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# Big Tech Acquisitions – Towards Empirical Evidence\*

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## Key Points

- The current policy discussion over big tech acquisitions debates whether merger control needs to be updated to account for the particular features of digital industries.
- Empirical evidence on the competitive effects of big tech acquisitions is still scarce.
- Based on product-level data from the Google Play Store, we find that half of the acquired apps are discontinued, while continued apps become free of charge but request more privacy-sensitive permissions post-acquisition.
- To fully evaluate the competitive effects of big tech acquisitions, it is necessary to study the impact on competing apps as well as potential spillovers to competing developers' other apps.

## 1 Introduction

Big Tech, commonly associated with the firms Google, Apple, Facebook, Amazon, and Microsoft (GAFAM), makes up the most valuable companies worldwide in 2020. In the ten years leading up to 2020, these five companies alone acquired more than 400 firms, predominantly in

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the technological sector.<sup>1</sup> However, most of these transactions were not scrutinized by competition authorities as they did not reach the traditional turnover thresholds, while those reviewed were not blocked following current merger control procedures. Prominent examples include the Google/YouTube, Facebook/Instagram, Facebook/WhatsApp, and Microsoft/GitHub mergers.

As a result, a number of policy reports voice their concerns about the competitive effects of such acquisitions that target potential competitors but fly under the radar because of the features and challenges of the digital economy.<sup>2</sup> In particular, firms in the digital economy often start to monetize only once they have acquired a large user base, thus not meeting current turnover thresholds for merger investigation.<sup>3</sup> Furthermore, digital industries are typically characterized by multi-sidedness, (indirect) network effects, access to data raising privacy issues, and often zero prices on one side of the market (typically the user side). Competition is then often about non-price outcomes, such as quality of service, data collection, and innovation. Consequently, some of these reports conclude that merger control enforcement needs to be updated to properly account for these particular features.<sup>4</sup> Germany, as one example, already considers the transaction value of the acquisition and in 2021 gave the competition authority power to intervene and prohibit abusive practices when a company has a paramount significance for competition across markets. Other authorities, like the Federal Trade Commission in the United States, announced that they will review all acquisitions made by Big Tech in the past, irrespective of their size.

Besides the discussion about the necessity to update current merger control, authorities are also starting to implement *ex ante* regulation of dominant digital platforms to complement antitrust intervention and restore competition in digital markets. In late 2020, the European Commission presented its proposal for the Digital Markets Act (DMA) containing behavioral obligations for large online platforms (so-called 'gatekeepers') aimed at reducing entry barriers and ensuring fairness in the relationship between the platform and its different user groups. The United Kingdom recently announced that it will set up a Digital Markets Unit within the Competition and Markets Authority (CMA) to enforce a new code of conduct applicable to platforms with considerable market power (digital businesses with so-called strategic market status), forcing platforms to be more transparent about the services they provide and how they use consumers' data. The proposal also requires firms with strategic market status to report all acquisitions to the CMA.

A particular case in point for these acquisitions is the market for mobile applications. In 2020, consumers spent 110 billion US dollars on the two major app platforms, while worldwide

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<sup>1</sup>Jason Furman and others, 'Unlocking Digital Competition' [2019] Report of the Digital Competition Expert Panel.

<sup>2</sup>OECD, 'Start-Ups, Killer Acquisitions and Merger Control' [2020] OECD Background Note; Australian Competition and Consumer Commission, 'Digital Platforms Inquiry' [2019] Final Report; Jacques Crémer, Yves-Alexandre de Montjoye, and Heike Schweitzer, 'Competition Policy for the Digital Era' [2019] Final Report for the European Commission Directorate-General for Competition; Furman and others (n 1); Fiona Scott Morton and others, 'Committee for the Study of Digital Platforms: Market Structure and Antitrust Subcommittee' [2019] Stigler Center for the Study of the Economy and the State.

