Vertical Integration in Platforms: Evidence from Mobile App Stores

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Regulatory Cases Against Apple App Store

- **April 2025—**EU fined Apple €500m for App Store payment rules
  - DMA steering rules
- **March 2024—**EU fined Apple €1.84b for App Store payment rules
  - Spotify steering complaint
- **March 2024—**DOJ and 16 states file case against Apple for iPhone and App Store restrictions on types of apps and smartwatch connectivity
- **May 2021 to April 2025—**Epic Games wins case against Apple for App Store steering practices

Regulatory Cases Against Alphabet Play Store

- **March 2025—**EU finds Alphabet self-preferenced in Play Store and Search
  - DMA
- **October 2024—**US judge orders Alphabet to facilitate rival app stores on Android OS
  - Epic Games case

Legislation Regarding App Stores

- EU's Digital Market Act
- US Federal
  - Proposed Open App Markets Act
  - Proposed App Store Freedom Act
- US States
- South Korea "Google power-abuse prevention law"

Research Question

- What are the implications of platform developer vertical integration?
  - Do mobile platform developers…
    - Harm or help third-party app developers?
    - Or have no specific effect other than to provide a platform?
  - Indicators—revealed preferences of consumers and app developers
    - Downloads of third-party apps
      - Global and US
    - Updates

Preview of Conclusions

- Patterns in impacts hard to find, but…
  - Apple and Google do not appear to hinder rivals
  - Top 20 Apps have more negative impacts on similar apps than do Apple and Google
- Next step: Apply machine learning to develop app predictions

Theory: If Platform Introduces an App…

- Appears to suppress rivals if
  - Downloads decline for preponderance of similar apps, relative to other app entry
  - Updates decline for preponderance of similar apps, relative to other app entry
- Appears to be helpful to rivals if
  - Downloads increase for preponderance of similar apps, relative to other app entry
- Appears to have no effect on rivals if
  - Downloads unaffected for preponderance of similar apps
- Appears to represent normal competition if
  - Downloads decline or increase for preponderance of similar apps, in line with other app entry
  - Updates increase for preponderance of similar apps, in line with other app entry

Technical Theory

- Firm i supplies a platform with a vector of specified features $\widehat{\boldsymbol{T}}_{i,t}$ at time t if…
  - $\pi\left(\widehat{\boldsymbol{T}}_{i,t}, \boldsymbol{Z}_{i,t}\right) \geq \pi\left(\widetilde{\boldsymbol{T}}_{i}, \boldsymbol{Z}_{i,t}\right) \forall\, \widetilde{\boldsymbol{T}}_{i} \subseteq \boldsymbol{T}$, where
    - $\boldsymbol{T}$= set of all possible features, including device, user interface, OS properties, first-party apps, prices, and rules for third-party developers
    - $\boldsymbol{Z_{i,t}}$ is a vector of exogenous parameters, including i's history and expectations of user and rival decision functions, regulations, technologies, and economic factors
- Third party j supplies its app on i with a vector of specified features $\widehat{\boldsymbol{T}}_{j,t}$ if…
  - $\pi\left(\widehat{\boldsymbol{T}}_{j,t}, \boldsymbol{Z}_{j,t} \middle| \widehat{\boldsymbol{T}}_{i,t}\right) \geq \pi\left(\widetilde{\boldsymbol{T}}_{j}, \boldsymbol{Z}_{j,t} \middle| \widehat{\boldsymbol{T}}_{i,t}\right) \forall\, \widetilde{\boldsymbol{T}}_{j} \subseteq \boldsymbol{T}$, where
    - $\boldsymbol{Z}_{j,t}$is a vector of exogenous parameters, including j's history and expectations of user and rival decision functions, regulations, technologies, and economic factors

Technical Theory II

- Differences between $\boldsymbol{Z}_{i,t-1}$ and $\boldsymbol{Z}_{i,t}$ induce i to change its feature choices, i.e., $\widehat{\boldsymbol{T}}_{i,t} \neq \widehat{\boldsymbol{T}}_{i,t-1}$. More specifically, $\widehat{\boldsymbol{T}}_{i,t} - \widehat{\boldsymbol{T}}_{i,t-1}$includes a first-party app
- Possible third-party impacts
  - Impacts *j*'s sales, i.e.,
    - Increases downloads or users, i.e., $\pi\left(\widehat{\boldsymbol{T}}_{j,t-1}, \boldsymbol{Z}_{j,t} \middle| \widehat{\boldsymbol{T}}_{i,t}\right) > \pi\left(\widehat{\boldsymbol{T}}_{j,t-1}, \boldsymbol{Z}_{j,t} \middle| \widehat{\boldsymbol{T}}_{i,t-1}\right)$
    - Or deceases downloads or users $\pi\left(\widehat{\boldsymbol{T}}_{j,t-1}, \boldsymbol{Z}_{j,t} \middle| \widehat{\boldsymbol{T}}_{i,t}\right) < \pi\left(\widehat{\boldsymbol{T}}_{j,t-1}, \boldsymbol{Z}_{j,t} \middle| \widehat{\boldsymbol{T}}_{i,t-1}\right)$
  - Increases profitability of updates, i.e., $\pi\left(\widehat{\boldsymbol{T}}_{j,t}, \boldsymbol{Z}_{j,t} \middle| \widehat{\boldsymbol{T}}_{i,t}\right) > \pi\left(\widehat{\boldsymbol{T}}_{j,t-1}, \boldsymbol{Z}_{j,t} \middle| \widehat{\boldsymbol{T}}_{i,t}\right)$ where $\widehat{\boldsymbol{T}}_{j,t} - \widehat{\boldsymbol{T}}_{j,t-1}$ includes an update
  - Impacts profitability of entry, i.e.,
    - Increases entry, i.e., $\exists\, j \in \boldsymbol{J}$ such that $\nexists \widetilde{\boldsymbol{T}}_j \subseteq \boldsymbol{T}$ where $\pi\left(\widetilde{\boldsymbol{T}}_j, \boldsymbol{Z}_{j,t-1} \middle| \widehat{\boldsymbol{T}}_{i,t-1}\right) \geq 0$ and $\exists \widetilde{\boldsymbol{T}}_j \subseteq \boldsymbol{T}$ where $\pi\left(\widetilde{\boldsymbol{T}}_j, \boldsymbol{Z}_{j,t1} \middle| \widehat{\boldsymbol{T}}_{i,t1}\right) \geq 0$, and the number of *j*'s for which this is true exceeds the number for which $\exists \widetilde{\boldsymbol{T}}_j \subseteq \boldsymbol{T}$ where $\pi\left(\widetilde{\boldsymbol{T}}_j, \boldsymbol{Z}_{j,t-1} \middle| \widehat{\boldsymbol{T}}_{i,t-1}\right) \geq 0$ and $\nexists \widetilde{\boldsymbol{T}}_j \subseteq \boldsymbol{T}$ where $\pi\left(\widetilde{\boldsymbol{T}}_j, \boldsymbol{Z}_{j,t1} \middle| \widehat{\boldsymbol{T}}_{i,t1}\right) \geq 0$,
    - Or decreases entry, i.e., the reverse is true

