# Competition by Design: Experimental Evidence on Search Engine Use and Choice Architecture Interventions

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Entrenched market dominance in digital platforms continues to raise pressing concerns for regulators and policymakers.[1] Concentrated power is often reinforced not only through technological advantages and network effects, but also through the design of user interfaces and contractual arrangements that shape consumer choice.[2] Despite growing reliance on remedies that target such mechanisms—most notably choice screens—there is limited empirical evidence on whether these interventions can meaningfully reshape market outcomes or enhance consumer welfare. This gap underscores the need to rigorously examine how design-based conduct remedies interact with entrenched market power in digital environments.

To assess the real-world effectiveness of conduct remedies in digital markets, this study undertakes what is the most comprehensive empirical evaluation of choice architecture interventions to date. We examine the first-order effects of default search engine settings alongside a range of carefully designed interventions, modeled on plausible remedial frameworks available to regulators and courts, on actual search behavior. The experimental design unfolds in two phases: the first phase establishes a behavioral baseline while administering the intervention

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[1] *See Digital Markets Investigation: Antitrust Investigation of the Rise and Use of Market Power Online and the Adequacy of Existing Antitrust Laws and Current Enforcement Levels*, HOUSE COMM. ON JUDICIARY, https://judiciary.house.gov/issues/issue/?IssueID=14921; Cecilia Kang & David McCabe, *House Lawmakers Are Considering 6 Bills Aimed at Big Tech*, N.Y. TIMES (June 23, 2021), https://www.nytimes.com/2021/06/23/technology/big-tech-antitrust-bills.html.

[2] *See* Ryan Calo, *Digital Market Manipulation*, 82 GEO. WASH. L. REV. 995 (2014); John M. Newman, *Anticompetitive Product Design in the New Economy*, 39 FLA. ST. U. L. REV. 681 (2012); Arunesh Mathur, Mihir Kshirsagar & Jonathan Mayer, *What Makes a Dark Pattern... Dark?: Design Attributes, Normative Considerations, and Measurement Methods*, *in* CHI '21: PROCEEDINGS OF THE 2021 CHI CONFERENCE ON HUMAN FACTORS IN COMPUTING SYSTEMS 1 (2021).

across experimental conditions, and the second phase, conducted after a delay, assesses the durability of observed behavioral shifts to evaluate the long-term efficacy of choice architecture interventions. In addition to behavioral measures, we also collect participants' perceptions of search engine quality, utility, and preferences at each phase, enabling us to track attitudinal changes in parallel with behavioral outcomes.

Crucially, this is the first academic study to examine search defaults on mobile—the context where most online searches occur—and it is also the first to directly manipulate default settings in a naturalistic environment. Leveraging recent iOS updates, we implement interventions using iOS Shortcuts and collect behavioral data via Safari history exports, enabling us to precisely manipulate default settings at scale. This methodological innovation not only allows us to study defaults directly, but also opens new horizons for field experiments in digital platform research by providing a scalable, ecologically valid framework for observing real-world mobile user behavior.

Our interventions were designed to mirror a range of remedial strategies that regulators and courts might deploy, from minimal nudges to more directive forms of default reassignment. Participants were recruited to complete one of fifteen conditions, spanning both desktop and mobile platforms.

**Desktop Conditions**

- **Condition 1: Control** - Participants do not receive any intervention aimed at modifying their search behavior.
- **Condition 2: Change Search Engine and Retain Change** - Participants must change their default search engine in their primary web browser on their primary desktop or laptop computer and are instructed to retain this change for at least seven days.

- **Condition 3: Change Search Engine** - This condition is the same as Condition 1, except participants are not required to retain the change for any specified duration.
- **Condition 4: Select Search Engine** - This condition is the same as Condition 2, except participants are only asked to affirmatively select their default search engine and so are not required to change the default from their current selection.
- **Condition 5: DuckDuckGo Education** - This condition is the same as Condition 3, except participants are also provided with educational material about the DuckDuckGo search engine and encouraged to consider switching to it.
- **Condition 6: DuckDuckGo Extension** - Participants are required to install the DuckDuckGo Search & Tracker Protection extension, which automatically enables DuckDuckGo as their default search engine.

**Mobile Conditions**

- **Condition 7: Control** - Participants do not receive any intervention aimed at modifying their search behavior.
- **Condition 8: Change Search Engine and Retain Change** - Participants must change their default search engine on their iPhone and are instructed to retain this change for at least seven days.
- **Condition 9: Change Search Engine** - This condition is the same as Condition 6, except participants are not required to retain the change for any specified duration.
- **Condition 10: Select Search Engine** - This condition is the same as Condition 7, except participants are only asked to affirmatively select their default search engine and so are not required to change the default from their current selection.

- **Condition 11: DuckDuckGo Education** - This condition is the same as Condition 8, except participants are also provided with educational material about the DuckDuckGo search engine and encouraged to consider switching to it.
- **Condition 12: Search Engine Ballot** - Participants must install and run a custom Shortcut on their iPhone that prompts them to select the default search engine on their iPhone from the following list: Google, Yahoo, Bing, DuckDuckGo, or Ecosia.
- **Condition 13: Search Engine Ballot with Google Last** - This condition is the same as Condition 10, except that Google is listed last among the search engine options.
- **Condition 14: Search Engine Ballot Excluding Google** - This condition is the same as Condition 10, except that Google is not listed among the search engine options.
- **Condition 15: Set DuckDuckGo as Search Engine** - Participants must install and run a custom Shortcut on their iPhone that selects DuckDuckGo as the default search engine on their iPhone.

