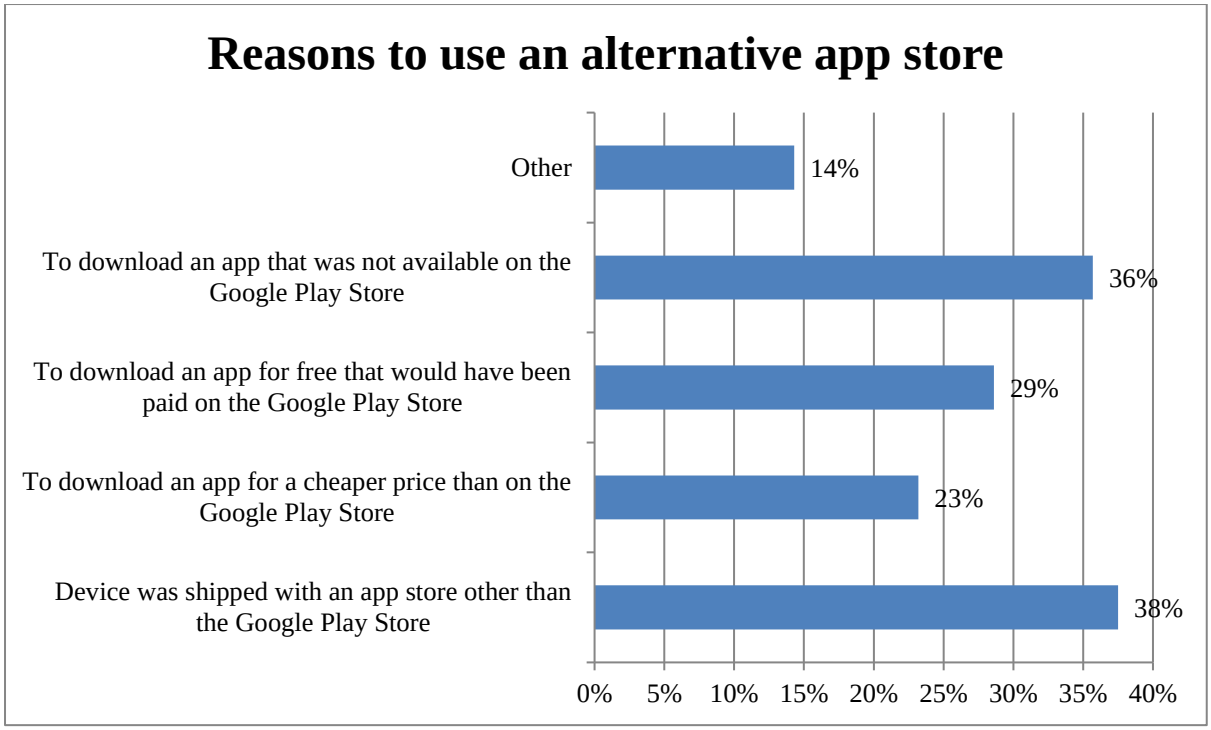

Figure 8: Reasons to use an alternative app store

When respondents were interviewed regarding the reasons they do not use an alternative app store, the overwhelming majority (68%) indicated that they did not feel the need. Nearly 40% indicated that they did not know alternative app stores existed, while only 10% indicated that they did not know how. A mere 2% had security concerns.

