Journal of Competition Law & Economics, 2024, **00**, 1–18
https://doi.org/10.1093/joclec/nhae010
Article

BIG TECH ACQUISITIONS AND PRODUCT DISCONTINUATION***

Axel Gautier* & Robert Maitry**

ABSTRACT

The five largest firms by market capitalization, Alphabet, Amazon, Apple, Meta, and Microsoft have massively acquired companies during the last decades, mainly but not exclusively young tech startups. Interestingly, most of the acquired products are discontinued post-acquisition. In this paper, we have collected data on the acquisitions of the big techs for a period of 7 years spanning from 2015 to 2021 and we analyze the evolution of the acquired firms' products post-acquisition. To analyze the decision to continue or not a product post-acquisition, we classify acquisition in four categories: products that are still offered under their initial brand name, products integrated in the acquirer's ecosystem, products that are no longer available and products that are killed by the acquirer. We use these classifications to provide detailed information and statistics on the discontinuation decision of the acquiring firm and we run Probit estimation to explain their determinants.

JEL: D43, G34, K21, L40, L86

I. INTRODUCTION

The five largest firms by market capitalization, Alphabet (Google), Amazon, Apple, Meta (Facebook), and Microsoft, sometimes referred to as the "big techs " or the "GAFAM", have massively acquired companies during the last decades, mainly but not exclusively young tech startups. To give an idea, we identify 329 acquisitions by these five companies for the period 2015–2021, which that is an average of 47 per year. Except for few large acquisitions, few of these takeovers have been reviewed by competition authorities and little is known about the evolution of acquired firms and their products after they were bought. The objective of this paper is to fill in this gap.

The digital sector is characterized by both increasing returns to scale and network effects, leading to market concentration and increasing margins especially among "superstar" firms, as documented by De Loecker *et al.* (2020). It is documented that acquisition has become the main exit route for startups and that this contributed to reinforce dominant firms like the GAFAM (Ederer and Pellegrino, 2023). Mergers in the digital economy may increase further

* HEC Liege, LCII, University of Liege, CORE and CESifo. E-mail: agautier@uliege.be
** HEC Liege, University of Liege.
*** The authors thank L. de Barsy, the editor and the referees for their useful comments. This paper is part of the ARC project on *digital platforms* (University of Liege).

Received: July 17, 2023. **Revised:** February 13, 2024. **Accepted:** July 1, 2024

market concentration and reduce competition and innovation. For these reasons, several papers analyze the consequences of merger, taking explicitly into account the specificities of the digital economy (Bryan and Hovenkamp, 2020; Motta and Peitz, 2021; Prat and Valletti, 2022). Most of these papers show that digital mergers raise specific concerns.

For these reasons, several recent high-profile reports (Argentesi *et al.*, 2019; Cremer *et al.*, 2019; Scott Morton *et al.*, 2019; Bourreau and Streel, 2020) and contributions to the academic literature (Valletti and Zenger, 2019; Parker *et al.*, 2021; Cabral, 2023) propose and discuss possible reforms of the merger control procedure to better address the specificities of the digital economy.

Still, the consequences of these numerous mergers on competition, innovation, and entry in the market remains largely unknown from an empirical point of view. To fill in this gap, several papers have proposed a retrospective analysis of mergers involving big techs, either based on selected case studies (Argentesi *et al.*, 2021; Parker *et al.*, 2021; Ivaldi *et al.*, 2023) or on an exhaustive analysis of all mergers (Affeldt and Kesler, 2021; Argentesi *et al.*, 2021; Gautier and Lamesch, 2021; Moss *et al.*, 2021). In the latter case, the idea is to provide a classification of acquired firms to analyze the underlying acquisition strategies of the main digital platforms. Argentesi *et al.* (2021) analyze the acquisitions of Amazon, Facebook (Meta), and Google (Alphabet) for the period 2008–2018. They classified acquisitions according to the product functionality of the acquired company and they identify nine clusters of products. They complete their analysis with a retrospective analysis of two mergers case scrutinized by the Competition and Markets Authority (CMA), the UK competition authority. Gautier and Lamesch (2021) provide a similar analysis including in addition Apple and Microsoft and they cover the period 2015–2017. They classify acquisitions not on the basis of products' functionalities but on the targeted user group, merchant, content creators, advertisers, etc. Moss *et al.* (2021) provide "word cloud " for each acquirer based on industry descriptors for each acquired company.

In our analysis, we will be interested in the decision of the acquirer to continue or discontinue the product developed by the acquired firm. To illustrate, Amazon acquired in 2015, Shoefitr, a service that would facilitate the choice of shoes size and thereby reducing the likelihood returning items. The service is no longer used by Amazon and the Shoefitr website is disactivated and Amazon announced that it was no longer using the service.[1]

There are several reasons to discontinue an acquired product.[2] First, the project may fail to deliver its promises and is then stopped. Second, the project may be a direct or potential competitor of the acquirer and the project is stopped to protect the acquirer's market position. This kind of "killer acquisition" has been documented in the pharmaceutical industry (Cunningham *et al.*, 2021). Following that, there are a lot of discussion on the importance of killer mergers in the digital economy (Cabral, 2023; Ivaldi *et al.*, 2023). Third, the project may be a component or a functionality that will be integrated in the main products of the acquiring firm (Bryan and Hovenkamp, 2020). Last, the acquirer may not be interested in the product itself but by the firm's assets, be it its technology, its talent (acqui-hire[3]), its user base, or anything else.

For Puranam and Srikanth (2007), when an acquisition is motivated by asset acquisition, the target is more likely to be integrated with the acquirer while when it is motivated by product acquisition, the target is more likely to be kept independent. Similarly, Cabral (2021) argues that IP rights are not well defined in the digital world and imitation is relatively easy. Acquisition

[1] More information on https://www.failory.com/amazon/shoefitr

[2] The evolution of the brand portfolio after a merger has been studied in the management literature (Dung *et al.*, 2010).

[3] Ng and Stuart (2022) show that this recruitment strategy is not very effective as acquired employees have a higher turnover than regularly hired employees.

may therefore be the most efficient way to transfer digital technologies. If acquisition is done for technology transfer, product discontinuation is indeed likely.

Empirical evidence show that product discontinuation is important in the digital economy. Gautier and Lamesch (2021) show that the five largest digital platforms discontinue 60% of their acquired products. Affeldt and Kesler (2021) show that half of the apps available on the Google Play Store and acquired by one of the GAFAM are discontinued post-acquisitions. For the remaining apps, they show that the monetization strategy changes, with apps becoming increasingly free but they collect more data from the users. Eisfeld (2023) studies startup acquisition in the software industry. She shows that 57% of the acquired products have been discontinued under their original brand name after acquisition. This percentage increases further when the acquirer is another software company and reaches 80% when the product is acquired by a GAFAM. Far from being marginal, product discontinuation seems to be the rule rather than the exception in digital markets.

Our analysis is closely connected to these works and our objective is to analyze the decision to discontinue a product post-acquisition. In a nutshell, for each acquired firm, we will check if its products are still available post-acquisition. If not, the firm/product will be considered as discontinued. Our work extends the analysis of Gautier and Lamesch (2021) in three directions: First, by collecting four additional years of data to cover a period of 7 years spanning from 2015 to 2021; second, by proposing a new classification of products post-acquisition based on four categories instead of two; third, by using the Argentesi *et al.* (2021) product classification in nine different clusters.

