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11226
2024

July 2024

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CESifo

Impressum:

CESifo Working Papers
ISSN 2364-1428 (electronic version)
Publisher and distributor: Munich Society for the Promotion of Economic Research - CESifo GmbH
The international platform of Ludwigs-Maximilians University's Center for Economic Studies and the ifo Institute
Poschingerstr. 5, 81679 Munich, Germany
Telephone +49 (0)89 2180-2740, Telefax +49 (0)89 2180-17845, email office@cesifo.de
Editor: Clemens Fuest
https://www.cesifo.org/en/wp
An electronic version of the paper may be downloaded
· from the SSRN website: www.SSRN.com
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CESifo *Working Paper No. 11226*

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Abstract

This paper examines the impact of the Digital Markets Act (DMA) on consumer behavior, focusing on changes in Google's search result presentation in the European Union (EU). Specifically, it investigates the effects of Google's removal of clickable maps in search results, a modification implemented in January 2024. This change forces users to perform additional searches to access Google Maps or alternative mapping services, thus increasing search costs. Using a difference-in-differences approach, we compare Google search volumes from EU to non-EU countries before and after the implementation of the DMA. By eliminating Google Maps' advantage of being only one click away from Google Search users, we find that EU consumers search significantly more for online mapping services. We measure a 25% and 18% increase in Google's search volume for the query terms maps and google maps, resulting in an excess of 34,407,000 and 8,901,000 searches over six months, respectively. This search increase suggests potential exposure to alternative mapping services. However, searches for services like apple maps and bing maps also rose, but not as significantly. Moreover, traffic data shows a non-significant decrease in visits to Google Maps, suggesting minimal migration to alternative services. These findings indicate that removing Google's one-click advantage can lead to higher search costs for users without significantly boosting the discovery or adoption of alternative mapping services in the short run.

JEL-Codes: L410, L860, K210.

Keywords: self-preferencing, online mapping services, Google Maps, Google Search, Digital Markets Act.

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July 10, 2024
We would like to thank Marc Bourreau, Joan Calzada, Renaud Foucart, Leonardo Madio, Klaus Miller, José Luis Moraga-Gonzalez, Liza Pronkina, Imke Reimers and Tommaso Valletti for insightful comments and discussions. We thank Sofia Hanna for her help collecting data. We are grateful for the financial support provided by Agence Nationale de la Recherche (ANR) under grant number ANR-21-CE26-0018-01 / HYBRID. All errors are ours.

1. Introduction

In the past years, there has been increasing scrutiny and criticism of the significant market power wielded by major online companies collectively known as GAFAM - Google, Apple, Facebook, Amazon, and Microsoft.[1] These tech giants have been accused of using their dominant positions to design and create online sites and marketplaces that favor their own products (Crémer, de Montjoye and Schweitzer, 2019). One notable example is the European Union's fine against Google for abusing its market dominance by favoring its own comparison shopping service, Google Shopping, in its search results (Cardoso and Ren, 2017). Similarly, Amazon was sued by the Federal Trade Commission in 2023 for biasing its "search results to favor Amazon's own products over those Amazon knows are of better quality" (FTC, 2023a; Etro, 2023).[2]

These allegations of abuse of dominance are based on the understanding that the way search results are presented can significantly alter consumer behavior. Online companies often counter these concerns by claiming that "competition is one click away" (Helft, 2009): platform design choices do not significantly prevent users from seeking the best service or product. According to this argument, if users choose GAFAM's services, it is because of their superior quality, not because alternatives are hidden.

This paper examines the impact of search result presentation on consumer behavior in response to recent changes mandated by the Digital Markets Act (DMA) in the European Union (EU). Among the several implications of the DMA, Google changed the design of its search page for users located in the EU beginning in January 2024. Specifically, when a user searches for a location-based query (e.g, for a place, a shop, or a restaurant), the prominently displayed map is no longer clickable and the signet towards Google Maps has disappeared (see Figure 1 for an example). Users can now only click on "directions" which provides transport advice but does not zoom on or recommend restaurants around the place of interest. This design change has drawn criticism from European users who are accustomed to clicking on the map to locate their desired destination on Google Maps.[3] Now, users must first access Google Maps (or another mapping service), often by typing `maps` or `google maps` into Google Search. After selecting an online mapping service, users need to search for their place of interest again. This change effectively removes Google's one-click advantage over its competitors in the online mapping services market.

We use the DMA-induced change in Google search pages to study how the search webpage design can

[1] For a general discussion on the antitrust concerns about digital platforms, see Scott Morton, Bouvier, Ezrachi, Jullien, Katz, Kimmelman, Melamed and Morgenstern, 2019; Fletcher, Crawford, Crémer, Dinielli, Heidhues, Luca, Salz, Schnitzer, Morton, Seim et al., 2023.

[2] Similar claims have been pushed within the ad tech industry by the Federal Trade Commission who accused Google of favoring bidders who use its technology in its marketplace which auctions ad-space (FTC, 2023b).

[3] See, for example, a user discussion on Reddit regarding the inability to click on maps in search results: https://www.reddit.com/r/GoogleMaps/comments/1bc7jy7/going.to.google.maps.directly.from.google.search/.

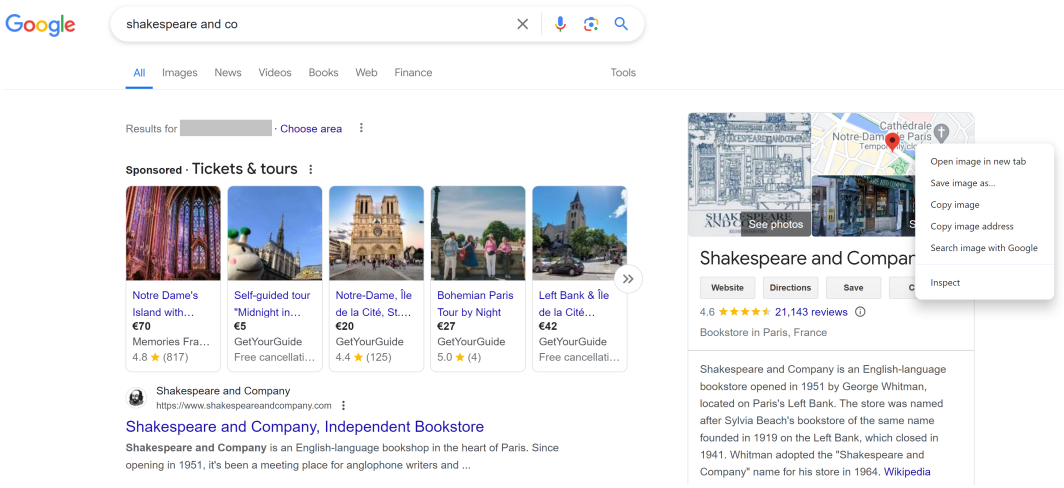


Figure 1. Snapshot of Google results for the query `Shakespeare and co` (July 3, 2024) from the EU: the map is not clickable and the Google Maps signet is absent.

affect users' search behavior and potentially redirect them to alternative services. Doing so, we answer the following questions: Did the DMA increase the probability for users to discover new alternative map services? Is competition really one click away? We use a difference-in-differences (DiD) approach to compare Google search volume from EU countries relative to a set of non-EU countries, after January 2024 relative to the previous year. We document that Google search volumes for the `maps` query increased by more than 25% in EU countries providing evidence of a significant increase in the search cost to access Google Maps.

The increase in searches for `maps` could potentially lead users to discover alternative services. Even though there is a cost to users in terms of additional search, this feature could be critical in the medium term for new alternatives to have the opportunity to attract users directly from Google's organic search. However, a significant portion of the increased search volume for `maps` is likely to ultimately drive users back to Google Maps. This hypothesis is supported by the following observations. Users searching Google for the query `maps` are very likely to see a link to Google Maps prominently displayed as one of the first organic search results, reinforcing their continued use of Google's mapping service. Moreover, searches for `google maps` have increased by a similar percentage as `maps` searches in EU countries compared to non-EU countries. This shows that users are not only generally searching for mapping services, but also specifically for Google Maps. The increase in search volume for alternative mapping services queries such as `apple maps` (+10%), and `bing maps` (+18%) is smaller and statistically significant, despite not being equally robust. Finally, data on web page traffic shows a negative but non-significant decrease in traffic to `www.google.com/maps`. This suggests that users have not migrated en masse to other mapping services.

The implications of our results indicate that competition for online mapping services is not truly "one

click away". The removal of clickable maps from Google search pages has not led to a significant discovery and adoption of alternative mapping services by users, at least in the short run. Instead, this change has led to many more searches in the EU, amounting to approximately 45 million additional searches over the first six months of the design change. This increase in search activity can be seen as a short-term negative effect for users due to higher search costs. While this design change has not yet led to a major shift to alternative services, it is possible that longer-term trends or further changes to the design of search pages could encourage users to switch. In addition, this increase in search volume may have had an unintended positive side effect for Google: more searches generate more ad impressions, potentially compensating Google with additional advertising revenue.

Our study provides new empirical insights into how large online firms can bias search results in their favor or use a tying strategy to integrate additional products into their core business. Due to the difficulty of gathering data from large online platforms, early research in this area has been primarily theoretical. Several authors have emphasized the various considerations platforms use to bias search results (Hagiu and Jullien, 2011; Inderst and Ottaviani, 2012) and recommendations (Bourreau and Gaudin, 2022), and more generally, to favor integrated products (Carlton, Gans and Waldman, 2010; Anderson and Bedre-Defolie, 2021; Hagiu, Teh and Wright, 2022). Much of the empirical literature on self-preferencing has focused on Amazon's marketplace and its practices (Gutierrez, 2021; Lam, 2021; Lee and Musolff, 2021; Raval, 2022; Farronato, Fradkin and MacKay, 2023; Reimers and Waldfogel, 2023). In contrast, our research analyzes Google's search engine and the impact of Google's search results presentation on consumer search behavior. Previous literature has shown that the Google algorithm can bias and influence organic search visits to news outlets (Calzada, Duch-Brown and Gil, 2023). In addition, Chiou (2017) shows that when Google integrated Google Flights into its search results, it resulted in fewer clicks to competing travel agencies. Similarly, through an experimental design, Kim and Luca (2019) document that users prefer when Google's organic search results display reviews from multiple platforms rather than exclusively Google reviews. We contribute to this literature by documenting the effects of a change in Google's search results that, while consistent with the spirit of the Digital Market Act, did not significantly alter traffic to Google Maps.[4]

We also contribute to the literature on how the design of search pages affects consumer search and choices. Prior research has shown that rankings significantly influence search behavior and purchase decisions (Bronnenberg, Kim and Mela, 2016; Ursu, 2018; Harris, Novarese and Wilson, 2022), and that users experience search fatigue (Ursu, Zhang and Honka, 2023), making it crucial for results to appear promi-

[4] See Decarolis and Li (2023) for a broader analysis on the impact of the DMA and other EU policies on online search and Google market power.

nently. The prominence of search results has also a notable impact on organic traffic from search engines (Baye, De los Santos and Wildenbeest, 2016). While these effects have been documented within various contexts, including Google search, our study extends these findings by exploiting a change in Google's one-click advantage driven by the DMA in the design of Google Search.