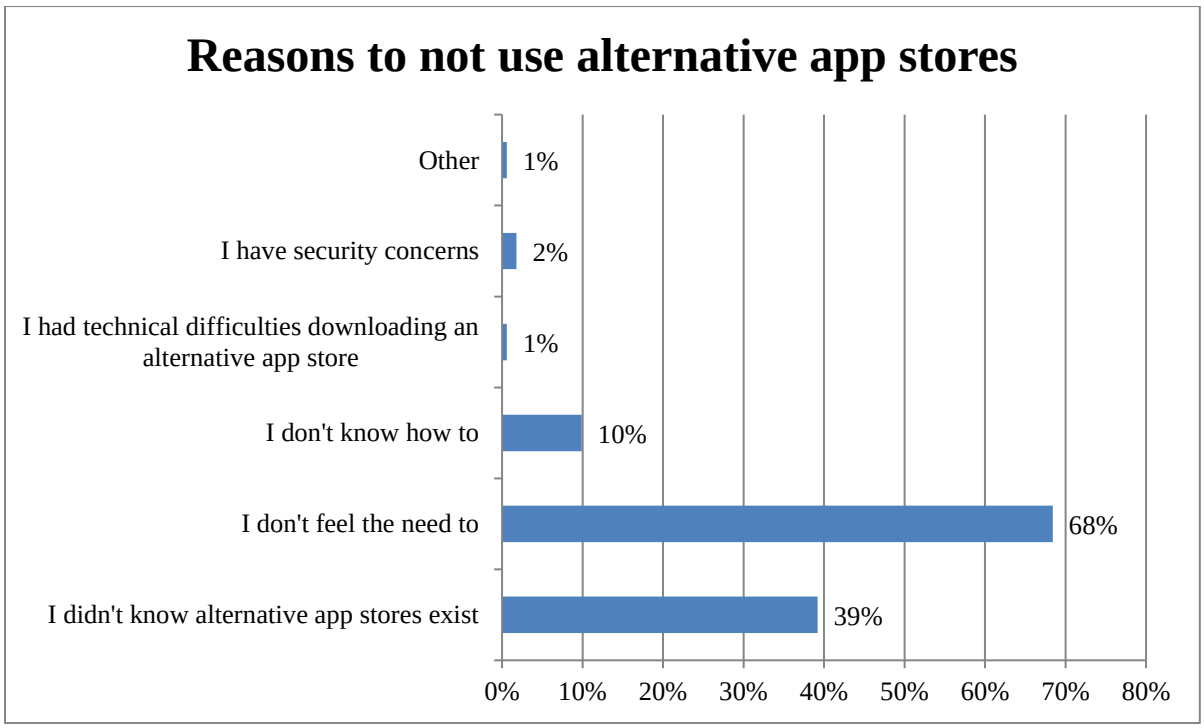

Figure 9: Reasons to not to use alternative app stores

6.3 Chi-squared analysis

By running the first six Chi square tests, a significant association between "sideloaded an app" and gender ($p < .001$), age ($p = .0008$), enthusiasm for new technologies ($p < .001$) and digital literacy ($p < .001$) was found. No significant association could be identified between "sideloaded an app" and "education level" and "screen time."

The second six chi-squared test demonstrated a statistically significant association between "use an alternative app store" with "age" ($p = .014$), but none with "gender" ($p = .461$), "education level" ($p = .584$), "screen time" ($p = .846$), "enthusiasm for new technologies" ($p = .099$) and "digital literacy" ($p = .291$).

The following cross-tabulation showed that significantly more men sideload apps than women. Of the responses indicating experience sideloading, 73.5% were given by males, while only 23.9% by females.