<sup>3</sup>Massimo Motta and Martin Peitz, 'Big Tech Mergers' [2020] Information Economics and Policy 100868.

<sup>4</sup>See, for example, Elena Argentesi and others, 'Ex-Post Assessment of Merger Control Decisions in Digital Markets' [2019] Document prepared by Lear for the Competition and Markets Authority.

mobile advertising revenue amounted to close to 200 billion US dollars.<sup>5</sup> Examples include the large takeovers of WhatsApp and Instagram by Facebook. While the former acquisition led to Facebook being fined by the European Commission for combining user data, the latter has been in the spotlight of the Big Tech hearing in the US House Judiciary Committee suggesting that one intention of the acquisition was to eliminate a potential competitor. Other prominent examples involve acquisitions of popular apps that were discontinued in the aftermath, such as Microsoft shutting down Wunderlist. However, the majority of acquisitions involve apps that are small and rather unknown. All of these acquisitions take place in a market that is, in principle, characterized by a competitive and dynamic environment with many apps and developers being active. This suggests that acquisitions will not only have an impact on the acquirer and the acquired firm, as often suggested by the current debate, but also on competitors.

Because of these features that are representative for many digital markets,<sup>6</sup> we study big tech acquisitions in the Google Play Store. Specifically, we look at the acquirer's strategy and the development of the acquired app in terms of prices, data collection, and innovation.

Based on comprehensive lists of all GAFAM acquisitions from 2015 to 2019, we identify more than 50 app acquisitions in the Google Play Store. We then match these with a comprehensive dataset covering almost all apps in the Google Play Store. This allows us to not only observe the acquired apps along with GAFAM as a developer, but also many competing apps. Relevant outcomes include app and in-app prices, updating behavior, and requested privacy-sensitive permissions. To the best of our knowledge, we are the first to empirically study the effects of big tech acquisitions based on a product-level dataset in a very important online market.

We find that half of the acquired apps are discontinued, which tend to be smaller, less frequently updated, and less privacy-intrusive than acquired apps that are continued. Following the acquisition by GAFAM, the monetization strategy seems to change as apps become free of charge but request more privacy-sensitive permissions. Compared to the whole Play Store, GAFAM seems to target more attractive apps, e.g., with respect to updating, data collection, and demand.

However, we cannot fully evaluate the competitive effects of big tech acquisitions by only looking at the acquirer and the target, as we must also take into account the impact on competing firms as well. In particular, in case of multi-product firms, one also has to consider potential spillovers to other markets. In future research, we aim to additionally study how GAFAM app acquisitions affect competing apps as well as potential spillover effects to other apps of competing developers.

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<sup>5</sup>See, for example, <https://sensortower.com/blog/app-revenue-and-downloads-2020> and <https://www.statista.com/statistics/303817/mobile-internet-advertising-revenue-worldwide/>.

<sup>6</sup>Cabral (2020) argues that digital industries are typically characterized by many smaller firms that compete with one or two dominant firms such as Google, Apple, or Facebook (see Luis Cabral, 'Merger Policy in Digital Industries' [2020] Information Economics and Policy 100866).

## 2 Literature on Big Tech Acquisitions

The literature on the competitive effects of big tech mergers or acquisitions is predominantly theoretical. It is often motivated by the example of incumbent high-tech companies buying up start-ups feared to be emerging or potential competitors. Typical features of digital industries include (direct and indirect) network effects, multi-sidedness, free provision of a service to one side of the market (while typically the advertising side pays), and the importance of data. On the side of the market that does not pay for the product or service, competition is then often about non-price outcomes, such as the quality of service, data collection, and innovation. Accordingly, research on big tech mergers or acquisitions mainly focuses on innovation rather than price effects, while data is not traditionally at the core of most of the analyses.

