Motivation

- On April 26, 2021 Apple introduced its App Tracking Transparency Framework (ATT)
  - Effectively shifts behavioral tracking (used in targeted advertising) from **opt-out** to **opt-in**
  - Users can block apps from even requesting permission to track
  - Anecdotal evidence suggests ATT greatly reduced percentage of users consenting to tracking
- Opportunity to study the relationship between tracking, data, and the provision of ad-supported goods
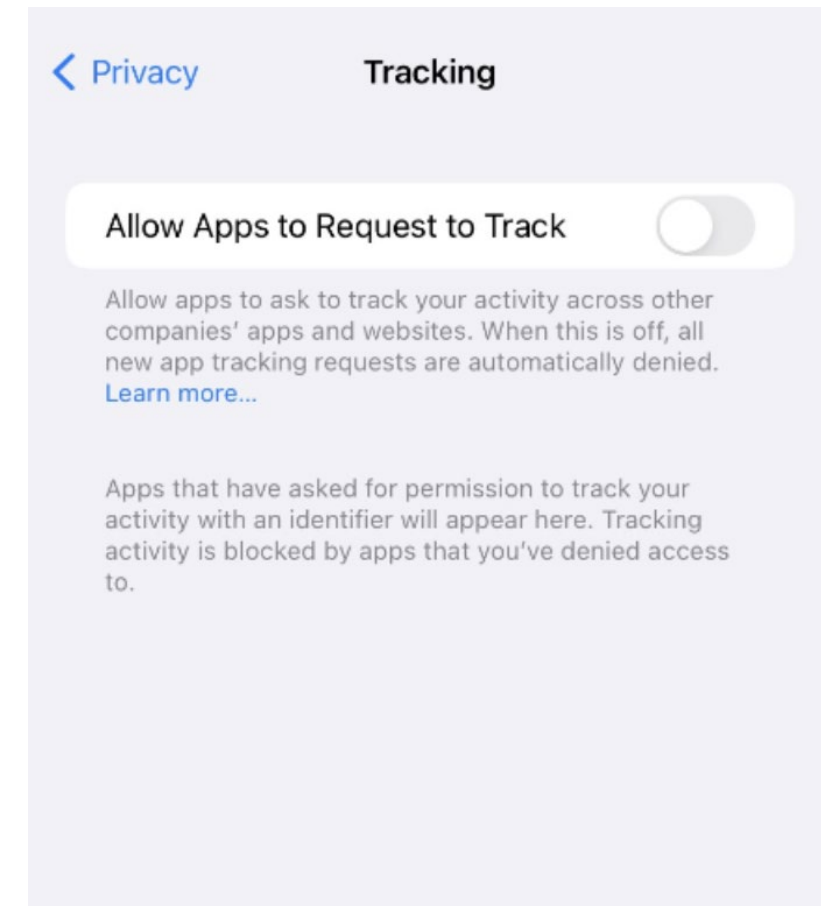
Apple vs. the free internet

Apple plans to roll out a forced software update that will change the internet as we know it—for the worse.

Take your favorite cooking sites or sports blogs. Most are free because they show advertisements.

Apple's change will limit their ability to run personalized ads. To make ends meet, many will have to start charging you subscription fees or adding more in-app purchases, making the internet much more expensive and reducing high-quality free content.

Beyond hurting apps and websites, **many in the small business community say this change will be devastating for them too, at a time when they face enormous challenges.** They need to be able to effectively reach the people most interested in their products and services to grow.

Forty-four percent of small to medium businesses started or increased their usage of personalized ads on social media during the pandemic, according to a new Deloitte study. Without personalized ads, Facebook data shows that the **average small business advertiser stands to see a cut of over 60% in their sales for every dollar they spend.**

Small businesses deserve to be heard. We're standing up to Apple for our small business customers and our communities.

Get the full story at fb.com/ApplePolicyUpdate

FACEBOOK

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Apple's ATT and the App Ecosystem

- If the profitability of app developers that rely on advertising is affected, incentives to participate in the ecosystem will be affected:
    - Will we see an increase in exit?
    - Will there be a decrease in updates?
    - Will the business model of apps change (ad-supported to in-app purchases)?
    - For apps that remain, how does the valuation of Apps by users change?
    - How does valuation for users differ for apps introduced after/before ATT?
    - Will demand for apps decrease or increase?
- Ultimately, what are the costs of this policy for users in terms of the availability and quality of "free" apps?