Finally, we contribute to the analysis of policies that regulate digital marketplaces and their intended and unintended effects. Previous research has been conducted on the General Data Protection Regulation (GDPR) and its effects on privacy and advertising (among others, Goldfarb, 2018; Johnson, Shriver and Goldberg, 2023; Goldberg, Johnson and Shriver, 2024; Miller and Skiera, 2024). More closely related to our study, Decarolis, Li and Paternollo (2023) study interventions in the EU, Russia, and Turkey designed to mitigate Google's search dominance and find that changes to default settings effectively reduced Google's market share. Our study is one of the first to examine the impact of the DMA. The closest paper to ours is Waldfogel (2024), which shows that shortly after the EU designated Amazon as a "gatekeeper" platform in September 2023, Amazon's product rank differential fell from a 30 position advantage to a 20 position advantage, while the rank positions of other major brands were unaffected. In contrast, our research focuses on a different platform–Google–and we are able to observe how users responded to the design change that Google implemented to comply with the DMA. Our results support supplementary policy interventions removing additional self-preferential features from Google Search. This could include removing the clickable-map from Google Search on mobile phones, as well as the "directions" button which steers users towards Google's online navigation services.

The remainder of this paper is organized as follows. In Section 2., we describe the empirical context and data used in our analysis, as well as the identification strategy used to isolate the effects of DMA-induced changes. Section 3. presents our main results, focusing on changes in search volume for `maps` and `google maps` queries. In Section 4., we analyze the impact on competitors' search volumes and examine traffic data for different mapping service web pages. Section 5. discusses the policy and management implications of our findings. Finally, Section 6. concludes the paper by summarizing our main findings and suggesting directions for future research.

2. Context, Data, and Empirical Strategy

2.1. Regulatory Context: the DMA and its Implementation

The European Union's Digital Markets Act (DMA) is a major regulatory initiative aimed at ensuring fair and open digital markets across the EU. The legislation, which "entered into force" on November 1, 2022,

targets large online platforms designated as "gatekeepers" to curb anti-competitive practices such as self-preferencing (Cabral, Haucap, Parker, Petropoulos, Valletti and van Alstyne, 2021). On September 6, 2023, the European Commission designated six large companies (Alphabet, Amazon, Apple, ByteDance, Meta, and Microsoft) as gatekeepers. These companies were given six months, until March 2024, to comply with the new obligations and prohibitions set forth in the DMA.[5,6]

The DMA calls for significant changes in the way these platforms operate. In particular, the six gatekeepers are asked to partially redesign the way information is presented to users in order to "ensure contestability (i.e., the reduction of entry barriers) and to ensure fairness (i.e., a balance between the rights and obligations of the gatekeepers and their business users) of EU digital markets" (De Streel, Bourreau, Feasey, Fletcher, Kraemer and Monti, 2024). Alphabet has been designated as a gatekeeper for a group of online intermediation services, including Google Maps. This service has traditionally been seamlessly integrated into Google's search results. Such integration has raised concerns about the contestability of the market for mapping services, as it could constitute a "dark pattern" used by the company to steer users to its own services. To comply with the DMA, Google could have displayed other geolocation applications alongside Google Maps. However, for desktop searches, Google decided to completely remove any link, clickable map, or signet that would allow users to directly access Google Maps with a single click (see Figure 1 for an example). This change does not affect mobile searches.[7] As a result, users in the EU must now manually navigate to Google Maps or other mapping services when searching for a location-based query.[8,9] We date the "choice architecture" change in Google search to the first week of January 2024, based on observed query patterns and online forum discussions.[10]

This change in Google's search interface is in the spirit of the DMA and addresses its main points by

[5] For an official statement from Google explaining its response to the DMA, see: https://blog.google/around-the-globe/google-europe/an-update-on-our-preparations-for-the-dma/.

[6] In the following figures, we refer to the period between September 2023 and March 2024 as the "DMA Compliance Period".

[7] For a broader discussion of Google's "choice architecture" options to comply with the DMA, see: https://www.latribune.fr/technos-medias/internet/entree-en-vigueur-du-digital-market-act-les-gafam-font-ils-preuve-de-mauvaise-foi-au-detriment-des-utilisateurs-992204.html.

[8] For more information, see: https://www.lemonde.fr/en/pixels/article/2024/03/06/digital-markets-act-how-the-way-you-use-google-maps-and-messenger-is-changing.html, https://www.francetvinfo.fr and Google's official statement at https://blog.google/around-the-globe/google-europe/new-competition-rules-come-with-trade-offs/.

[9] The "directions" button is still present and directs users to Google Maps, but only for transport advice. Users cannot directly zoom in on the area of interest or search for recommendations around that location.

[10] On Reddit website, the subreddit discussion concerning the absence of clickable maps starts on January 2024 (https://www.reddit.com/r/GoogleMaps/comments/19ahfx2). On January 19th, 2024, one user writes that "It used to be that under every Google search you had a button to search it in Maps, (but it doesn't anymore). Anyone know how to fix this? It's really annoying." As a reply, other users commented that "it started a few weeks ago, between end 2023 and beginning 2024" and "I had this issue for months now. I always fixed it by clearing the cache, but it doesn't work anymore." These statements suggest the design change was being tested and expanded progressively across Europe even though it did not concern all users at first. The increase in the number of Reddit posts concerning the design change after the first week of January 2024 indicates the broader rollout of this update around this month.

eliminating the one-click advantage that Google Maps previously had over other services. However, the DMA also requires gatekeepers to continually monitor the effects of their "choice architecture" changes. Specifically, gatekeepers must submit a compliance report within six months of their designation to be updated annually describing "the measures it has taken to ensure compliance".

2.2. Data for Search Queries and Website Traffic

This study relies on data measuring search query volumes over time. We construct country-level panel data on a weekly level by leveraging three sources. First, we collect data from Google Trends for 35 countries from Saturday, January 1^{st}, 2023 to Saturday, June 8^{th}, 2024.[11] This group of countries includes all treated European Union countries, excluding Cyprus and Malta for which data were often not available for many queries of interest. Additionally, we included a set of 10 countries that the DMA did not impact to form a control group: Australia, Canada, Egypt, Japan, Mexico, Morocco, Russia, South Korea, United Kingdom, and the United States.[12]

Google Trends provides insight into the search behavior of Google Search users by analyzing the frequency and volume of specific search queries over time. Google Trends data has been used extensively in economics and marketing research for the past fifteen years (Choi and Varian, 2012; Jun, Yoo and Choi, 2018). Most studies use Google Trends queries as proxies for other outcomes such as the GDP or the well-being of a region (Brodeur, Clark, Fleche and Powdthavee, 2021; Ferrara and Simoni, 2023). Differently, we are directly interested in the search data provided by Google Trends.[13] This data consists of web-search intensity, understood as the number of times a query term was searched normalized by a country-specific factor.[14] This factor is the maximum number of searches for this query term over the selected period.[15]

We augment Google Trends data with estimated search volumes for each query using data provided by the third-party company Glimpse (https://meetglimpse.com/). This allows us to convert the estimates of query rate changes into query volumes.

For each country and week, we collect information for six query terms. These terms are the generic query `maps`, and five queries related to Google Maps and its main competitors: `apple maps`, `bing maps`,

[11] We use week level data to avoid the noise associated with within-week variation in search intensity.

[12] Using a virtual private network (VPN), we have checked for the presence of the click feature on Google Search to access Google Maps in all countries part of the control group.

[13] As a placebo test, we also collect data on Youtube search as discussed in Section 3.2..

[14] Google samples its Google Search users to generate their data. This means that different samples of users can generate different Google Trends results. Our data is collected at country and week level. Thus, we do not expect variations due to sampling error to have a significant effect.

[15] More information concerning how Google Trends data is generated is available at https://support.google.com/trends/answer/4365533?hl=en (Google, 2024). See Brodeur et al. (2021) and France, Shi and Kazandjian (2021) for articles discussing Google Trends data and related econometric considerations.

Table 1. Google Search Volumes and Shares before and after January 2024 for EU and non-EU countries

	EU		Non-EU	
Before DMA (Jan 23 - Dec 23)	Search Volumes	Share (%)	Search Volumes	Share (%)
`apple maps`	274	.14	2,122	.31
`bing maps`	109	.05	1,801	.26
`google maps`	50,836	26.59	340,721	49.91
`mappy`	10,374	5.42	86	.01
`maps`	129,232	67.6	337,564	49.45
`openstreetmap`	341	.17	280	.04
	EU		Non-EU	
After DMA (Jan 24 - Jun 24)	Search Volume	Share (%)	Search Volume	Share (%)
`apple maps`	308	.12	2,132	.33
`bing maps`	131	.05	1,656	.26
`google maps`	61,838	24.24	300,469	47.43
`mappy`	9,245	3.62	80	.01
`maps`	183,198	71.82	328,759	51.9
`openstreetmap`	357	.14	295	.04

Notes: The sample includes weeks between January 2023 and June 2024 for 25 European and 10 non-European countries. Search volumes are averaged at the week level across the different countries composing the EU and non-EU groups. Shares are calculated by summing the average search volumes per country over the pre-DMA period and post-DMA period.