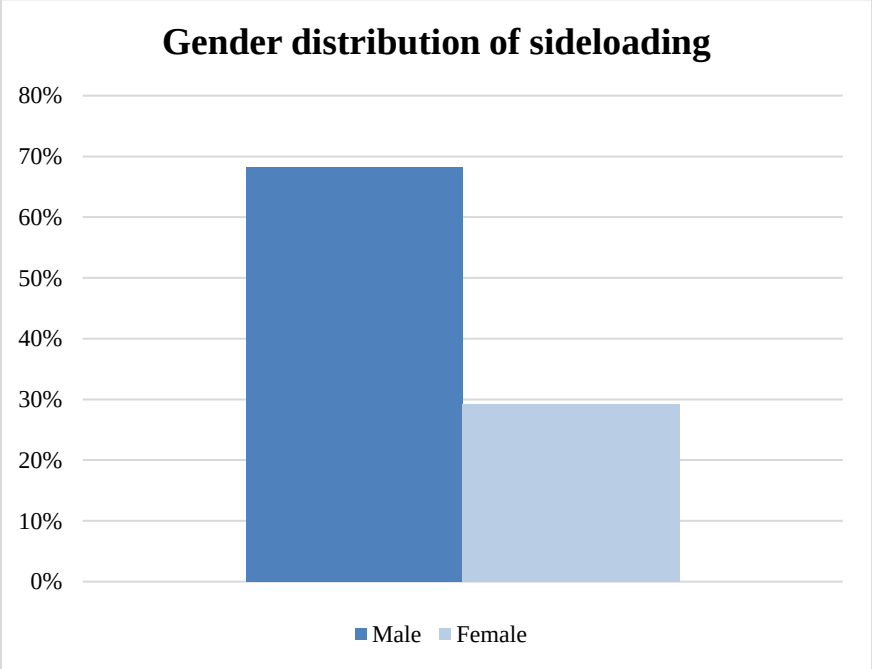

Figure 10: Gender distribution of sideloading

Sideloading was most common among young and middle-aged respondents. While 75% of 0–17-year-olds indicated that they had sideloaded ($n = 4$), only 25.9% in the age bracket 56–65 indicated that they have made use of sideloading. Among the over 66-year-olds, this percentage dropped to zero.

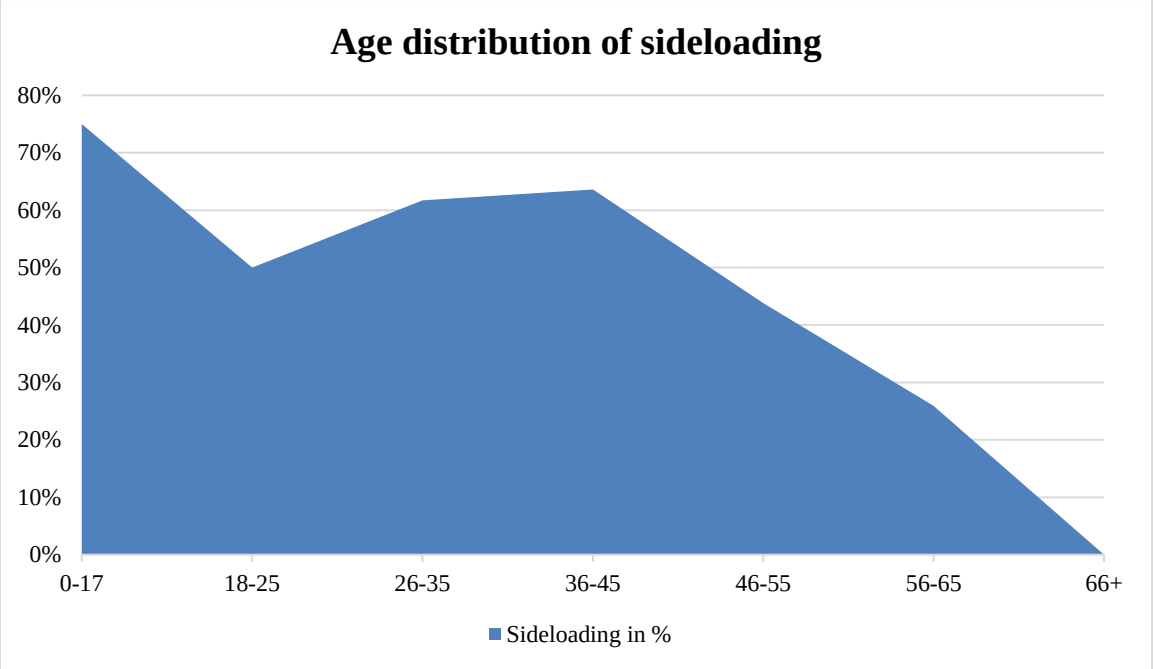

Figure 11: Age distribution of sideloading

The age structure among alternative app store users differs. The highest share of users of alternative app stores is among the 36–45-year-olds (48.5%), followed by the 26–35-year-olds (27.1%).