Our database contains all acquisition by the GAFAM for the period 2015–2021 and we systematically check the evolution of a product post acquisition. We classify firms in four different categories depending on the evolution of the acquired products post-acquisition. First, the firm is *continued* if its products are still offered under their initial brand name and the acquired firm keeps some autonomy, notably an independent website. Second, the firm is *integrated* if its products are still offered, eventually under a different brand name, but the acquired company is part of the acquirer. Contrary to continued firms, integrated firms no longer have an independent website. Third, a firm is *not active* if its products are no longer available. Fourth, a firm is *killed* if there is a clear announcement that the product will no longer be supplied or maintained. In our sample, we found that 28% of firms are continued, 6% are integrated, 45.5% are discontinued, and 12% have been killed. We were not able to recover the information for 8.5% of the firms.

Our contributions can be summarized as follow. First, we provide additional statistical evidence on the characteristics of the acquired firms. Among the 329 acquisitions we identified for the period 2015–2021, half of the firms were created less than 5 years before acquisition and three quarter less than 8 years. In terms of funding, half of the firms raised less than $ 10 millions. This confirm that most of the acquisitions by the big techs are young startups at the premise of their development. Second, based on our classification of acquisitions in product clusters, we observe that many acquisitions (30% of the total sample) concerns firms active in AI and data analytics. That is technologies that firms can be integrated in their ecosystem and that can be used to improve their products by integrating AI and data-based solutions. All firms made massive acquisitions in this cluster which raise competition concerns. Indeed, competitors, especially smaller scale ones, may have less access to those technologies and this can reinforce the dominant position of the big techs.

Third, most of the products are no longer available after acquisition, confirming previous studies. Based on our classification in four categories, we construct three indicators for product discontinuation. First, when the firm is killed; second, when the products are no longer available (killed+not active); third, when the acquired firm is no longer "autonomous" (killed+not

active+integrated). We run Probit regressions to identify factors that make discontinuation, defined by our three measures, more likely.

When the discontinuation measure includes non active firms, we observer that younger firms are more likely to be discontinued post-acquisition and firms that managed to complete more funding rounds are less likely to be discontinued. More "mature firms" measured by their age or their funding, are less likely to be discontinued than the others. Furthermore, it appears that Apple has a more systematic discontinuation policy than the others; a plausible explanation being that it wants to offer products under a unified brand name. Also, firms providing digital content, notably game studios, are less likely to be discontinued than the other firms.

For the 40 companies that we identified as being "killed ", we observe that the only relevant determinant of these killer discontinuation is to be in the main product cluster of the acquirer. This means that close competitors are more likely to be killed.[4]

Finally, regarding the global acquisition strategies of the five tech giants, we observe that Alphabet and Meta target younger companies than the others. But, even if the firms have different business models and product supply to the clients, they have a relatively similar acquisition strategy, with a lot of acquisitions in the same clusters, notably those providing AI solutions. This suggests that competition for acquisition could be quite intense among large platforms and may explain why startups active in AI are acquired earlier than in other product clusters.

This paper is organized as follows: In Section 2, we describe our data and provide detailed descriptive statistics on the sample of acquired firms. In Section 3, we classify targets in clusters of products to analyze the merger strategies of the GAFAM. In Section 4, we run Probit regressions to analyze the determinants of product discontinuation. Section 5 concludes and we provide additional material in the Appendix.

II. DATA SOURCE AND DESCRIPTIVE STATISTICS

In this section, we detail the construction of the database and we provide detailed statistics on acquisitions, the characteristics of the acquired firms, and their products.

A. Big tech acquisitions

The first step is to construct an exhaustive list of acquisition by Alphabet, Apple, Amazon, Meta, and Microsoft for the period 2015–2021. For that, we use the data from Gautier and Lamesch (2021), covering the period 2015–2017, the *Wikipedia* pages covering the acquisition of those companies and the investor relations section of the *Microsoft* website to construct our database. We identify 329 acquisitions for the period 2015–2021.[5]

The summary statistics are represented on Figure 1. The figure is based on Table A1 in Appendix A. Alphabet and Microsoft are the companies that made the most acquisitions from 2015 to 2021 with 82 and 93 acquisitions, respectively. Apple made 60 acquisitions during that period and Amazon 50 acquisitions. Meta has the lowest number of acquisitions with a total of 44.

Alphabet made the most purchases in the period from 2015 to 2017 and was overtaken by Microsoft from 2018 onwards. The number of annual acquisitions declines from a maximum of 65 in 2015 to 31 in 2021. In 2020, worldwide M&A deal activity decreased sharply with the occurrence of the COVID-19 pandemic in March 2020 (Harroch, 2020). Despite the growing calls for a stricter merger regulation in the digital economy, the enforcement has not

[4] As product discontinuation may occur several years after the acquisition, the existence of a competitive threat may not be the main motive for the acquisition, and we can certainly not conclude that from our analysis.

[5] Parker *et al.* (2021) identify 267 M&A cases for the period from 2015 to 2019, while we identify 264 M&A for this period in our data.

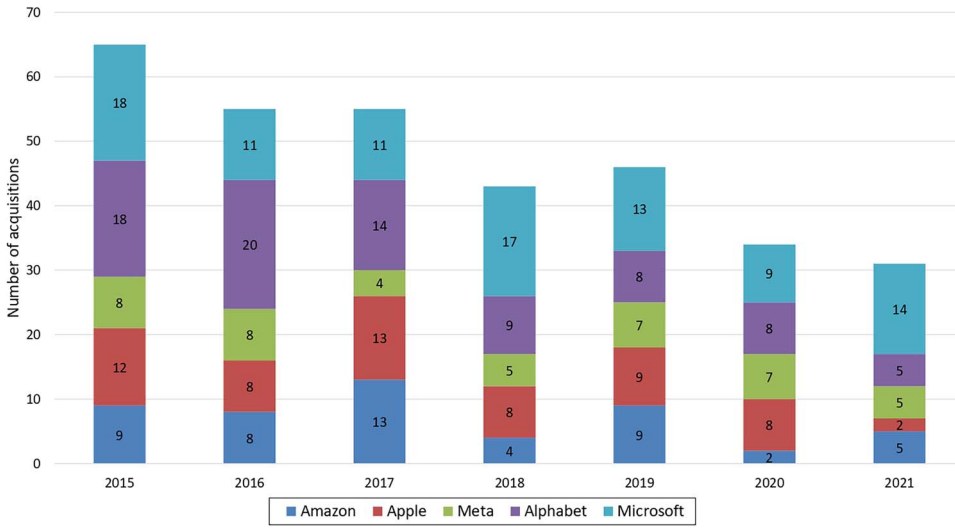


Figure 1. Number of acquisitions, 2015–2021.

fundamentally changed during our observation period and all acquisitions have been cleared by the competition authorities, with the exception of Giphy in 2022.

B. Information on acquired firms

In the second step, we use *Crunchbase*[6], a database tracking the companies in the technology sector to extract relevant information on the acquired firms. The acquired companies are searched using their names and we collect data on their website, the foundation year, the founding country, the number of funding rounds, the total funding, and a short description of the activity of the company. This information will be used to classify companies in different product segments.

Table 1 provides information on the age and the funding of acquired companies. The median age of acquired companies is 5 years and the mean is 7 years. These findings highlight the fact that big techs mostly target young firms. This is especially true for Meta and Alphabet with a median age below the sample average and no acquisition of a company founded before the year 2000. On the contrary, Amazon and Microsoft acquired relatively older companies. The data on funding confirm these observations.[7] The average company raised an amount of $ 43.9 million before being acquired but half of the acquired raised less than a $ 10 million company. So an important part of the sample is composed of very young and small-scale startups. Meta and Alphabet particularly target those companies. Finally, most of the acquisitions are US companies.