`google maps`, `mappy`, and `openstreetmap`.[16] Through these query terms, we aim to capture the redirection of search from Google Search towards Google Maps, and potentially to alternative mapping services.[17]

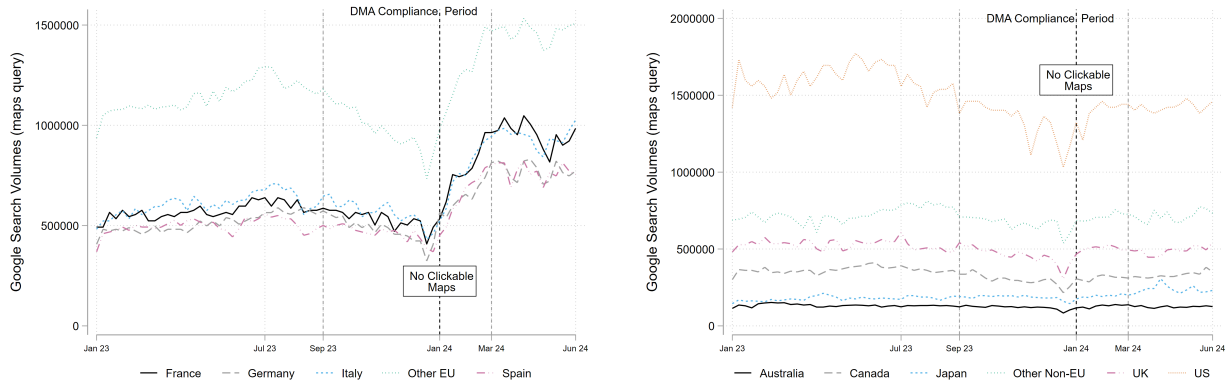
Finally, to assess if the DMA led to variations in the usage of Google Maps and other alternative mapping services, we construct a complementary panel dataset based on estimated website traffic data. Online traffic estimates are provided at monthly level for each country by the search engine marketing company Semrush (https://www.semrush.com/) based on anonymized clickstream data.[18]

Before discussing the identification strategy, we provide some summary statistics about the market for online map services and the associated Google search volumes. In Table 1, we present average weekly search volumes before and after the DMA for EU and non-EU countries for all six queries related to map services. Before the DMA, `google maps` and `maps` accounted for 92% of the average weekly search volumes in Europe, and 99% in non-EU countries. These extremely high search volumes indicate that typing `maps`

[16] Apple Maps belongs to Apple Incorporated; Bing Maps is owned by the Microsoft Corporation; Google Maps belongs to Alphabet Incorporated; Mappy is a French free map service owned by the French public transport company *Régie Autonome des Transports Parisiens* (RATP); OpenStreetMap is a free and open map database owned by the OpenStreetMap Foundation.

[17] These terms can be expanded into many sub-queries. For example, a user interested in a Parisian bookstore as in Figure 1 might search `google maps Shakespeare and co` or `google maps bookstore paris` and be redirected to Google Maps. Thus, we are likely capturing an underestimation of the volume of search queries generated as a result of the DMA.

[18] See https://www.semrush.com/kb/998-where-does-semrush-data-come-from for more information.



(a) EU countries **(b)** non-EU countries

Figure 2. Google Search Volumes over Time for `maps` Query

Notes: The graph plots the Google search volumes for European countries and non-European countries European. The sample includes weeks between January 2023 and June 2024.

or `google maps` is by far the most common way for users to access mapping services through the search engine.[19] The main difference between EU and non-EU countries before the DMA is related to searches for the query `mappy`, a French map app particularly popular in France.

After the DMA, the shares for the queries `google maps` and `maps` remain similar in both EU and non-EU countries. However, search volumes in EU countries increased significantly, from an average of 212,657 weekly searches per country to 291,925 (+37%). Conversely, in non-EU countries, the search volumes fell from 678,285 to 629,228 (-7%). This indicates that users in EU countries have changed their querying behavior as a result of the design change in Google Search, while this is not the case in non-EU countries.

To reinforce this argument and show the abrupt change in search behavior by EU users, we plot the volumes over time for the query `maps` for EU and non-EU countries in Figure 2.[20] In EU countries, we can clearly observe a sudden increase in the volume of searches starting in January 2024, when the DMA-induced change in the Google Search webpage was implemented. Non-EU countries share similar dynamics to EU countries before January 2024, characterized by a slight decline in the volume of searches during the second half of 2023. In contrast to EU countries, the non-EU countries do not show any observable increase in search volumes in the months following January 2024. This suggests that non-EU countries can act as a control group for EU countries. Non-EU countries are not directly subject to the DMA. Moreover, we believe the use of VPN services by EU users is uncommon for this type of online search activity. Ac-

[19] Table A1 in Appendix A shows the share of traffic arriving at `www.google.com/maps` from the query `maps` on Google Search at the country level. The share of traffic is significant in most large European countries (Austria, Belgium, Finland, France, Germany, Ireland, Italy, Netherlands, Portugal, and Spain).

[20] Time series plots of the other queries for each country are provided in Online Appendix A. The plot for the query `google maps` shows similar dynamics to those in Figure 2. The plots for all other queries are much noisier and do not present clear discontinuities after January 2024.

cordingly, EU users are unlikely to use non-EU versions of Google within Europe, thus limiting the risk of contamination of the control group. Based on this descriptive evidence, in the next Section, we present our empirical strategy to measure the impact of the DMA comparing search volumes for the queries `maps` and `google maps` for countries in the EU and non-EU over time.

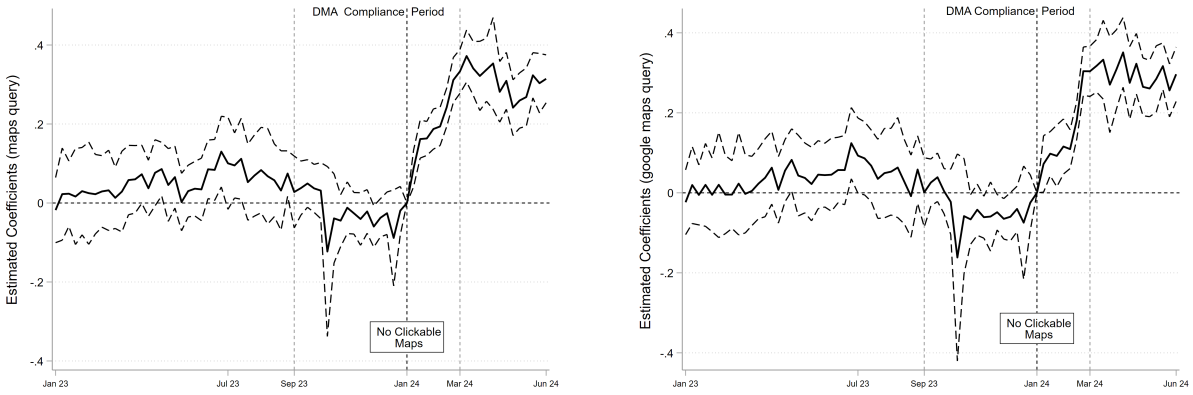
2.3. Identification Strategy

Our aim is to identify the change in propensity to search for the queries of interest (`maps`, and `google maps`) as a result of the DMA. To do so, we consider the DMA as a shock affecting only users based in EU countries. We use non-European countries as a control group to account for initial differences in query rates by employing a two-way fixed effect linear model in a difference-in-differences framework. Specifically, we estimate the following specification:

$$\ln\left(Y_{it}\right) = \alpha_i + \omega_t + \gamma_{\text{DMA}} \times \mathbb{1}\left(\text{country } i \text{ in EU}\right) \times \mathbb{1}\left(\text{time } t \text{ post} - \text{DMA}\right) + \varepsilon_{it}, \tag{1}$$

where Y_{it} denotes the search volumes for the query of interest for country i in week t. α_i and ω_t are country and time fixed effects (at the week level), respectively. γ_{DMA} is our target treatment effect parameter, identified as the difference between average values of the dependent variable for countries in the EU compared to those outside of the EU after the DMA changes are implemented, but after accounting for initial differences between countries. We assume the change in one's ability to click on the map to access Google Maps from Google Search occurred starting on January 1$^{\text{st}}$, 2024. ε_{it} is an unobserved error term assumed to have a zero conditional mean. To demonstrate the robustness of our estimates, we report specifications with and without week fixed effects and include a country-specific linear time trend.

To assess the validity of the DiD design, we present two event study plots to verify that the parallel trends assumption holds during the pre-treatment period. To this end, Figure 3 plots coefficients measuring the differences between EU and non-EU countries over time for the query terms `maps` (Panel 3a) and `google maps` (Panel 3b). Using the week of January 1$^{\text{st}}$, 2024, as a reference point, we observe the absence of significant deviations between the control and treatment groups during the pre-DMA period, as the 95% confidence intervals include zero for almost all coefficients for both keywords. The only recognizable difference can be observed during the summer weeks of 2023, likely reflecting the peak in the summer tourist season in Europe. Yet, these differences have a much smaller magnitude compared to the striking increase in search volumes of queries starting in January 2024. Importantly, the increase stops and the search volumes reach a plateau when the compliance period ends and the DMA becomes fully enforceable in March



(a) `maps` **(b)** `google maps`

Figure 3. Event study: log of Google Search Volumes for `maps` and `google maps`

Notes: The log of Google search volumes for `maps` and `google maps` queries are regressed on country fixed effects and on the products between a dummy variable taking value 1 if the country is in the European Union and a full set of dummy variables for each snapshot. The graphs plot the estimated coefficients on these products. The value of the coefficient corresponding to January 2024 is normalized to zero. In both graphs, the sample includes weeks between January 2023 and June 2024. Figures 3a and 3b show the analysis for search volumes about `maps` and `google maps`, respectively. Standard errors (5%) are clustered by country.

2024. Overall, the two event studies suggest the existence of a dynamic effect that is visibly statistically significant at the beginning of 2024; and support the assumption of parallel trends during 2023 underlying the DiD identification strategy.

3. The DMA's Impact on "Google Maps" and "Maps" Queries

3.1. Main Results

We now present the main empirical results. Table 2 shows three specifications for the DiD estimates in Equation 1 for the queries `maps` (Columns (1), (2), and (3)) and `google maps` (Columns (4), (5), and (6)). We use a log transformation for Google search volume so that the estimates can be interpreted as percentage changes. We report standard errors clustered at the country level (Bertrand, Duflo and Mullainathan, 2004). The sample includes weeks between January 2023 and June 2024 for 20 European and 10 non-European countries.

In Columns (1) and (4), we use country fixed effects, which remove all time-invariant elements that affect users' search behavior at the national level. In Columns (2) and (5), we include time (week) fixed effects to account for time-varying confounders that affect all countries similarly. In Columns (3) and (6), we also include country-specific linear time trends to account for differential time variation in users' search behavior across countries. The estimates of the coefficient γ_{DMA} in Equation 1 are positive and significant at the

Table 2. Difference-in-Differences: log of Google Search Volumes for `maps` and `google maps` Queries

	(maps)			(google maps)		
	(1)	(2)	(3)	(4)	(5)	(6)
$EU \times post^{DMA}$	0.237***	0.231***	0.255***	0.160***	0.222***	0.244***
	(0.019)	(0.034)	(0.044)	(0.017)	(0.037)	(0.056)
Country FEs	✓	✓	✓	✓	✓	✓
Date FEs		✓	✓		✓	✓
Country-Specific Time Trends			✓			✓
R^2	0.99	1.00	1.00	0.99	0.99	1.00
N	2625	2625	2625	2625	2625	2625
Mean Dep. Var.	11.169	11.169	11.169	10.675	10.675	10.675

Notes: The sample includes weeks between January 2023 and June 2024 for 20 European and 10 non-European countries. "Country-Specific Time Trends" include separate time trends for each country. Standard errors clustered by country are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

1% level for all specifications. The DMA is associated with an increase in search volume of at least 23% for the query `maps` and 16% for `google maps` in EU countries compared to non-EU countries. The magnitude of these estimates is economically significant, as it documents that a large volume of users in the EU have searched for general mapping services, and more specifically for Google Maps, because they cannot access them directly by clicking within Google Search.