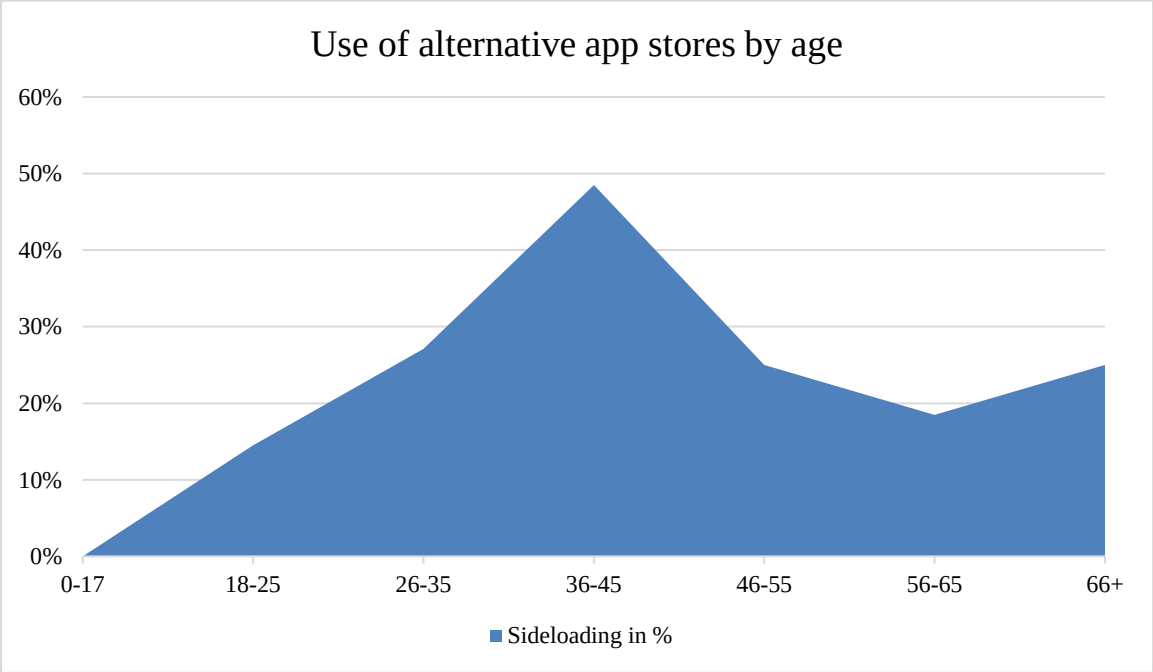

Figure 12: Use of alternative app stores by age

A similar pattern can be identified in the relationship between sideloading and the respondent's enthusiasm for new technologies. Among the respondents who strongly agreed with the statement that they are enthusiastic for new technologies, 73.2% had sideloaded, while 44.4% of respondents who agreed somewhat with the statement sideloaded, along with 21.7% of the respondents who somewhat disagreed.