For these digital industries, Motta and Peitz (2020)<sup>7</sup> provide an overview of competitive effects of such acquisitions along with several theories of harm resulting in a call for stricter merger control. The theoretical model, in which an incumbent can acquire a potential competitor, highlights that the competitive effects of the acquisition depend on the likely counterfactual: if the start-up has the ability to pursue its project absent the merger, the acquisition is always anti-competitive. The acquisition can only be pro-competitive if the potential competitor is unable to pursue the project absent the merger and if the incumbent has an incentive to develop the project following the acquisition. Instead, Cabral (2020)<sup>8</sup> provides a more cautious note, highlighting the importance of technology transfer through acquisitions and the discouragement of entrants' innovation incentives due to strict merger policies. In particular, Cabral (2020) argues that digital industries are characterized by high uncertainty about where the next competitive threat comes from, which lowers the preemption motive for acquisitions. Rather, due to poorly working markets for technology transfer, acquisitions are a means for incumbents to appropriate complementary technology. If this technology is worth more in the hand of the incumbent, the higher acquisition price generates innovation incentives for entrants in the first place.

This relates more broadly to studies on incentives to innovate for both the incumbent and start-up with an intervening competition authority. Letina, Schmutzler, and Seibel (2020)<sup>9</sup> show that a prohibition of acquisitions leads to reduced innovation efforts and, as a result, the authors argue that acquisitions should rather be challenged in industries where innovation effects are considered small to justify enhancing competition. In contrast, Fumagalli, Motta, and Tarantino (2020)<sup>10</sup> show that merger policy does not need to be lenient towards all acquisitions of potential competitors. The beneficial effects of acquisitions on innovation can instead be reached by policies pushing incumbents to early acquisitions of financially constrained start-ups. Kamepalli, Rajan, and Zingales (2020)<sup>11</sup> show that acquisitions by the incumbent lower payoff prospects of

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<sup>7</sup>Motta and Peitz (n 3).

<sup>8</sup>Cabral (n 6).

<sup>9</sup>Igor Letina, Armin Schmutzler, and Regina Seibel, 'Killer Acquisitions and Beyond: Policy Effects on Innovation Strategies' [2020] University of Zurich Working Paper No. 358.

<sup>10</sup>Chiara Fumagalli, Massimo Motta, and Emanuele Tarantino, 'Shelving or Developing? The Acquisition of Potential Competitors under Financial Constraints' [2020] Barcelona GSE Working Paper Series No. 1197.

<sup>11</sup>Sai Krishna Kamepalli, Raghuram Rajan, and Luigi Zingales, 'Kill Zone' [2020] NBER Working Paper No. 27146.

new entrants and thus discourage them from investing ('kill zones'). Bryan and Hovenkamp (2020)<sup>12</sup> study acquisitions of start-ups in a model with two incumbents, one leader and one laggard, where the start-up does not have the ability to enter the market. Absent limits on start-up acquisition, the leader will always acquire the start-up to prevent the laggard from catching up technologically. This also implies that start-ups bias their R&D investment towards improving the leader's technology rather than towards technology helping the laggard to catch up. They propose antitrust intervention in the form of compulsory licensing to laggards in cases of start-up acquisitions by dominant incumbents. Differently from the previously mentioned papers, Katz (2020)<sup>13</sup> models competition for the market rather than in the market. In his infinite horizon entry model, the incumbent and entrant compete for the market for one period, then one of them exits the market while the other reaps monopoly profits until the next entry event. He argues for higher antitrust scrutiny of incumbents' acquisitions of emerging or potential competitors when competition is for the market, however whether the prohibition of mergers increases or decreases innovation incentives of entrants depends on the characteristics of the concerned market.