Econometric Research Model

- Dependent variables
  - Third-party updates
  - Downloads of third-party apps (global and US)
  - Numbers of monthly active users of third-party apps
- Explanatory variables
  - Introduction of first-party apps
  - Introduction of top third-party apps
  - Fixed effects of third party and time period
  - App similarity

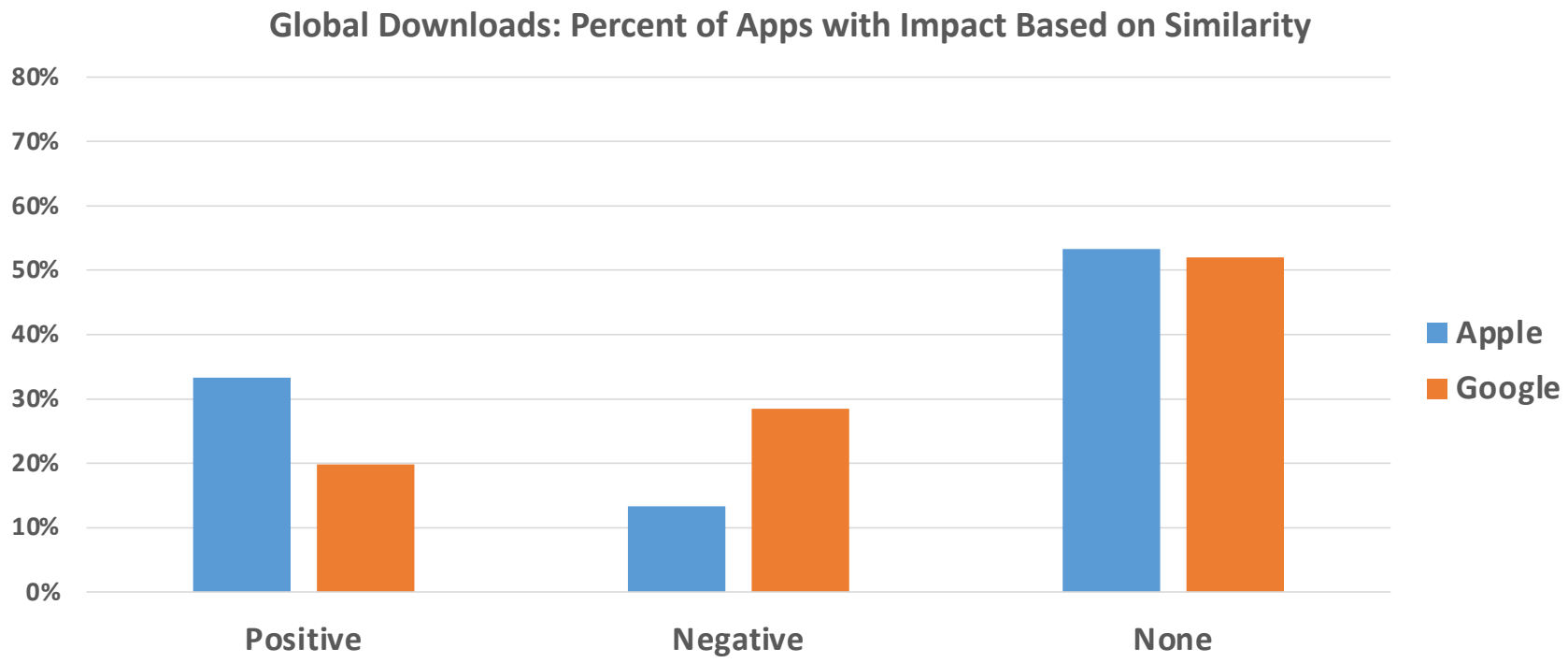
Data

- Sensor Tower monthly data for ~all apps, January 2012 through May 2021
  - Apple has 30 own apps on iOS. None on Android.
  - Google has 116 own apps on Android and 83 on iOS
- App descriptions
  - From Sensor Tower and Web

App Similarity

- Similarity of apps' textual descriptions
- Use LLM for vector embedding
  - Numeric representation of 768-element vector
  - BERT-base-multilingual-cased model
    - Variant of Google's BERT allowing for different languages
- Cosine similarity scores
  - For two apps, a and b
  - $cos(\theta) = \frac{|\boldsymbol{A}|\cdot|\boldsymbol{B}|}{\|\boldsymbol{A}\|\cdot\|\boldsymbol{B}\|}$, where $\boldsymbol{A}$ and $\boldsymbol{B}$ are vectors of a and b respectively
    - $-1 \leq cos(\theta) \leq 1$