C. Product discontinuation

To understand the evolution of products and companies post acquisition, we recover information on the operating status of the acquired company. Our objective is to check, for each acquisition, if the companies' products are still offered or not. We use a methodology similar to Gautier and Lamesch (2021) but we classify firms in four categories, instead of two, based on their product offer post-acquisition.

[6] https://crunchbase.com

[7] Information on total funding was not available for all 329 observations;, therefore, this statement refers to the 217 observations for which such information is available.

Table 1. Age, funding, and origin of acquired companies

(a) Age of targets (in years)

Acquirer	Min	1st quartile	Median	Mean	3rd quartile	Max	NA
All	0	3	5	7	8	97	5
AMZN	1	4	5	9.64	8	97	0
APPL	1	3	5	6.66	9	32	1
META	1	3	4	4.72	6	17	1
ALPHA	0	3	4	5.03	7	20	2
MSFT	1	4	7	8.57	11.5	39	1

(b) Total amount of funding (in million $)

Acquirer	Min	1st quartile	Median	Mean	3rd quartile	Max	NA
All	0.015	3.12	9.5	43.90	26	1000	112
AMZN	0.05	2.4	10	61.96	26.5	1000	13
APPL	0.35	2.5	8.45	60.86	27.87	1000	20
META	0.12	3.5	5.65	43.89	20	173.5	18
ALPHA	0.015	2	6.75	31.57	20.4	352.5	30
MSFT	0.25	5.5	14.53	41.04	31.4	574.9	31

(c) Origin of targets

Region	US	Non-US	Unknown
No. of obs.	214	104	11

A company is said to be *continued* if it is still active and offer products under its initial brand name and maintains an independent website; A company is said to be *integrated* if its products are still offered, eventually under a different name, but the company's website is now part of the acquirer. Figure C3 in Appendix C provides two examples of integrated companies.[8] A company is said to be *killed* if the acquirer or the acquired company announced that the product will no longer be supplied or maintained.[9] Figure C4 in Appendix C shows examples of a discontinuation announcement. Finally, the company is classified as *inactive* if its products are no longer offered and its website is disactivated but there is no explicit announcement that the company or its product have been discontinued. If there is an announcement by one of the parties, that the acquired company will now be active as part of one of the acquirer's team (see an example in Figure C5 in Appendix C), but there is no product supplied, the company is classified as inactive.[10] Similarly, if a product no longer exists under its initial name or a rebranded name but it is said to be integrated in the acquirer's ecosystem, for instance, in its global cloud offer, it is classified as inactive.

To be more explicit, we use the following procedure to classify companies: We check the company website (as it appears on Crunchbase).

1. The website is active,
   (a) If the website is maintained and products are offered: the company is classified as *continued*.

[8] The frontier between integrated and continued is in few cases a bit blurry.

[9] For the killer acquisitions identified by Cunningham *et al.* (2021), the purpose of the acquisition is to kill the target. For the killer discontinuation we identified, killing the target and discontinuing its product is the consequence of the acquisition but nothing can be said on the purpose. Discontinuation might be a consequence of a technical or a commercial failure.

[10] This means that acqui-hired companies will be treated as inactive.

Table 2. Continuation status after acqusition

Acquirer	Continued	Integrated	Not active	Killed	NA	Total
Amazon	15 (30%)	7 (14%)	16 (8%)	7 (14%)	5 (10%)	50
Apple	5 (8%)	1 (2%)	42 (70%)	7 (12%)	5 (8%)	60
Meta	12 (27%)	0 (0%)	24 (55%)	4 (9%)	4 (9%)	44
Alphabet	18 (22%)	8 (10%)	39 (48%)	8 (10%)	9 (10%)	82
Microsoft	41 (44%)	3 (3%)	29 (31%)	14 (15%)	6 (7%)	93
Total	**91 (28%)**	**19 (6%)**	**150 (45.5%)**	**40 (12%)**	**29 (8.5%)**	**329**

(b) If the website is not maintained or products are no longer available, then go to step 3.

2. The website's link redirects to the acquirer's website,
   (a) If the product is announced to be discontinued or not maintained, the company is classified as *killed*.
   (b) If the acquired firm's product is offered on the acquirer's website either under its initial brand name or under a new name but with an explicit link with the initial product, the company is classified as *integrated*.
   (c) If there is no product offer that could be directly be associated with the acquirer, then go to step 3.
3. The website is no longer active,
   (a) Check on the Appstores if there is a product offered and maintained. If yes, the company is considered as *continued*.
   (b) Check the web for product discontinuation announcement (mainly tech and economic news, CrunchBase, X (ex-Twitter), LinkedIn, and Wikipedia). If such an announcement is found, the company is classified as *killed*.
   (c) In all other cases, the company is classified as *not active*.

The data have been collected in January 2024 and we managed to recover all the relevant information for 300 out of the 329 acquisitions.

Table 2 shows the number of companies depending on their operational status. In total, less than a half of the products of acquired companies (110 products) are still supplied under their initial brand name or a rebranded name. For the remaining 190 companies, there is no product supplied after acquisition either because the product have been explicitly discontinued or because they disappear and little can be said on these inactive products. They could be discontinued or integrated as part of a more global offer but our data do not allow us to screen among these possible explanations. The very high rate of discontinuation confirms the findings of Gautier and Lamesch (2021).

We observe that companies have very different policies. Microsoft and Amazon continue to offer more products than the others, especially Apple who has a systematic discontinuation policy. Microsoft bought a large number of companies active in gaming, especially game developer studios, with a well-established reputation among gamers and Microsoft unify all of them in the *Xbox* gaming group but keeps their original brand. We will further analysis the determinant of the continuation decision in Section 4.

III. A CLASSIFICATION OF ACQUIRED PRODUCTS BY CLUSTER

The next step in our analysis is to classify acquired firms by product categories. The idea is to identify different product categories and assign each acquisition to one of those. In parallel,

we use the annual accounts (10-k files) of the acquirers to identify the product categories that generate the largest income.

Such a classification is useful for three reasons. First, although big techs are large technology companies operating as multi-sided platforms, they differ in their core business areas and their main sources of revenue. This is likewise reflected in their strategy for acquisition. Second, this classification is needed for the retrospective analysis of acquisitions. By categorizing the companies acquired, one can reveal potential patterns in their strategy, if the analysis exhibits a greater number of acquisition in one business area, e.g. in data business and analytics. Third, it is possible to examine the overlaps between the business areas of the acquired companies and the discontinuation analysis. Acquisitions in the core business area can be considered as substitutes for the main product of the acquirer and therefore are more likely to be discontinued. Acquisitions in business areas other than the main area of the acquirer can be considered complements and are therefore less likely to be discontinued.