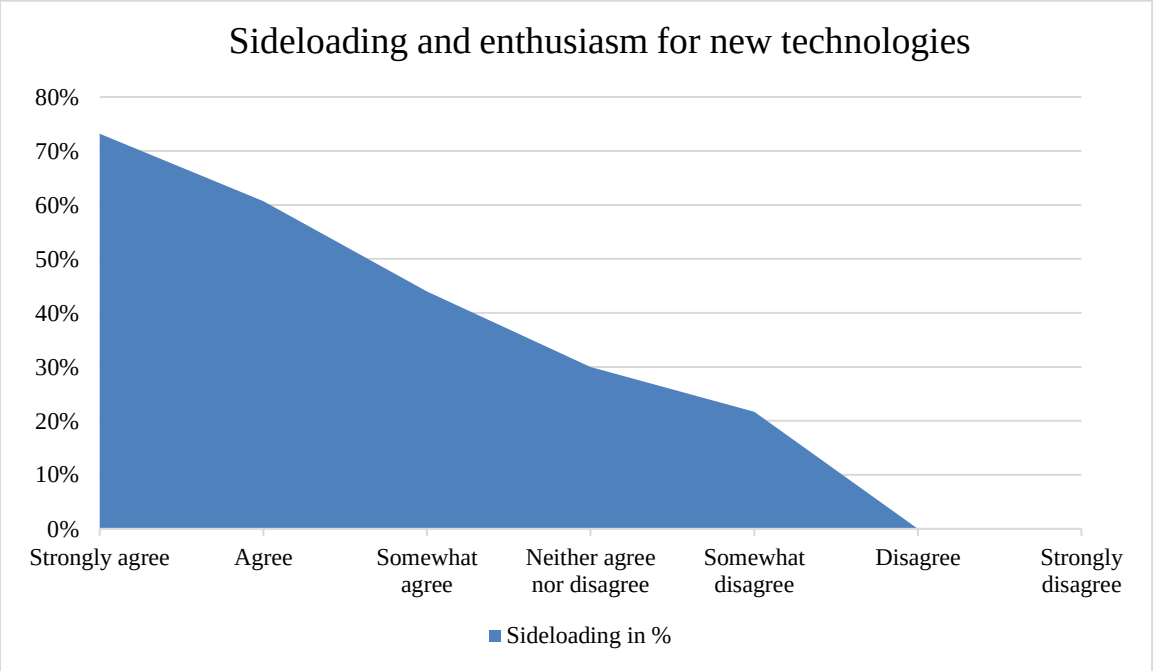

Figure 13: Sideloading and enthusiasm for new technologies

7 Discussion

This chapter evaluates the primary findings, discussing whether the results support the hypotheses. Correlations and patterns are identified, and alternative explanations for certain unexpected results are provided. Finally, several policy options are provided aiming to assist EU policymakers in designing digital competition tools that consider the findings of the study and react to market dynamics adequately.

The most interesting finding of the study was that more than half of respondents had sideloaded, while only a small minority had used alternative app stores. This finding contradicts the hypothesis that because of a high degree of user lock-in at the Play Store, predominantly informed by network effects and the status-quo bias, Android users are not multi-homing on app downloads.

The high number is explained by the reasons users had sideloaded. More than three-quarters had done so to receive an app unavailable on the Play Store. An implication is that sideloading was chosen only as an alternative because searching for an app in the Play Store did not yield the targeted result. Here lock-in effects are intact, because users first consulted the Play Store and only then chose sideloading as an alternative.

Apps can be unavailable on the Play Store for various reasons. For example, certain app developers have opted not to distribute their apps globally. Google allows app developers to target their apps only to certain countries, for example if an app does not work in a certain region because of legal rights issues or to maintain clarity for users ("geo-restricting") (Google, 2021). For example, the Dutch video streaming service Videoland distributes its app only to Android users with a BeNeLux regional setting, because users outside this region cannot watch the content. The fact that a user "must be in that country and have a payment method from the new country" to change the Play Store's regional settings, which is possible only once each year, makes it even more difficult to download geo-restricted apps through the Play Store (Google, 2021). As a result, it can be expected that Android users then opt to sideload the app instead.

Another scenario could involve a user's intention to install an app removed from the Play Store or not approved by Google for distribution through the App Store. A famous example of an app removed from the App Store is the widely consumed Fortnite, which was made available to be sideloaded by the developer after Google removed it from the Play Store for not using Google proprietary in-app purchase system, through which a 15–30% commission

goes to the tech giant (Needleman, 2020). Millions are expected to use sideloading to receive the app after Google dropped the app from its Play Store. Users are also expected to sideload to install apps that did not pass Google's strict Play Store authorization procedure. Examples include Hunk.tv, an app that allows the user to stream copyrighted movies and series for free, or YouTube Vanced, an app that enables users to download YouTube Videos, a practice users usually have to pay for in the official YouTube app.