Results 1



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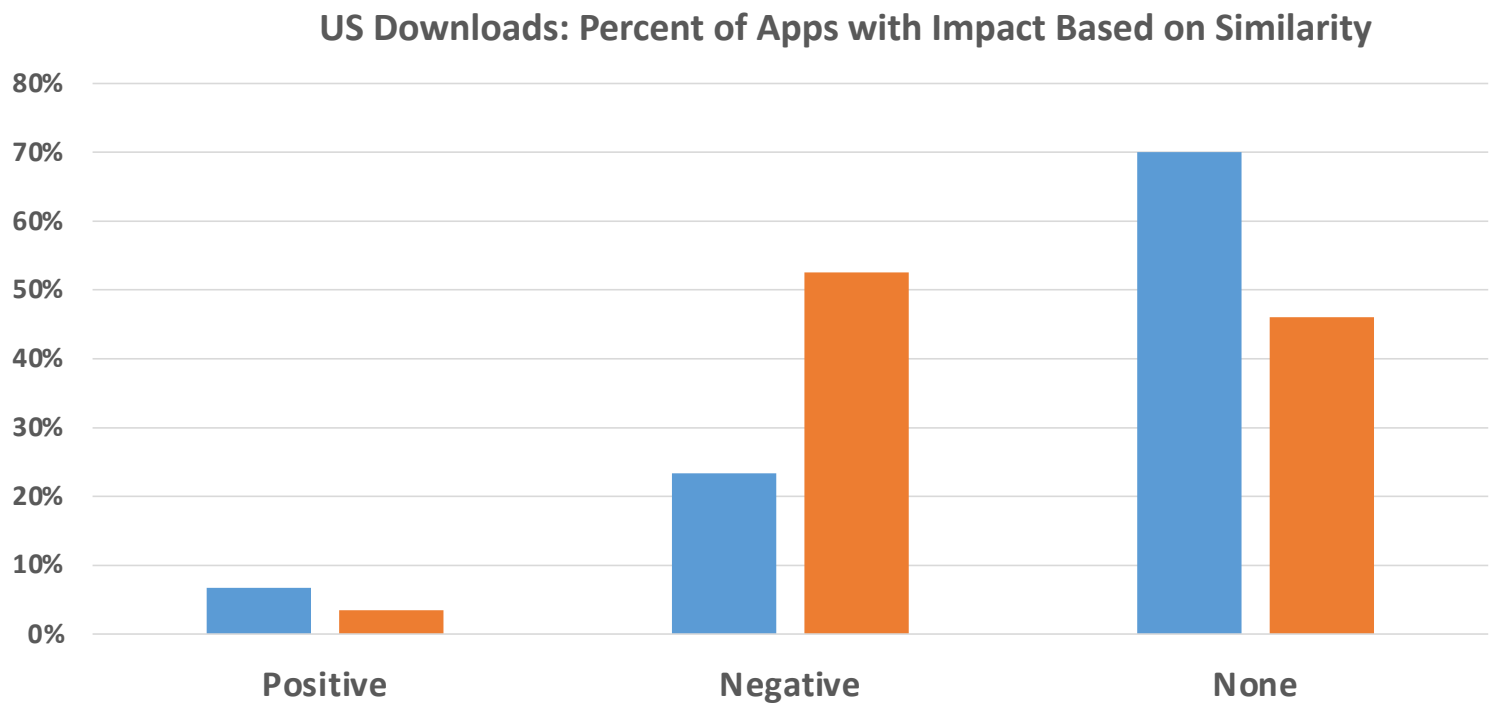
Results 2



Relative to Global:

Fewer apps have positive effects.

More apps have no effects.

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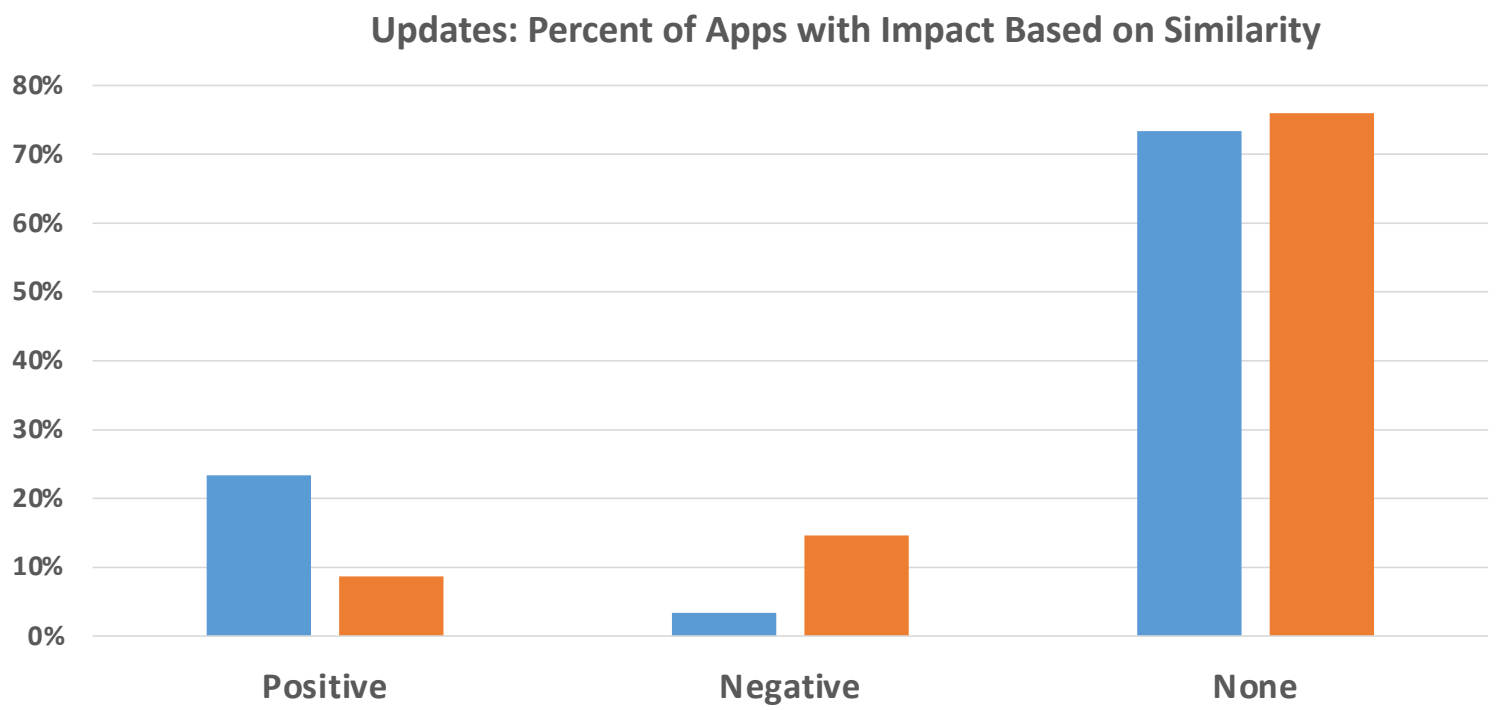
Results 3



Relative to Downloads:

More apps have no effects.