A. Clusters of products

Gautier and Lamesch (2021) propose such a classification. They analyse Big techs as multi-sided platforms and they identify five users groups gravitating around the platform: consumers, merchants, advertisers, content editor, and business. They classify acquisitions according to the targeted users and defined a sixth category for products design for the operation of the platform. Argentesi *et al.* (2021) propose an alternative classification based on product characteristics instead of user groups. They identify nine clusters of products defined as follows:

- **Communication apps and tools (CAT):** companies active in the supply of platforms that create or simplify ways of interaction between individuals and/or within organizations. Such ways of interaction include direct communication, such as messaging and emailing, and sharing of content and personal information
- **Tools for developers (TD):** companies that provide tools and solutions for software developers to create and optimize their digital products. This excludes products and services supplied to final consumers
- **Physical goods and services (PGS)**: companies that manufacture, distribute, or sell physical goods of any kind or facilitate through services and software such activities, including price comparison websites, marketplaces, and online retailers
- **Digital content (DC):** companies that deliver, create, or facilitate the fruition of digital content such as movies, games, digital text, and other digital media
- **Remote storage and file transfer (RS):** companies that provide file storage, cloud, file sharing, and related services
- **Advertising tools and platforms (ATP):** companies active in the advertising industry as provider of advertising content, advertising platforms, or active as intermediaries between advertisers and consumers or advertisers and suppliers
- **Artificial intelligence, data science, and analytics (AI):** companies active in the creation, distribution, or enhancement of self-learning software, image, speech or text recognition software, virtual assistants, analytics, and machine learning services for big data
- **Home, well-being, and other personal needs (HW):** Companies active in the provision of software and applications designed to simplify and/or improve experience for different aspects of daily life such as: transportation, health, learning, entertainment, well-being, and home automation
- **Other (O):** Companies that cannot be clearly assigned to one of the above clusters.

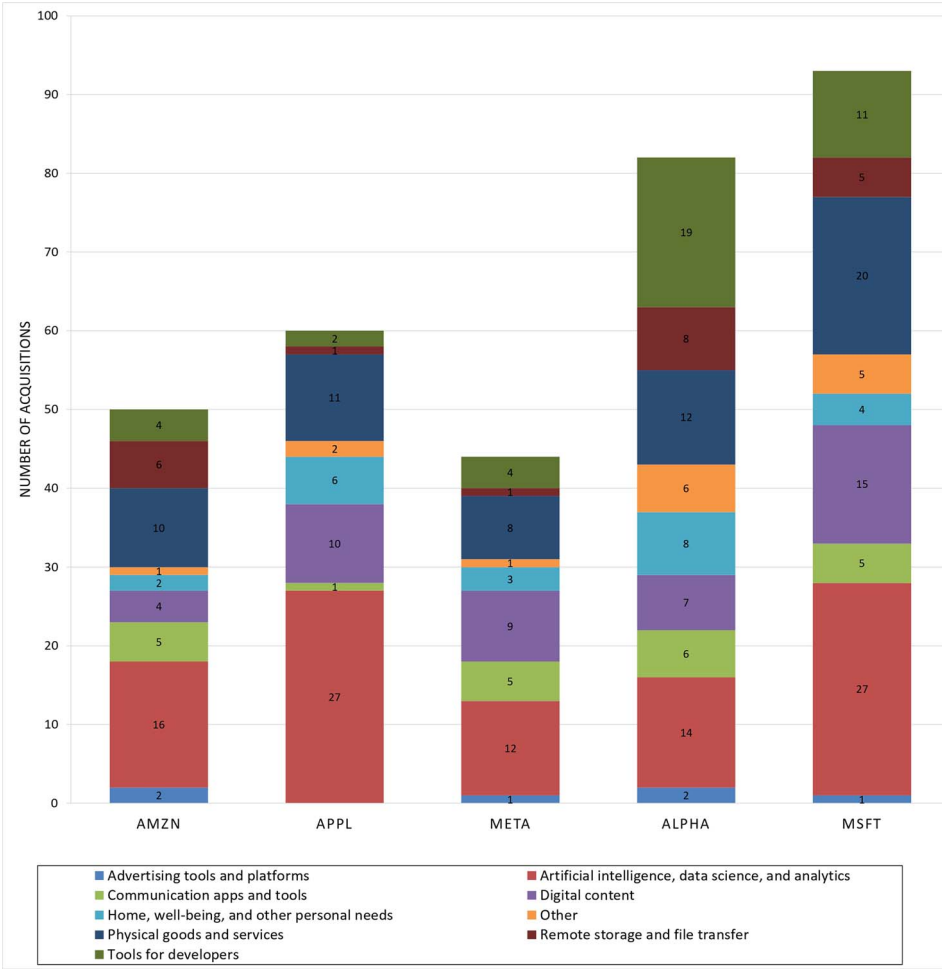


Figure 2. Acquisitions classified by cluster.

B. A classification of acquired products

In this paper, we use the clusters defined by Argentesi *et al.* (2021), and we use the description of the activities of *Crunchbase* to classify products.[11] The classification in clusters is represented in Figure 2. Table A2 in Appendix A contains additional summary statistics.

The classification and the figure reveal several interesting features regarding the acquisition strategies of the big techs. First, from Figure 2, it appears that, even if the five firms are quite different in terms of revenue sources and business model, they have relatively similar acquisition strategies. All firms acquire massively in the AI clusters, which is the largest acquisition cluster for all firms, except Alphabet for which it is the second largest. Similarly, all firms acquire massively in firms providing digital content and physical good and services. These relatively similar patterns show that the acquirers are interested in the same line of products and that there is potentially a competition for acquisition in those fields, especially for AI companies.

[11] From our data, we cannot make inference on the impact of these acquisitions on the evolution of competition and innovation in the nine clusters of products we identified.

Second, we observe that big techs do not acquire massively in the clusters where they already hold a strong market position. The revenues from Alphabet and Meta mainly come from advertising but their acquisitions in this field are limited. Similarly, Amazon, which dominates the online sales, does not make more acquisitions than the others in the physical good cluster. So it seems that acquisitions do not aim to reinforce the platforms' main market but rather either to expand to new areas, like digital content for Apple, or to complementary services like AI. The only exception to that is Microsoft that acquires massively in the tools for developers cluster. Providing digital solutions to business and individual clients is one of the main business line at Microsoft and the company use acquisitions to reinforce its position in the market. Alphabet who competes with Microsoft for this kind of products is also investing a lot in that cluster; it is even the largest acquisition cluster for Alphabet.

Third, Alphabet, Microsoft, and Amazon who compete fiercely in the cloud business, trying to offer the best solution to individuals, companies, and public institutions, and making substantial revenues in this field, are acquiring more products classified as "remote storage and file transfer".

Fourth, we observe that the AI and data cluster is the most represented with almost 30% of the acquisitions in that field, and all the five acquirers being equally active. This reflects the importance of AI and data in the development of the digital platforms and the race between tech giants to develop and integrate these advanced tools in their ecosystem. Big techs massively use acquisitions to develop AI and data-based solutions and they compete intensively in this field, also to acquire new and innovative startups in those fields. Furthermore, in that cluster, firms are younger than the sample average. With an average age at acquisition of 6.2 years and a median age of 4 years, the youngest startups are particularly well represented in that cluster.

