

Beyond Market Concentration: Measuring Contestability in Digital Markets

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Abstract

How can contestability in digital markets be measured consistently across jurisdictions and markets? This paper develops a multidimensional measurement framework that defines contestability as the opportunity for incumbent positions to be challenged, rather than as observed market structure or downstream competitive outcomes. The framework organizes contestability into four dimensions: User Mobility and Switching, Rival Access and Distribution, Platform Neutrality and Non-Discrimination, and Data, Interoperability and Infrastructure Access.

The paper makes three contributions. Conceptually, it distinguishes the conditions enabling competitive challenge from concentration, entry, market-share changes, and other outcomes that contestability may affect. Methodologically, it develops two complementary measures. *De Jure Contestability* captures the formal legal and regulatory protections supporting the relevant contestability mechanisms, while *De Facto Contestability* measures the extent to which those mechanisms operate in practice within a defined market. The framework specifies a common measurement hierarchy, separate units of observation, transparent scoring rules, and traceable evidence standards. *Effective Contestability* is treated as a research-question-dependent composite rather than as a structural causal relationship.

Empirically, we construct a June 2026 *De Jure* dataset covering sixteen obligation categories across nine jurisdictions and apply the *De Facto* framework to EU online search and mobile app distribution. The market applications cover Google Search, Apple iOS/App Store, and Google Android/Google Play. The results reveal substantial variation in formal regulatory environments and persistent gaps between legal protections and realized competitive conditions. They also show that the mechanisms constraining contestability differ across markets and platform ecosystems. The framework provides a basis for comparing regulatory regimes, monitoring implementation, and studying how contestability affects entry, innovation, and other competitive outcomes.

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1 Introduction

Digital markets are often concentrated because of network effects, scale economies, accumulated data advantages, switching costs, and platform control over distribution and technical infrastructure. Concentration, however, does not reveal whether incumbent positions can be challenged. A concentrated market may remain contestable if users can switch, rivals can reach customers and essential inputs, and platforms cannot discriminate against them. Conversely, the presence of several firms may coexist with substantial barriers to entry and expansion. Yet researchers and competition authorities lack a standardized framework for measuring these conditions across jurisdictions, markets, and time.

This paper develops a multidimensional framework for measuring digital-market contestability. We define contestability as the institutional, technological, economic, and behavioral conditions that determine whether existing rivals and potential entrants can enter, reach users, compete on the merits, and scale viable alternatives. Contestability is therefore a competitive opportunity, rather than a measure of market structure or a downstream outcome. We organize it into four dimensions: **User Mobility and Switching**; **Rival Access and Distribution**; **Platform Neutrality and Non-Discrimination**; and **Data, Interoperability, and Infrastructure Access**.

The framework evaluates these conditions through two complementary layers. *De Jure Contestability* measures formal legal and regulatory support for competitive challenge. *De Facto Contestability* measures whether the corresponding mechanisms operate in practice within a defined market. The two layers share a common economic architecture but use different units of observation and evidence. Jurisdiction-level legal records can be restated for particular markets, while realized conditions are measured at the market level and, where conditions are platform-specific, at the gatekeeper–market level. A derived measure of *Effective Contestability* may summarize aligned *De Jure* and *De Facto* conditions, but the two component measures remain the primary outputs.

The paper makes three contributions. First, it defines contestability as a distinct empirical construct and separates it from concentration, entry, market shares, innovation, and welfare. Second, it develops a transparent measurement architecture with explicit units of observation, scoring rules, applicability and missing-evidence conventions, aggregation procedures, and source-level documentation. Third, it demonstrates the framework through a bounded pilot. We construct a June 2026 jurisdiction-level *De Jure* comparison across nine legal systems; apply the *De Jure* framework to online search and mobile app distribution in the European Union; and construct EU gatekeeper–market *De Facto* measures for Google Search, Apple iOS/App Store, and Google Android/Google Play. The market applications compare a December 2023 baseline with later conditions observed through 2026. They were selected primarily because sufficiently detailed public legal, technical, and market evidence was available for indicator-level coding. The comparisons are descriptive and do not identify the causal effect of regulation. The Coding Handbook and the versioned item-level database underlying the reported results are provided as online supplementary materials.¹

The pilot produces two main findings. Formal contestability protections vary substantially across jurisdictions, not only in breadth but also in legal form: some systems rely on generally applicable ex ante rules, while others depend more heavily on sector-specific statutes, firm-specific remedies, guidance, or phased intervention. In the EU market applications, for-

¹Online Appendix A: Coding Handbook; Online Appendix B: Contestability Database and replication materials.

mal protection expands much more than realized contestability. The sources of the remaining gap differ across markets. In app distribution, the clearest openings follow the removal of discrete platform restrictions, but fees, eligibility rules, and interface frictions remain. In search, user-choice and data-related conditions improve, while ranking, default distribution, web-scale infrastructure, and accumulated data remain important constraints. These differences show why mechanism-level profiles and evidence coverage are more informative than aggregate scores alone.

The remainder of the paper proceeds as follows. Section 2 develops the economic concept of contestability and the four-dimensional framework. Section 3 presents the measurement methodology. Section 4 describes the empirical design and pilot implementation. Section 5 reports the jurisdictional and market-level results. Section 6 discusses interpretation, limitations, and the research agenda, and Section 7 concludes.

2 Contestability in Digital Markets

2.1 From Contestable-Market Theory to Digital Platforms

The economic concept of contestability originates in the theory of contestable markets developed by Baumol et al. (1982). Its central insight was that market performance depends not only on the number of incumbent firms, but also on the threat imposed by potential entry. Even a concentrated market may be disciplined by competition when entry is sufficiently easy and exit is sufficiently inexpensive. This perspective shifted attention from observed market structure toward the conditions under which incumbents can be challenged.

However, the classical benchmark rests on assumptions that are difficult to reconcile with modern digital markets. Entry into a digital platform ecosystem is rarely costless. Rivals may face numerous, and in some cases formidable barriers, including direct and indirect network effects, accumulated data advantages, substantial infrastructure requirements, contractual restrictions, and platform-controlled channels of access and distribution. These barriers may persist even when the technological cost of creating a digital product is relatively low. Moreover, platforms often control the operating systems, interfaces, ranking systems, data, or marketplaces through which potential competitors must reach users. As a result, the possibility of nominal entry does not necessarily imply that a rival can develop, distribute, and scale a viable competitive alternative.

These features motivate a more operational concept of contestability. Rather than asking whether entry and exit are literally costless, we ask whether rivals can realistically overcome the barriers to entry and expansion and challenge incumbent firms on the merits of their products and services. Contestability is therefore a matter of degree. A market becomes more contestable as the institutional, technological, economic, and behavioral frictions confronting challengers are reduced.

This interpretation is consistent with the growing use of contestability in digital competition policy. Major policy reports in the United States, European Union, and United Kingdom emphasize switching costs, access restrictions, interoperability, data advantages, and platform conduct as central determinants of competitive opportunity. The Digital Markets Act (DMA) similarly treats contestability as the ability of firms to overcome barriers to entry and expansion and challenge gatekeepers effectively. Although these policy approaches differ in institutional design, they share a move away from treating contestability as synonymous with the number or current market share of competitors.

We accordingly define digital-market contestability as: the institutional, technological, economic, and behavioral conditions that determine whether existing rivals and potential entrants can realistically enter, reach users, compete on the merits, and scale viable alternatives to incumbent platforms. This definition treats contestability as a competitive opportunity. It does not require a market to exhibit low concentration, frequent entry, or immediate displacement of the incumbent. Instead, it asks whether the channels required for a credible competitive challenge remain open.

2.2 Contestability, Market Structure, and Competitive Outcomes

Contestability should be distinguished from both market structure and competitive outcomes. Market-structure measures, including market shares, concentration ratios, and the Herfindahl–Hirschman Index (HHI), describe the current distribution of economic activity among firms. They provide important information about the position of incumbents, but they do not directly identify the conditions under which that position can be challenged. A concentrated market may remain relatively contestable if users can switch, rivals can access customers and essential inputs, and incumbent firms cannot use their control of the ecosystem to foreclose competition. Conversely, the presence of several firms does not necessarily imply meaningful contestability if rivals depend on the incumbent’s infrastructure, distribution channels, or data and remain unable to expand.

This distinction is particularly important in digital markets. Network effects, economies of scale, data accumulation, and ecosystem integration tend to generate concentrated market structures even when firms initially compete intensely for platform leadership. Thus, market concentration may reflect superior technology or earlier competition for the market, persistent barriers protecting an incumbent, or some combination of the two. Observed market shares alone cannot distinguish among these explanations. The browser market illustrates this point. Users can install alternative browsers, and common web standards allow rival browsers to access much of the same online content. At the same time, default placement, pre-installation, and integration with operating systems continue to constrain user mobility and rival distribution. Concentration alone therefore cannot reveal either how open the market is to competitive challenge or which mechanisms continue to restrict that challenge.

Traditional concentration measures also depend heavily on the market boundaries selected by the analyst. Digital platforms frequently operate across interconnected services—including search, advertising, operating systems, app distribution, commerce, communications, cloud services, and artificial intelligence. Small changes in the treatment of these related activities can materially affect measured concentration. Contestability does not eliminate the need to specify the relevant market, but it shifts attention toward the underlying frictions governing user mobility, rival access, platform treatment, and access to technical resources. These mechanisms can often be observed and compared even when platform ecosystems make conventional market boundaries difficult to draw.

Contestability must also be distinguished from downstream competitive outcomes. Entry, entrant survival, changes in market share, prices, quality, innovation, productivity, and consumer welfare may all respond to contestability, but they are not themselves the conditions that make a market contestable. These outcomes are jointly shaped by contestability and by other factors, including product quality, technological change, demand conditions, and firm-specific capabilities. A highly contestable market may therefore continue to exhibit a dominant incumbent, while a decline in incumbent market share does not necessarily imply that the

underlying barriers to entry and expansion have been removed.

Including such outcomes directly in the index would also create circularity. For example, using entrant growth or incumbent market-share decline as measurement components would make it difficult subsequently to examine whether greater contestability promotes entry or changes market structure. We therefore treat these variables as external outcomes that can be used to validate the index and to study the consequences of contestability, rather than as components of the measure itself.

Our proposed framework separates: **Market structure** which describes the current distribution of firms and activity; **Contestability**, which describes the conditions governing competitive challenge; and **Competitive outcomes**, which may result from those conditions. This separation allows market shares, entry, innovation, and welfare to be used as external outcomes for validation and empirical analysis rather than as mechanical components of the measure.

2.3 A Multidimensional Concept of Contestability

Contestability in digital markets cannot be represented adequately by a single observable variable. Generally, a challenger needs to pass through several distinct stages: users must be able to move toward alternatives; rivals must be able to reach those users; platforms must not discriminate against rivals once access is obtained; and rivals must possess the technical resources and data needed to provide and scale a competitive service.

We organize these conditions into four dimensions. They correspond to four fundamental questions:

1. Can users leave incumbent platforms and adopt competing services?
2. Can rivals reach users and distribute competing products or services?
3. Can rivals compete fairly after obtaining access?
4. Can rivals obtain the data, interoperability, infrastructure, and other technical resources required to compete and scale?