3.2. Robustness Checks

Placebo Test using Youtube Search. Has there been a generalized surge in the interest for mapping services in Europe at the beginning of 2024? We are not aware of any significant event that could have generated an increase in the general interest in maps and Google Maps services (aside from the DMA) that could affect EU users' search behavior in such a strong and unprecedented way. To explore this potential external increase in interest, we estimate Equation 1 for the search query `maps` using search volumes on Google's video-sharing platform, YouTube, as the dependent variable.[21] Given that YouTube cannot be used to find Google Maps or an alternative map provider, we do not expect the DMA to have any effect on the volume of searches there. Results are displayed in Appendix B in Table B1. After controlling for time fixed effects, we do not observe any statistically significant effect, despite having a very precisely estimated coefficient. Moreover, there is an absence of any systematic difference between the EU and non-EU countries before 2024, as shown by the event study plot in Figure B1. This test is in line with the absence of any other events except for the DMA that could lead to changes in Google searches for mapping services by EU users.

[21] Nearly identical results can be found using the query term `google maps`. Poisson Pseudo-Maximum Likelihood estimation is used to account for zero observations while simultaneously estimating a percentage effect of the DMA (Chen and Roth, 2023).

Synthetic Difference-in-Differences. As we are comparing the outcomes across a few countries over time, identification strategies such as synthetic difference-in-differences and synthetic control could be considered as alternative empirical designs to assess if our two-way fixed effects model is restrictive and driving our point estimates. In Online Appendix B, we estimate the synthetic difference-in-differences model (Arkhangelsky, Athey, Hirshberg, Imbens and Wager, 2021) along with the synthetic control model (Abadie and Gardeazabal, 2003) for the queries `maps` and `google maps`. Table B2 reports the results. The point estimates yielded by all three econometric methods are sufficiently similar to be within each other's 1% confidence intervals. Qualitatively speaking, Figures B2b and B3b, which display the synthetic time series plots, provide evidence of a 23% increase in the search volumes of EU countries post-DMA relative to the synthetic control group.

Other Robustness Checks. To conclude this Section, we propose two additional robustness checks. As of now, our outcome variables are obtained using data by Google Trends and Glimpse. In Appendix B, we use data solely from Google Trends. Google Trends provides search intensity for queries: it equals the volume of search for a keyword divided by the maximum observed volume of search for that keyword over the data horizon (i.e., $I_{it} = Y_{it}/\max_t(Y_{it})$). Table B3 reports the point estimates for Equation 1, and Figure B4 displays the associated event-study plots. As expected, the results are identical to those using volumes in Table 2.

Finally, we employ an alternative identification strategy using 2023 as a control group for 2024, the year of implementation of the DMA (similarly to Liaukonytė, Tuchman and Zhu, 2023). Table B4 estimates a linear regression with country fixed effects, including only EU countries, starting from June 2022 to obtain a full year of pre-treatment data. The results, without relying on an extra-territorial set of countries, show qualitatively similar effects for queries `maps` and `google maps`, with treatment effects measured at 31.5% and 28%, respectively.

4. Implications from the Spillover Effects

4.1. Impact on Google Maps' Competitors

With the previous identification strategy, we have shown that EU users have reacted to the DMA-imposed changes in Google Search webpages by searching more frequently for the query terms `maps` and `google maps`. As Google Maps links appear as top results after searching for `maps` (see Table A1), we can safely assume that most of these additional searches lead EU users to Google Maps services. However, some users may have also started searching for alternative map services. To explore this possibility, we estimate Equa-

Table 3. Difference-in-Differences: Google Search Volumes (Poisson Pseudo-Maximum Likelihood) for Queries about Alternative Mapping Services

	(apple maps)	(bing maps)	(mappy)	(openstreetmap)
$EU \times post^{DMA}$	0.099*	0.183*	0.217	0.098
	(0.060)	(0.105)	(0.165)	(0.104)
Country FEs	✓	✓	✓	✓
Date FEs	✓	✓	✓	✓
Country-Specific Time Trends	✓	✓	✓	✓
Pseudo R^2	0.94	0.97	1.00	0.84
N	2459	2475	1812	2325
Mean Dep. Var.	865.315	620.859	9596.020	371.042

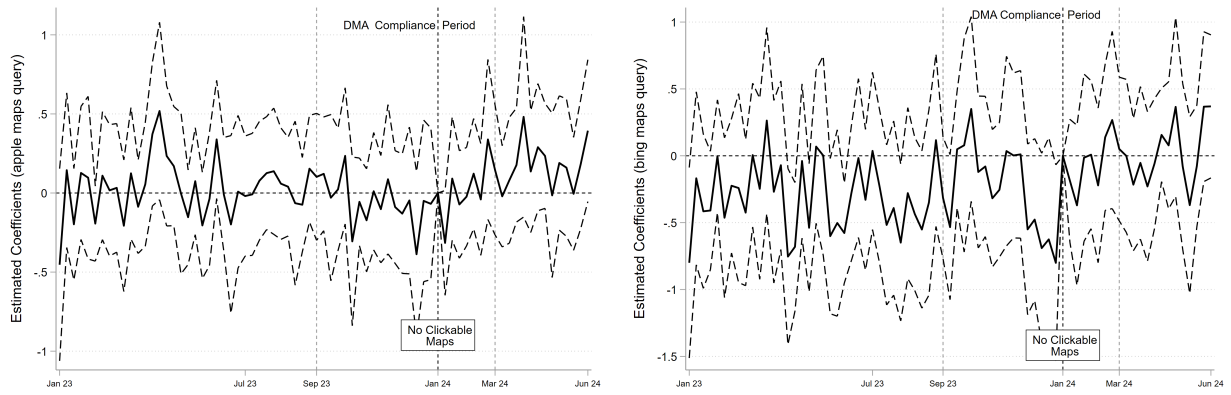
Notes: The sample includes weeks between January 2023 and June 2024 for 20 European countries and 10 non-European countries. To preserve the percentage interpretation of the coefficients and to account for zero values in the observations, we use a Poisson pseudo maximum likelihood model. In all columns, observations are omitted to ensure the maximum likelihood estimates to exist (see Correia, Guimarães and Zylkin, 2019). For `mappy`, 150 observations are omitted because two control countries (Egypt and Morocco) consistently have zero search volume throughout the analysis period. Standard errors clustered by country are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

tion 1 using query terms for competing map services.[22] We report results for our most demanding specification, which includes country-specific linear time trends. As shown in Table 3, there is evidence of an increase in the volume of searches for some competing mapping services. Specifically, Apple Maps shows a 10% increase in search volumes with a parameter estimate significant at the 10% level. Bing Maps exhibits nearly an 18% growth in search queries with a parameter estimate significant at the 10% level. None of the other mapping services show any significant change resulting from the DMA in Europe. These findings suggest that other major tech companies (GAFAMs) may have benefited from the DMA, observing an increase in queries for their services.

Nonetheless, the evidence that EU users are substituting Google Maps with other online mapping services is weak. In Figure 4, we plot coefficients measuring the differences between EU and non-EU countries over time for the query terms `apple maps` and `bing maps`. For both queries, we do not observe any compelling change in the difference between EU and non-EU countries following the DMA. Applying synthetic difference-in-differences estimators, all point estimates are not statistically significant (Table C1). Accordingly, despite some promising hints that the DMA could increase the use of competing map services, we cannot reject the null hypothesis that the DMA did not increase the search volumes for competitors during the first six months of its implementation.[23]

[22] Poisson Pseudo-Maximum Likelihood estimation is used to account for zero observations while simultaneously estimating a percentage effect of the DMA (Chen and Roth, 2023).

[23] Note that Apple Maps cannot be accessed from a desktop browser; hence, the non-significant negative point estimate is unsurprising.



(a) `apple maps` **(b)** `bing maps`

Figure 4. Event study: Google Search Volumes (Poisson Pseudo-Maximum Likelihood) for `apple maps` and `bing maps`

Notes: The Google search volumes for `apple maps` and `bing maps` queries are regressed on country fixed effects and on the products between a dummy variable taking value 1 if the country is in the European Union and a full set of dummy variables for each snapshot. The graphs plot the estimated coefficients on these products. The value of the coefficient corresponding to January 2024 is normalized to zero. To preserve the percentage interpretation of the coefficients and to account for zero values in the observations, we use a Poisson pseudo maximum likelihood model. In both graphs, the sample includes weeks between January 2023 and June 2024. Figures 4a and 4b show the analysis for search volumes about `apple maps` and `bing maps`, respectively. Standard errors (5%) are clustered by country.

4.2. Impact on Online Traffic

To complement previous analyses based on search volume, we replicate our analysis using data measuring traffic to `www.google.com/maps` and `www.bing.com/maps` to determine whether actual usage of online map providers has changed as a result of the policy. Since actual traffic volume is only available to the domain owners, Google and Microsoft, we rely on data from the SEO company Semrush, which cleans, processes, and distributes clickstream data based on 2 million anonymous user clicks per minute. Data with traffic estimation to a specific domain name from a specific country is provided on a monthly level.[24]

To assess the impact of the DMA on actual traffic volumes, we rely on three different variations of our identification strategy: synthetic differences-in-differences, difference-in-differences as in Equation 1, and synthetic control. The results are reported in Table C2 in Online Appendix C. Concerning Google Maps, we do not observe any statistically significant estimates, with a negative point estimate of -22.5% in traffic volume based on synthetic differences-in-differences and -22% using the standard DiD based on Equation 1. Using synthetic control, the magnitude is smaller at -12.6%. These results align with the previous analysis based on Google search data: EU users did not abandon Google Maps services but, through additional searches, most of them are redirected to Google Maps.

[24] This corresponds to the "organic traffic" variable provided by Semrush.

Evidence supporting an increase in traffic for Bing Maps is mixed and not very robust. All three methods yield point estimates with large magnitudes (+23%, +30%, and +25%, respectively). The treatment effects measured by the standard DiD and synthetic control are statistically significant at the 10% level. However, the synthetic differences-in-differences method does not yield a satisfactory control group, as shown in the left panel of Figure C2. Similarly, the standard DiD yields an event-study plot that does not convey a clear story due to very large confidence intervals, as seen in Figure C3. Conversely, the control group obtained from the synthetic control fits the pre-treatment data reasonably well, as shown in Figure C4. These last estimates provide some support to the idea that the DMA could have partially increased traffic towards Bing Maps, a competitor of Google Maps. Accordingly, we can conclude that there is no evidence that the DMA caused a drop in Google Maps traffic and some partial evidence suggesting it could have led to a growth in traffic for Bing Maps.