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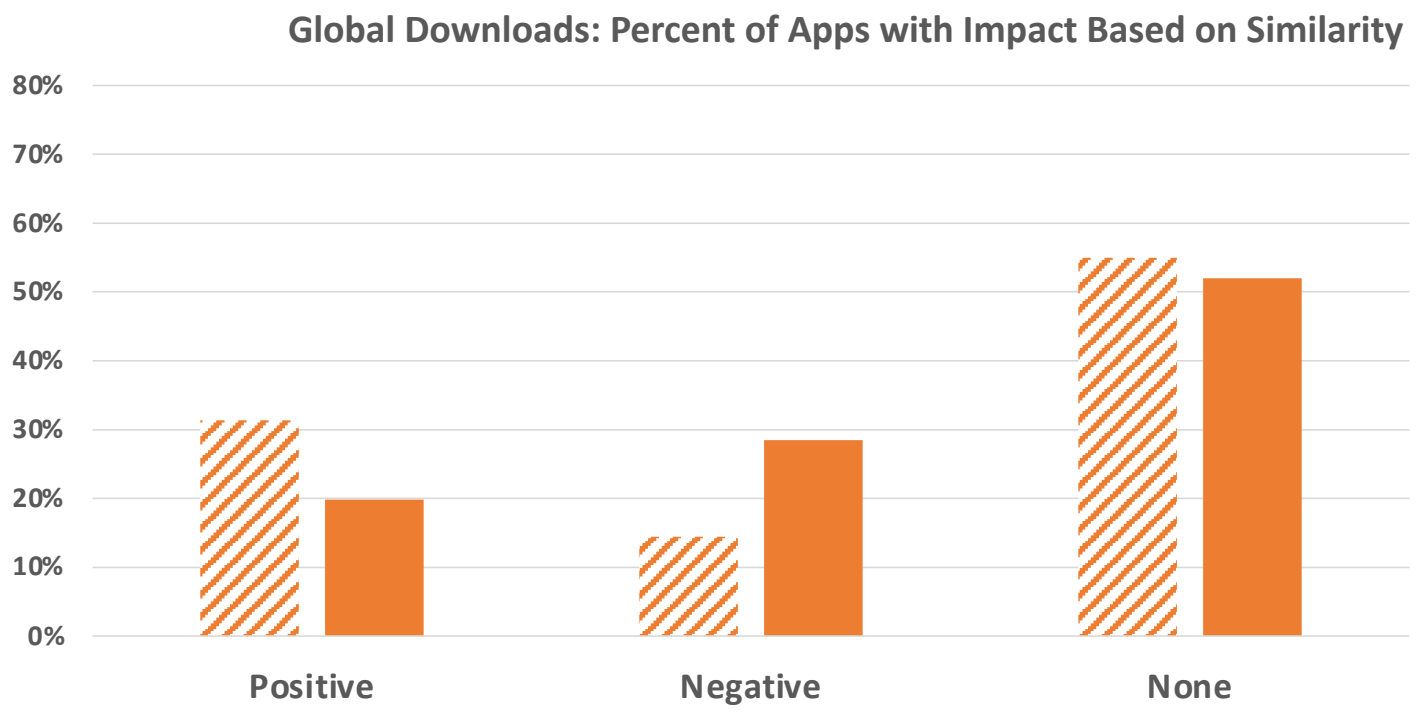
Results 1b



Relative to iOS:

Fewer apps have positive effects.

More apps have negative effects.

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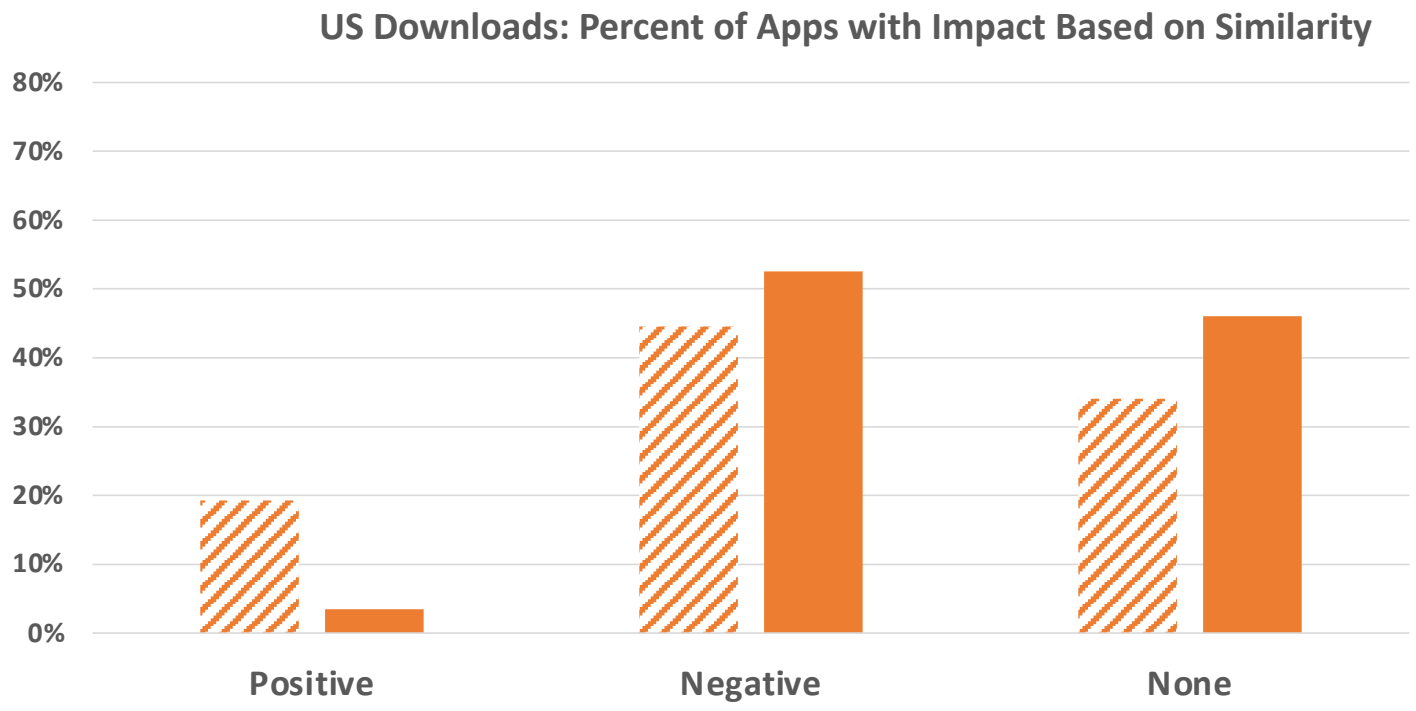
Results 2b



Relative to iOS:

Fewer apps have positive effects.