Dimension 1: User Mobility and Switching User Mobility and Switching captures the demand-side frictions that prevent users from leaving an incumbent service or adopting alternatives. These frictions include default bias, direct switching costs, loss of user data, contractual or technical lock-in, the inability to remove pre-installed services, and manipulative choice architecture.

The existence of a rival product is not sufficient for contestability if users cannot adopt it without incurring substantial costs or navigating obstructive interfaces. Reducing these barriers makes demand more responsive to differences in price, quality, privacy, and innovation and strengthens the ability of users to reward superior alternatives.

Dimension 2: Rival Access and Distribution Rival Access and Distribution captures the supply-side conditions governing whether competitors can enter, reach users, and transact with customers. Relevant mechanisms include access to alternative distribution channels, the ability to communicate and contract directly with users, commercial and pricing independence, and access to platform-controlled intermediation or distribution services on workable terms.

This dimension is distinct from user mobility. Users may be willing and technically able to switch, but contestability will remain weak if rivals cannot obtain distribution or access

potential customers. Similarly, the formal availability of a distribution channel may provide limited competitive opportunity if its commercial terms, eligibility requirements, or interface design make it impractical to use.

Dimension 3: Platform Neutrality and Non-Discrimination Platform Neutrality and Non-Discrimination concerns the treatment of rivals after they have entered or obtained access to a platform ecosystem. Digital platforms often operate simultaneously as market organizers and competitors within the markets they organize. This dual role creates incentives to favor the platform’s own products or services through ranking, placement, tying, bundling, access conditions, or the discriminatory use of non-public business-user information.

Contestability therefore requires more than formal market access. Rivals must be able to compete under conditions that do not systematically privilege the incumbent’s vertically integrated services. This dimension captures whether competitive opportunities remain neutral after entry, rather than whether entry or distribution is possible in the first instance.

Dimension 4: Data, Interoperability, and Infrastructure Access Data, Interoperability, and Infrastructure Access captures the structural and technical resources required to develop, provide, improve, and scale a competing service. Relevant barriers include restricted access to APIs and operating-system functions, lack of technical or network interoperability, control over essential infrastructure, unequal access to competitively relevant data, and incumbent advantages arising from exclusive data accumulation or cross-service data combination.

This dimension is particularly important in markets where the quality of a service depends on scale, learning, connectivity, or access to accumulated information. A rival may reach users and receive formally neutral treatment while still being unable to offer a viable product because it lacks the data, technical interfaces, network access, or infrastructure controlled by the incumbent. Data accessibility and limits on data accumulation address two sides of the same structural problem: whether rivals can obtain the inputs required to compete and whether the incumbent can reinforce its advantage by combining inputs unavailable to competitors.

The four dimensions are distinct but complementary. Improvements in one dimension do not necessarily offset barriers in another. A choice screen may make it easier for users to express a preference, but it will generate limited competitive pressure if rivals cannot obtain distribution. Alternative distribution may permit entry, but competitors may remain disadvantaged by self-preferencing. Neutral platform treatment may still be insufficient where rivals lack the data or infrastructure necessary to provide a comparable service.

The framework classifies each contestability mechanism according to its immediate economic function. User data portability, for example, belongs to D1 when its principal function is to reduce users’ switching costs. Rival or business-user access to competitively necessary data belongs to D4. The use of non-public business-user information by a platform to compete against those users belongs to D3 because it constitutes discriminatory platform conduct. This functional classification minimizes overlap and preserves the diagnostic interpretation of the four dimension scores.

2.4 Market Scope and Cross-Jurisdiction Comparability

The framework is applied within a defined digital market. For measurement purposes, a market is a standardized category of digital service or platform activity within which the same

Table 1: Dimensions of Digital-Market Contestability

Dimension	Core Question	Principal Economic Mechanisms
D1. User Mobility and Switching	Can users leave the incumbent and adopt alternatives?	Reduces default bias, switching costs, behavioral lock-in, manipulative choice architecture, and barriers to removing services or transferring user data.
D2. Rival Access and Distribution	Can rivals enter, reach users, and distribute their services?	Reduces restrictions on distribution, steering, commercial independence, contracting, and access to platform-controlled channels.
D3. Platform Neutrality and Non-Discrimination	Can rivals compete fairly after obtaining access?	Limits self-preferencing, discriminatory ranking or treatment, tying, bundling, and strategic use of non-public business-user information.
D4. Data, Interoperability, and Infrastructure Access	Can rivals obtain the technical resources necessary to compete and scale?	Reduces barriers arising from control over interfaces, infrastructure, interoperability, networks, and data; limits advantages from exclusive data accumulation and cross-service combination.

contestability mechanisms can be identified and evaluated across jurisdictions and observation periods.

Under the DMA, a designated Core Platform Service may provide a practical market unit. Examples include online search engines, operating systems, software application stores, online social networks, and interpersonal communications services. Outside the DMA context, the framework can be extended to other digital markets once their boundaries and relevant contestability mechanisms have been specified clearly.

The framework permits different market applications but does not permit the definition of the same market to vary opportunistically across jurisdictions. For a cross-jurisdictional or intertemporal comparison, the market definition must be held constant. Differences in the services supplied, legal coverage, incumbent conduct, technological architecture, or user behavior should be reflected in the contestability scores and supporting evidence rather than through jurisdiction-specific changes to the boundaries of the measured market.

Before applying the framework to a new market, the researcher must therefore:

- specify the services and platform activities included;
- identify the firms or services through which the market will be observed;
- determine which contestability mechanisms operate within that market; and
- apply the resulting scope consistently across the jurisdictions and periods being compared.

This market unit serves a comparative measurement function. It does not necessarily coincide with, or substitute for, the case-specific relevant-market analysis required in a particular

competition-law investigation. Formal antitrust market definition answers whether products or services impose sufficient competitive constraints in a specific legal case. Our framework instead requires a stable unit within which contestability mechanisms can be evaluated consistently.

The need for a standardized market unit is especially important for *De Facto Contestability*. Observed competitive conditions cannot be meaningfully assigned to a jurisdiction in the abstract: user behavior, platform architecture, distribution channels, infrastructure requirements, and incumbent conduct differ substantially across search, app distribution, messaging, marketplaces, and other digital services. *De Facto* measurement therefore begins at the market-jurisdiction level. A broader jurisdiction-level summary could later be constructed from multiple market observations, but doing so would require an explicit rule for weighting economically heterogeneous markets.

3 Measurement Framework

This section translates the conceptual definition of contestability into comparable empirical measures. The framework distinguishes three related measurement objects—the general legal environment of a jurisdiction, the formal protections applicable within a defined digital market, and the observed operation of contestability mechanisms in that market. These objects are connected sequentially, jurisdiction-level legal environment $\rightarrow$ market-level formal protections $\rightarrow$ market-level realized conditions. The first two objects form the *De Jure* layer. The third forms the *De Facto* layer.

This sequence resolves several distinctions that are important for interpreting the empirical applications. The jurisdiction-level *De Jure* Index and a market-level *De Jure* score are not additive measures. The former summarizes a jurisdiction’s broader regulatory environment, while the latter displays that legal environment for a specific market. Similarly, online search and mobile app distribution are different applications of the framework and are not aggregated into a common market score. Apple and Google are assessed separately within mobile app distribution because platform-specific conditions differ even under a common legal framework.

The *De Jure* and *De Facto* indices are the primary outputs. Unless these measures refer to the same market, jurisdiction, and observation period, they cannot be compared or combined. An *Effective Contestability* measure combining them is a secondary summary whose construction depends on the research question.

3.1 Measurement Architecture

The framework has three analytical levels:

$$\text{Contestability Dimension} \rightarrow \text{Contestability mechanisms} \rightarrow \begin{cases} \text{De Jure obligation category,} \\ \text{De Facto indicator.} \end{cases}$$

A contestability dimension is a broad category of competitive friction. The four dimensions introduced in Section 2—User Mobility and Switching, Rival Access and Distribution, Platform Neutrality and Non-Discrimination, and Data, Interoperability, and Infrastructure Access—constitute the highest level of the framework.

A contestability mechanism is the economic channel through which competitive opportunities can be facilitated, for example, reducing default bias, enabling alternative distribution, preventing discriminatory ranking, and facilitating technical interoperability.

The mechanism is the bridge between the two measurement layers. A *De Jure* obligation category is a standardized form of formal right, prohibition, or requirement intended to support the mechanism. A *De Facto* indicator is an observable condition used to evaluate whether the mechanism operates in practice. For instance, reducing default bias is an economic mechanism. In the *De Jure* layer, it may be evaluated through active-choice or default-setting obligation. In the *De Facto* layer, it may be observed through the design of a choice screen, the presence of preselection, and the steps required to select or change a provider. The legal category and empirical indicator need not be identical or one-to-one. They must, however, be linked to the same economic mechanism.

This three-layer distinction serves two purposes. First, it prevents economic mechanisms, legal instruments, and observed market conditions from being conflated. A single legal article may establish several distinct obligations, while several legal provisions may jointly support one obligation. Second, it enables the framework to maintain a stable conceptual architecture while using market-specific indicators. The same mechanism may be observed differently in search, app distribution, messaging, or marketplaces, but its economic meaning remains unchanged.

Classification follows the immediate economic function of the obligation or indicator. Each item is assigned to one primary mechanism and one dimension, even where it may generate downstream effects through several channels. For example, access to an operating-system interface is classified under technical interoperability because that is its immediate function, even if the resulting access subsequently improves distribution or switching. This unique assignment rule limits overlap and double-counting.

3.2 Units of Observation

The three measurement objects use different but linked units of observation (Table 2).

Table 2: Measurement Objects and Units of Observation

Measurement object	Primary unit	Question answered
Jurisdiction-level <i>De Jure</i> Contestability	Obligation category–jurisdiction–date	To what extent does the jurisdiction’s formal legal environment support the standardized catalog of contestability mechanisms?
Market-level <i>De Jure</i> Contestability	Obligation category–market–jurisdiction–date	Which formal protections apply to competitive challenge within the defined market?
Market-level <i>De Facto</i> Contestability	Indicator–gatekeeper–market–jurisdiction–date	To what extent does the corresponding mechanism operate in practice for the assessed service or ecosystem?

3.2.1 *De Jure* Contestability

The primary *De Jure* coding unit begins at the obligation category–jurisdiction level. This jurisdiction-first approach reflects the structure of digital regulation. Some obligations apply broadly across digital services, while others are sector-specific, market-specific, or imposed only on designated firms. Beginning with the jurisdictional legal environment avoids repeating the

same legal research separately for each market and permits systematic comparisons among regulatory regimes.

For each jurisdiction, the framework evaluates whether the legal and regulatory system provides formal support for each contestability mechanism and records the markets, services, firms, and activities covered by the relevant legal provisions. The resulting jurisdiction-level measure summarizes the breadth and strength of the formal regulatory environment. It is an overview of the regulatory environment, but it does not imply that every obligation applies in every digital market.