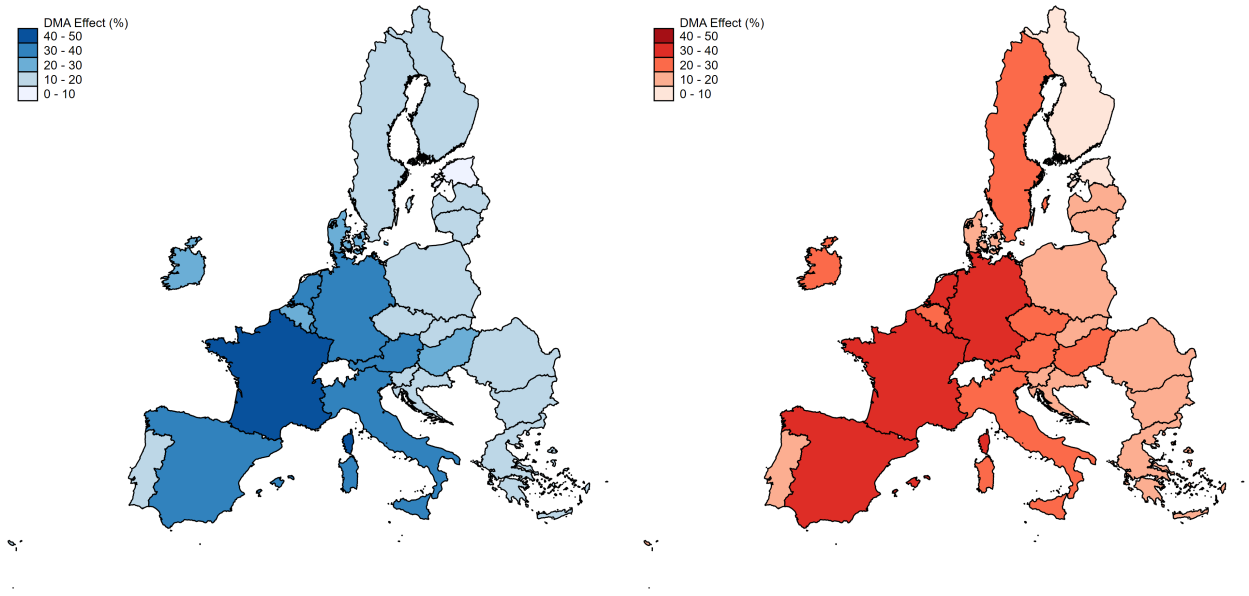
5. Policy and Managerial Implications

We now discuss implications for policymakers and managers, clarifying how the policy affects user welfare and behavior. In terms of welfare, consumers experience a loss due to increased search costs. Users now have to click twice more to access Google Maps: first, they must use Google Search, then search for `maps` or `google maps`, and finally add the original destination to Google Maps. While this may seem minimal, the aggregate treatment effect impacts a vast population. To illustrate, Table C3 in Appendix C calculates the number of excess searches resulting from the DMA, relying on country-specific treatment effects approximated using heterogeneous effects from Equation 1. These effects are shown in Figures 5a and 5b with maps of EU countries. France exhibits the largest increase in searches for `maps`, while Germany, France, Spain, and the Netherlands show the highest increase for `google maps`. In the first six months of the policy, there were 34,407,000 excess searches for `maps` and 8,901,000 for `google maps` in the EU. Assuming the two extra searches take 3 seconds each (one on Google Search and within Google Maps) and an average market wage of 22.9 euros per hour (European Average Salary in 2022[25]), a back-of-the-envelope calculation estimates the policy cost at 1,652,922 euros for six months, or approximately 3.3 million euros per year.[26]

This cost should be weighed against the benefits of limiting Google's ability to steer consumers from Google Search to Google Maps. Our findings suggest that the DMA has slightly increased the search and traffic volume towards Bing Maps. To make the market for online mapping services more contestable by

[25] See https://ec.europa.eu/eurostat/web/products-eurostat-news/w/DDN-20230420-1.

[26] The calculation is: `[22.9x(34407000+8901000)x3x2]/(60x60)`. Note: Cyprus and Malta are not included in our analysis. Without clickable maps in search results, users may stop searching for specific maps queries like `maps Shakespeare and Co`. As users adapt to the design change, excess search costs may decline over time.



(a) `maps` **(b)** `google maps`

Figure 5. Country-Specific DMA Treatment Effect on Google Search Volumes over Time for `maps` and `google maps` Queries

Notes: The sample includes weeks between January 2023 and June 2024 for 20 European and 10 non-European countries. Treatment effects are calculated using Equation 1 but allowing for country-specific parameters for the effect of the DMA. The estimates are also reported in Table C3 in Appendix C.

competing providers, Google's one-click advantage could be further restricted to enhance user benefits from DMA-induced changes in web search. Future policy might include the elimination of Google's clickable map on the mobile search interface and the "directions" button, which currently guides users towards Google's proprietary navigation tools.

This redirection in traffic along with the rise in search costs for online mapping services has direct implications for all the ecosystem of businesses that rely on google services to be discovered by users. Now, users who search for restaurants or shops in Google Search cannot click on the map to access reviews from Google Maps or discover local competitors. This impacts businesses that rely on their Google Maps reputation to attract customers. The strategic response of these businesses can vary. They may need to (i) increase their presence on other platforms (e.g., Tripadvisor, TheFork); (ii) enhance their visibility on other online mapping services (e.g., Bing Maps); (iii) market themselves directly in Google Search, particularly in location search queries related to mapping services (e.g., `maps Shakespeare and Co`); or, (iv) attract customers more directly offline by building an offline reputation. Additionally, shops should account for the change in the composition of users arriving on Google Maps. Only those who value Google Maps sufficiently to bear the additional search cost will end up on the platform. It can be conjectured that these consumers might be more price-sensitive or attentive to reputation. Consequently, the content advertised

by businesses may need to emphasize information that reflects these users' concerns (e.g., loss-leader products). Overall, although the significance of Google Maps for companies has diminished, businesses should anticipate further changes and adapt their marketing strategies accordingly.

6. Conclusion

This article assesses the impact of the Digital Markets Act (DMA) on traffic diversion from Google Maps to competitors. It documents an increase in direct searches for map-related sites on Google Search following the implementation of the DMA by comparing European countries with non-European countries using a difference-in-differences framework. This additional search activity did not affect Google Maps traffic suggesting that most EU users are not substituting Google Maps with other online mapping services. Therefore, removing Google's one-click advantage did not significantly change the market of mapping services in the short run, possibly due to Google's already dominant position.

Future research could examine the long-term effects of the DMA, such as its effect on entry or changes in search rankings of competing online mapping services. Of particular importance to policymakers and managers are the implications of Google's integration of Google Maps data directly into Google Search. For example, when searching for a restaurant near a landmark, Google Search directly displays restaurant recommendations (price range, number of stars, number of reviews, type of restaurant, address, etc.). It also introduced two new badges, "Places" and "Places Sites," which display a list of restaurants (with direct links to Google Maps) and a list of restaurant reviews, respectively (see Figure D1 in Appendix D). This direct integration blurs the evidence of self-preferencing, as it becomes difficult to distinguish Google Search from Google Maps. Future research and policymakers could explore this strategy further. Policymakers could focus on ensuring that competing mapping services have equal access to these new signets and recommendation spaces.

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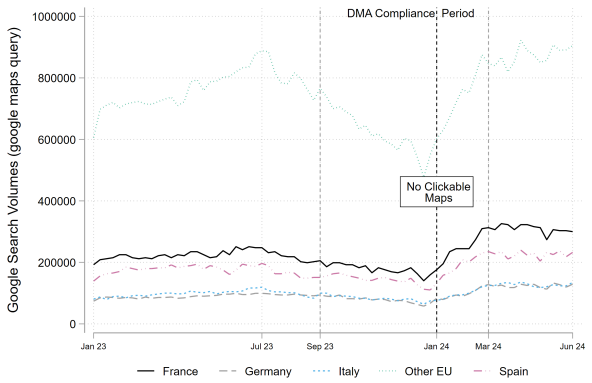
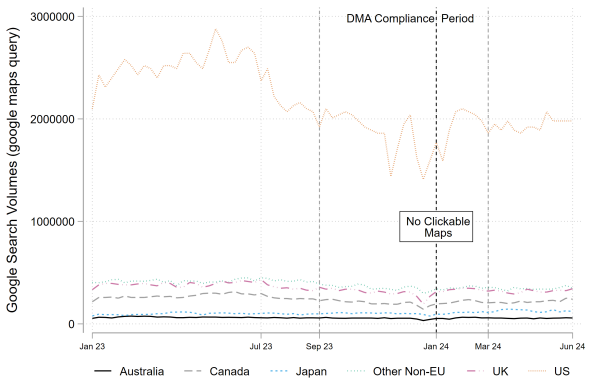
A APPENDIX - Data and Empirical Strategy



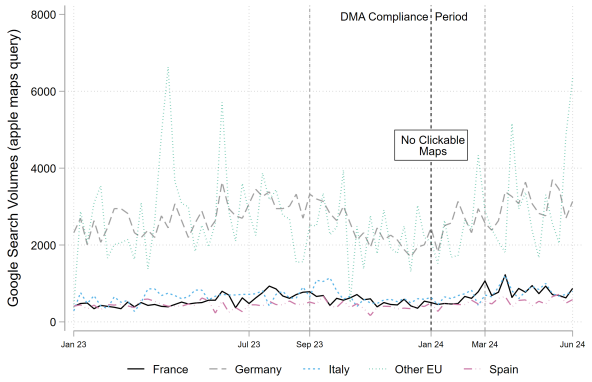
(a) EU countries



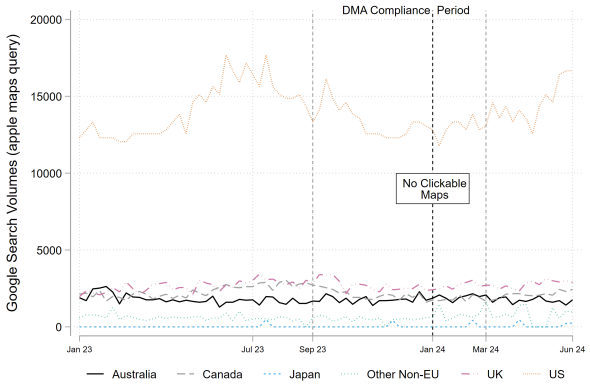
(b) non-EU countries

Figure A1. Google Search Volumes over Time for `google maps` Query

Notes: The graph plots the Google search volumes for European countries and non-European countries European. The sample includes weeks between January 2023 and June 2024.