This highlights the importance of AI and data technologies for operating and improving multi-sided platforms, but also for their future strategies. They all include AI tools in their products to improve their functionalities. For Amazon, artificial intelligence, data science, and analytics contribute to the improvement of Amazon's virtual assistant Alexa. It also helps the tech giant to expand its cloud computing business AWS and to enhance the search algorithm of the online retail platforms. Furthermore, Amazon can be expected to stay active in the field of self-driving cars, as the company acquired Zoox in 2020, which had raised $1 billion in funding by then. For Apple, it contributes to the operating systems for its iPhones, iPads, and Mac computers. Apple is also working to improve its voice assistant Siri by acquiring companies involved in the development of voice recognition, voice assistants, and voice technology. Also, for Meta, the AI technology serves as a support for its social networks by improving data analytics and therefore, advertisers can target customers more precisely. Moreover, Meta is working to create the Metaverse, a three-dimensional virtual space that can be entered using VR (virtual reality) technology to interact with other people. For this purpose, Meta acquirers companies active in this cluster. Alphabet makes acquisitions in this cluster in order to further improve its search engine and Android operating system, but also for applications such as VR. Microsoft is the tech giant with the highest number of acquisitions in this cluster. The aim is to develop in the field of cloud computing to improve Microsoft Azure and Windows operating systems for personal computers to better serve businesses. Tech giants seem increasingly interested in improving their platform of services and their data analysis by acquiring relevant companies. This therefore improves their ability to make predictions, identify user preferences for the development of products and services, and monetize data through advertising[12]

Fifth, these big techs firms are competing for the attention of the consumers (Prat and Valletti, 2022) by providing streaming services, social networks, gaming, etc. With more users

[12] Moss *et al.* (2021) note that the "digital business ecosystems (DBE)" operated by big platforms are increasingly focused on developing activities in the fields of artificial intelligence, data analytics, and cloud computing.

on their platforms, they can therefore collect more data and explore the preferences of their users. This information can then be monetized through advertising, devices sales, or selling complementary services. Companies have different monetization strategies for their online content but competition for attention is fierce and intensified recently. In our classification, the digital content cluster is the third-largest and all firms are acquiring in that cluster, demonstrating that big techs do not only compete for attention but also for acquisition of content providers.

Finally, Gautier and Lamesch (2021) classified acquisitions not on the basis of the products functionalities but on user segments. They found that Microsoft, Amazon and Apple acquired products targeted to their main user segment, Business for Microsoft, Merchants for Amazon and platform infrastructure for Apple. Their results are not necessarily incompatible; The acquisition of Voysis by Apple in 2020, a voice AI startup that will improve Apple's virtual assistant Siri is classified in the cloud cluster but would have been classified as targeted to the platform infrastructure by Gautier and Lamesch (2021). Together, these classifications reveal that big techs acquire technologies, AI-based solutions, to improve their core products, not necessarily to enter new markets. Combining the two classifications, we may posit that acquisitions are used by platforms to develop complementary and innovative services, mainly AI, to reinforce their main business and not necessarily to develop new offers or extend to new markets. For that reason, we observe similar acquisition strategies despite very different business models and revenue streams.

IV. AN EMPIRICAL ANALYSIS OF PRODUCT DISCONTINUATION

A. Model specification

In this section, we investigate the drivers of shutdown decisions by the acquirer. For that, we look at the factors affecting the continuation's status of a company's product using a Probit model. Our analysis replicates the study of Gautier and Lamesch (2021) with an extended dataset, new explanatory variables and a new classification for product discontinuation. For the estimations, we reduce the sample of acquisitions by removing observations for which variables were missing.

We formulate the following hypothesis. First, younger and smaller companies are more likely to be discontinued. Those companies are less likely to reach a critical mass of users or are at an earlier stage of their product development and hence, they are more likely to be integrated in the acquirer's ecosystem. Furthermore, there is a greater uncertainty regarding their success than their older counterparts, making project failure more likely. The variable *Age* measures the age of the company (in years) at the time of acquisition. The variable *Funding round* counts the number of funding rounds a company successfully completed prior to acquisition; unfortunately this variable is only available for a limited number of observations.[13]

Second, companies with activities overlapping with the acquirer are more susceptible to being discontinued. This echoes the killer acquisition motive identified by Cunningham *et al.* (2021). They found that acquisitions of pharmaceutical companies that have an overlapping drug portfolio with the acquirer are more likely to be discontinued post acquisition. For that, we define a core cluster for each acquirer as the cluster in which the platform realizes the highest sales. For Alphabet (advertising), Amazon (physical goods), Apple (communication apps and tools), and Meta (advertising), there is one well-identified cluster that accounts for the largest part of the company's revenue; for at least than 2/3 third of the firm's revenue for all the sample period (based on the companies' 10-k files). Microsoft has a more diversified revenue and derive revenues from products in different clusters. Communication apps and tools, including Microsoft's operating systems and revenues from Linkedin and the Xbox. The cloud cluster also generates substantial revenues, with Azure, the cloud-computing platform of Microsoft as the

[13] The total funding is missing for a larger subset of firms and there is a very large variability in the total funding amount, so we prefer not to use this variable.

main component. These two clusters are retained as the main clusters for Microsoft. Following Cunningham *et al.* (2021), we assume that acquired companies operating in the same cluster as the main cluster of a acquirer, i.e. in the cluster with the highest annual revenues, are more likely to be discontinued after the acquisition.

Third, we include control variables for the different clusters we identified. More precisely, we add a dummy variable for the four largest clusters (AI, DC, PGS, and TD), the remaining ones being treated as the default category. Finally, we include acquirers' dummies in our estimations.

To summarize, we estimate the following model:

$$P(Discon_i = 1|Age_i, A_i, X_i, Y_i, Z_i) = \Phi(\alpha + \beta_1 Age_i + A_i'\gamma + X_i'\delta + Y_i'\zeta + Z_i'\eta) \quad (1)$$

The dependent variable $Discon_i$ is a binary variable and monitors the post-acquisition operating status of the acquired entity *i*. We construct three measures for this variable.

1. The variable $Discon_i^1$ takes a value of 1 if company *i* was either integrated, not active or killed and 0 if it is continued.
2. The variable $Discon_i^2$ takes a value of 1 if company *i* was either not active or killed and 0 if it is continued or integrated.
3. The variable $Discon_i^3$ takes a value of 1 if company *i* was classified as killed and 0 otherwise.

The vector $A_i\prime$ contains dummies for each acquirer: $Alphabet_i$, $Meta_i$, $Apple_i$, and $Amazon_i$, Microsoft being considered as the base category. The vector $Y_i\prime$ is a dummy variable for the clusters. Finally, in addition to *Age*, we have a control variable (vector Z_i) for the *Funding rounds*, the nationality of the firm (US v. outside US) and for the *Main* cluster. ϕ denotes the Cumulative Density Function of the standard normal distribution. The change in the probability of a company discontinuation is estimated using a Probit regression model.[14]

B. Results

The results of the estimations are presented in Table 3. We present the results of five different models: Models 1 and 3 use $discon^1$, Models 2 and 4 use $discon^2$ and Model 5 uses $discon^3$. We integrate the funding variable in Models 3 and 4 and the estimations are based on a reduced sample.

We first refer to Models 1-4. In all these specifications, the variable age is negative and significant, indicating that younger startups are more likely to be discontinued. Or differently, it is less likely to find their products on the market after acquisition. This does not come as a surprise as younger firms are less likely to have a large user base, a strong market notoriety and they have products at an earlier stage of development. Similarly, in models 3 and 4, the variable funding round, which measures the acquired firm's development stage is negative and significant. Firms that completed more funding rounds are less likely to be discontinued.

Regarding the acquirer's identity, compared to Microsoft, all firms are more likely to discontinue their acquisition, as the coefficients are positive but not always significant. The effect is the strongest and the more significant for Apple which is, everything else equal, more likely than the others to discontinue the products it acquires. Apple has a commercial strategy to integrate all its products under unified and well-known brand name and the result does not come as a surprise. In some specifications, we also observe that the coefficient for Alphabet is also significant.

Regarding the product clusters, we observe that products in the digital content cluster are less likely to be discontinued than the others. Many firms in this cluster are related to gaming

[14] In our model, some of the variables entering the Probit regressions might be endogenous, which might potentially bias the results. For instance, products in some clusters may, by their nature, more likely to be discontinued. For this reason, our results should be interpreted with caution.