For market-specific analysis, the jurisdiction-level records are restated for that market. This market-level *De Jure* measure identifies the contestability mechanisms operating within that market and evaluates whether the jurisdiction’s formal obligations cover the assessed market. This measure captures the legal protections applicable to competitive challenges within a particular market, rather than the jurisdiction’s broader regulatory environment.

The distinction between jurisdiction-level and market-level scope is important. A sector-specific law may receive a limited scope score in the jurisdiction-wide comparison because it covers only part of the mechanism’s broader economic domain. The same law may provide full coverage when the analysis is restricted to the sector it directly governs.²

3.2.2 De Facto Contestability

De Facto Contestability begins directly at the market level because realized competitive conditions depend on technology, platform architecture, distribution channels, user behavior, rival capabilities, and many other market-specific factors. When those observed conditions differ substantially across gatekeepers or platforms within the market, the assessment may be conducted at the more specific gatekeeper–market–jurisdiction level. Several gatekeepers operating within the same market are assessed separately using the same market definition, applicable mechanism set, indicator definitions, and scoring criteria.

Conversely, a jurisdiction-wide *De Facto* score should not be treated as a primitive unit of measurement. Constructing such a score before measuring individual markets would combine heterogeneous competitive conditions into a single number. Search, app distribution, operating systems, messaging, and marketplaces differ in their technological architecture, network effects, distribution channels, infrastructure requirements, and sources of incumbent advantage. As such, these markets are different in the mechanisms through which contestability can be observed. Any jurisdiction-wide aggregate would require explicit—and potentially contestable—choices about which markets to include, how to weight their relative economic importance, and how to deal with unequal evidentiary coverage. Without a transparent rule for making those choices, the aggregate index could be driven disproportionately by those best-documented markets, concealing bottlenecks in particular services, and obscuring the mechanism-level variation that the framework is designed to diagnose.

3.3 Scoring Rules

3.3.1 De Jure Scoring

De Jure Contestability measures the strength of the formal legal, regulatory, and institutional conditions supporting competitive challenges. It does not measure compliance or realized market

²The Online Appendix: Coding Handbook records market coverage separately from the underlying legal assessment.

Table 3: De Jure Factor-Level Scoring Rules

Factor	Score 0	Score 0.5	Score 1
Existence	No operative obligation on point applies at the observation date. General competition or consumer law has not generated a relevant duty; an instrument remains proposed; or an enacted framework authorizes future obligations but none has yet become applicable.	A relevant protection exists only partially, addresses the mechanism indirectly, has weaker formal status, or arises through guidance, case-specific precedent, or commitments that do not establish a complete obligation on point.	A binding and operative statute, regulation, judgment, order, or imposed requirement fixes the substantive obligation and applies at the observation date.
Scope	No firm, service, market, sector, or activity relevant to the category is covered.	Coverage is limited to named firms, a sectoral subset, restricted activities, or only part of the category’s economic domain.	The obligation covers the full economic domain relevant to the category at the level of analysis.
Enforceability	No effective formal enforcement mechanism exists.	Enforcement requires additional case-by-case action, carries limited sanctions, relies on weaker guidance, or depends on machinery that is not yet operative.	An identifiable regulator or supervising court can enforce the obligation directly through sanctions, remedies, supervision, or private enforcement.

effects. Instead, it asks whether an operative obligation exists, how broadly it applies, and whether it is supported by credible enforcement.

Each *De Jure* obligation category is evaluated along three factors:

1. **Existence:** whether an operative obligation addressing the relevant mechanism is legally present;
2. **Scope:** the coverage of firms, services, markets, or activities; and
3. **Enforceability:** whether the obligation is supported by credible oversight, sanctions, judicial supervision, or private enforcement.

Each factor is scored on a scale of 0, 0.5, or 1. A score of zero indicates that the relevant condition is absent. A score of one-half indicates that it is partial, legally weak, sectoral, firm-specific, or dependent on additional case-by-case action. A score of one indicates a binding and operative obligation with comprehensive coverage of the relevant domain and credible enforcement. Table 3 shows this rule in detail.

$$q_{ijt}^{DJ} = \min \{E_{ijt}, S_{ijt}, \text{Enf}_{ijt}\}, \quad (1)$$

where E_{ijt} , S_{ijt} , and Enf_{ijt} denote Existence, Scope, and Enforceability, respectively; i denotes the De Jure obligation category; j denotes the jurisdiction; and t denotes the observation date.

The minimum rule reflects the complementarity of the three factors. Stronger enforcement cannot compensate for the absence of an obligation. Similarly, a well-defined obligation binding only one firm does not provide the same market-wide protection as a generally applicable rule, and a broadly written obligation without credible enforcement may provide little effective formal protection.

The factor decomposition is retained even when only the final score enters the index. Two observations may receive the same final score while representing different legal environments. For example, a strong obligation with narrow firm or sector coverage and a broadly applicable obligation established through weak legal guidance may both receive a score of 0.5. Reporting the underlying factors allows these differences to remain visible.

3.3.2 *De Facto* Scoring

De Facto Contestability measures whether users and rivals can exercise the relevant competitive opportunity in practice. It does not ask whether an obligation formally exists. Nor does it directly score success, such as entrant market share, incumbent profitability, or rival survival. Each contestability mechanism is operationalized through one or more observable market-specific indicators. Each market-specific indicator used must specify: i) the competitive path being assessed; ii) the frictions relevant to that path; iii) the observable conditions corresponding to scores of 0, 0.5, and 1.

The same 0, 0.5, and 1 scale is used:

$$q_{ijkgt}^{DF} \in \{0, 0.5, 1\}, \quad (2)$$

where k denotes the defined digital market and g denotes gatekeeper.

A score of zero indicates that the relevant mechanism is not meaningfully realized or remains highly restrictive. A score of one-half indicates a partial or friction-laden opening. A score of one indicates that the mechanism is effectively available in practice according to the predefined market-specific criteria. Table 4 explains this in more detail.

Table 4: General *De Facto* Scoring Rule

Score	General condition
0	The mechanism provides no meaningful working competitive path. The option is prohibited, technically unavailable, contractually blocked, or obstructed to such an extent that users or rivals cannot exercise it in practice.
0.5	A working path exists, but material technical, commercial, procedural, behavioral, or informational frictions remain. Such frictions may include fees, restrictive eligibility conditions, warning screens, multi-step procedures, incomplete coverage, limited functionality, delayed or batch-only access, withheld information, or operation supported only by unverified gatekeeper reporting.
1	The mechanism is operational and broadly usable under the predefined market-specific criterion, without material gatekeeper-imposed restrictions, and is supported by evidence appropriate to the condition being measured.

Across different markets, indicators would be different because the same economic mechanism may manifest differently under different technologies and platform architectures. However,

within a market comparison, indicator definitions and scoring criteria are stable across gatekeepers, jurisdictions, and observation periods. For intertemporal comparisons, the same indicator definition and scoring thresholds are applied in both periods. A score changes only where documented evidence shows that the observable condition changed. The resulting pre/post difference is descriptive but does not identify the causal effect of regulation by itself.

3.3.3 Applicability and Missing Evidence

Before aggregation, each potential obligation category or indicator is assigned one of three coding statuses: *Scored*, *Not Applicable*, or *Missing*.

An item is *Scored* when the associated contestability mechanism is relevant to the observation and sufficient evidence is available to assign a score of 0, 0.5, or 1. A score of zero therefore indicates that a relevant legal protection or realized competitive condition is absent or highly restrictive; it does not indicate that the item is irrelevant to the market.

An item is classified as *Not Applicable* when the underlying contestability mechanism does not operate within the defined market. For example, a messaging interoperability obligation would not enter an assessment of online search unless messaging interoperability formed part of the specified market architecture. Not Applicable is a statement about the scope of the measurement framework for that market, rather than about the strength of contestability.

An item is classified as *Missing* when the underlying mechanism is applicable but the available evidence is insufficient to assign a defensible score. Missing observations are kept distinct from both zero scores and Not Applicable items. This distinction prevents an absence of evidence from being interpreted as evidence of an absent legal protection or restrictive market condition.

In the jurisdiction-level *De Jure* assessment, the obligation categories are evaluated across all jurisdictions, and the absence of an operative obligation is scored as zero. Not Applicable arises primarily when the jurisdiction-level records are subsequently applied to a specific market. In the *De Facto* assessment, both applicability and evidence availability are determined directly at the market–gatekeeper–jurisdiction level.

3.3.4 Aggregation and Weighting

The framework aggregates scores in stages while preserving the four dimension-level results for diagnostic analysis.

Let D_{dkt}^I denote dimension d for index layer $I \in \{DJ, DF\}$, jurisdiction j , market k , and period t . Under the baseline specification, the dimension score is the unweighted arithmetic mean of the applicable obligation-category or indicator scores:

$$D_{dkt}^I = \frac{1}{N_{dkt}} \sum_{i=1}^{N_{dkt}} q_{idkt}^I, I \in \{DJ, DF\}, \quad (3)$$

where N_{dkt} is the number of applicable scored items within dimension d .

Where several market-specific indicators measure distinct observable aspects of the same contestability mechanism, the detailed coding rules may first combine those indicators into a mechanism-level score. This prevents a mechanism from receiving additional implicit weight merely because more observable indicators are available for it.

The overall *De Jure* or *De Facto* Index is the equal-weighted average of the four dimensions:

$$C_{jkt}^I = \frac{1}{4} \sum_{d=1}^4 D_{djkt}^I, I \in \{DJ, DF\}. \quad (4)$$

Equal weighting is adopted as the benchmark because it is transparent, reproducible, and does not impose strong assumptions about the relative economic importance of the four channels of contestability. The dimension scores remain separately available because a higher score in one dimension does not necessarily compensate economically for a low score in another.

Alternative weighting schemes may be informative when they are supported by theory or empirical evidence. For example, interoperability may be particularly important in messaging, while alternative distribution may be central to app stores. Any departure from equal weighting should be specified before examining the resulting rankings, applied consistently across comparable observations, and reported as a robustness exercise rather than substituted silently for the benchmark.

Only applicable, scored items enter the benchmark aggregation. Items classified as *Not Applicable* are excluded from the denominator. Missing items are not assigned a numerical value, and the share of applicable items for which a score is available is reported alongside the resulting index.

3.4 Evidence Standards, Confidence, and Documentation

Every score must be traceable to documented evidence corresponding to the relevant jurisdiction, market, and observation period. The type of evidence required depends on the object being measured.

De Jure coding relies mainly on authoritative legal sources, including enacted legislation and regulation, binding court judgments and remedies, regulatory decisions, conduct requirements, implementing acts, and official administrative rules. Where primary legal text is available, it forms the basis of scoring. Academic commentary and secondary analysis may assist interpretation but do not replace the legal authority.

De Facto evidence is selected according to the condition being measured. Relevant sources include regulatory monitoring and non-compliance findings, independent technical audits, structured testing, market and usage datasets, academic studies, platform compliance and transparency reports, developer documentation, and surveys of users or business participants. There is no single source hierarchy applies to all indicators. Platform documentation may establish that a technical option formally exists, while independent testing or market data may be necessary to evaluate usability, adoption, or commercial effectiveness.