Cunningham, Ederer, and Ma (forthcoming)<sup>14</sup> show empirically for the pharmaceutical industry that incumbents acquire (possible) entrants to discontinue the target's innovation, thus pre-empting potential competition, thereby coining the term 'killer acquisitions.' However, the relevance of killer acquisitions for digital markets is *a priori* not clear, as these markets are often characterized by an abundance of products (translating to many entrants) paired with an unpredictability of success that considerably weakens the pre-emption motive.<sup>15</sup>

The only empirical papers studying acquisitions of GAFAM comprise Gautier and Lamesch (2020)<sup>16</sup> and Koski, Kässi, and Braesemann (2020)<sup>17</sup>. Gautier and Lamesch (2020) look into acquisition strategies, finding acquisitions between 2015 and 2017 by GAFAM to take place in the firms' core segments and mostly accompanied by shutdowns. Koski, Kässi, and Braesemann (2020) find entry rates and venture capital funding to be reduced in the target's product market following big tech (GAFAM & IBM) acquisitions for the period from 2003 to 2018.

To the best of our knowledge, we are the first to empirically study GAFAM acquisitions in the market for mobile applications based on product-level data. The market for mobile applications is a prime example of a relevant online market, as it entails a dynamic environment with many active apps, in which innovation and privacy considerations are more important parameters of competition than price. It is also a market in which different types of acquisitions take place and spillovers can be studied.

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<sup>12</sup>Kevin A Bryan and Erik Hovenkamp, 'Antitrust Limits on Startup Acquisitions' (2020) 56 Review of Industrial Organization 615.

<sup>13</sup>Michael L Katz, 'Big-Tech Mergers: Innovation, Competition for the Market, and the Acquisition of Emerging Competitors' [2020] Information Economics and Policy 100883.

<sup>14</sup>Colleen Cunningham, Florian Ederer, and Song Ma, 'Killer Acquisitions' [forthcoming] Journal of Political Economy.

<sup>15</sup>Cabral (n 6).

<sup>16</sup>Axel Gautier and Joe Lamesch, 'Mergers in the Digital Economy' [2020] Information Economics and Policy 100890.

<sup>17</sup>Heli Koski, Otto Kässi, and Fabian Braesemann, 'Killers on the Road of Emerging Start-ups—Implications for Market Entry and Venture Capital Financing' [2020] ETLA Working Papers No 81.

### 3 Data on Google’s Play Store and GAFAM acquisitions

We web-scraped apps on the Google Play Store quarterly from October 2015 to October 2019, recording all the publicly available information on the respective app and its developer. Based on an initial list of available apps on AndroidPIT<sup>18</sup>, we retrieved similar apps from the respective Play Store page and repeated the process with newly found apps until the similar apps did not yield any additional apps. In the subsequent quarters, this process of gathering similar apps for all the previously found apps was repeated. This resulted in 1 to 2.5 million apps observed each of the 17 quarters and more than 30 million observations for the full dataset. In the following, the relevant measures are briefly presented, while a detailed overview of all variables is provided in Kesler, Kummer, and Schulte (2019).<sup>19</sup>

**Play Store Data.** In order to quantify effects across several relevant outcomes, we approximate dimensions of prices, quality, and innovation. We observe app prices as well as prices of in-app products and construct two indicator variables, equal to one if the respective monetization strategy is present as apps having a price at all makes the biggest difference for users.<sup>20</sup> Besides the access to user data being a means of payment, it can also be considered as affecting a product’s quality. One measure of data collection is the number of privacy-sensitive permissions an app requests upon installation. Based on Kummer and Schulte (2019),<sup>21</sup> we identify a list of permissions that collect privacy-sensitive information of the user. Our measure of innovation is based on updates. Specifically, we generate an indicator variable of whether the app has been updated in the previous quarter (corresponding to the last 90 days). Further relevant characteristics are the number of installations and ratings as well as the app’s birth quarter along with information about which developer the app belongs to.