More apps have no effects.

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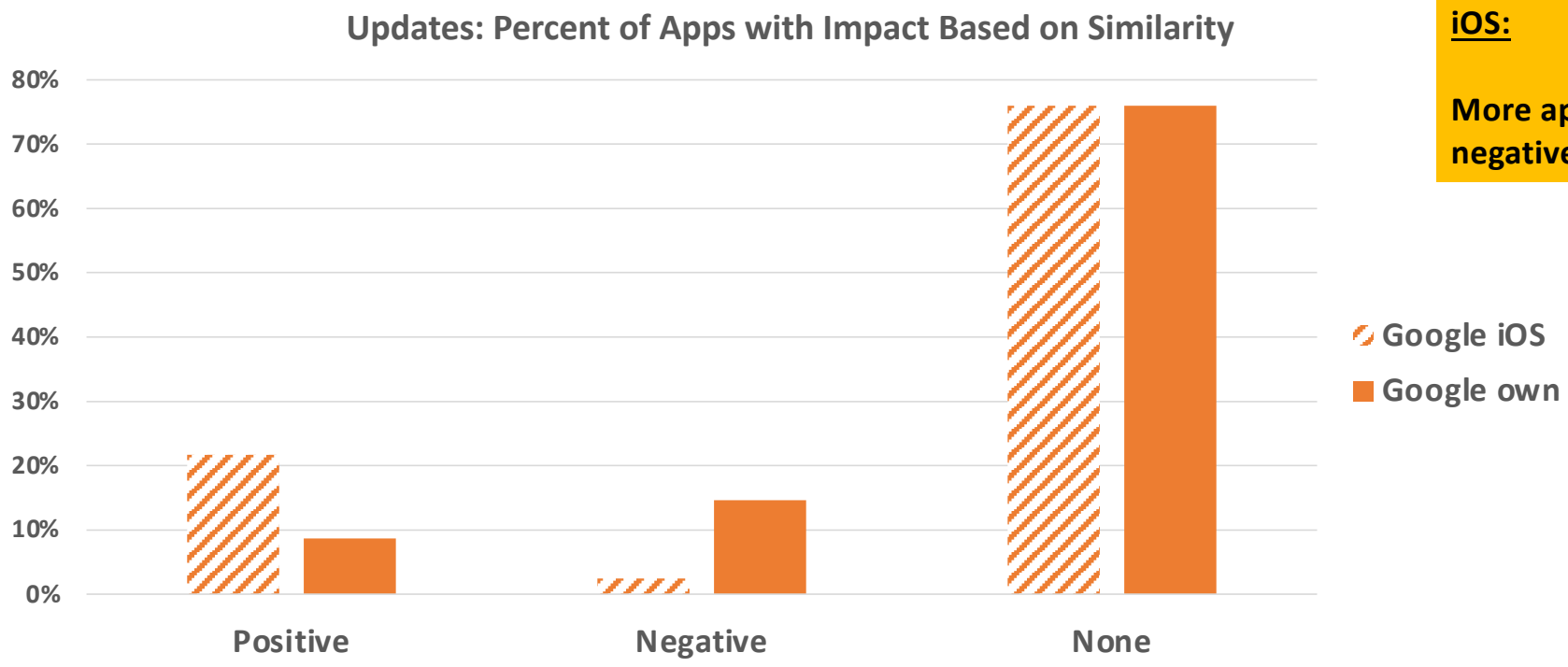
Results 3b



Relative to iOS:

More apps have negative effects.

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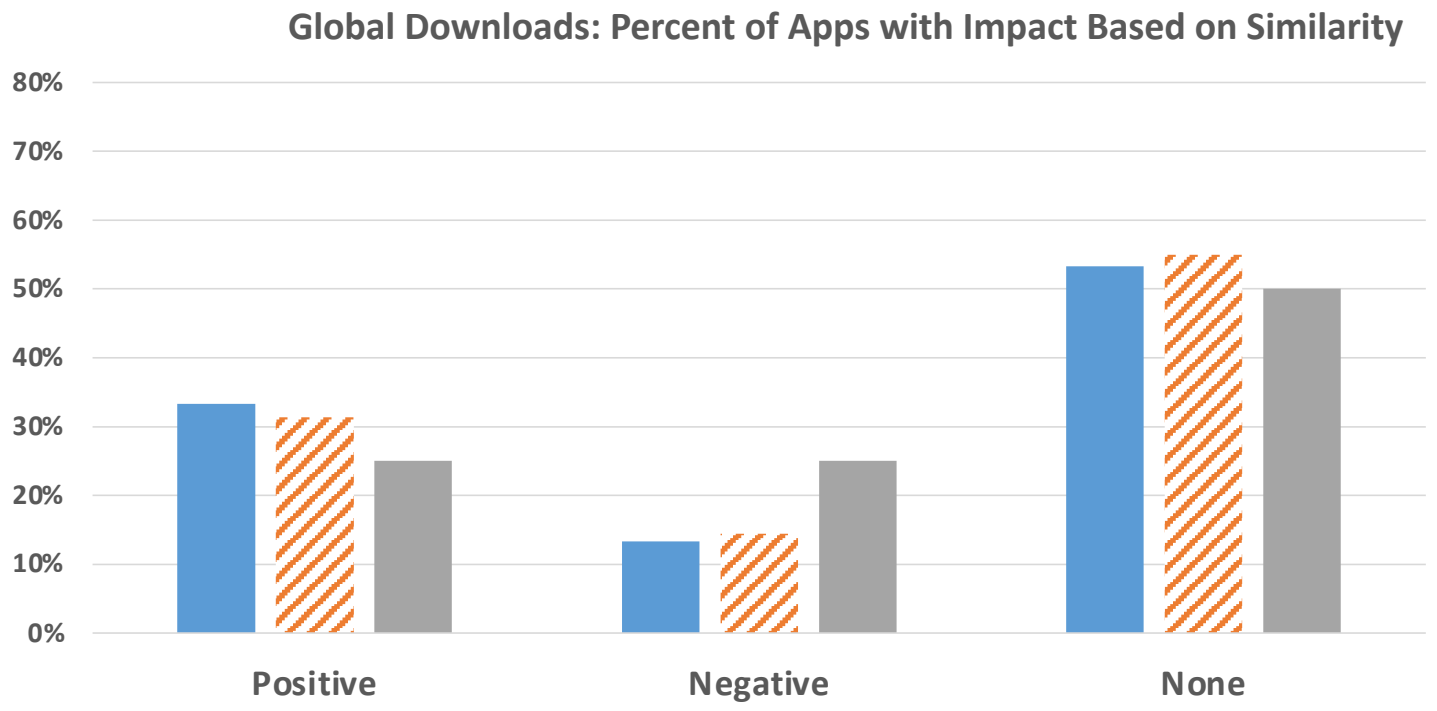
Results 1c