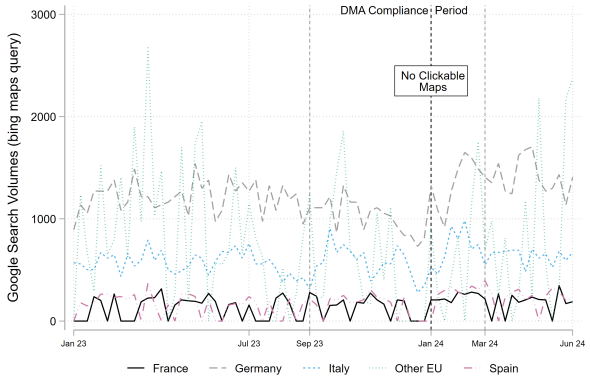
(a) EU countries



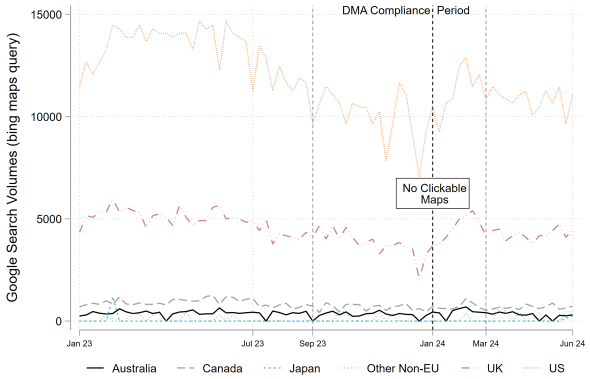
(b) non-EU countries

Figure A2. Google Search Volumes over Time for `apple maps` Query

Notes: The graph plots the Google search volumes for European countries and non-European countries European. The sample includes weeks between January 2023 and June 2024.



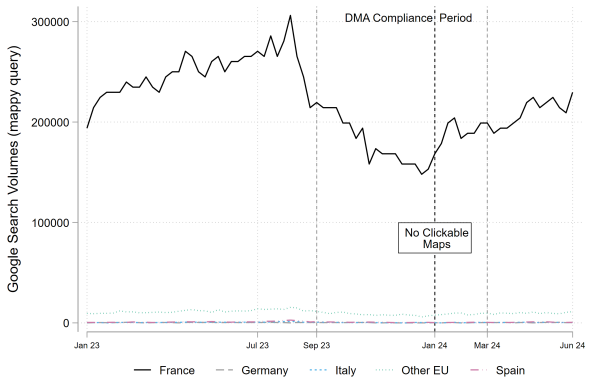
(a) EU countries



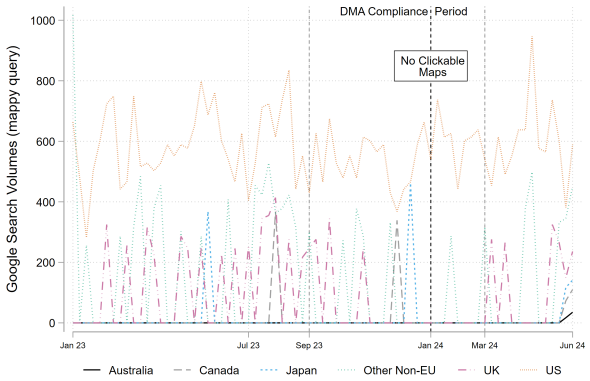
(b) non-EU countries

Figure A3. Google Search Volumes over Time for `bing maps` Query

Notes: The graph plots the Google search volumes for European countries and non-European countries European. The sample includes weeks between January 2023 and June 2024.



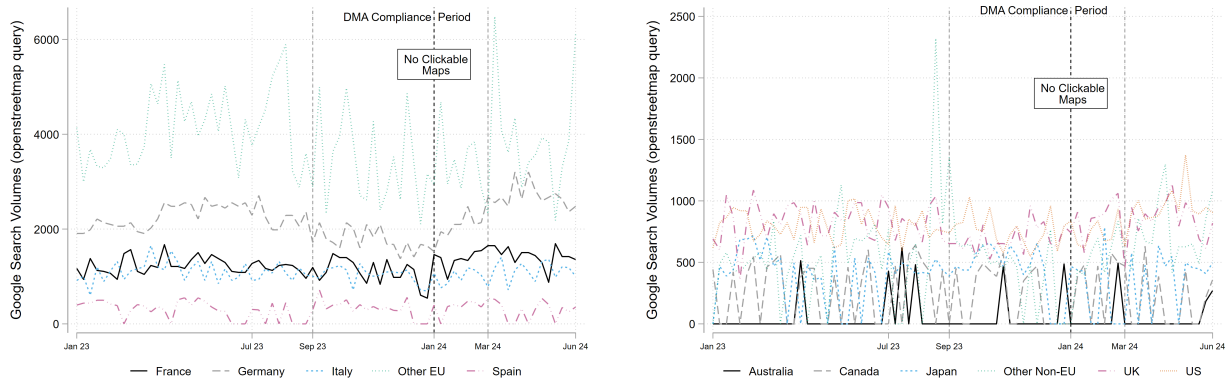
(a) EU countries



(b) non-EU countries

Figure A4. Google Search Volumes over Time for `mappy` Query

Notes: The graph plots the Google search volumes for European countries and non-European countries European. The sample includes weeks between January 2023 and June 2024.



(a) EU countries **(b)** non-EU countries

Figure A5. Google Search Volumes over Time for `openstreetmap` Query

Notes: The graph plots the Google search volumes for European countries and non-European countries European. The sample includes weeks between January 2023 and June 2024.

Table A1. From the maps Keyword to www.google.com/maps

EU Countries	Traffic Volumes from maps	Percent of Traffic Volumes from maps (%)	Position Google Search
Austria	860100	54.49	1
Belgium	453840	41.86	1
Bulgaria	6396	11.34	2
Croatia	6396	4.91	2
Czech Republic	7826	4.65	2
Denmark	21398	22.39	2
Estonia	4290	14.41	2
Finland	470000	37.17	1
France	1517760	35.27	1
Germany	1855040	27.82	1
Greece	63500	11.28	1
Hungary	9568	8.12	2
Ireland	211500	28.57	1
Italy	2266720	42.79	1
Latvia	4290	12.32	2
Lithuania	31980	39.6	2
Netherlands	453840	24.89	1
Poland	705000	7.53	1
Portugal	470000	76.03	1
Romania	21398	18.16	2
Slovakia	115620	13.51	1
Spain	1855040	47.31	1
Sweden	386810	30.3	1

Notes: The shares of online traffic arriving at www.google.com/maps from the query maps on Google Search are measured at the country level in June 2024. The data is obtained using estimated website traffic data provided by the search engine marketing company Semrush.

B APPENDIX - Main Results and Robustness Checks

2.1. Placebo using Youtube Search

Table B1. Difference-in-Differences: Google Trends (Poisson Pseudo-Maximum Likelihood) for `maps` Query (YouTube search)

	(1)	(2)	(3)
$EU \times post^{DMA}$	-0.075***	0.003	0.034
	(0.026)	(0.031)	(0.040)
Country FEs	✓	✓	✓
Date FEs		✓	✓
Country-Specific Time Trends			✓
Pseudo R^2	0.53	0.54	0.51
N	2625	2625	2552
Mean Dep. Var.	48.875	48.875	50.274

Notes: The sample includes weeks between January 2023 and June 2024 for 20 European and 10 non-European countries. "Country-Specific Time Trends" include separate time trends for each country. To preserve the percentage interpretation of the coefficients and to account for zero values in the observations, we use a Poisson pseudo maximum likelihood model. In Column (3), 73 observations are omitted to ensure the maximum likelihood estimates to exist (see Correia et al., 2019). Standard errors clustered by country are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

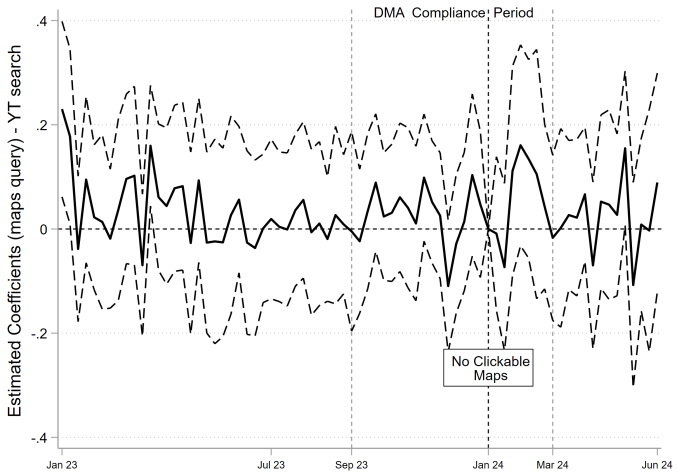


Figure B1. Event study: Google Trends (Poisson Pseudo-Maximum Likelihood) for `maps` (YouTube Search)

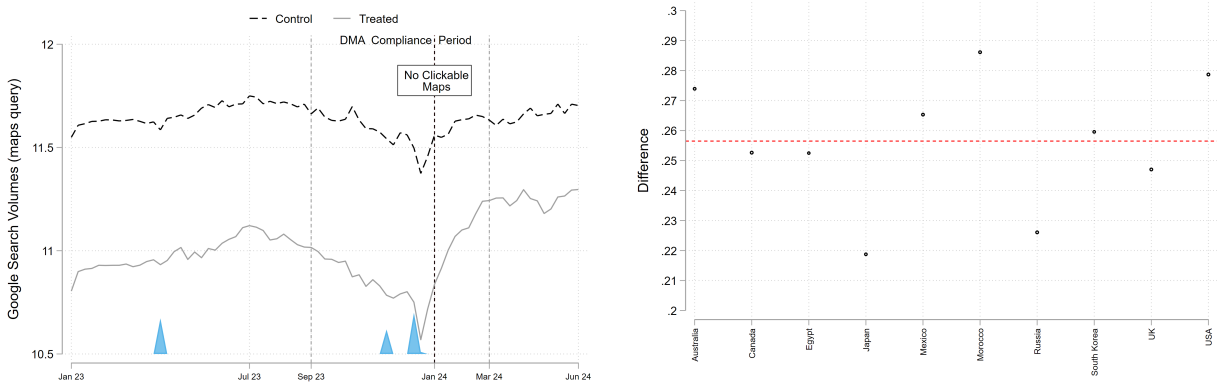
Notes: The Google Trends for the query `maps` on YouTube search is regressed on country fixed effects and the interaction terms between a dummy variable indicating whether a country is in the European Union and a full set of dummy variables for each snapshot. The graphs plot the estimated coefficients for these interaction terms. The coefficient value for January 2024 is normalized to zero. To preserve the percentage interpretation of the coefficients and to account for zero values in the observations, we use a Poisson pseudo maximum likelihood model. The sample includes weekly data from January 2023 to June 2024. Standard errors (at the 5% level) are clustered by country.