**GAFAM acquisitions.** To identify acquired apps, we build a database of all acquisitions by GAFAM from October 2015 to October 2019 based on various sources, such as Gautier and Lamesch (2020),<sup>22</sup> several policy reports, such as Argentesi and others (2019),<sup>23</sup> and comprehensive lists on Wikipedia.<sup>24</sup> This is complemented by Google searches, e.g., ‘company name acquires app.’ For all of the 203 identified acquisitions, we follow a specific routine to determine, whether the target company has or had an app on the Google Play Store and retrieve its Google

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<sup>18</sup>See, for example, [https://web.archive.org/web/20130819094306/http://www.androidpit.de/de/android-market/paid-android-apps-BOOKS\\_AND\\_REFERENCE](https://web.archive.org/web/20130819094306/http://www.androidpit.de/de/android-market/paid-android-apps-BOOKS_AND_REFERENCE).

<sup>19</sup>Reinhold Kesler, Michael Kummer, and Patrick Schulte, ‘Competition and Privacy in Online Markets: Evidence from the Mobile App Industry’ [2019] ZEW Discussion Paper No. 19–064.

<sup>20</sup>Another important monetization strategy is advertising. However, we observe information about the presence of ads only from the seventh quarter onwards in our observation period.

<sup>21</sup>Michael Kummer and Patrick Schulte, ‘When Private Information Settles the Bill: Money and Privacy in Google’s Market for Smartphone Applications’ (2019) 65(8) Management Science 3470.

<sup>22</sup>Gautier and Lamesch (n 16).

<sup>23</sup>Argentesi and others (n 4).

<sup>24</sup>See, as an example for Google, [https://en.wikipedia.org/wiki/List\\_of\\_mergers\\_and\\_acquisitions\\_by\\_Alphabet](https://en.wikipedia.org/wiki/List_of_mergers_and_acquisitions_by_Alphabet).

ID to play it back to our main dataset.<sup>25</sup> As a result, we managed to find 54 acquired apps that can also be successfully identified in our dataset. Figure 1 provides an overview of these acquisitions and shows these in the order of appearance with the arrow pointing towards the earliest takeover by the respective company in the observation period.