Related Work

- Janßen et al (2022) find that GDPR induced the exit of about a third of available apps in the Google play store and significantly reduced entry
  - GDPR affected Apple and Android's ecosystems equally, whereas ATT only affects Apple's
  - Not only about causality, but also about ability to explore additional questions by contrasting the evolution of the two ecosystems

- Lefrere et al (2024) find that ad-supported news and media websites response to GDPR evolve over time, but find no effect of those responses over websites' ability to stay in business, produce content, and engage visitors
  - Responses are not static. They change significantly over time even within sites

- Li and Tsai (2022) study how ATT has hampered the ability of app developers to attract users through advertising

- Kesler (2022) studies how app developers have changed their monetization strategies after ATT

Data and Timeframe

- Use data from a provider (AirNow) that tracks all apps in both Google Play and iOS App Store

- Data period: Eighteen-month window around April 2021 policy change
  - Minimizes confounding effects on either ecosystem
  - Long enough to capture pre-trends, and short- and long-term effects

- We study the universe of Apps on Apple's App Store and the Google Play Store.
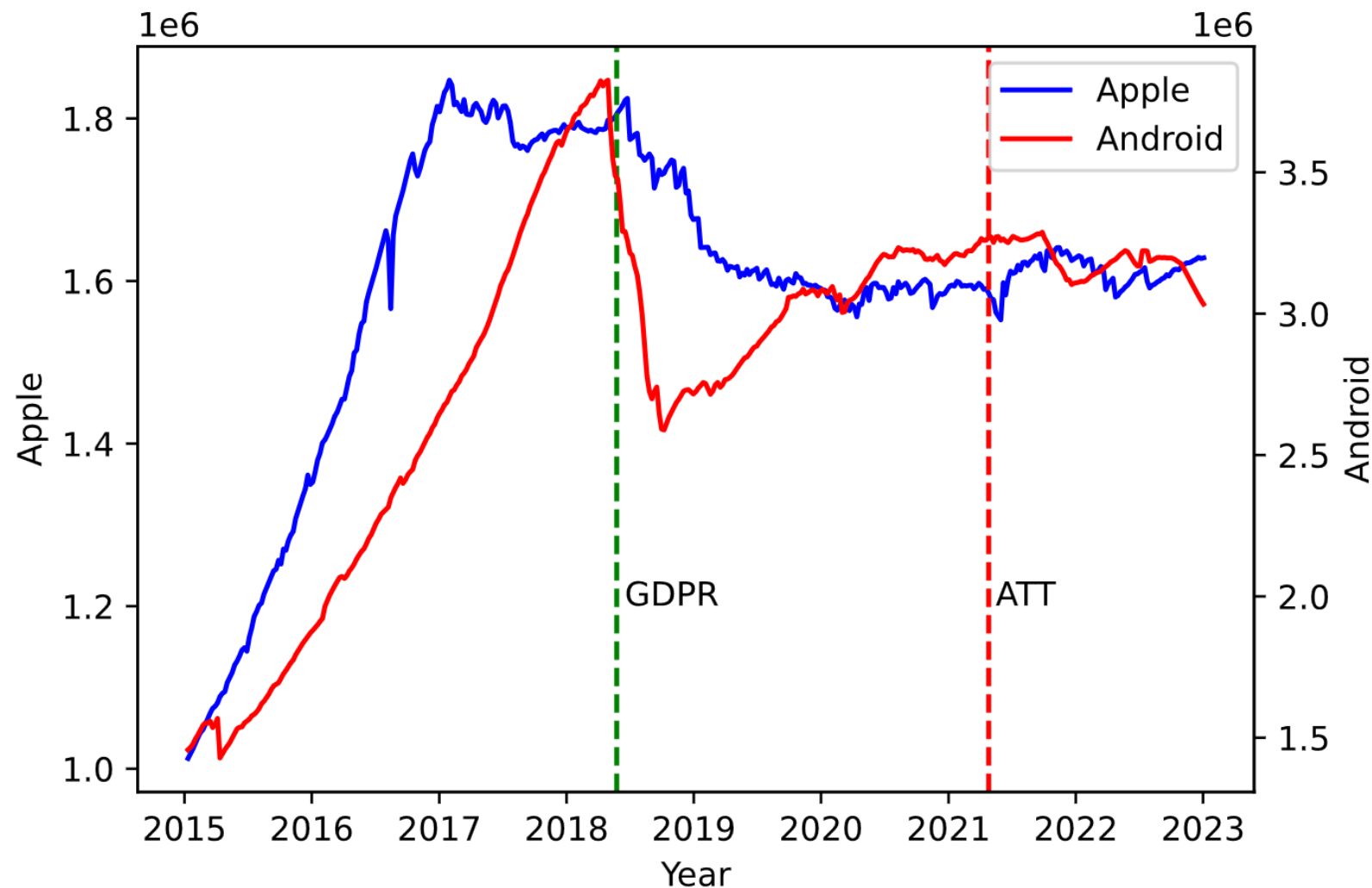
Methodology