2.2. Using Synthetic Difference-in-Differences

Table B2. Comparing Specifications: log of Google Search Volumes for `maps` and `google maps` Queries

	`maps`			`google maps`		
	(Synth. DiD)	(DiD)	(Synth. Control)	(Synth. DiD)	(DiD)	(Synth. Control)
$EU \times post^{DMA}$	0.256***	0.231***	0.240***	0.245***	0.222***	0.219***
	(0.029)	(0.031)	(0.032)	(0.024)	(0.033)	(0.027)
N	2625	2625	2625	2625	2625	2625

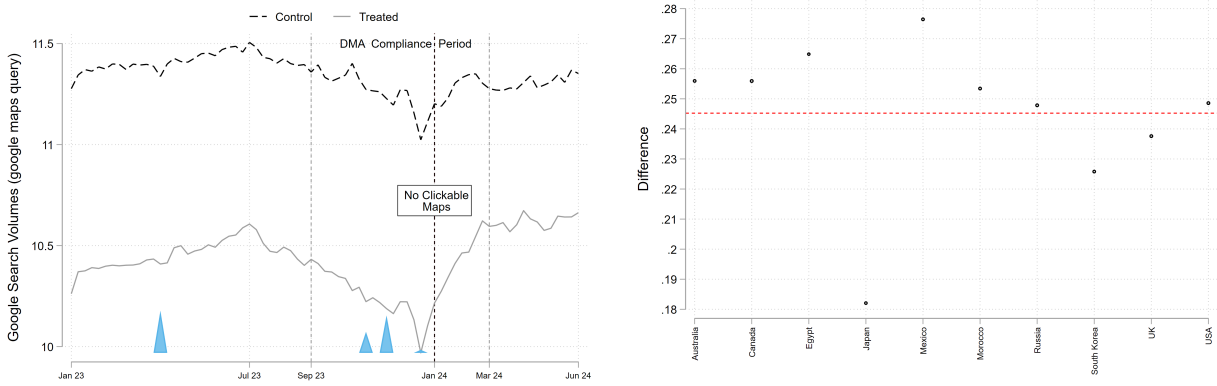
Notes: The sample includes weeks between January 2023 and June 2024 for 20 European and 10 non-European countries. Bootstrap standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.



(a) Week Weights **(b)** Country Weights

Figure B2. Synthetic DiD: log of Google Search Volumes for the `maps` Query

Notes: The graphs plot the week and country weights for the synthetic difference-in-differences estimator for the `maps` query. The sample includes weeks between January 2023 and June 2024.



(a) Week Weights **(b)** Country Weights

Figure B3. Synthetic DiD: log of Google Search Volumes for the `google maps` Query

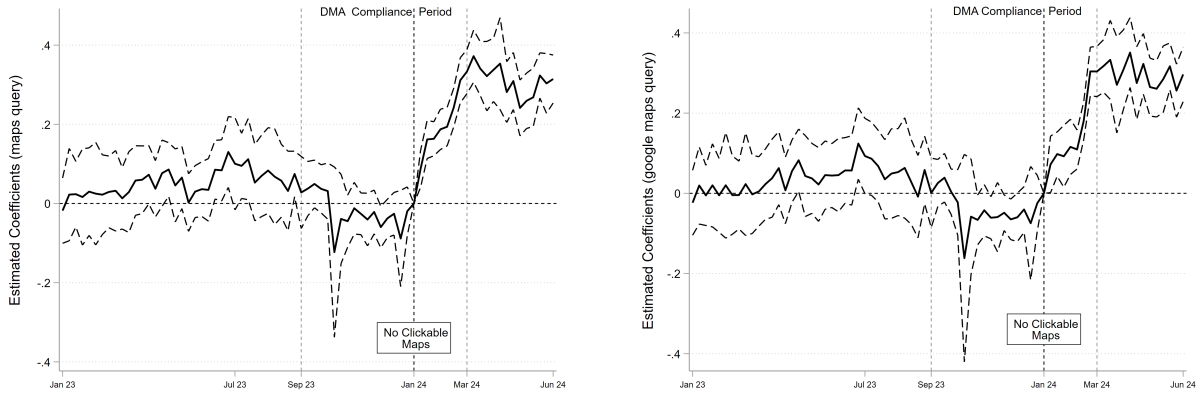
Notes: The graphs plot the week and country weights for the synthetic difference-in-differences estimator for the `google maps` query. The sample includes weeks between January 2023 and June 2024.

2.3. Using only Google Trends

Table B3. Difference-in-Differences: log of Google Trends for `maps` and `google maps` Queries

	`maps`			`google maps`		
	(1)	(2)	(3)	(4)	(5)	(6)
$EU \times post^{DMA}$	0.237***	0.231***	0.255***	0.159***	0.222***	0.244***
	(0.019)	(0.034)	(0.044)	(0.017)	(0.037)	(0.056)
Country FEs	✓	✓	✓	✓	✓	✓
Date FEs		✓	✓		✓	✓
Country-Specific Time Trends			✓			✓
R^2	0.60	0.82	0.86	0.58	0.83	0.87
N	2625	2625	2625	2625	2625	2625
Mean Dep. Var.	4.196	4.196	4.196	4.190	4.190	4.190

Notes: The sample includes weeks between January 2023 and June 2024 for 20 European and 10 non-European countries. "Country-Specific Time Trends" include separate time trends for each country. Standard errors clustered by country are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.



(a) `maps` **(b)** `google maps`

Figure B4. Event study: log of Google Trends for `maps` and `google maps`

Notes: The Google Trends for `maps` and `google maps` queries are regressed on country fixed effects and on the products between a dummy variable taking value 1 if the country is in the European Union and a full set of dummy variables for each snapshot. The graphs plot the estimated coefficients on these products. The value of the coefficient corresponding to January 2024 is normalized to zero. In both graphs, the sample includes weeks between January 2023 and June 2024. Figures 3a and 3b show the analysis for search volumes about `maps` and `google maps`, respectively. Standard errors (5%) are clustered by country.

2.4. Using only the Previous Year as a Control Group

Table B4. Using the Previous Year as Control: log of Google Search Volumes for `maps` and `google maps` Queries

	`maps`			`google maps`		
	(1)	(2)	(3)	(4)	(5)	(6)
2024 × *Jan – Jun*	0.223***	0.315***	0.315***	0.135***	0.278***	0.278***
	(0.021)	(0.016)	(0.016)	(0.017)	(0.019)	(0.019)
Country FEs	✓	✓	✓	✓	✓	✓
Linear Time Trend		✓			✓	
Country-Specific Time Trends			✓			✓
R^2	0.99	0.99	0.99	0.97	0.98	0.98
N	2625	2625	2625	2625	2625	2625
Mean Dep. Var.	11.004	11.004	11.004	10.439	10.439	10.439

Notes: The sample includes weeks between June 2022 and June 2024 only for 20 European countries. For each country, the period from January 2023 to June 2023 forms the "control group". "Linear Time Trend" includes a single time trend for all countries. "Country-Specific Time Trends" include separate time trends for each country. Standard errors clustered by country are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

C APPENDIX - Spillover Effects

3.1. Impact on Competitors

Table C1. Synthetic Difference-in-Differences: log of Google Search Volumes for Queries about Alternative Mapping Services

	(apple maps)	(bing maps)	(mappy)	(openstreetmap)
$EU \times post^{DMA}$	-0.108	0.183	0.016	-0.070
	(0.381)	(0.233)	(0.264)	(0.274)
N	2625	2625	2475	2625

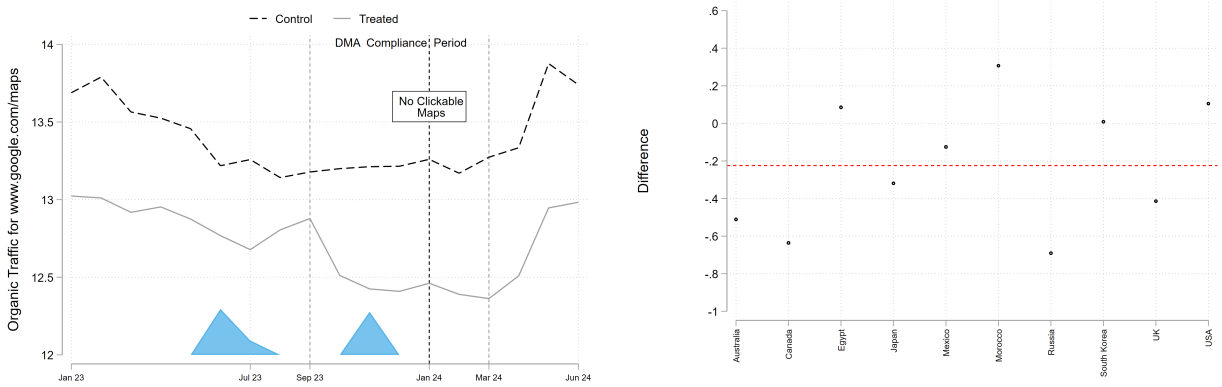
Notes: The sample includes weeks between January 2023 and June 2024 for 20 European countries and 10 non-European countries. To preserve the percentage interpretation of the coefficients and to account for zero values in the observations, we added one to the observations with zero search volumes. For mappy, 150 observations are omitted because two control countries (Egypt and Morocco) consistently have zero search volume throughout the analysis period. Standard errors clustered by country are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

3.2. Impact on Traffic Volumes

Table C2. Comparing Specifications: log of the Organic Traffic Volume for `www.google.com/maps` and `www.bing.com/maps`

	`www.google.com/maps`			`www.bing.com/maps`		
	(Synth. DiD)	(DiD)	(Synth. Control)	(Synth. DiD)	(DiD)	(Synth. Control)
$EU \times post^{DMA}$	-0.225	-0.220	-0.126	0.228	0.301*	0.248*
	(0.166)	(0.191)	(0.254)	(0.162)	(0.158)	(0.147)
N	630	630	630	630	630	630

Notes: The sample includes months between January 2023 and June 2024 for 20 European and 10 non-European countries. Bootstrap standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

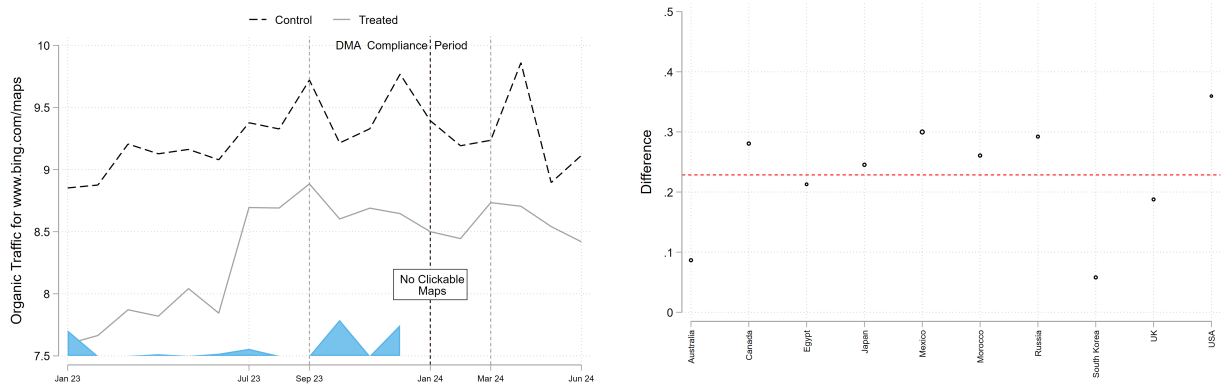


(a) Month Weights

(b) Country Weights

Figure C1. Synthetic DiD: log of the Organic Traffic Volume for `www.google.com/maps`

Notes: The graphs plot the week and country weights for the synthetic difference-in-differences estimator for `www.google.com/maps`. The sample includes months between January 2023 and June 2024.