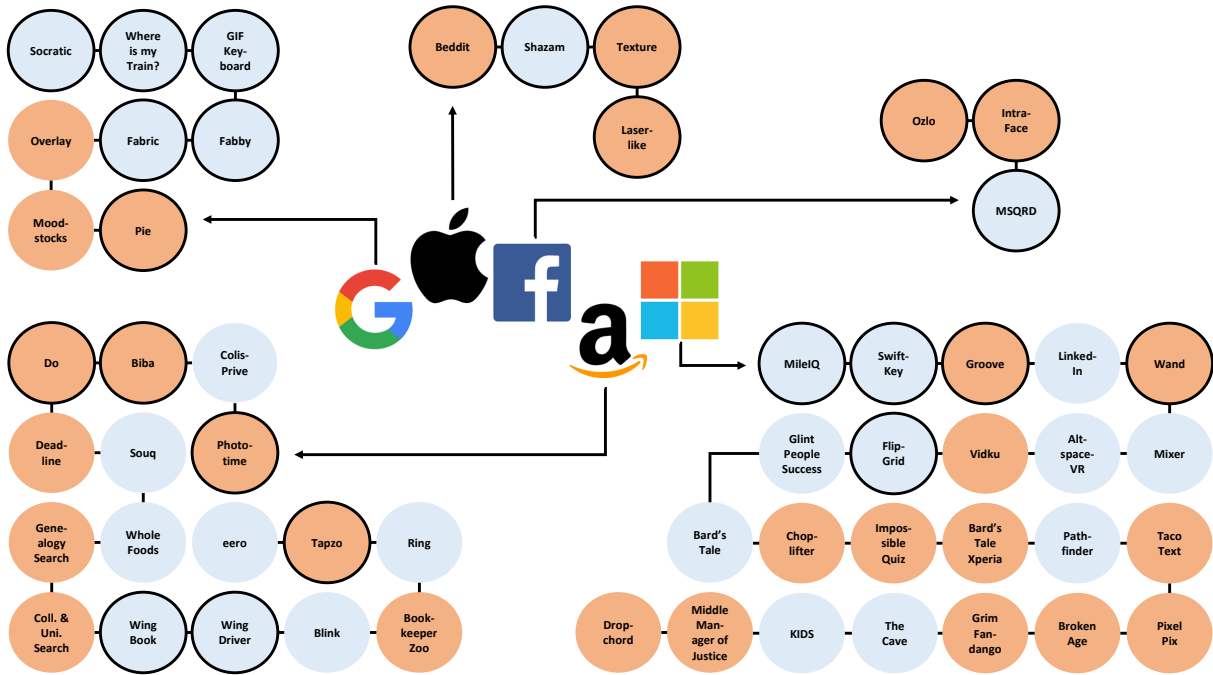


Figure 1: Overview of GAFAM acquisitions

The acquisitions are further manually characterized into whether the acquired app is discontinued (highlighted in orange in Figure 1) and whether the acquired app constitutes the main part of the target company (outline in bold in Figure 1). For example, we consider the app as the main part of business for Shazam, while Whole Foods and LinkedIn have its main part outside the app. Besides these large takeovers, our sample also includes smaller companies that make it more difficult to assess the importance of the app. Although our observation period covers shutdowns of popular apps like Tapzo, which was covered by the media, the majority is inferred from the unavailability of the app in the Play Store and by looking up the unpublished date on AppBrain. Unfortunately, for most acquisitions, the transaction values are not disclosed, especially if the target company is small.

<sup>25</sup>First, this routine involves the question, whether news articles about the acquisition mention any apps. We then look at the target company’s website (and its archives) as well as into articles reporting about the firm for indications about the presence of an app. If an app is mentioned anywhere, we query the name on the Play Store. In case the app is no longer available, we try to retrieve links containing the Google ID from past news articles or search entries, as well as archived versions of the corresponding firm website.



## 4 Descriptive Analysis of Apps Acquired by GAFAM

Distinguishing the 54 acquisitions by the five companies, Table 1 shows that Microsoft is the most active acquirer followed by Amazon, while Apple is not that active on Google’s Play Store.<sup>26</sup> If we then look at how many apps were discontinued around the time of acquisition, we see that half of all the apps are shut down.<sup>27</sup> When dividing continued into an active and inactive status, we see that the latter, being defined as no updates post-acquisition, is less frequent. However, divided by acquirer, it seems that Apple, Facebook, and Microsoft predominantly shelve their acquired apps (through shutdowns and inactivity), whereas it is less conclusive for Google and Amazon.

Table 1: Continued, Inactive, and Discontinued Apps by Acquirer

Acquirer	Continued Active	Continued Inactive	Discontinued	Total
Google	5	0	3	8
Apple	1	0	3	4
Facebook	0	1	2	3
Amazon	9	0	7	16
Microsoft	7	4	12	23
Total	22	5	27	54

Table 2 compares means of continued and discontinued apps for the whole period before the acquisition date regarding a selection of key variables. Discontinued apps are more likely for pay, update less frequently, and request fewer privacy-sensitive permissions. Finally, they also have fewer installations and ratings.<sup>28</sup>

In Table 3, we look into whether the app constitutes the main part of the business for the target company of the acquisition. Accordingly, only 24 of the identified GAFAM app acquisitions can be considered as such. However, there are interesting patterns by acquirer. Acquisitions that include apps by Facebook, Apple, and, to a lesser degree, Google seem to target app-based companies, while the majority of firms acquired by Amazon and Microsoft do not mainly revolve around apps.

<sup>26</sup>If we look at how many apps are linked to the main profile of each developer, one can see that, as expected, Google itself is the most prevalent on its own platform, whereas Apple is barely active. Microsoft is very active, followed by Amazon and Facebook. Interestingly, only 5 of the 54 acquired apps are later linked to the main GAFAM profile.