Apple Relative to Google and Top 20:

More apps have positive effects.

Fewer apps have negative effects.

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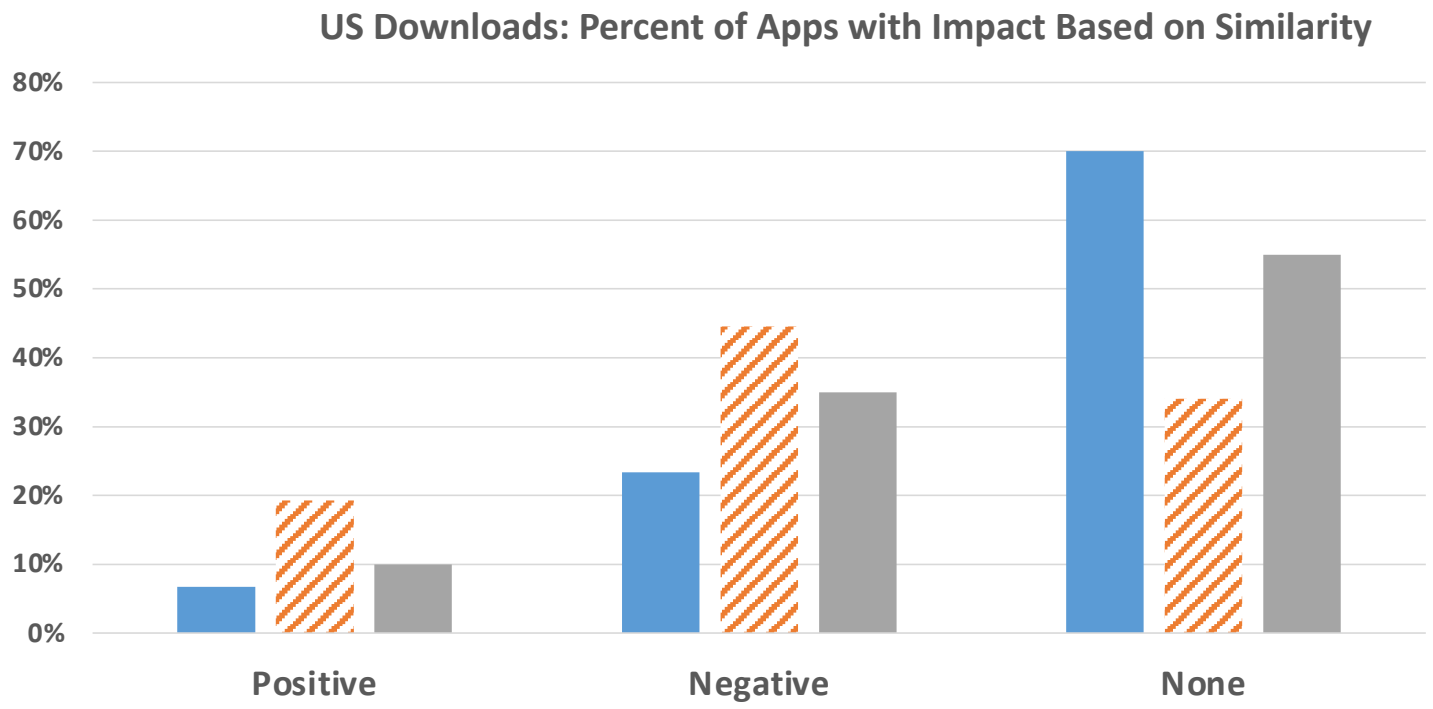
Results 2c



Apple Relative to Google and Top 20 on iOS:

Apple least impactful.