The nevertheless unexpectedly high number of respondents who sideloaded can also be partially explained by the limitations of the survey, first and foremost by a limited representativity of the sample. First, making use of alternative means of app download on the Android platform requires a level of technological literacy, requiring one to put a check mark in the right spot in the system settings. Because the survey was conducted exclusively online, among young respondents with a high level of tech-literacy, it can therefore be assumed that respondents were more literate in internet technologies and therefore might have been more likely to discover alternative means to download apps. This notion is supported by the responses indicating tech literacy among respondents. Almost three-quarters at least somewhat agreed with the statement that they are enthusiastic for new technologies and that they handle technologies well without assistance.

Furthermore, it is also assumed that after entry into force of the DMA, Apple's iOS will provide for a similarly easy installation process as that of the Android system. However, while the proposal for a DMA clearly mandates the allowance of "the installation and effective use of third-party software applications or software application stores using, or interoperating with, operating systems of that gatekeeper and allow these software applications or software application stores to be accessed by means other than the core platform services of that gatekeeper," it can be expected that Apple will try to circumvent switching to sideloading or to a third-party app store by other means, such as hidden settings or prominent warnings (European Commission, 2020). If Apple manages to successfully deter iOS users from employing alternative means of app download with, for example, more obfuscating system settings, this approach would limit the ability to draw conclusions from Android users to Apple users.

It can therefore be expected that the number of people who sideloaded or made use of a third-party app store is lower than depicted in this study.

Based on these findings, it can therefore be doubted whether the user's ability to sideload will benefit app developers on the Apple system once sideloading will be permitted,

because most users nevertheless first consult the proprietary app store to look for apps. While some increase in sideloading can nevertheless be expected, as the study shows, it can be doubted whether the possibility to sideload will benefit app developers because of several disadvantages of sideloading vis-à-vis app store downloads that are particularly crucial for smaller app developers.

First, the ability of users to sideload apps is likely to benefit already-prominent app store developers predominantly only because they do not rely so heavily on their app discoverability. According to the ACM study presented in the theoretical chapter (2019, p. 22), "Discoverability is the degree to which (in this case) an app can be found or discovered by consumers. Discoverability is a concern for app providers since apps cannot be used if consumers cannot find it." According to the ACM study (2018), this challenge is especially difficult for app developers who do not have big brand awareness, because they depend on the discoverability of app stores. While small developers will suffer most from the discoverability issue, the example of the removal of *Fortnite* from the app store also demonstrates that big developers with high brand awareness rely on discoverability.

Second, sideloading is likely to increase the number of illegal app downloads. The survey revealed that one-third of respondents who sideloaded did so to receive a paid app for free. This suggests that sideloading is frequently misused to install pirated apps. A plethora of websites (e.g., apk4free.org) exist allowing Android users to download and install apps distributed for a fee on the Play Store. According to Koetsier (2017), app store developers lose 3–4 billion dollars per year due to app pirating. Smit (201) expects 15–20% of all app installations to be pirated apps. Due to the open nature of the Android platform, the problem is significantly more prevalent on it, and "27 percent of developers believe piracy in Android is a huge problem, with more than three-quarters saying that it's easy to copy and republish an Android application" (Cheng, 2011). Especially small developers, who do not have enough resources to fight the piracy of their apps, struggle with illegal app downloads (Walter, 2015).

In terms of alternative app stores, the hypothesis expecting a relatively small share of multi-homing among Android users was confirmed. Less than a quarter of Android users have made use of an alternative app store. Only 25% of the respondents have made use of an app store other than the Play Store. Here strong network effects can be observed that lead to the low acceptance rate of alternative app stores.

In view of the reasons why respondents have made use of alternative app stores, the prevalence of the status quo-bias becomes even more apparent, because the largest share of

respondents (38%) indicated that they used an alternative app store, as their device was shipped with a different app store preinstalled. The number of Android users with a different app store pre-installed has most likely increased since the US Technology ban on Huawei forced Google to seize business with the company in May 2015, resulting in Huawei being unable to pre-install the Play Store on its devices (Brown, 2021). Additionally, the fact that most respondents who used an alternative app store did so because their device came with a different app store pre-installed leads to the expectation that, on the Apple platform, the share of people who will actually use an alternative app store will be even lower, because all Apple devices will come with the Apple App Store pre-installed, since the company also produces the hardware.