<sup>27</sup>There are 4 acquired apps that are discontinued more than 1 quarter pre-acquisition. 3 apps were discontinued 2 quarters pre-acquisition, 1 app 5 quarters pre-acquisition. However, for all of these apps, we only found an announcement and no acquisition date. For the 3 apps that were discontinued 2 quarters prior to the announcement date, it may be the case that the acquisition actually took place earlier than it was announced. All 4 acquisitions for which the discontinuation was more than 2 quarters prior to the acquisition were by Microsoft.

<sup>28</sup>Computing the mean only with observations of the last pre-acquisition period, the patterns (especially regarding updates and installations) remain qualitatively the same, albeit less significant.

Table 2: Acquired Apps Pre-Acquisition by Discontinuation

	Continued Mean	Discontinued Mean	Difference
App Price (1=Yes)	0.14	0.39	-0.24***
In-App Product (1=Yes)	0.14	0.20	-0.06
Days Since Last Update	209.66	615.14	-405.48***
Update in the Last Quarter (1=Yes)	0.78	0.29	0.49***
P-S Permissions	2.99	2.50	0.49
Installations (k)/Age in Quarters	1,089.40	34.08	1,055.32***
Ratings (k)	257.90	10.07	247.84***
Age in Quarters	10.07	11.26	-1.20
Observations	167	180	
Number of Apps	25	26	

Notes: \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

To study what happens subsequent to the acquisition, we compare pre- and post-acquisition numbers for acquired apps in Table 4. We restrict to apps that have observations both before and after, as in some instances apps are discontinued right after the acquisition or similarly apps are born and already bought up until we see them only at the end of the next quarter.<sup>29</sup> For the remaining apps, we compute averages for the whole period before and after the acquisition. Accordingly, we observe them being less often for pay afterwards, while they request more privacy-sensitive permissions once part of GAFAM.<sup>30</sup>

Table 3: Acquired Apps Main Part of Business by Acquirer

Acquirer	App Main Part of Business	App Not Main Part of Business	Total
Google	6	2	8
Apple	4	0	4
Facebook	3	0	3
Amazon	6	10	16
Microsoft	5	18	23
Total	24	30	54

<sup>29</sup>This implies that some apps included in Table 4 are observed pre- and post-acquisition but are discontinued several periods later, while some apps that are continued post-acquisition are not included as we do not observe them pre-acquisition.

<sup>30</sup>In order to rule out composition effects, for robustness, we restrict both to apps with sufficient periods before and after as well as to a constant set of apps. Patterns remain regarding privacy and demand measures, while a more distinct decrease in in-app products emerges.

Table 4: Acquired Apps Pre- and Post-Acquisition

	Pre Mean	Post Mean	Difference
App Price (1=Yes)	0.16	0.04	0.12***
In-App Product (1=Yes)	0.16	0.15	0.01
Days Since Last Update	323.35	205.13	118.22**
Update in the Last Quarter (1=Yes)	0.68	0.72	-0.04
P-S Permissions	2.68	3.40	-0.71***
Installations (k)/Age in Quarters	788.88	1,378.43	-589.55**
Ratings (k)	188.19	397.95	-209.77***
Observations	238	197	
Number of Apps	34		

Notes: \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

Finally, in Table 5, we compare acquired apps with the total market by averaging key variables across the whole sample period, respectively. Acquired apps are more likely to have payment options and are updated more regularly, while they also request more privacy-sensitive permissions and experience a greater demand. This suggests that GAFAM targets more attractive markets in various dimensions, although one must account for the long tail of the Play Store.