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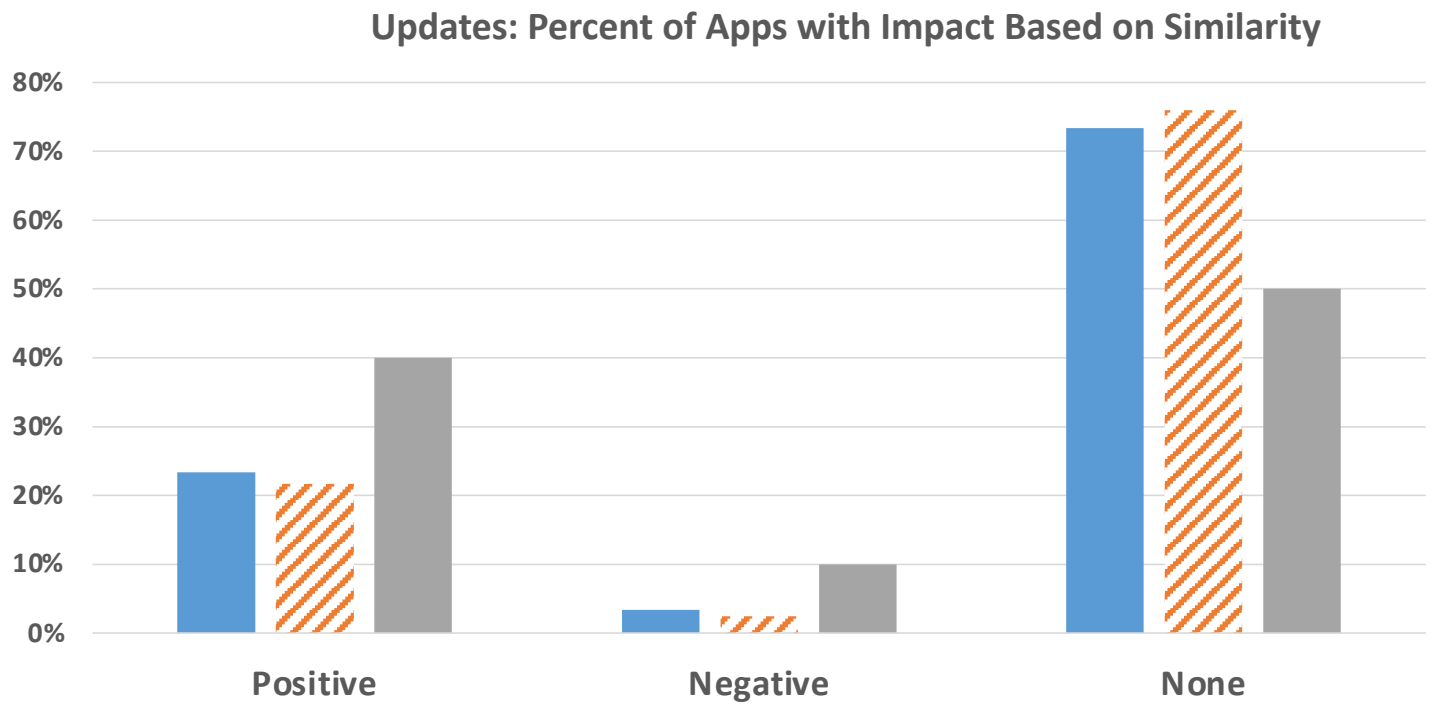
Results 3c



Relative to Apple, Google, and Top 20 iOS:

Apple and Google similar.

Top 20 most impactful.

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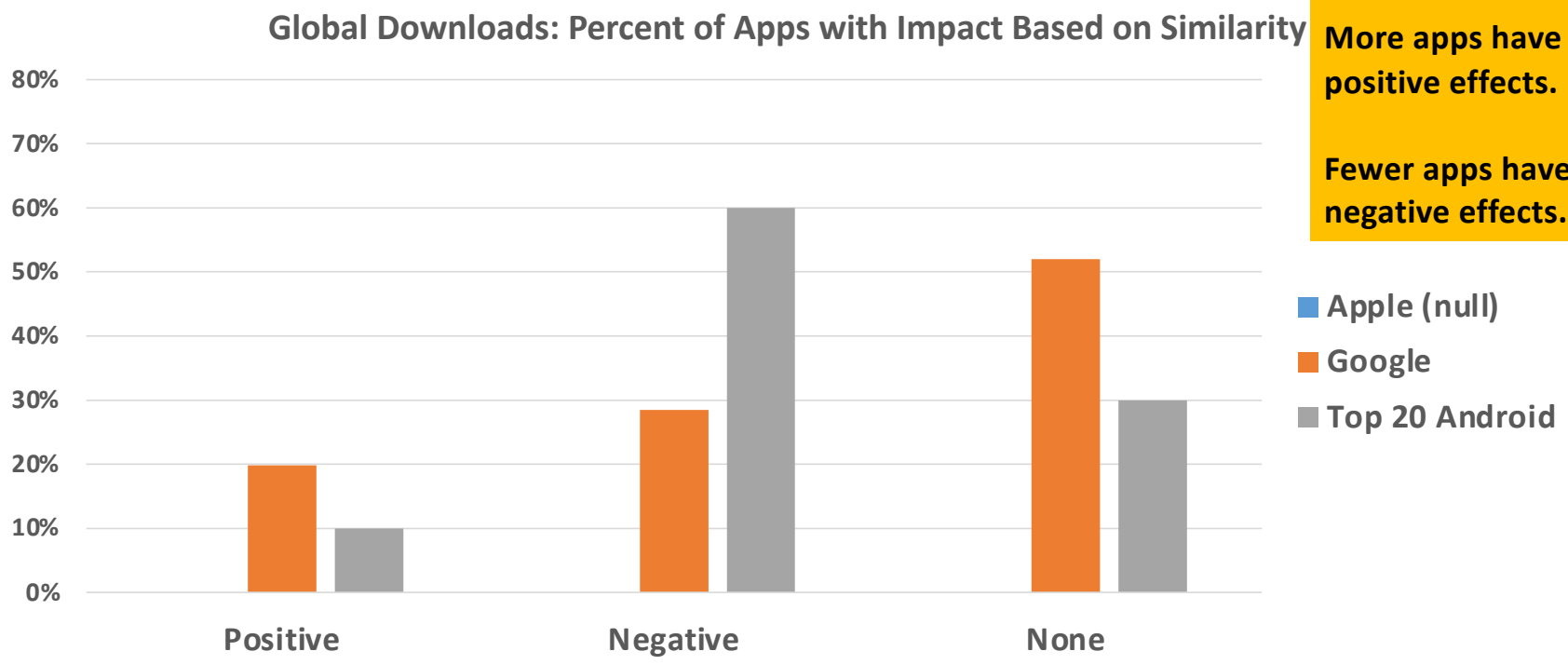
Results 1d



Google Relative to Top 20:

More apps have positive effects.

Fewer apps have negative effects.