- We assume ATT is an exogenous shock that only affects the Apple ecosystem

- Difference-in-difference framework. Compare evolution of Google vs Android Apps

- Also employ event-study analysis to check for parallel trends, short-term, long-term, and delayed effects

Methodology

We analyze several variables

- Entry, Exit, and Update:
  - Related to incentives to keep investing and innovating in the ecosystem
- Use of Software Developer Kits by Apps:
  - Allow us to measure if developers have changed how developers adjust functionalities included in their Apps
- Number of New Ratings and Average Rating:
  - Proxy for demand side effects

Exit, Entry, and Updates

- If the ability to monetize investments in app development is negatively affected by ATT, we should expect to see less entry

- Similarly, if keeping an app in the market is costly, we should expect increased exit

- In general, cost of keeping an app listed is low. Past research has looked at updates as a measure of continued commitment of developers with the app. However, this measure has limitations:
  - If the app is stable and well liked, incentives to updates may be lower
  - If app is poorly rated, there are more incentives to update

Exit, Entry, and Updates

- For entry and exit we calculate genre-level entry and exit counts:
$$Y_{p,g,t} = \alpha_1 * PostATT_t * Apple_p + \delta_g + \mu_{g,t} + \epsilon_{g,t}$$
  - p = platform, g = genre, t = month
  - $Y_{p,g,t}$ = Log (1 + Count of Entry/Exit by platform, genre, time)
  - $PostATT_t$ and $Apple_p$ are dummy variables
  - δ_g and $\mu_{g,t}$ are genre and month fixed effects
  - α_1 is the coefficient of interest. Measuring degree at which entry and exit on Apple's platform respond to the introduction of ATT

- For updates we use app-level data:
$$Y_{i,t} = \beta_1 * PostATT_t * Apple_i + \omega_i + \mu_t + \epsilon_{i,t}$$
  - $Y_{i,t}$ is equal to 1 if app i was updated during time t

Exit, Entry, and Updates

	Log Entry Count (1)	Log Exit Count (2)	Update (3)
After ATT x Apple	-0.1634***	0.0651*	-0.0041***
	(0.0611)	(0.0333)	(0.0001)
Platform-Genre FE	✓	✓	
Period FE	✓	✓	✓
App FE			✓
Cohen's D	-0.3587	0.2732	-0.0186
Dependent variable mean	7.0268	7.2847	0.07768
R^2	0.91637	0.97163	0.37103
Observations	817	817	87,036,182

Robust standard errors in parenthesis.