Table 3. Probit estimations 2015–2021

Dependent variable	**Model 1** *Discon*[1]	**Model 2** *Discon*[2]	**Model 3** *Discon*[1]	**Model 4** *Discon*[2]	**Model 5** *Discon*[3]
β_1[Age]	−0.0438***	−0.051***	−0.044***	−0.432***	−0.012
	(0.013)	(0.014)	(0.017)	(0.176)	(0.015)
γ_1[Alphabet]	0.535***	0.273	0.529 *	0.315	0.147
	(0.242)	(0.234)	(0.281)	(0.278)	(0.291)
γ_2[Amazon]	0.316	−0.018	0.210	0.129	0.064
	(0.251)	(0.245)	(0.282)	(0.282)	(0.309)
γ_3[Meta]	0.410	0.487	0.255	0.288	−0.107
	(0.276)	(0.277)	(0.323)	(0.325)	(0.373)
γ_4[Apple]	1.249***	1.245***	1.199***	1.288***	0.255
	(0.293)	(0.287)	(0.342)	(0.346)	(0.305)
ζ_1[AI]	−0.105	−0.109	0.053	0.070	–
	(0.239)	(0.233)	(0.266)	(0.267)	
ζ_2[DC]	−0.805***	−0.803***	−0.531	−0.553*	–
	(0.284)	(0.282)	(0.326)	(0.331)	
ζ_3[PGS]	−0.260	−0.129	0.019	0.103	–
	(0.258)	(0.253)	(0.304)	(0.301)	
ζ_4[TD]	−0.150	−0.227	−0.055	0.097	–
	(0.291)	(0.274)	(0.351)	(0.351)	
η_1[US]	−0.105	−0.247	−0.242	− 0.292	−0.036
	(0.239)	(0.184)	(0.237)	(0.238)	(0.217)
η_2[Main]	0.325	0.272	0.396	0.167	1.029***
	(0.280)	(0.269)	(0.319)	(0.306)	(0.270)
η_2[Funding rounds]	–	–	−0.108***	−0.187***	–
			(0.044)	(0.048)	
α[Constant]	Yes	Yes	Yes	Yes	Yes
N	292	292	218	218	292
Pseudo *R*-squared	0.151	0.154	0.151	0.193	0.076

Robust standard errors in parentheses $p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

and acquirers are less likely to discontinue game studios who have successful products and who managed to establish a strong reputation in the field. We observe that, in that clusters, products are more likely to survive acquisitions than in the other clusters.

Products identified to be in the cluster linked to the acquirer's main revenue source do not have a higher probability to be discontinued. Similarly, regarding the nationality of the target, we do not observe differences between US and non-US companies that are equally likely to be discontinued.

Finally, if we use the killer discontinuation as the dependent variable (Model 5), we observe that the only significant variable is the main segment. This means that a discontinuation announcement, that is an explicit termination of the acquired product, are more likely in the field where the acquirer has the strongest market position. And this is true irrespective of the age of the target, as the variable is not significant in this model. This result suggests that close competitors are more likely to be killed by their acquirer. The use of this measure of discontinuation should be interpreted with caution as there are only 40 companies for which a discontinuation announcement has been found.

In Appendix B (Table B3), we present the estimations of models 1 and 2 for based on two subsamples depending on the acquisition date, covering respectively the period 2015–2017 and 2018–2021. There are too few observations to estimate model 5 on these subsamples. These additional estimations largely confirm our base results.

V. CONCLUSIONS

In this paper, we have shown that acquirer massively discontinue the products of the companies they buy. If product discontinuation in itself is not a concern, products fail or are becoming obsolete, the importance of the phenomenon is raising concerns. Building on previous studies, this paper has the ambition to provide more information on the phenomenon. Our analysis shows products of younger firms are more likely to be discontinued. This result does not come as a surprise as a younger firm is less likely to have a well-established brand name and a large customer base. We also show that Apple has a more systematic discontinuation policy than the other big techs. And, regarding killer discontinuation, we observe that they occur mainly in the "main" segment, where the acquirer holds a stronger market position.

Our analysis also show that acquisition and discontinuation strategies differ depending on the nature of the products. Firms are competing fiercely for the attention of the consumers and they are buying many content providers. Those are being less likely to be discontinued. Alphabet, Amazon and Microsoft who have a strong cloud business supply are acquiring massively to reinforce their offer. Similarly, all firms are investing a lot in AI to complement their offer. Massive acquisitions in this field imply that many of these new technologies are appropriated by the tech giants who already hold strong market positions. This may prevent the smaller digital companies to compete on the same level-playing field with them, i.e. those acquisitions may slow down the diffusion of AI-based solutions in the market and restrict entry by competitors. Hence, even if these products are not discontinued because they represent a competitive threat for the acquirer, that is even if these acquisitions cannot be labelled as killer acquisition (an hypothesis we cannot verify), they raise competition concerns and a stricter merger control should be applied to guarantee that products and innovations are well-diffused in the market.[15] Furthermore, there is a risk that the largest platforms that already have access to a lot of data, have also access to the best technologies to manage these data, creating further barriers to entry.

As a concluding word, we would like to stress the limits of our analysis. In particular, it is important, and probably frustrating, to say that we cannot conclude that product discontinuation is harmful for competition or for innovation. The reason is that product discontinuation may result from different strategies that we do not observe. The acquirer may have an anti-competitive motivation and deliberately eliminate a product that is too close to its owns. But the acquirer may have other motivations. It may be interested in the technology developed by the startup and integrate this technology in its products. For instance, AI is a complement to many existing products of the GAFAM like search engines, cloud solutions, or tools for software development. Or, it may be interested in buying teams of engineers specialized in one field. It is often more convenient to "acqui-hire" a whole team in a specialized area than conducting separate hires (Varian, 2021). Finally, the acquired product may be a failure.

To understand better the motivations of the acquirer and thereby assess correctly the potential anticompetitive effects of the acquisition plus discontinuation, one needs to dig deeper and analyze further not only the evolution of the products, but also the evolution of the acquirerÕs technology and its team. Tracking the evolution of technologies post-acquisition and the evolution of the team will provide further information on the underlying motivations for acquisition. Further analysis of the evolution of firms, products, technologies, and employees after acquisition would provide additional information and would help competition authorities in defining a coherent and a more adapted strategy to cope with startup acquisitions in the digital sector. This is clearly an interesting area for further research.

[15] Bryan and Hovenkamp (2020) show that acquisition limits the diffusion of innovations as there is too little licensing by the acquirer.

A. Additional statistics on acquisition

Table A1. Acquisitions per year for each firm

	2015	2016	2017	2018	2019	2020	2021	Total
AMZN	9	8	13	4	9	2	5	**50**
APPL	12	8	13	8	9	8	2	**60**
META	8	8	4	5	7	7	5	**44**
ALPHA	18	20	14	9	8	8	5	**82**
MSFT	18	11	11	17	13	9	14	**93**
Total	**65**	**55**	**55**	**43**	**46**	**34**	**31**	**329**

Table A2. Acquisitions per cluster by company

	DC	HW	TD	RS	AI	O	PGS	CAT	ATP	Total
AMZN	4	2	4	6	16	1	10	5	2	**50**
APPL	10	6	2	1	27	2	11	1	0	**60**
META	9	3	4	1	12	1	8	5	1	**44**
ALPHA	7	8	19	8	14	6	12	6	2	**82**
MSFT	15	4	11	5	27	5	20	5	1	**93**
Total	**45**	**23**	**40**	**21**	**96**	**15**	**61**	**22**	**6**	**329**