The framework records confidence assessment for each evidence/source *De Facto* observations. High confidence indicates direct and sufficiently complete evidence; moderate confidence indicates credible evidence with meaningful limitations; and low confidence indicates reliance on proxies, self-reported information, or incomplete public data. Confidence affects the interpretation of the estimate but does not directly change the numerical score.

For each item, the supporting database records the unit of observation, dimension, mechanism, obligation category or indicator, applicability status, numerical score, supporting source, relevant extract or data point, coding rationale, evidence limitations, coder and review status, methodological version, and revision history. Ambiguous or conflicting evidence is reviewed and documented rather than resolved through an unstructured overall judgment. These procedures create an audit trail from the reported index to the underlying legal documents, datasets, and coding decisions.

The paper reports the common measurement architecture and scoring rules. Online Appendix A provides the Coding Handbook, including the complete obligation and indicator definitions, market-specific scoring anchors, coding rationales, and source references. Online Appendix B provides the item-level Contestability Database, codebook, source register, review status, and revision history. All results reported in this paper are generated from Database Release 1.1, dated June 10, 2026.

3.5 Effective Contestability

The *De Jure* and *De Facto* indices are the primary outputs of the measurement framework. They capture distinct aspects of contestability. The former measures the formal legal and regulatory support for competition, while the latter measures the extent to which the corresponding contestability mechanisms operate in practice. Any measure that combines the two is a derived summary rather than an independently observed component of the index.

There is no uniquely correct way to combine the two layers. The appropriate specification depends on the research question and on the assumed relationship between formal protection and practical realization. In some applications, the two indices should remain separate. For example, a study of regulatory design may use *De Jure* Contestability as the principal explanatory variable, while a study of observed market openness may focus directly on *De Facto* Contestability. Similarly, an analysis of implementation may examine the difference between the two measures rather than combine them into a single index.

For applications concerned with contestability that is both formally supported and practically realized, we use the multiplicative specification:

$$EC_{jkt}^P = C_{jkt}^{DJ} C_{jkt}^{DF}, \quad (5)$$

where C_{jkt}^{DJ} and C_{jkt}^{DF} denote the market-level *De Jure* and *De Facto* Contestability Indices for jurisdiction j , market k , and observation date t .

The product treats formal protection and practical realization as complementary inputs. A high score in one layer cannot fully compensate for a severe shortfall in the other. Strong legal obligations generate limited Effective Contestability when users and rivals cannot exercise the corresponding opportunities in practice. Meanwhile, favorable market conditions receive a lower Effective Contestability score when they are not supported by operative and enforceable protections and may therefore be more easily reversed.

This interpretation is narrower than observed market openness. The product equals zero when either component equals zero, even if the other component is high. This property is appropriate when the object of interest is institutionally supported and realized contestability. But it would be too restrictive if the objective were simply to summarize the current competitive environment. For that reason, the component indices are always reported alongside the composite.

Alternative constructions may be preferable for other research questions. An arithmetic specification,

$$EC_{jkt}^A = \lambda C_{jkt}^{DJ} + (1 - \lambda) C_{jkt}^{DF}, \quad 0 \leq \lambda \leq 1, \quad (6)$$

treats the two layers as partially substitutable and may be useful when the objective is to summarize the overall regulatory and market environment. Equal weighting corresponds to $\lambda = 0.5$, while other values may be used when the research design places greater emphasis on either formal institutions or realized conditions.

A bottleneck specification,

$$EC_{jkt}^B = \min \{C_{jkt}^{DJ}, C_{jkt}^{DF}\}, \quad (7)$$

may be appropriate when contestability is assumed to be constrained entirely by the weaker layer. This rule imposes stricter complementarity than the arithmetic average and focuses attention on the binding institutional or implementation constraint.

For questions concerning implementation, it may be more informative not to construct a composite at all, but instead to report the implementation gap:

$$G_{jkt} = C_{jkt}^{DJ} - C_{jkt}^{DF}. \quad (8)$$

A positive value indicates that formal protections exceed their observed realization, while a negative value indicates that market conditions are more open than the formal regulatory framework alone would suggest. The gap is descriptive and does not by itself identify the causal effect of regulation.

4 Empirical Design and Pilot Implementation

Although the framework is designed for application across jurisdictions and digital markets, the empirical pilot in this paper is implemented in a much narrower boundary. It consists of three distinct exercises with different units of observation and geographic coverage.

We first construct a jurisdiction-level *De Jure* dataset describing a more comprehensive formal regulatory environment across nine jurisdictions: the European Union, Germany, the United States, Turkey, Japan, Korea, China, the United Kingdom, and Australia. This is the only cross-jurisdictional component of the pilot.

Then we restate those legal records for the specific pilot markets in the European Union only. These market–jurisdiction-level applications cover online search and mobile app distribution and identify the formal protections applicable to competitive challenge within each defined market.

Finally, we construct *De Facto* measures at the gatekeeper–market–jurisdiction level, also in the European Union only. The three observations are Google Search in online search, Apple iOS/App Store in mobile app distribution, and Google Android/Google Play in mobile app distribution.

This pilot implementation does not constitute a complete jurisdiction–market–gatekeeper panel. We do not construct market-level *De Jure* measures for all nine jurisdictions or aggregate the selected European Union market observations into a jurisdiction-level *De Facto* index. The three exercises illustrate different parts of the measurement framework: the nine-jurisdiction comparison demonstrates jurisdiction-level legal measurement, while the European Union market applications demonstrate how jurisdiction-level legal records can be restated for particular markets and compared with realized competitive conditions.

4.1 Scope of the Pilot and Observation Dates

Table 5 summarizes the three empirical layers and their coverage in the current pilot.

The jurisdiction-level *De Jure* assessment is a snapshot as of June 2026. The observation date is distinct from the date on which a source was retrieved, reviewed, or entered into the database. Only if an obligation’s requirements are legally operative and applicable in the observation window, that obligation contributes to the June 2026 *De Jure* score. Other instruments, such

Table 5: Structure of the Pilot Implementation

Measurement layer	Primary unit	Pilot coverage	Observation date /evidence window
Jurisdiction-level <i>De Jure</i>	Obligation category–jurisdiction–date	Sixteen standardized obligation categories across nine jurisdictions	Legal environment operative in June 2026
Market–jurisdiction-level <i>De Jure</i> in EU	Obligation category–market–jurisdiction–date, with assessed service recorded where coverage is gatekeeper-specific	EU online search and mobile app distribution; complete intertemporal panels currently constructed for Google Search and Apple iOS/App Store	December 2023 pre-compliance legal baseline and June 2026 legal environment
Gatekeeper–market-level <i>De Facto</i> in Eu	Indicator–gatekeeper–market–jurisdiction–date	Google Search, Apple iOS/App Store, and Google Android/Google Play in the European Union	December 2023 baseline and later-period evidence available through 23 July 2026

as pending legislation, announced reforms, or enacted instruments with future commencement dates are retained in the database but do not contribute to the current-period score.

Market observations in December 2023 provide a baseline immediately preceding the principal compliance deadline for obligations imposed on designated gatekeepers under the DMA. The term *pre-compliance* refers to the legal timing of the substantive obligations. Observations in July 2026 are an evidence window rather than a single-day snapshot. Each record keeps the date of the underlying platform change, regulatory finding, technical test, contractual term, or market observation. Announced functionality does not affect a score until it becomes operational and observable.

4.2 Jurisdiction-Level *De Jure* Dataset and Construction

The jurisdiction-level *De Jure* index measures the breadth and strength of the formal legal protection supporting contestability mechanisms in each legal system. It is constructed before any market-specific application and describes the jurisdiction’s more comprehensive regulatory environment rather than the protections applicable to a single digital market.

The coded object is the obligation category rather than a statute, judgment or the whole regulatory instruments. A single legal instrument may establish several distinct obligations and appear in several records. On the contrary, several provisions or instruments may jointly establish one obligation category. In this case, all relevant legal bases are recorded, but the obligation category is scored only once. This approach prevents the number, length, or internal structure of the legal documents from affecting the index.

This jurisdiction-level dataset covers nine regions. These jurisdictions were selected to capture substantial variation in the legal design of digital market regulation. The sample includes comprehensive ex ante regulation, sector-specific statutory regimes, designation-based frameworks, firm-specific judicial remedies, administrative guidance, and jurisdictions in which proposed digital competition regimes have not yet entered into force.

In this exercise, the European Union and Germany are treated as separate observations because they represent different legal environments. The European Union observation records the Union-level acquis. The German observation records the legal framework applicable in

Germany, including directly applicable Union law and the additional national layer. Treating them separately allows the national overlay to remain visible. However, it does not imply that the two observations are institutionally independent or that either serves as the benchmark for the index.

The pilot contains 144 obligation–category–jurisdiction records, corresponding to sixteen *De Jure* obligation categories across nine jurisdictions. Each record identifies the associated dimension and contestability mechanism, the jurisdiction, observation date, and the legal instrument bearing on the obligation. The database keeps detailed Existence, Scope, and Enforceability assessments together with the resulting obligation-category score. It also records the factor-level coding rationale, legal form, operative legal provisions, firms and services covered by the obligation, and relevant pending instruments.

The legal dataset is constructed in four stages. We first compile an inventory of the statutes, regulations, court remedies, regulatory decisions, conduct requirements, and administrative rules relevant to digital-market contestability in each jurisdiction. The inventory records the citation, legal status, effective date, and official source of each instrument. Pending and proposed instruments are recorded as a pipeline register but do not enter the current-period score.

We then map each *De Jure* obligation category to the specific articles, orders, or provisions bearing on it. This stage distinguishes the legal source from the obligation being measured. The operative legal text is thereafter extracted from the primary source. For non-English instruments, the database retains both the original-language text and the translation used for coding. Finally, coders assess Existence, Scope, and Enforceability and record the corresponding scores, rationale, legal basis, market coverage, evidence date, and review status.

This process creates a traceable chain from the reported index to the underlying legal authority:

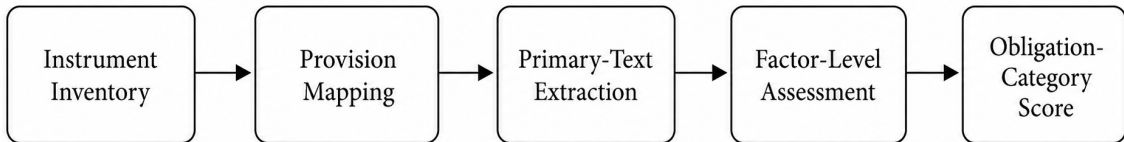


Figure 1: Legal Dataset Construction

Legal form is not a separate component of the index. It provides a common vocabulary for comparing how obligations become operative across legal systems and helps coders apply the Existence, Scope, and Enforceability criteria consistently. The classification distinguishes, among other forms, generally applicable *ex ante* rules, firm-specific binding orders, regulator-enforceable commitments, administrative guidance, *ex post* case practice, statutory frameworks requiring case-specific activation, designation frameworks without an operative obligation on point, and pending or absent instruments.