*** $p < 0.01$, * $p < .05$, * $p < 0.1$

Reduced entry after ATT?
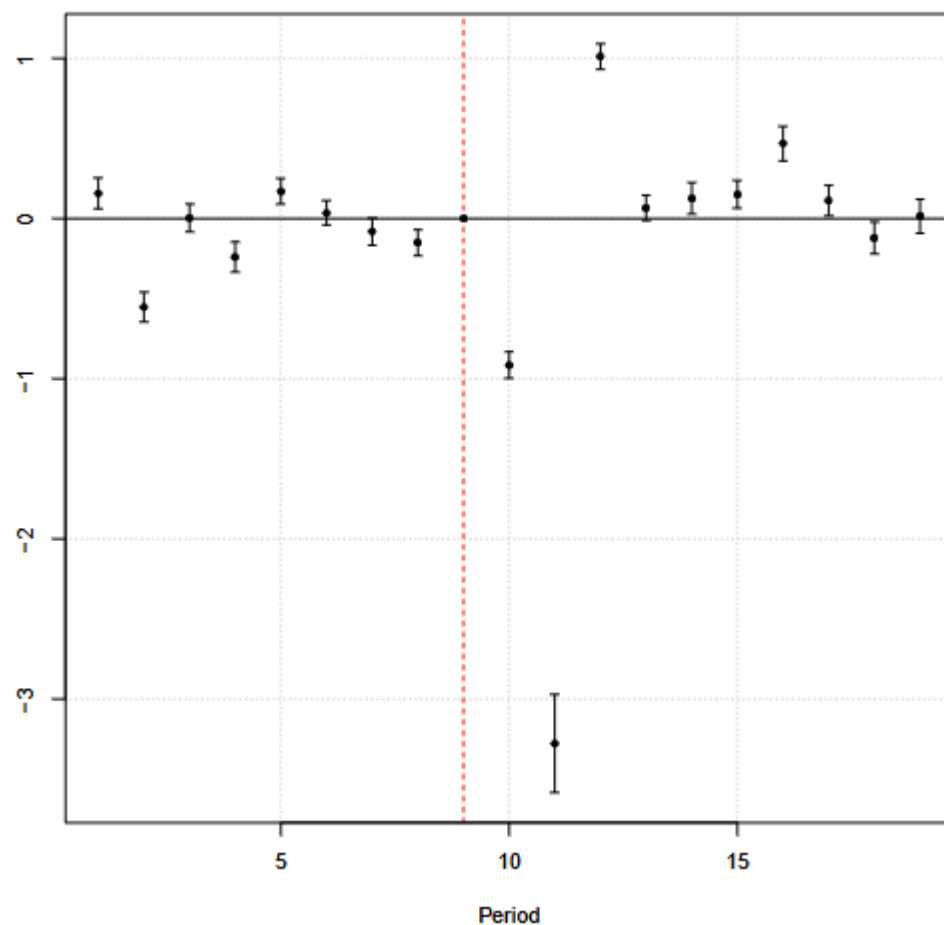
Looking at the event study plot of Entry shows that:

- Right after ATT is introduced, there is a sharp drop in entry

- Entry recovers a few weeks after

- More than a decrease in interest by developers, this is more consistent to an adaptation period

Usage of Software Development Kits (SDKs)

- SDKs are third-party tools developers can use to incorporate functionalities in their apps. We focus on:
  - **Monetization**: Use to monetize apps through advertising
    - Examples: Facebook audience network, Google AdMob, ironSource...
  - **Ad Mediation**: Similar to monetization, but connects to multiple platforms trying to allocate impressions to the platform offering higher price
    - Examples: AdMob Mediation Adaptor, ironSource Mediation Adaptor, ...
  - **Payment:** Used for securely processing card transactions
    - Examples: Mastercard CBP, Stripe, Square, Venmo, ...
  - **Authentication:** Allow apps to let users log in using credentials from different platforms
    - Examples: Facebook login, Firebase Auth, Google Sign In, Validator, ...

Usage of Software Development Kits (SDKs)

	Monetization (1)	Ad Mediation (2)	Authentication (3)	Payments (4)
After ATT x Apple	-0.0258***	-0.0020**	0.0052***	0.0062***
	(0.0017)	(0.0008)	(0.0007)	(0.0004)
App FE	✓	✓	✓	✓
Period FE	✓	✓	✓	✓
Cohen's D	-0.0460	-0.0038	0.0171	0.0269
Dependent variable mean	1.2140	0.24741	1.0353	0.51105
R^2	0.88746	0.86648	0.89495	0.90325
Observations	8,448,364	8,448,364	8,448,364	8,448,364

Robust standard errors in parenthesis.

*** $p < 0.01$, * $p < .05$, * $p < 0.1$

Usage of Software Development Kits (SDKs)

- Decrease in the use of Monetization and Ad Mediation SDKs, along with increase in Authentication and Payments SDKs suggest a shift towards revenue models less centered on advertising

- However, while effects are statistically significant, they are small and indicate trivial differences

- Not all apps rely on advertising to the same degree. Game apps are by a large margin the most likely to use Monetization and Ad Mediation SDKs
  - They show the biggest decline in the use of Monetization and Ad Mediation
  - And the largest increase in the use of payment SDKs