As for sideloading, the second most common reason Android users have made use of an alternative app store was to download an app unavailable on the Google Play Store. It can be expected that Android users have made use of app stores that do not follow a strict geo-restring policy or list apps that have been removed from the Play Store. Similarly, sideloading app stores have also been used to download paid apps for free. This leads to the assumption that among users who make use of alternative app stores, these are often consulted to download pirated apps.

With respect to the reasons Android users have not made use of sideloading, almost 70% of respondents indicated they did not feel the need to consult an alternative app store or that they were unaware of alternative app stores. As described extensively in the methodological chapter, indirect network effects lead to exponential growth on both sides of the market, making market participants on both sides of the market favor one platform. Technical barriers to installing a third-party app store played only a subordinate role here.

Certain of the demographic findings presented in the results chapter are notable. It was remarkable that sideloading was significantly more common among male respondents. Simultaneously, younger and more tech-enthusiastic respondents were more prone to sideload than were older respondents and those who indicated they were not tech savvy. This shows that sideloading is more common among younger generations, who are also more likely to sideload. Unsurprisingly, the younger generations tend to apply alternative means of download more often because large shares of them are digital natives. With the time, more people can be expected to multi-home in app-downloading because digital natives will eventually displace older generations consisting of digital immigrants.

The study conducted has shown that a strong degree of lock-in within the app ecosystem can be observed on the Android platform, despite the lack of technical restrictions preventing Android users from multi-homing on app downloads, as is currently in place on Apple devices.

Two predictions for the Apple platform can be made. First, some users are expected to make use of sideloading when the operating system is opened. This number will likely be lower on the Apple system than it is on the Android, because it is unlikely that the company will ship its devices with other app stores pre-installed. It can be doubted whether the ability of Apple's users to sideload will benefit app developers because of an expected increase in app piracy and the lack of discoverability suffered by small app developers.

Second, it can be expected that only a small percentage of Apple users will migrate to a different app store. It cannot be expected that Apple will allow third-party app stores to come pre-installed on its devices, leading to the expectation that an even smaller share of Apple users will multi-home in app stores, as compared to on the Android platform. Since age significantly influences multi-homing rates, it can be expected that this dynamic will change with the time, requiring a follow-up study.

A first follow-up study should be conducted once Apple is obliged to open its operating system to confirm the findings of the study presented in this thesis. A second study should be conducted 10 years after Apple has opened its operating system to determine whether the implications resulting from different multi-homing behavior in younger age brackets changed the dynamic in general.

Recommendations

Based on the insights generated by the study, certain policy recommendations can be established that would improve the effect of Article 6c on the competitive landscape of the app ecosystem.

First, to improve the visibility of alternative app stores and to counteract the network effects active in the field, the Commission should consider mandating Apple (and Google) to let device users choose to set their preferred app store when setting up the device for the first time. Microsoft was obliged to follow similar rules after a 2009 Commission decision to provide "a 'Choice Screen' enabling users of Windows XP, Windows Vista and Windows 7 to choose which web browser(s) they want to install in addition to, or instead of, Microsoft's browser Internet Explorer." If Apple users could select alternative app stores instead or in addition to the App Store, the visibility of third-party app stores would likely increase alongside

the number of Apple users who use a third-party app store. The potential of choice screens on mobile devices is currently explored by the Australian competition watchdog ACCC (ACCC, 2021)

Second, for alternative app stores to gain traction, they must have at least the same features as the proprietary app store. It must, for example, be possible for a third-party app store to update apps downloaded through the alternative store. A corresponding article should be included in the DMA to prevent Apple from discouraging users from using alternative app stores by introducing unfair conditions for them to operate in and by making them less attractive for Apple users to switch to. An alternative app store should be given the same rights as the proprietary app store to create a level playing field and fair conditions between the incumbent and the competitors.