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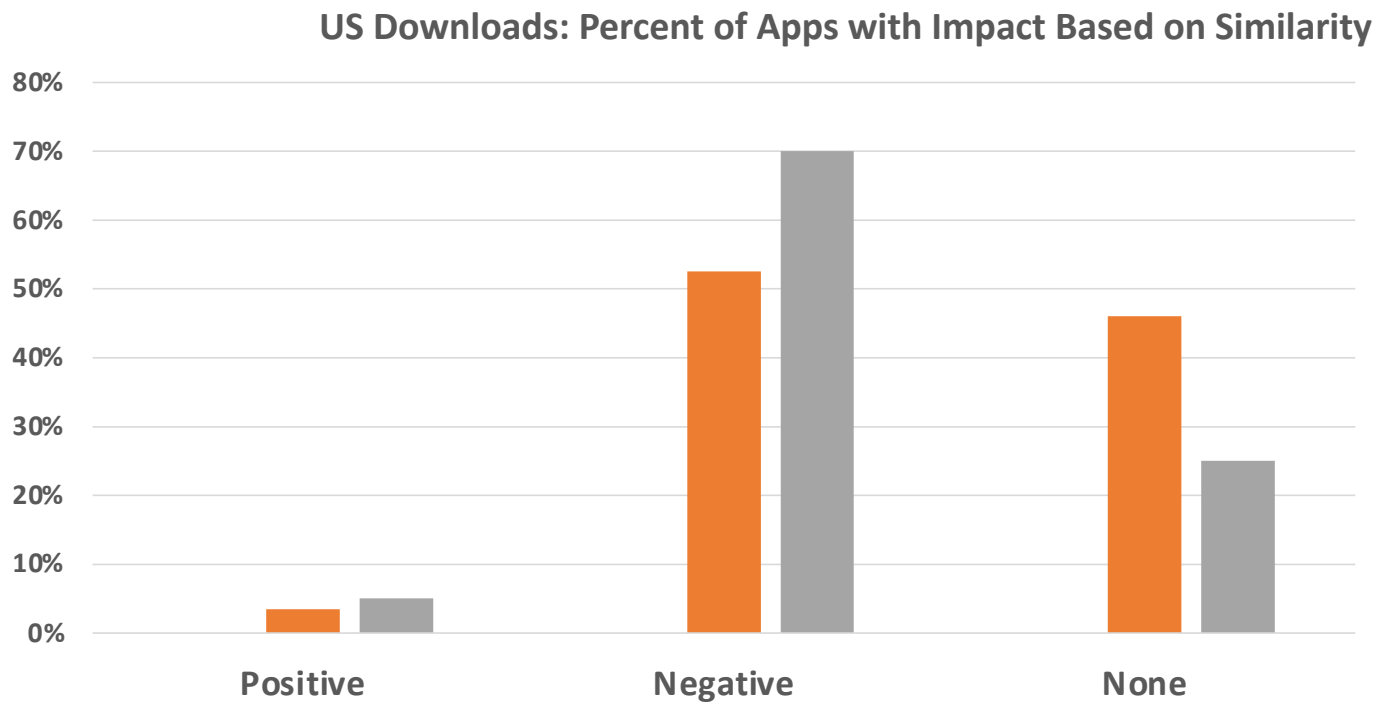
Results 2d



Google Relative to Top 20 Android:

Fewer apps have negative effects.

More apps have no effects.

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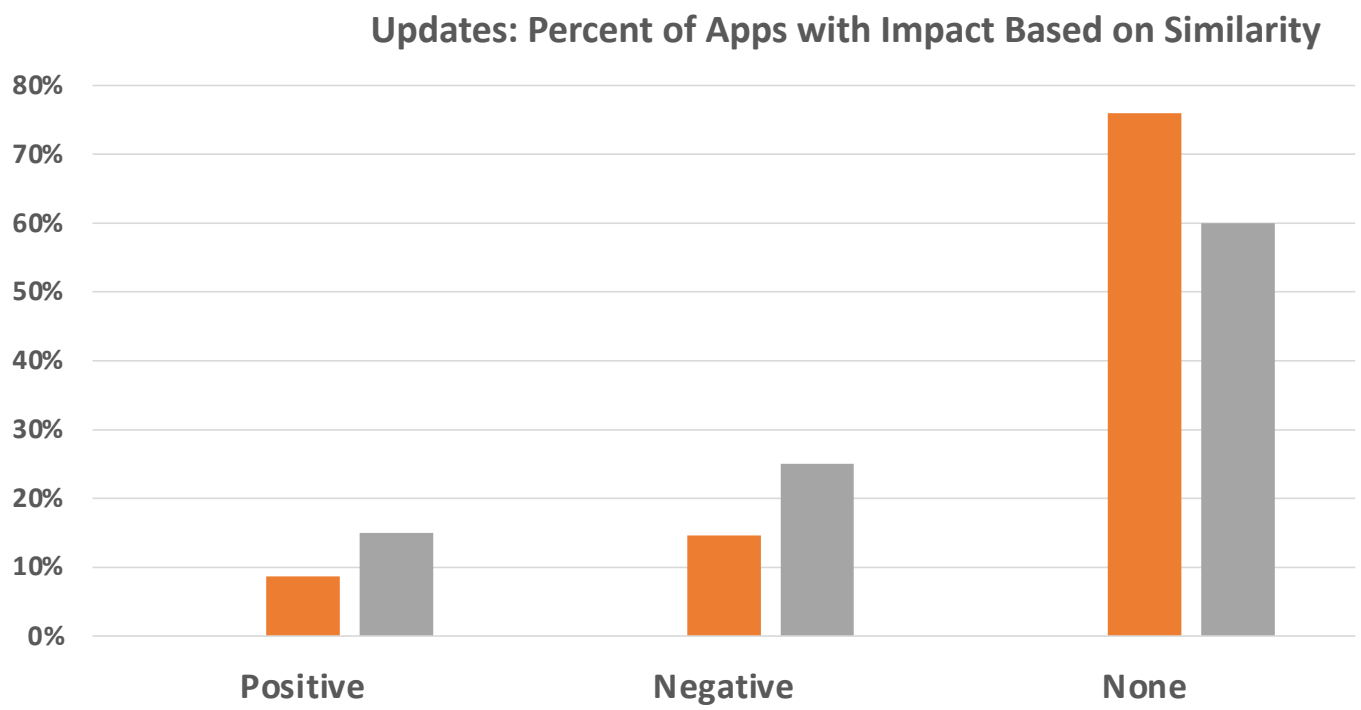
Results 3d



Google Relative to Top 20 Android:

Fewer apps have negative effects

More apps have no effects.

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Conclusions

- Apple and Google have few impacts on similar third-party apps
- Top 20 Apps have more negative impacts on similar third-party apps than do Apple and Google
- Google has more negative impacts on third-party apps when on Android than when on iOS
- Otherwise, unable to find pattern in impacts on third-party apps
- Next step: Apply machine learning to develop app predictions

Thank you!

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