The urgency of this inquiry is reflected in recent regulatory efforts. On both sides of the Atlantic, regulators have intensified their scrutiny of Google's dominance in the market for general search services, raising concerns that the company has engaged in exclusionary practices to preserve its position as the default gateway to the internet.[3] In the United States, this culminated in a landmark ruling on August 5, 2024, when a federal court held that Google had violated § 2 of the Sherman Act by unlawfully monopolizing the online search market.[4]

The remedies, however, announced only last week, reflect a cautious approach to addressing Google's dominance.[5] Rather than eliminating default-placement payments, the court

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[3] *See* David McCabe, *'Google Is a Monopolist,' Judge Rules in Landmark Antitrust Case*, N.Y. TIMES (Aug. 5, 2024), https://www.nytimes.com/2024/08/05/technology/google-antitrust-ruling.html.
[4] United States v. Google, LLC, No. 20-cv-3010, 2024 WL 3647498 (D.D.C. Aug. 5, 2024).
[5] United States v. Google, LLC, No. 20-cv-3010, 2025 WL 2523010 (D.D.C. Sept. 2, 2025).

opted to limit such agreements to one-year terms. Its most significant measure requires Google to share certain search data with “qualified competitors.” Its most assertive measure requires Google to share certain search data with “qualified competitors.” In doing so, the court appears to be addressing the structural challenge that rivals in a market characterized by strong network effects: without large volumes of user queries, smaller search engines struggle to improve their algorithms and compete effectively. By requiring Google to share some of this data, the remedies seek to mitigate barriers to entry and provide rivals with the scale they would not otherwise achieve. At the same time, the measures do less to confront the influence of Google’s entrenched position as the default search option.

This study will provide empirical evidence on precisely that point. By collecting both behavioral data and participants’ assessments of search engine quality, we test whether Google’s market position reflects intrinsic superiority or the advantages conferred by control over search engine choice architecture. Importantly, our design enables us to track how perceptions of quality evolve as users are exposed to alternative search engines through the interventions. If initial differences in perceived quality diminish after participants interact with other search engines, this would suggest that at least part of Google’s perceived superiority arises from limited exposure rather than inherent product advantages. In that case, remedies focused on enhancing rivals’ technical quality through data sharing are unlikely to significantly alter market dynamics, since the key driver of Google’s dominance lies not in product superiority but in the defaults shaping user choice.

Scholarly and policy debates on choice architecture interventions have drawn on some prior empirical work, though none has matched the scope or ecological validity of our study. For instance, Mozilla conducted research demonstrating that browser choice screens can

meaningfully influence user selection, and that the design of such screens—including their order and presentation—affects outcomes.[6] Yet that study relied on participants interacting with a simulated environment rather than observing behavior in the natural settings where search and browsing actually occur. As such, while valuable in illustrating the conceptual importance of choice architecture design, it fell short of capturing the dynamics of real-world default effects.

A recent working paper from January takes important steps toward empirically examining how default search engines shape user behavior, employing methods and research questions aligned with ours.[7] Their study relies on a desktop extension-based approach and examines how requiring participants to actively select a default search engine, as well as incentivizing them monetarily to switch, impacts their search engine usage, thus addressing issues highly relevant to our own inquiry.

Our work, however, extends this line of research in several key directions. Most notably, while the authors explicitly note that their experimental design could not be implemented on mobile, we are able to overcome this barrier by leveraging new features on iOS. Given that the majority of search activity now occurs on mobile devices, this represents a substantial expansion of the inquiry into a policy-relevant setting where desktop analysis likely does not generalize.

Second, while their study is primarily concerned with the effect of browser defaults on Google's market share, our analysis goes further by modeling a range of potential remedial frameworks and evaluating their relative effectiveness. This allows us not only to measure whether defaults matter but also to explore how policy interventions might alter their impact.

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[6] Mozilla Research, *Can Browser Choice Screens Be Effective?: Experimental Analysis of the Impact of Their Design, Content, and Placement* (Sept. 21, 2023), https://research.mozilla.org/files/2023/09/Mozilla-Research-Report-Can-Browser-Choice-Screens-Be-Effective_-21-September.pdf.

[7] Hunt Allcott et al., *Sources of Market Power in Web Search: Evidence from a Field Experiment* (Nat'l Bureau of Econ. Rsch., Working Paper No. 33410, 2025), https://www.nber.org/system/files/working_papers/w33410/w33410.pdf.

Third, they themselves note that they were unable to automate default changes, instead requiring participants to implement those changes manually—a limitation they acknowledge as undermining realism. By contrast, we are able to achieve automated changes through iOS Shortcuts, enabling a more seamless and ecologically valid intervention.

Taken together, our contributions strengthen the empirical foundation of this line of work. We expand the setting to mobile platforms where most search takes place, test a wider set of policy-relevant interventions, and implement automated default changes that enhance the realism of treatment conditions. In doing so, we advance the methodological toolkit for studying digital platform behavior, moving the literature toward more robust and externally valid designs.

Data collection is already underway, and we will have preliminary findings ready to present by the time of the conference.