B. Additional Probit estimations

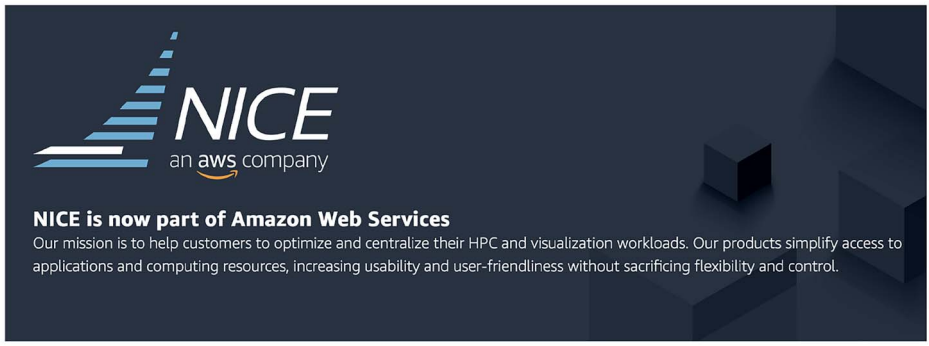
Table B3. Probit estimations 2015–2017 and 2018–2021

Dependent variable **Period**	**Model 1** *Discon*[1] **2015–2017**	**Model 1** *Discon*[1] **2018–2021**	**Model 2** *Discon*[2] **2015–2017**	**Model 2** *Discon*[2] **2018–2021**
β_1[Age]	−0.054***	−0.025	−0.053***	−0.033
	(0.020)	(0.014)	(0.023)	(0.024)
γ_1[Alphabet]	0.318	0.600	0.140	0.323
	(0.415)	(0.346)	(0.373)	(0.347)
γ_2[Amazon]	1.000**	−0.118	0.068	−0.352
	(0.498)	(0.367)	(0.386)	(0.380)
γ_3[Meta]	0.346	0.563	0.485	0.693*
	(0.517)	(0.368)	(0.502)	(0.376)
γ_4[Apple]	0.420	2.003***	0.343	2.143***
	(0.426)	(0.502)	(0.406)	(0.506)
ζ_1[AI]	−1.050**	0.397	−0.469	0.254
	(0.494)	(0.330)	(0.381)	(0.381)
ζ_2[DC]	−0.962*	−0.690*	−0.634	−0.806**
	(0.592)	(0.394)	(0.487)	(0.411)
ζ_3[PGS]	−0.991**	−0.649	−0.409	−0.052
	(0.496)	(0.383)	(0.393)	(0.387)
ζ_4[TD]	−0.600	−0.519	−0.646	−0.451
	(0.518)	(0.481)	(0.391)	(0.487)
η_1[US]	−0.600	−0.173	−0.392	− 0.242
	(0.359)	(0.265)	(0.308)	(0.269)
η_2[Main]	−0.315	0.893**	−0.310	0.994**
	(0.479)	(0.440)	(0.385)	(0.446)
α[Constant]	Yes	Yes	Yes	Yes
N	143	149	143	149
Pseudo *R*-squared	0.180	0.223	0.120	0.253

Robust standard errors in parentheses $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

C. Classification of acquired companies: illustrating examples

a



b

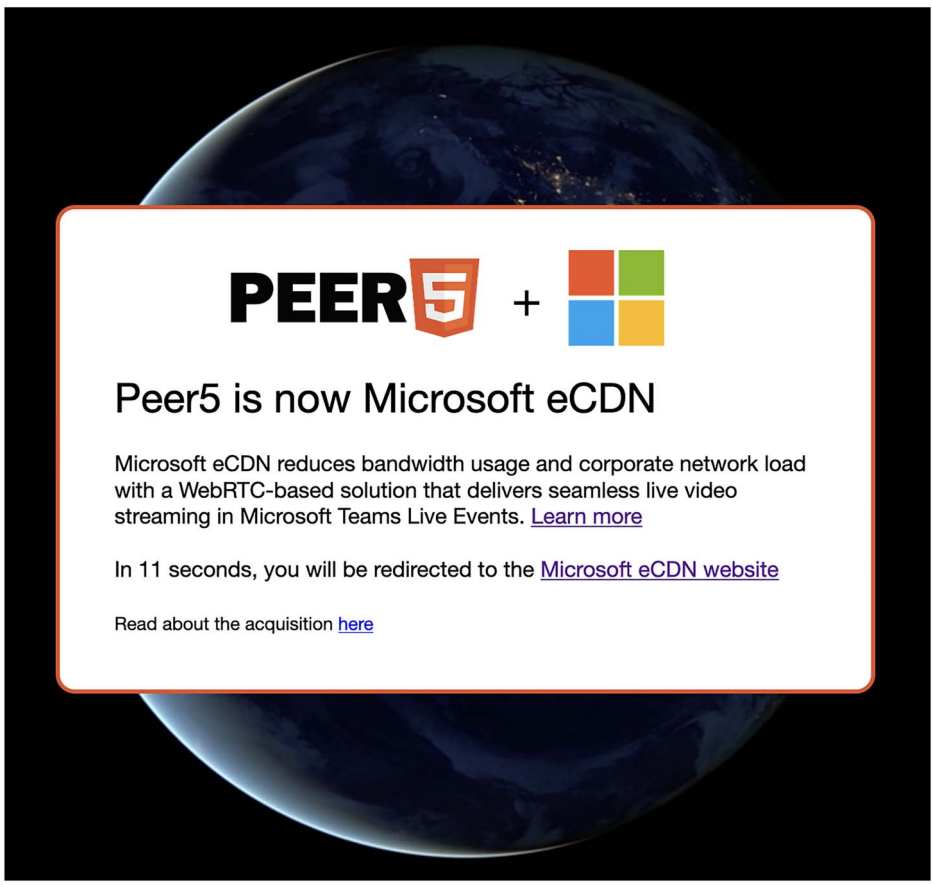
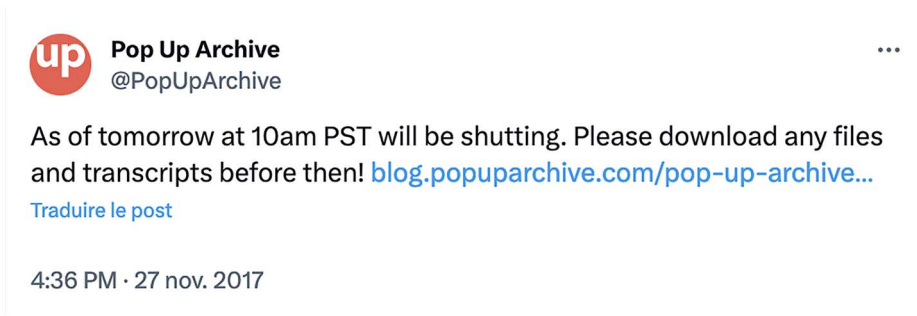