However, legal form does not determine a score. The factor scores are determined by the substantive content, coverage, and enforceability of the obligation in the individual record. The complete taxonomy and its typical factor configurations are reported in Appendix ?? and in the Coding Handbook.

Illustration: a firm-specific judicial remedy. The United States default-setting record illustrates how the methodology treats general antitrust law and firm-specific judicial relief. In *United States v. Google LLC*, the final judgment imposed contractual restrictions affecting Google’s distribution and default-placement agreements. The judgment creates a concrete and enforceable obligation.

Existence is scored 0.5 because the remedy protects user control over defaults indirectly through restrictions on distribution agreements rather than establishing a complete user right to select and change defaults. Scope is scored 0.5 because the judgment binds a firm rather than the market generally. Enforceability is scored 1 because the obligation is supervised by the court and supported by formal monitoring and retained enforcement jurisdiction. Using the scoring rules described in Section 3.3.1, the final score is $\min(0.5, 0.5, 1) = 0.5$. This example shows why binding judicial relief receives credit without being treated as equivalent to a generally applicable rule. It also displays why the theoretical possibility of intervention under general antitrust law does not create a positive score where no statute, judgment, or order has imposed the relevant obligation.

The jurisdiction-level construction also prepares the legal records for market-specific application. Each record contains a coverage field identifying the firms, services, sectors, markets, and activities governed by the obligation. Market-level *De Jure* measures can be derived by applying the existing legal research to a narrower market unit rather than repeating the underlying source collection.

4.3 European Union Pilot Market Design

The market definitions and applicable mechanism sets are common design inputs to both market-level layers. Although the choice of pilot markets was driven by the feasibility of measuring *De Facto* conditions, the market boundaries also determine which jurisdiction-level legal records enter the market-level *De Jure* applications.

4.3.1 Selection of the Pilot Markets

The *De Facto* pilot focuses on online search and mobile app distribution primarily because relatively detailed public evidence was available to implement the framework at the mechanism level. Both markets have been subject to sustained regulatory and enforcement activity, generating records that are granular to evaluate particular contestability mechanisms, and sufficiently dated to support an intertemporal comparison.

The available evidence include regulatory decisions and monitoring reports, gatekeeper compliance documents, published fee schedules, technical and developer documentation, and independent evidence on traffic, usage, or adoption. Few other digital markets currently offer the same combination of public legal, technical, commercial, and temporally comparable public evidence.

The market selection is purposive and driven by measurement feasibility. It should not be interpreted as a claim that online search and app distribution are representative of all digital markets or that they are necessarily the markets in which contestability concerns are most severe.

Evidence-driven selection may overrepresent services that have received intensive regulatory scrutiny and underrepresent markets for which equally important competitive conditions remain less publicly observable.

Nevertheless, the selected applications provide two secondary analytical advantages. First, they represent different technological architectures and sources of competitive friction. Second, mobile app distribution enables a within-market comparison between Apple and Google under a common EU legal environment.

4.3.2 Pilot Market Definition

Search market is assessed through Google Search. The measure is a gatekeeper-specific observation within the online-search market rather than an average across all search providers.

Mobile app distribution is assessed through two distinct gatekeeper-market observations: Apple iOS/App Store and Google Android/Google Play. The same market definition and indicator architecture are applied to both ecosystems, but the observations are not averaged at the coding stage. Apple and Google control different operating systems, stores, interfaces, contractual arrangements, and developer-governance systems. Averaging them would remove the platform-level variation the framework is intended to diagnose. A combined market-wide measure would require a separate rule for weighting the relative economic importance of the two ecosystems.

Table 6: Pilot Market Definitions

Market	Assessed service and gatekeeper	Included conditions	Adjacent-service evidence enters where	Excluded conditions
Online search	Google Search, operated by Alphabet	Search defaults and choice processes; distribution of the search service, including pre-installation and default agreements; ranking and presentation of results, including vertical units displayed within the results page; portability and use of search-related data; and conditions applying to business users acquired through Search	The evidence documents a contestability mechanism operating within the search service. Android, Chrome, or another adjacent service may therefore enter where it affects search defaults, search distribution, ranking, or access to search-related users or data.	Browser competition as a separate market; unrelated app-store or messaging conduct; and operating-system or device interoperability that does not operate through search
Mobile app distribution	Apple iOS/App Store and Google Android/Google Play, assessed separately	Distribution channels available to developers, including alternative stores and direct installation; user acquisition and installation of applications; steering and off-platform transactions; payment and billing conditions; app-review and access terms; relevant default-app categories and removal of pre-installed applications; and technical access necessary to distribute or operate applications	The adjacent operating-system or device condition directly affects the ability to develop, distribute, install, use, or compete through applications.	Operating-system conduct unrelated to application distribution or operation; online-search ranking conduct; and unrelated communications-service conditions

4.3.3 Applicable Mechanisms and Comparison Design

For each pilot market, the evidence are scored based on the identified contestability mechanisms. Scoring of market-level *De Jure* and gatekeeper–market-level *De Facto* are governed by the same market boundary and mechanism. In other words, the obligation category and observable indicator used to operationalize a mechanism may differ, but both must refer to the same underlying competitive channel.

A legal provision or empirical observation concerning an adjacent service enters only when a documented economic or legal connection shows that it affects the mechanism in the assessed market. Within each market, applicability is held constant across different observation periods. Differences in legal coverage, platform architecture, conduct, or evidence appear in the scores or Missing status rather than changing the applicable set.

We use the following questions to guide applicability.

1. Does the contestability mechanism operate in the defined market?
2. Does the legal framework contain an operative obligation supporting that mechanism?
3. Does the available evidence show that the mechanism operates in practice?

The first question determines applicability. The second is answered by the market-level *De Jure* layer. The third is answered by the gatekeeper–market-level *De Facto* layer. The full applicability matrices are reported in online Coding Handbook.

4.4 European Union Market-Level *De Jure* Implementation

We restate the European Union legal records for the two defined pilot markets. The market-level exercise does not begin with another legal-research process separating from jurisdiction-level *De Jure*. It applies the existing legal sources, provision extracts, factor assessments, and coverage information to a narrower market unit.

The market restatement proceeds in five steps. We first fix the jurisdiction to European Union and also fix the markets, assessed services and observation date. Next, we identify the contestability mechanisms operating within the defined market. Then we link each applicable mechanism to the corresponding European Union obligation-category record. After that, we determine whether the operative legal instrument covers the assessed market and relevant activity, and reassess the factor values where the narrower unit changes their interpretation. Finally, we aggregate the market-level obligation-category scores using the procedures in Section 3.3.4.

A mechanism that is not operative in the defined market is classified as Not Applicable and excluded from the market-level aggregation. An applicable mechanism for which no operative obligation exists receives a score of zero. The distinction is substantive: zero records the absence of formal protection for a competitive channel that operates in the market, whereas Not Applicable means that the channel itself lies outside the market definition.

The factor values are not copied directly from the jurisdiction-level record. The jurisdiction-level assessment provide a starting point, but the market application tests whether the obligation is practical for the assessed service and how completely it covers the particular market.

Scope is sensitive to the level of analysis. A sector-specific obligation may cover only part of a jurisdiction-wide domain but cover the full domain of that mechanism within the sector it directly regulates. However, a firm-specific judgment, order, or conduct requirement remains limited in Scope because it binds the specific firm rather than establishing a rule applicable

throughout the market. Existence and Enforceability are also reconsidered when an instrument does not apply to the assessed market, or requires an additional activation decision.

Each market-level record includes the underlying jurisdiction-level legal basis together with the market-applicability determination, assessed-service coverage, market-level factor scores, and coding rationale. This measure captures the formal protections applicable to competitive challenge within the defined EU market and provides the legal component to which the corresponding *De Facto* observation can be aligned.

4.5 European Union Gatekeeper-Market-Level *De Facto* Implementation

The pilot *De Facto* implementation contains three gatekeeper-market observations across two digital markets. The mobile app-distribution application covers Apple’s iOS and App Store ecosystem and Google’s Android and Google Play ecosystem. The online search application covers Google Search. All three observations are constrained to the European Union and are evaluated relative to the same general implementation period.

We do not aggregate these observations into a jurisdiction-level European Union *De Facto* index. The observations do not constitute a representative sample of digital markets in the European Union. A jurisdiction-wide aggregate would require explicit choices about which markets to include, how to weight markets of different economic importance, and how to account for unequal coverage of the evidence. Constructing an aggregate index from the present pilot would obscure the variation the market-level framework is designed to identify.

Each market is evaluated using observable indicators predefined based on the economic mechanisms identified in Section ???. Each indicator specifies: i) the competitive path or condition being assessed; ii) the evidence relevant to that condition; iii) the market-specific conditions corresponding to scores of 0, 0.5, and 1; iv) the gatekeeper and service to which the evidence must refer; v) any proxy or evidence limitation affecting interpretation.

Apple and Google operate distinct mobile ecosystems, and the technical and commercial conditions facing rivals differ substantially between the two. Apple and Google use the same app-distribution indicator definitions and scoring rules, while the evidence and scores remain gatekeeper-specific. The search indicators are adapted to the architecture and competitive bottlenecks of online search but remain linked to the same four contestability dimensions and underlying economic mechanisms.

For each gatekeeper-market observation, the database records market-specific indicators corresponding to the applicable contestability mechanisms. The type of evidence required depends on the indicator. User Mobility and Switching is evaluated using evidence concerning portability, active choice, default control, service removal, and the practical frictions involved in adopting an alternative. Rival Access and Distribution draws on evidence concerning access to distribution channels, steering and contracting restrictions, platform-access conditions, fees, and other commercial requirements affecting entry and expansion. Platform Neutrality and Non-Discrimination is evaluated through preferential ranking, self-preferencing, tying, bundling, and the treatment of business users and third-party services. Data, Interoperability, and Infrastructure Access covers technical interfaces, operating-system and device functions, platform-generated data, search crawling and indexing infrastructure, and cross-service data accumulation.

Illustration: alternative app distribution on iOS. The relevant mechanism is the ability of rival developers and distributors to reach users outside a channel controlled exclusively by

the incumbent. The *De Facto* indicator evaluates whether alternative app-distribution routes are operational and practically usable in the Apple ecosystem.

At the December 2023 baseline, third-party app stores and direct web distribution were prohibited. So the indicator receives a score of zero, indicating no working alternative-distribution path existed. Then in the later period, third-party app stores operate in the European Union and web distribution is permitted. Therefore, the mechanism no longer receives a score of zero. But it does not receive a score of one neither, because the available routes remain subject to fees, eligibility conditions, installation procedures, warning screens, and other restrictions. Evidence of limited adoption is used as supporting evidence of a continued friction rather than as an automatic numerical threshold. The score of the mechanism in the later-period is 0.5, which means a working path exists with considerable commercial and procedural frictions.

This example illustrates that the *De Facto* assessment does not ask only whether an option has been formally announced or technically enabled. It asks whether the option provides a meaningful competitive path under the predefined market-specific criterion.