Table 5: Acquired Apps and Total Market

	Total Mean	Acquired Mean	Difference
App Price (1=Yes)	0.08	0.19	-0.11***
In-App Product (1=Yes)	0.08	0.16	-0.08***
Days Since Last Update	541.15	345.71	195.45***
Update in the Last Quarter (1=Yes)	0.19	0.59	-0.40***
P-S Permissions	1.39	2.94	-1.55***
Installations (k)/Age in Quarters	493.42	951.90	-458.48**
Ratings (k)	2.23	234.58	-232.35***
Age in Quarters	11.30	13.16	-1.86***

Notes: \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

## 5 Conclusion

In this paper, we provide first empirical evidence on the effects of big tech acquisitions in terms of prices, quality, and innovation, based on product-level data from the Google Play Store. We find that about half of the apps acquired by GAFAM are discontinued, which tend to be smaller, less frequently updated, and less privacy-intrusive than apps that are continued. Following the acquisition, the monetization strategy seems to change as apps become free of charge but also request more privacy-sensitive permissions. Compared to the whole Play Store, GAFAM seems to target more attractive apps, e.g., with respect to updating, data collection, and demand. However, this can only be considered a first step towards empirical evidence.

First, more differentiated outcome measures are necessary. In particular, some of the privacy-sensitive permissions that we measure as data collection, may be necessary for the functionality of the app, as well. One example may be a navigation app requesting the location of a user. Looking into the use of permissions by paid apps, which are less likely to rely on data for revenue generation, might shed light on which permissions are necessary in a certain category. Moreover, updates are not necessarily related to an innovation or change in the functionality of an app, as they might include minor bug fixes. Hence, whether an update provides significant changes in app functionality or minor updates should be accounted for.

Second, the assessment of the competitive effects of big tech acquisitions in such markets is more complicated than just looking at the acquirer and target companies alone. Rather, one must also consider the effects on competing firms, as well as, in case of multi-product firms, potential spillovers or reallocation of efforts to other product markets. This makes the assessment of the overall effect of an acquisition on consumer surplus and total welfare more difficult. However, having the universe of the Play Store apps allows for approximating competitors. In particular, we can approximate the relevant product market as the set of related apps for the acquired app at the time of acquisition. Google suggests these competing apps according to the similarity. Although this can be considered quite narrow, it may work as a first definition of very close competitors following other studies.<sup>31</sup> Alternative sets of competitors may be found using text analysis of app descriptions to measure similarity among apps. Furthermore, such a dataset allows for studying the potential spillovers of GAFAM app acquisitions to other product markets. We can link each app to its developer such that one can extend the analyses from apps directly affected by GAFAM acquisitions to affected developers, looking at whether the developer's behavior changes also with respect to (seemingly) unaffected apps.

While there is some theoretical literature on the competitive effects of big tech acquisitions, there is little empirical evidence about the competitive effects of such acquisitions. Particularly, in digital industries, where prices might not be the main parameter of competition, we must look at the effects of acquisitions in terms of quality of service provided, privacy, and data collected as well as incentives to innovate. One recent example is Google's 2.1 billion US dollars

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<sup>31</sup>Kesler, Kummer, and Schulte (n 19); Wen Wen and Feng Zhu, 'Threat of Platform-Owner Entry and Complementor Responses: Evidence from the Mobile App Market' (2019) 40(9) *Strategic Management Journal* 1336.

acquisition of Fitbit. Despite ongoing policy discussions about whether stricter merger control is in order when it comes to big tech companies, the European Commission cleared the Fitbit acquisition in December 2020. The decision was subject to Google promising to share part of the Fitbit data with competing wearable firms and to refrain from using Fitbit's health data for targeted advertising for the next ten years. Interestingly, the Australian competition authority did not accept such behavioral remedies. The merger was cleared by the European Union despite the opposition from consumer organizations and competition experts that were concerned about issues relating to the health and activity data that Fitbit collects. In particular, they were concerned that the merger would give Google the possibility to leverage its market power into health and insurance markets in the future, an issue not considered by the European Commission in its assessment of the acquisition.<sup>32</sup> The controversy about the case and the discussion about the effects of the merger on outcomes other than price, highlights the need for further empirical evidence on the specific competitive effects of mergers in digital industries.

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<sup>32</sup>See, for example, <https://www.politico.eu/article/europe-must-not-rush-google-fitbit-deal-data-privacy/> or <https://voxeu.org/article/googlefitbit-will-monetise-health-data-and-harm-consumers>.