Changes in Users' Valuation of Apps

- ATT may lead to changes that decrease users' valuations of Apps:
  - Less frequent update can lead to unsolved bugs outdated Apps
  - If Apps adjust their business model towards using more in-app payments or increasing the number of ads, users may dislike the change
  - Advertising, recommendations, and functionalities may become less relevant
- ATT could also lead to positive changes in users' valuations, for example if it leads to a reduction in predatory privacy practices
- We study the new number of ratings received by apps (which is a proxy for the number of downloads, and thus of demand)
- And the average rating of new ratings received (as a proxy for quality)

Number of Ratings and Average Rating

	Log # New Ratings (1)	No Rating (2)	Avg. Rating (3)
After ATT x Apple	-0.0176***	0.0105***	-0.0101***
	(0.0002)	(0.0001)	(0.0019)
App FE	✓	✓	✓
Period FE	✓	✓	✓
Cohen's D	-0.0525	0.0476	-0.0092
Dependent variable mean	0.19973	0.87653	3.9250
R^2	0.80218	0.58455	0.43475
Observations	78,518,418	78,518,418	9,694,838

Robust standard errors in parenthesis.

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Declining Ratings?

- After ATT, apps in the Apple ecosystem are receiving fewer new ratings, and lower ratings than before ATT

- As we know ATT apparently is causing developers to update their apps less frequently, let's analyze how ATT affects existing vs new apps

- We analyze ratings during the first month an App is available in the store, comparing Apps introduced before and after ATT

- For existing Apps, we analyze ratings for Apps that are:
  - Not updated after ATT
  - That are updated more frequently after ATT
  - That are updated less frequently after ATT

Ratings During First Month of Sale

	No Rating (1)	Log # New Ratings (2)	Avg. Rating (3)
After ATT x Apple	-0.0277***	0.0644***	0.0087
	(0.0009)	(0.0027)	(0.0112)
Platform-Genre FE	✓	✓	✓
Period FE	✓	✓	✓
Cohen's D	-0.0789	0.0615	0.0096
Dependent variable mean	0.84456	0.39457	4.1814
R^2	0.05862	0.05374	0.03544
Observations	2,112,133	2,112,133	328,301

Robust standard errors in parenthesis.

*** $p < 0.01$, * $p < .05$, * $p < 0.1$

Ratings: Existing Apps by Update Frequency

	Log # New Ratings (1)	No Rating (2)	Avg. Rating (3)
After ATT x Apple × Zero	-0.0168***	0.0130***	-0.0334***
	(0.0001)	(0.0001)	(0.0032)
After ATT x Apple × (Weakly) Higher	0.0034***	-0.0012***	0.0133***
	(0.0004)	(0.0002)	(0.0030)
After ATT x Apple × Lower	-0.0319***	0.0114***	-0.0086***
	(0.0003)	(0.0002)	(0.0026)
App FE	✓	✓	✓
Period FE	✓	✓	✓
Cohen's D			
Dependent variable mean	0.20093	0.87548	3.9233
R^2	0.80129	0.58330	0.43389
Observations	77,477,703	77,477,703	9,647,402

Robust standard errors in parenthesis.

*** $p < 0.01$, * $p < .05$, * $p < 0.1$

Summary of Results

- Right after ATT there is a noticeable **reduction in the number of available apps** in the iTunes ecosystem
  - However, **reduction is temporary**
  - In fact, by 3-4 months after ATT, the number of apps had recovered and even **increased** vis-a-vis the Android ecosystem
- There is **no evidence of increased exit or reduced entry in the long term**
- **Update frequency** slightly decreases.

Summary of Results

- Examining the usage of SDKs suggests Apps may be adjusting their revenue model

- There is a **decrease** in the use of **Monetization** and **Ad Mediation** SDKs

- There is an **increase** in the use of **Authentication** and **Payment** SDKs

- The **effects are statistically significant, but their magnitude is economically trivial**

Summary of Results

- Number of **new ratings and average rating is lower after ATT for existing apps**

- **Not all Apps are affected in the same way**

- **New apps** introduced after ATT:
  - **Are more likely to get at least one review** during their first month in the market
  - Get more reviews on average as apps introduced before ATT during their first month

- For existing Apps:
  - Those that are **not updated, or are updated less frequently** after ATT get **fewer and lower ratings**
  - Those are **updated more frequently** after ATT get **more and higher ratings**

Thank you!