The baseline observation is December 2023. The later observation incorporates evidence available through 23 July 2026. The same indicator definitions, applicability determinations, and scoring anchors are applied in both periods. A score changes only where documented evidence establishes a change in the observable condition relevant to the indicator.

We also need to note that the pre/post changes are descriptive. They may reflect DMA implementation, platform strategy, regulatory and judicial decisions, or changes in user and developer behavior. The comparisons do not, by themselves, identify the causal effect of regulation.

4.6 Data Alignment

The market-level empirical layers are linked through common contestability dimension, contestability mechanism, jurisdiction, market, gatekeeper, and observation date. A market-level *De Jure* record and a gatekeeper-market *De Facto* record can be combined only when they are aligned. Alignment occurs at the mechanism level rather than through an assumption that a legal obligation category and an empirical indicator are identical. For example, an active-choice obligation and the observed design and operation of a choice screen may represent the same mechanism even though the legal requirement and empirical evidence take different forms.

Effective Contestability is calculated only for observations for aligned market-level measurements. In the current pilot, complete intertemporal alignment is available for Google Search and Apple iOS/App Store.

5 Pilot Applications and Results

This section reports the three empirical exercises described in Section 4. We first present the jurisdiction-level *De Jure* comparison across nine legal systems. Then we present the European Union market applications for mobile app distribution and online search. Finally, we align the formal and realized measures where both are available, and summarize what the pilot demonstrates.

The three exercises should not be interpreted as a balanced jurisdiction–market–gatekeeper panel. The jurisdiction-level comparison is the only cross-jurisdictional exercise. Both market-level applications are confined to the European Union, and complete intertemporal market-level *De Jure* panels are currently available only for Google Search and Apple iOS/App Store. The

market-level changes are descriptive. They document how the legal and market conditions differ between the December 2023 baseline and the later observation. They do not identify the causal effect of the DMA.

5.1 Jurisdiction-Level *De Jure* Contestability

We apply the *De Jure* component of the framework to sixteen obligation categories across the nine jurisdictions described in Section 3. The results measure the extent to which each jurisdiction’s legal and regulatory environment formally supports the contestability mechanisms identified in the framework. They do not measure compliance, implementation, or realized market conditions which are examined separately through the *De Facto* layer.

All results refer to the June 2026 coding snapshot. The sixteen obligation-category scores are aggregated within the four dimensions, and the jurisdiction-level index is the equal-weighted average of the resulting dimension scores. Table 7 reports the dimension-level and overall values. Figure 2 presents the underlying obligation-category scores.

Table 7: Jurisdiction-Level *De Jure* Contestability

Jurisdiction	D1	D2	D3	D4	Overall Index
European Union	1.00	1.00	1.00	1.00	1.00
Germany	1.00	1.00	1.00	1.00	1.00
Japan	0.60	0.75	1.00	0.50	0.71
Turkey	0.20	0.38	0.83	0.38	0.45
China	0.40	0.25	0.50	0.25	0.35
Korea	0.30	0.38	0.50	0.13	0.33
United States	0.30	0.25	0.00	0.25	0.20
United Kingdom	0.20	0.00	0.33	0.25	0.20
Australia	0.10	0.00	0.00	0.13	0.06

Notes: D1 denotes User Mobility and Switching; D2 denotes Rival Access and Distribution; D3 denotes Platform Neutrality and Non-Discrimination; and D4 denotes Data, Interoperability, and Infrastructure Access. Dimension scores are arithmetic means of the applicable obligation-category scores in the jurisdiction-level coding. The overall index assigns equal weight to the four dimensions. Figures are rounded to two decimal places.

The results reveal substantial variation in both the overall strength and the composition of formal contestability protections. The European Union and Germany reach the upper bound (score of 1.00) because in every category, an operative, sufficiently broad, and enforceable obligation has been identified. This reflects the comprehensive obligation structure of the DMA and related European instruments. Germany’s result incorporates directly applicable Union law together with the national layer.³ But a score of 1 does not imply that the corresponding obligations have been implemented effectively or eliminated the underlying market friction.

Outside the two European observations, Japan receives the highest score, at 0.71. Its scores are driven by strong protections in Rival Access and Distribution and Platform Neutrality, especially within the mobile-software ecosystem, including operating systems, app stores, browsers,

³Because the index is bounded above by one, the German provisions do not raise the aggregate score above the EU value; their contribution instead appears in the underlying evidence and in markets or activities not fully covered by the DMA.

and search engines. Its lower D1 and D4 scores reflect the sectoral boundary of that regime and the absence of complete protection for several mechanisms outside the regulated mobile services.

Turkey, China, and Korea form an intermediate group, with overall scores of 0.45, 0.35, and 0.33, respectively. These jurisdictions contain meaningful formal protections, but their regimes are concentrated in particular sectors or mechanisms. Turkey’s strongest provisions govern e-commerce marketplaces. China’s result is distributed across statutes, administrative regulations, guidance, and enforcement practice, producing a relatively broad set of partial protections. Korea’s enacted rules focus most strongly on app-store payment practices, supplemented by sectoral portability, consumer-protection rules, and ex post competition enforcement.

The United States and the United Kingdom receive lower overall scores of 0.20. They illustrate two different sources of limited jurisdiction-wide coverage. In the United States, formal contestability protections arise mainly from firm-specific judicial remedies rather than generally applicable platform regulation. The United Kingdom has enacted an ex ante institutional framework, but substantive obligations arise only when the Competition and Markets Authority imposes firm-specific conduct requirements. The index credits only requirements, commitments or other protections that are operative at the observation date. Australia receives a limited current-period credit (score of 0.06), because most of its wider digital-competition proposals remain in the pipeline rather than in force.

The dimension profiles provide information that the overall index conceals. D1 is the most widely represented dimension outside European region. Portability, consumer-protection, choice, and service-removal rights can arise under privacy, consumer, telecommunications, or sectoral law even where no general digital-markets regime exists.

D2 and D3 are more closely associated with regulation of particular platform relationships. App-store and marketplace regimes frequently address distribution, steering, commercial independence, ranking, tying, and the treatment of business users. This produces relatively strong D3 scores in Japan and Turkey despite their narrower jurisdiction-wide coverage.

D4 remains the least comprehensively developed dimension outside the European Union and Germany. Some jurisdictions receive partial credit from privacy-law restrictions on cross-service data accumulation or combination. Such restrictions are analytically distinct from competition-specific rights granting rivals access to data, infrastructure, or interfaces. The dimension score should therefore be read together with its underlying categories rather than as evidence that all forms of data or interoperability access are equally protected.

More generally, equal final scores can rest on different factor configurations. A value of 0.5 may represent a binding but firm-specific remedy, a sectoral statute covering only part of a mechanism’s wider domain, a generally applicable rule that addresses the mechanism only partially, or a weaker form of guidance or case-specific practice. The aggregate index summarizes formal support while the factor scores, legal form, and market-coverage fields preserve the institutional differences beneath that summary.

5.2 EU Market Market-Level *De Jure* Contestability

The second pilot exercise restates the European Union’s jurisdiction-level legal records for the two defined digital markets: mobile app distribution and online search.

The market-level results differ conceptually from the jurisdiction-level European Union score. Mechanisms that do not operate within the defined market are classified as Not Applicable and excluded from aggregation. For mechanisms that do apply, Existence, Scope, and Enforceability

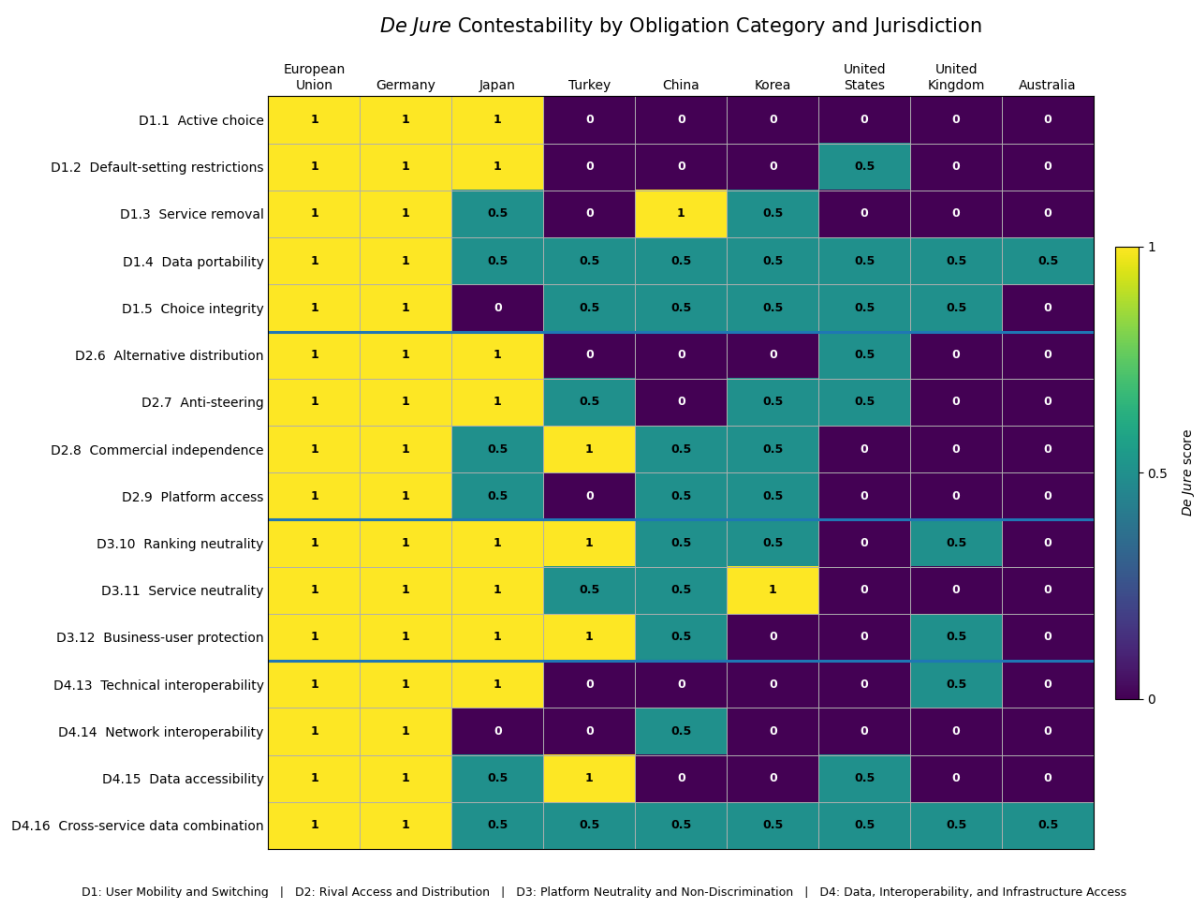


Figure 2: Obligation-Category Scores Across Jurisdictions

Notes: The figure reports the 0, 0.5, and 1 *De Jure* scores for each obligation category and jurisdiction. Obligation categories are grouped by the four contestability dimensions.

are assessed relative to the assessed market. A generally applicable or sector-specific obligation may provide full coverage within a market even where its jurisdiction-wide Scope is more limited. By contrast, a firm-specific judgment or remedy remains limited in Scope because it binds a specific firm rather than establishing a rule applicable throughout the market.