Third, the Commission should initiate the advancement of the development of Progressive Web Apps (PWA). PWAs are web applications that work on the basis of HTML5, CSS3 and JavaScript and do not require installation through an app store but are run through the browser. Already today, PWAs exist that load instantly, function offline, support push notifications, self-update, and have an app launch portion from a mobile phone's home screen. PWAs have multiple advantages over classic apps that must be installed on a device (Anderson & Addie, 2021). Because PWAs are delivered through the browser and do not require installation through an app store, they run on most platforms with a web browser and receive no scrutiny from the gatekeeper. Purchases done through a PWA are not wired through the app store operator, and app piracy is reduced due to the web-based character of the apps. The Commission could mandate gatekeepers to grant PWAs corresponding hardware rights with native apps and increase the development of PWAs through targeted training programs.

8. Conclusion

This research aimed to determine to what extent the DMA can increase the competition with the Apple App Store and create pressure on unfair conditions in app stores by encouraging European Apple users to make use of distribution channels other than the App Store. By instrumentalizing a current app store's multi-homing behavior among Android users, the study shows that the effect of the DMA on the competitive landscape within the app store ecosystem is most likely to be limited. It can be expected that sideloading will increase to a limited extent, but it can be expected that sideloading will be misused frequently for piracy. Furthermore, app distribution through sideloading is not feasible for smaller app store developers due to issues related to discoverability. The study has also showed that only small share of Android users employs alternative app stores, and many of those who do, are using an alternative app store that comes pre-installed with their phone. While it is unlikely that Apple will ship its devices with different app stores pre-installed, it can be expected that alternative app stores will not find high acceptance rates when Apple make available alternative app stores.

The empirical chapter has largely confirmed the expectations established by the theoretical chapter. Market dynamics such as network effects and the status-quo bias were expected to be strong enough to lock mobile phone users into a proprietary app store without imposing technical restrictions. Multi-sided digital markets are characterized by the presence of high indirect network effects, high multi-homing costs, strong direct network effects and little platform differentiation. Both Google's Play Store and Apple's App Store inhibit most of those key characteristics. They connect users of Android and iOS systems with app developers, and the strong interdependence of these two groups creates indirect network effects that significantly increase the overall popularity of the devices on which they run. On mobile operating systems, an end user of an app store benefits from numerous app developers due to the choice and competition on the other end of the market. This advantage led to a strong degree of entrenchment of both the Android and the iOS platform. Because of a large market population on both sides of the Play Store, both app developers and Android users concentrate on the proprietary app store to distribute or retrieve app stores, reducing the need for alternatives.

With the DMA, the Commission has successfully identified the anti-competitive dynamics active in the app store ecosystem and, with the proposed Article 6c, it addresses the user lock-in into proprietary app stores by mandating Apple to allow installation from apps outside Apple's App Store. However, the study suggests that the chosen policy instrument is

reacting to the market dynamics insufficiently. The results stemming from the empirical chapter indicate that the phenomena outlined in the theoretical chapter are strong enough to prevent users from multi-homing even if no technical restrictions to do so are imposed. While at first glance, a relatively large number of respondents sideloaded, these findings were put into perspective by the reasons for doing so and the limitations of the study. Simultaneously, despite the limitations of the study, Android users are not frequently making use of alternative app stores. It must be pointed out that especially smaller app developers depend on app stores, due to discoverability that can be achieved only when their apps appear in an app store.

Article 6c of the DMA should be sidelined with other policies that promote the use of alternative app stores. Therefore, introducing a mandatory choice screen when Apple users set-up their operating system would be a suitable option to increase the acceptance of alternative app stores and create competition between app stores that will create pressure on the unfair conditions present in the App Store.

Further research can be done to evaluate the findings of this study by conducting a survey similar to this study's Android user survey, but among Apple users and after the tech giant has opened its operating system to sideloading and alternative app stores.

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