Figure C3. Examples of integrated companies: Nice (Amazon) and Peer5 (Microsoft)

a



b

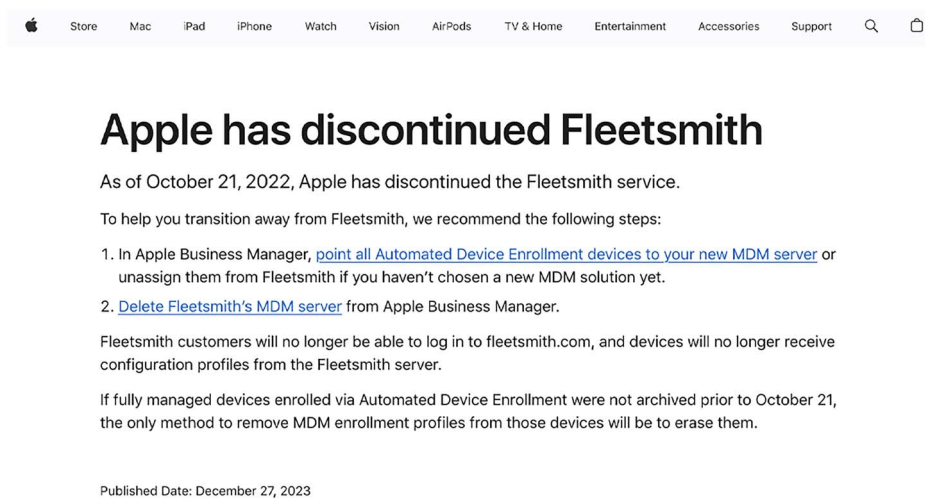


Figure C4. Examples of discontinuation announcements: Pop Up Archive (Apple) and FleetSmith (Apple)

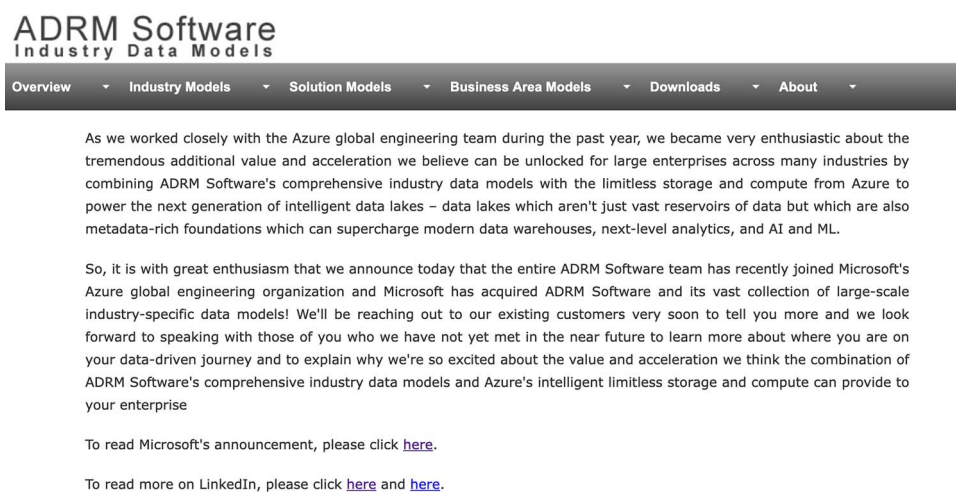


Figure C5. Example of inactive company: ADRM software (Microsoft)

REFERENCES

Affeldt, P., Kesler, R. 2021. Competitors' reactions to big tech acquisitions: Evidence from mobile apps, DIW Discussion Papers 1987, Available at SSRN: https://ssrn.com/abstract=3998875.

Argentesi, E., Buccirossi, P., Calvano, E., Duso, T., Marrazzo, A., Nava, S. 2019. Ex-post assessment of merger control decisions in digital markets. Report to the Competition Market Authority, available at https://assets.publishing.service.gov.uk/media/5ce54e9aed915d2475aca875/CMA_past_digital_mergers_GOV.UK_version.pdf.

Argentesi, E., Buccirossi, P., Calvano, E., Duso, T., Marrazzo, A., Nava, S. 2021. Merger policy in digital markets: An ex post assessment, *Journal of Competition Law & Economics*, **17**: 95–140.

Bourreau, M., de Streel 2020. *Big tech acquisitions, competition & innovation effects and EU merger control*. Report to the CERRE, available at https://cerre.eu/wp-content/uploads/2020/03/cerre_big_tech_acquisitions_merger_control_EU_2020.pdf.

Bryan, K., Hovenkamp, E. 2020. Antitrust limits on startup acquisitions, *Review of Industrial Organization*, **56**: 615–36.

Cabral, L. 2021. Merger policy in digital industries, *Information Economics and Policy*, **54**: 100866.

Cabral, L. 2023. Big Tech Acquisitions, CEPR Discussion Paper No. 18272. CEPR Press, Paris & London. https://cepr.org/publications/dp18272.

Cremer, J., de Montjoye, Schweitzer, H. 2019. Competition policy for the digital era, Report to the European Commission, available at https://data.europa.eu/doi/10.2763/407537.

Cunningham, C., Ederer, F., Ma, S. 2021. Killer acquisitions, *Journal of Political Economy*, **129**: 649–702.

De Loecker, J., Eeckhout, J., Unger, G. 2020. The rise of market power and the macroeconomic implications, *The Quarterly Journal of Economics*, **135**: 561–644.

Ederer, F., Pellegrino, B. 2023. The great startup sellout and the rise of oligopoly, *AEA Papers & Proceedings*, **113**: 274–8.

Dung, A.V., Yongjiang, S., Gregory, M. 2010. Brand and product integration in horizontal mergers and acquisitions, *European Journal of International Management*, **4**: 79–119.

Eisfeld, L. 2023. Entry and acquisitions in software markets, Working paper TSE, University of Toulouse, available at https://luiseeisfeld.github.io/assets/docs/JMP_Eisfeld_TSE.pdf.

Gautier, A., Lamesch, J. 2021. Mergers in the digital economy, *Information Economics and Policy*, **54**: 100890.

Harroch, R. 2020. *The Impact of the Coronavirus Crisis on Mergers and Acquisitions*. Forbes, https://www.forbes.com/sites/allbusiness/2020/04/17/impact-of-coronavirus-crisis-on-mergers-and-acquisitions/.

Ivaldi, M., Petit, N., Ünekbaş, S. 2023. Killer acquisitions: Evidence from EC merger cases in digital industries, TSE Working Paper No. 13-1420, available at SSRN: https://ssrn.com/abstract=4407333.

Motta, M., Peitz, M. 2021. Big tech mergers, *Information Economics and Policy*, **54**: 100868.

Moss, D., Gundlach, G., Krotz, R. 2021. *Market power and digital business ecosystems: Assessing the impact of economic and business complexity on competition analysis and remedies*. Report American Antitrust Institute, available at SSRN: https://ssrn.com/abstract=3864481.

Ng, W., Stuart, T. 2022. Acquired employees versus hired employees: Retained or turned over? *Strategic Management Journal*, **43**: 1025–45.

Parker, G., Petropoulos, G., Van Alstyne 2021. Platform mergers and antitrust, *Industrial and Corporate Change*, **30**(30): 1307–36.

Prat, A., Valletti, T. 2022. Attention oligopoly, *American Economic Journal: Microeconomics*, **14**: 530–57.

Puranam, P., Srikanth, K. 2007. What they know vs. what they do: How acquirers leverage technology acquisitions, *Strategic Management Journal*, **28**: 805–25.

Scott Morton, F., Bouvier, P., Ezrachi, A., Jullien, B., Katz, R., Kimmelman, G., Melamed, A.D., Morgenstern, J. 2019. Committee for the study of digital platforms: Market structure and antitrust subcommittee report. Stigler Center for the Study of the Economy and the State. University of Chicago Booth School of Business, available at https://research.chicagobooth.edu/-/media/research/stigler/pdfs/market-structure---report-as-of-15-may-2019.pd.

Valletti, T., Zenger, H. 2019. Increasing market power and merger control, *Competition Law & Policy Debate*, **5**: 40–9.

Varian, H. 2021. Seven deadly sins of tech? *Information Economics and Policy*, **54**: 100893.