The pilot includes complete December 2023 and June 2026 market-level legal panels for online search (assessed through Google Search), and mobile app distribution (assessed through Apple iOS/App Store). The December 2023 observations describe the formal protections operative before the DMA obligations became binding on designated gatekeepers. The June 2026 observations describe the later legal environment using the same market definition, applicable mechanisms, obligation categories, and factor-level scoring rules.

Table 8: European Union Market-Level *De Jure* Contestability

Market and Assessed Service	Period	D1	D2	D3	D4	Overall Index
Online search: Google Search	December 2023	0.50	0.38	0.50	0.13	0.38
Online search: Google Search	June 2026	1.00	1.00	1.00	1.00	1.00
Online search: Google Search	Change	+0.50	+0.62	+0.50	+0.87	+0.62
Mobile app distribution: Apple iOS/App Store	December 2023	0.40	0.25	0.50	0.25	0.35
Mobile app distribution: Apple iOS/App Store	June 2026	1.00	1.00	1.00	1.00	1.00
Mobile app distribution: Apple iOS/App Store	Change	+0.60	+0.75	+0.50	+0.75	+0.65

Notes: The December 2023 observations are pre-compliance legal baselines. The June 2026 observations describe the later legal environment. D1 denotes User Mobility and Switching; D2 denotes Rival Access and Distribution; D3 denotes Platform Neutrality and Non-Discrimination; and D4 denotes Data, Interoperability, and Infrastructure Access. The market definition, applicable categories, and scoring rules are held constant across periods. Figures are rounded to two decimal places from the underlying obligation-category records.

The December 2023 results show that both markets already received partial formal support from the pre-existing European Union acquis, but the sources and distribution of that protection differed. In online search, the baseline combined generally applicable data protection rules, transparency requirements, and firm-specific competition-law remedies. Formal coverage was therefore strongest where earlier legal instruments directly addressed search defaults, portability, ranking, or related platform conduct, and weakest where contestability depended on broader interoperability, data access, or infrastructure obligations.

The mobile app-distribution baseline rested more heavily on generally applicable instruments governing online intermediation, platform transparency, consumer choice, and data protection. These rules provided partial formal support for several mechanisms but did not establish the full set of distribution, steering, technical-access, and platform-neutrality obligations subsequently associated with the DMA.

By June 2026, the market-level legal environment is substantially improved in both applications. The principal DMA obligations provide direct formal support for user choice and default control, distribution outside gatekeeper-controlled channels, steering and commercial independence, non-discriminatory platform treatment, interoperability, and access to competitively relevant data. The increase in the market-level *De Jure* scores reflects both the addition of previously absent protections and the replacement of partial, or firm-specific protections with more direct obligations.

The later-period legal scores should not be interpreted as evidence that the relevant competitive paths operate without friction. A score of 1 in the *De Jure* layer means that the applicable obligation satisfies the predefined criteria for Existence, Scope, and Enforceability. It does not

establish compliance, practical usability, market adoption, or the removal of structural barriers. Those questions are addressed separately by the gatekeeper–market-level *De Facto* results in Section 5.3.

5.3 European Union Gatekeeper–Market-Level *De Facto* Contestability

5.3.1 Mobile App Distribution

The mobile app-distribution application evaluates the conditions under which developers can reach users and users can obtain applications within the two principal mobile ecosystems. Apple and Google control distinct operating systems, application stores, technical interfaces, payment arrangements, and developer-governance systems. As such, the two ecosystems are coded separately using the same market definition, indicator set, scoring criteria, and observation periods.

Table 9 reports the dimension-level and overall *De Facto* results for the gatekeeper–market observations in the pilot.

Table 9: *De Facto* Contestability by Dimension in Mobile App Distribution

Observation	Period	D1	D2	D3	D4	Overall	Scored / applicable
Apple iOS/App Store	Dec. 2023	0.10	0.00	0.00	0.33	0.11	13/15
Apple iOS/App Store	later observation	0.60	0.50	0.50	0.50	0.53	13/15
Google Android/Google Play	Dec. 2023	0.30	0.25	0.00	0.00	0.14	10/15
Google Android/Google Play	later observation	0.50	0.50	0.50	0.50	0.50	10/15

Notes: The baseline is December 2023. The later observation incorporates evidence available through 23 July 2026. “Scored / applicable” reports the number of indicators supported by sufficient evidence relative to the number classified as applicable. Not Applicable indicators are excluded before determining the applicable set. Missing indicators receive no numerical value but remain in the coverage denominator.

Apple iOS and the App Store Apple’s *De Facto* Contestability Index increases from 0.11 in December 2023 to 0.53 in the later observation. The increase of 0.42 is the largest among the three gatekeeper–market observations. In fact, this large movement reflects a low baseline in which several competitive paths were unavailable. The later observation gives users more choice and default controls and permits removal of applications that previously could not be deleted. Third-party app stores and web distribution are operational, developers have additional routes for communicating external offers and using alternative payment providers, and access has expanded to browser engines, payment functions, and other device features.

The later score remains substantially below one because these openings continue to involve considerable frictions. Alternative distribution is subject to eligibility conditions, notarization, installation procedures, warning screens, and fees associated with acquisition or store services. Ranking neutrality lacks complete independent verification, some competitively relevant ranking information remains unavailable, and public evidence is insufficient to score business-user information protection. Therefore, the index records a formal opening without treating actual permission or technical availability as equivalent to unrestricted competitive access.

Google Android and Google Play Google Play’s *De Facto Contestability* Index increases from 0.14 to 0.50, a change of 0.36. Its baseline exceeds Apple’s because Android already permitted sideloading, alternative application stores, and centralized management of several default application categories before the DMA. The later improvement is concentrated in choice processes, removal of some pre-installed Google applications, alternative billing and off-platform transactions, and restrictions on cross-service data combination.

The alternative-distribution indicator does not rise because Google introduced an additional registration or installation program. Sideloading and third-party stores were already available, while technical and commercial barriers remained. Similarly, alternative billing creates a path without eliminating the service fees, contractual conditions, and steering restrictions relevant to the mechanism.

Comparison Within Mobile App Distribution The two ecosystems converge to similar aggregate scores in the later period, but they arrive there from different starting points and through different mechanisms. Apple’s larger movement reflects the removal of categorical prohibitions: alternative stores, external transactions, non-incumbent browser engines, and removal of core applications had previously been unavailable. Android began with a more open distribution architecture, so its measured changes are concentrated in a narrower set of previously restricted channels. Moreover, two ecosystems also differ in evidence coverage. Google Play’s D4 result is based on substantially narrower evidence. Several technical-interoperability and business-user data-access indicators remain Missing.

The platform-specific observations are the primary results. The pilot does not average them into one app-distribution score. Such an aggregate would require an explicit rule for weighting the two ecosystems and a treatment of their unequal measurement coverage. A common-support robustness exercise may instead restrict both observations to indicators scored for both gatekeepers before applying a stated platform-weighting rule.

5.3.2 Online Search

The online-search application assesses Google Search as the gatekeeper service around which the principal barriers to competitive challenge are organized. Google Search’s *De Facto Contestability* Index rises from 0.36 to 0.52. Table 9 decomposes the scores and shows the coverage underlying each dimension.

The overall 0.52 score should not be interpreted as a measure of Google’s market share, concentration, profitability, dominance, or likelihood of displacement. It summarizes the operation of the specified contestability mechanisms for which sufficient evidence is available. A highly concentrated market may receive partial credit where particular competitive paths are open, while still containing substantial default, ranking, data, scale, and infrastructure barriers.

User Mobility and Switching provides the largest measured improvement. The later observation includes a randomized, non-preselected choice process and easier initial provider selection. The dimension remains partial because changing the default after setup still involves friction and because the available portability mechanism is batch-based, with no documented rival search engine using exported search history as a direct input.

Rival Access and Distribution is the highest-scoring dimension in both periods. This result is driven principally by two relatively open conditions: rival search engines can be reached through the open web, and merchants or advertisers acquired through search can communicate and transact outside the service. It should not be read as evidence that entry into general

Table 10: Decomposition of Google Search *De Facto* Contestability

Dimension	July 2026 Score	Scored / Applicable	Principal Source of Credit	Principal Remaining Constraint
D1. User Mobility and Switching	0.40	5/5	Randomized, non-preselected search-provider choice screens and greater initial user choice	The screen is presented only in specified circumstances and ordinarily once per device; the Search application remains non-removable; portability remains partial
D2. Rival Access and Distribution	0.67	3/4	Rival search engines remain reachable through the open web; merchants can communicate and transact outside Search; publishers have a working route to users	Commercial-pricing flexibility remains Missing; default distribution and publisher-access conditions continue to create friction
D3. Platform Neutrality and Non-Discrimination	0.50	2/3	Dedicated comparison-site units and other result-page changes increased the visibility of some rival services	Continued preferential treatment of Google’s specialized services; business-user information protection remains Missing
D4. Data, Interoperability, and Infrastructure Access	0.50	2/2	Search-data licensing and consent requirements for cross-service data combination provide partial openings	The Article 6(11) specification measures take effect after the observation window; the practical effect of consent design remains uncertain
Overall	0.52	12/14	<i>Equal-weighted average of the four dimension scores</i>	

Notes: Two D4 indicators—technical interoperability and cross-platform messaging connectivity—are classified as Not Applicable to the defined online-search market. The D4 coverage entry therefore reports two scored indicators out of two applicable indicators, although the complete D4 indicator catalogue contains four items. The overall score is not a measure of Google’s market share, profitability, dominance, or probability of displacement.

search or access to search users is easy. Two of the four applicable indicators in this dimension remain Missing, and large-scale distribution, default placement, crawling, indexing, and data advantages remain relevant elsewhere in the diagnostic profile.

Platform Neutrality improves but remains partial. Changes to result-page design increased the visibility of some comparison services, but available evidence continued to identify preferential presentation of Google’s own specialized services. The absence of sufficient public evidence on protection of non-public business-user information also limits coverage.

Data, Interoperability, and Infrastructure Access improves through additional data access and restrictions on cross-service data combination. The dimension does not imply that rivals possess equivalent search infrastructure. Web-scale crawling and indexing, accumulated query and interaction data, and withheld ranking information remain important constraints. Some of these structural conditions are difficult to capture through a single directly observable indicator and should be considered alongside, rather than inferred away by, the aggregate score.

Search presents a different contestability problem from app distribution. Some gatekeeper-controlled frictions, including default choice and consent design, can change through discrete and observable measures. Other constraints depend on scale-intensive infrastructure, accumulated data, ranking conduct, and continuous access to users and therefore may change more gradually or require repeated monitoring.

5.4 Alignment of Contestability

The aligned analysis combines two European Union market-level *De Jure* panels with three gatekeeper–market-level *De Facto* observations. The online-search *De Jure* panel is aligned with the Google Search *De Facto* observation. The mobile-app-distribution *De Jure* panel is aligned separately with the Apple iOS/App Store and Google Android/Google Play *De Facto* observations.