(a) Month Weights **(b)** Country Weights

Figure C2. Synthetic DiD: log of the Organic Traffic Volume for `www.bing.com/maps`

Notes: The graphs plot the week and country weights for the synthetic difference-in-differences estimator for `www.bing.com/maps`. The sample includes months between January 2023 and June 2024.

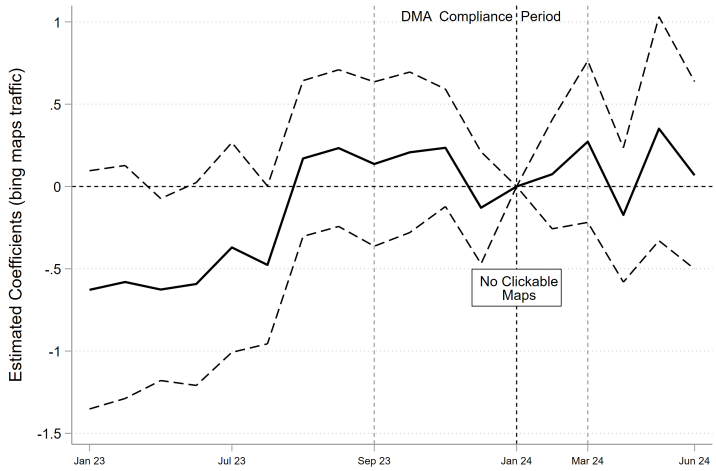
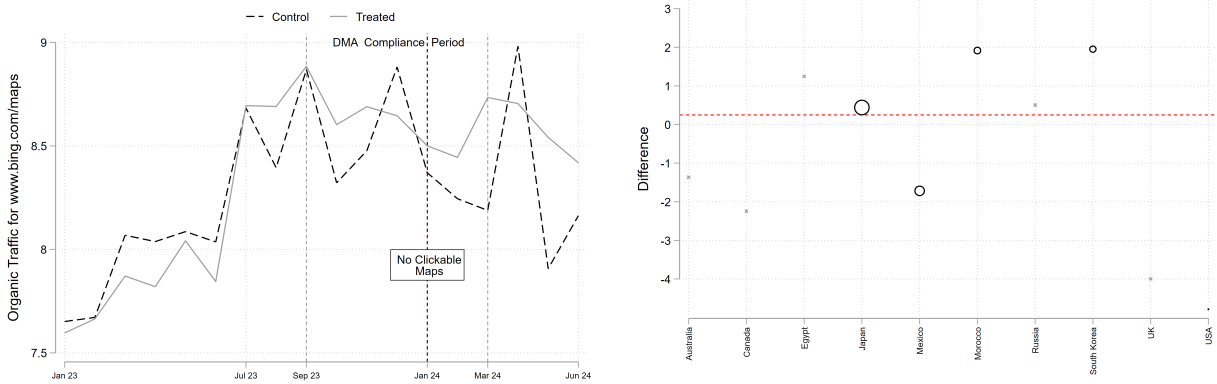


Figure C3. Event study: log of the Organic Traffic Volume for `www.bing.com/maps`

Notes: The log of the Organic Traffic Volume for `www.bing.com/maps` is regressed on country fixed effects and the interaction terms between a dummy variable indicating whether a country is in the European Union and a full set of dummy variables for each month. The graphs plot the estimated coefficients for these interaction terms. The coefficient value for January 2024 is normalized to zero. The sample includes monthly data from January 2023 to June 2024. Standard errors (at the 5% level) are clustered by country.



(a) Month Weights

(b) Country Weights

Figure C4. Synthetic Control: log of the Organic Traffic Volume for `www.bing.com/maps`

Notes: The graphs plot the week and country weights for the synthetic control estimator for `www.bing.com/maps`. The sample includes months between January 2023 and June 2024.

Table C3. Excess Search for `maps` and `google maps` by EU country

	`maps`			`google maps`		
EU Countries	Impact (%)	Volumes (in 1k)	Excess Search (in 1k)	Impact (%)	Volumes (in 1k)	Excess Search (in 1k)
Austria	.34	3,984	1,387	.27	1,110	302
Belgium	.26	4,257	1,116	.28	1,480	420
Bulgaria	.19	514	102	.19	329	65
Croatia	.11	492	59	.13	607	82
Czech Republic	.18	740	138	.21	712	151
Denmark	.23	1,755	409	.19	625	120
Estonia	.08	317	27	.09	293	26
Finland	.16	1,830	307	.09	687	64
France	.44	19,391	8,532	.37	6,260	2,324
Germany	.35	15,930	5,732	.33	2,499	832
Greece	.13	859	117	.15	860	135
Hungary	.22	765	171	.29	762	223
Ireland	.22	978	215	.21	963	202
Italy	.36	19,183	7,092	.27	2,547	698
Latvia	.17	324	58	.18	328	59
Lithuania	.14	487	70	.15	389	60
Luxembourg	.32	228	75	.38	126	48
Netherlands	.33	3,192	1,062	.33	762	256
Poland	.14	3,075	449	.16	4,552	746
Portugal	.2	2,170	445	.17	1,126	194
Romania	.19	1,819	353	.14	849	122
Slovakia	.13	442	60	.18	287	51
Slovenia	.16	561	94	.16	298	48
Spain	.38	15,859	6,027	.31	4,666	1,465
Sweden	.19	1,595	310	.23	882	208

Notes: The sample includes weeks between January 2023 and June 2024 for 20 European and 10 non-European countries. The impact is calculated based on Equation 1 but allowing for a country-specific effect. The column "Volumes (in 1k)" is the total number of queries between January and June 2024 in the specific European country, measured in thousands. "Excess Search (in 1k)" multiplies the column "Impact (%)" by "Volumes (in 1k)" to measure the number of excess queries resulting from the end of Google's one-click advantage.

D APPENDIX - Policy and Managerial Implications

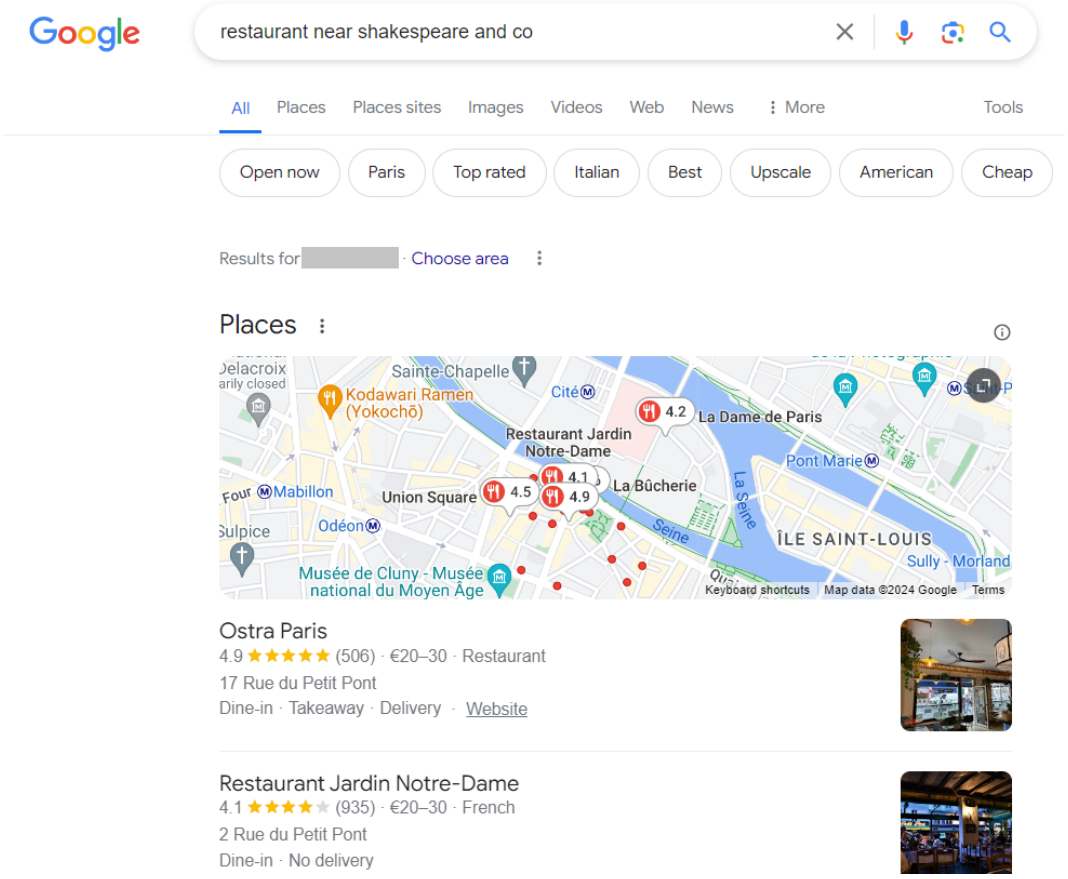


Figure D1. Snapshot of Google results for the query `restaurant near shakespeare and co` (July 3, 2024) from the EU: the map is not clickable. The "Places" signet shows a list of restaurants in the area with direct links to Google Maps. The "Places sites" shows a list links towards restaurant reviews.