This structure follows the different units of observation used by the two layers. The *De Jure* measure describes the formal protections applicable within a defined market and jurisdiction. The *De Facto* measure captures the realized conditions associated with a particular gatekeeper or ecosystem. Consequently, Apple and Google may share the same market-level legal environment while receiving different *De Facto* scores because their platform architectures, conduct, implementation choices, and evidentiary records differ.

Effective Contestability can be reported for all three gatekeeper–market observations, provided that the corresponding *De Jure* and *De Facto* measures use the same market definition, applicable mechanism set, jurisdiction, and observation period. For mobile app distribution, the common market-level *De Jure* score is combined separately with the Apple and Google Play *De Facto* scores:

Table 11: Aligned European Union Market-Level Contestability

Market and Assessed Service	<i>De Jure</i>		<i>De Facto</i>		Effective	
	Dec. 2023	June 2026	Dec. 2023	July 2026	Dec. 2023	Later
Online search: Google Search	0.38	1.00	0.28	0.52	0.10	0.52
Mobile app distribution: Apple iOS/App Store	0.35	1.00	0.11	0.53	0.04	0.53

Notes: The December 2023 *De Jure* values are pre-compliance legal baselines. The later legal observation is June 2026, while the later *De Facto* observation incorporates evidence through 23 July 2026. Effective Contestability is the product of the aligned *De Jure* and *De Facto* indices. Products are calculated from the underlying unrounded component values; they may differ slightly from products calculated using the rounded entries displayed in the table.

The aligned applications display a common pattern: formal legal support increases more sharply than realized contestability. Comprehensive formal coverage can coexist with technical, commercial, behavioral, evidentiary, and structural limitations on the practical exercise of competitive opportunities.

6 Implications, Limitations, and Research Agenda

6.1 Using the Contestability Measures

The framework measures competitive opportunity rather than market structure or performance. Concentration describes the current distribution of activity among firms. However, contestability identifies the mechanisms that determine whether that distribution can be challenged. Entry, market shares, prices, innovation, and welfare are external outcomes rather than included in the index.

The dimension-level results are at least as important as the aggregate score. Two jurisdictions or platforms may receive similar overall values while facing different constraints in user mobility, rival distribution, platform neutrality, or access to data and infrastructure. So, the framework is best used as a diagnostic profile rather than as a ranking alone.

The two primary measures also support different applications. *De Jure* Contestability can be used to compare regulatory design and the diffusion of legal institutions. *De Facto* Contestability can be used to monitor realized market conditions and to study their relationship with entry, commercialization, investment, innovation, and consumer outcomes. A legal–practical gap or an Effective Contestability composite may be useful where the research question requires the two layers to be considered jointly, but neither replaces the underlying dimension and mechanism scores.

6.2 Legal–Practical Gap

A high *De Jure* score does not establish that the corresponding competitive opportunities are viable in practice. Formal obligations may coexist with fees, technical restrictions, interface friction, incomplete data access, weak dispute procedures, or structural barriers that regulation does not remove immediately. Regulatory monitoring should examine the full path through which a user or rival exercises an opportunity, rather than only whether a compliance feature has been announced.

Conversely, a lower *De Jure* score does not necessarily imply regulatory inaction. It may reflect reliance on sector-specific rules, firm-specific remedies, phased designation, or case-by-case intervention rather than generally applicable *ex ante* obligations.

The difference between the two layers is descriptive. It may identify mechanisms for which formal protection exceeds observed realization, but it does not by itself establish non-compliance, regulatory failure, or causation. The gap may also reflect technological constraints, market structure, rival capabilities, adjustment lags, or incomplete public evidence.

6.3 Limitations

The implementation remains a pilot. Jurisdiction-level *De Jure* measurement covers nine legal systems; market-level *De Jure* measurement covers online search and mobile app distribution in the European Union; and *De Facto* measurement covers three EU gatekeeper–market observations. The results do not support a global ranking of digital markets, cross-jurisdictional *De Facto* comparisons, or a jurisdiction-level *De Facto* index.

The pilot markets were selected partly because they offer unusually extensive public evidence. This improves measurement feasibility but limits representativeness. Moreover, regulatory findings, gatekeeper disclosures, technical evidence, and market data vary in coverage and independence, while some relevant contracts, algorithms, and technical conditions remain non-public. Reporting Missing observations, coverage, and evidence confidence makes these limitations visible but does not eliminate them.

Finally, categorical scoring and aggregation require judgment. Predefined rules and an audit trail improve transparency, but they do not remove uncertainty in borderline cases. Equal weighting is also a transparent baseline rather than a claim that all mechanisms have equal economic importance. Comparisons are strongest within the same market across gatekeepers or over time, and the reported pre/post changes are descriptive rather than causal.

6.4 Research Agenda

The next stage of the project has four priorities. First, the framework should be extended to additional markets, gatekeepers, jurisdictions, and observation periods. Second, coding reliability should be evaluated through independent double-coding, adjudication records, and agree-

ment statistics. Third, robustness should be tested under alternative weighting rules, Missing-data treatments, evidence-confidence thresholds, and constructions of Effective Contestability. Fourth, the measures should be validated against external outcomes. Future research can examine whether changes in contestability predict challenger commercialization, entry and expansion, innovation, investment, market structure, and consumer outcomes. Repeated measurement may also support causal research designs, but the pre/post comparisons reported in this paper are descriptive and do not themselves identify the effect of regulation.

7 Conclusion

This paper develops a framework for measuring digital-market contestability as the conditions under which incumbent positions can be challenged. It separates formal legal support, captured by *De Jure* Contestability, from realized market conditions, captured by *De Facto* Contestability, and organizes both around four common dimensions.

The pilot shows that formal protections vary across jurisdictions and that broad legal coverage may coexist with substantial practical frictions that differ across markets and platform ecosystems. The contribution is not a definitive ranking or causal estimate, but a transparent and extensible measurement framework for comparing regulatory design, monitoring implementation, and studying how contestability affects entry, innovation, and market outcomes.

Data and Materials Availability

The Coding Handbook, item-level Contestability Database, codebook, source register, and replication files are available at [LINK](#). The archived release corresponding to this paper is Version 1.1, dated September 25, 2026, and is available at [LINK](#). A separately labeled living version of the database may be updated as legal and market conditions change.

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A *De Jure* Data Construction and Legal Sources

A.1 Structure of the Legal Coding Records

Table A.1 describes the principal fields retained for each obligation-category-jurisdiction observation. The underlying database may contain additional administrative variables, but the fields below are sufficient to reproduce and review the reported scores.

Table A.1: Principal Fields in the *De Jure* Dataset

Field	Description
Obligation category	The standardized formal protection, prohibition, right, or requirement used to evaluate a contestability mechanism.
Contestability mechanism	The economic channel through which the obligation is expected to facilitate or restrict competitive challenge.
Dimension	The dimension to which the mechanism is assigned: User Mobility and Switching; Rival Access and Distribution; Platform Neutrality and Non-Discrimination; or Data, Interoperability, and Infrastructure Access.
Jurisdiction and observation date	The legal system and date to which the coding assessment applies.
Final score	The obligation-category score obtained from the minimum of Existence, Scope, and Enforceability.
Existence	Whether an operative obligation addressing the mechanism is present in the enacted legal framework.
Scope	The range of firms, services, sectors, markets, and activities covered by the obligation.
Enforceability	The extent to which the obligation is supported by credible regulatory or judicial oversight and sanctions.
Factor rationale	The explanation for the separate Existence, Scope, and Enforceability assessments.
Legal form	The institutional form through which the obligation becomes operative, using the taxonomy in Table A.2.
Instrument basis	A concise identification of the statute, regulation, article, court order, settlement, conduct requirement, or administrative rule relied on.
Full legal basis	The full title and citation of the operative legal instrument.
Market coverage	The firms, services, markets, or sectors governed by the obligation.
Evidence notes	Additional information relevant to the legal interpretation or coding decision.
Pipeline	Proposed, pending, or announced instruments that may affect future observations but do not enter the current-period score.
Evidence date	The date or period through which the legal assessment has been updated.
Review status	The status of the record in the coding and review process.

A.2 Legal-Form Taxonomy

Table A.2 classifies instruments according to how their substantive obligations become operative. The typical factor treatment provides a coding benchmark rather than an automatic score; the legal text and institutional setting of the individual observation remain controlling.

Table A.2: Legal-Form Taxonomy

Form	Definition	Typical Factor Treatment
F1	A generally applicable statute or regulation that fixes the content of a binding obligation ex ante and applies without a further activation order.	Existence = 1; Scope = 1 when the instrument covers the mechanism's full domain and = 0.5 when it covers a sectoral subset; Enforceability generally = 1.
F2	A firm-specific binding court order, settlement, consent decree, or imposed conduct requirement containing a fixed substantive obligation.	Existence = 1; Scope generally = 0.5 because the instrument binds named firms; Enforceability generally = 1.
F2g	Sub-regulatory administrative guidance that may influence conduct but has weaker formal status and more limited sanctioning mechanisms.	Existence generally = 0.5; Scope depends on coverage; Enforceability generally = 0.5.
F3	Ex post enforcement practice under general competition or consumer law where obligations arise from individual decisions or commitments and do not operate as a general prospective rule.	Existence generally = 0.5; Scope = 0.5; Enforceability generally = 0.5.
F4	A statutory catalogue specifying conduct that a regulator may prohibit against designated firms, but requiring an additional case-specific activation order.	Before activation, Existence, Scope, and Enforceability are generally 0.5. Once an order is issued, the order is assessed as an F2 instrument.
F5	An enacted designation framework empowering a regulator to formulate future obligations where the statute does not itself fix the substantive requirement and no conduct requirement on point has been imposed.	Existence = 0; Scope may be recorded as 0.5 for designated addressees; Enforceability may be 0.5, but the minimum rule produces a final score of zero.
F6	A bill, proposal, consultation draft, or announced regulatory regime that has not entered into force.	Existence = 0; Scope = 0; Enforceability = 0.
F7	No legal instrument on point beyond general competition or consumer law that has not generated an operative obligation.	Existence = 0; Scope = 0; Enforceability = 0.

A.3 Principal Legal Sources

Table A.3 summarizes the principal operative sources included in the June 2026 legal snapshot. The complete database records the article-level mapping, official source, status, operative provision, and translation where applicable.

Table A.3: Principal Legal Sources by Jurisdiction

Jurisdiction	Principal Operative Sources
European Union	Digital Markets Act; General Data Protection Regulation, Article 20; Digital Services Act, Article 25; Platform-to-Business Regulation; and Data Act provisions relevant to switching and data access.
Germany	European Union instruments; Act against Restraints of Competition, including Sections 19a and 20(3a); subsequent amendments concerning digital-market and DMA enforcement; and firm-specific orders issued by the Federal Cartel Office.
United States	Firm-specific judicial remedies and settlements, including <i>Epic Games v. Apple</i> , <i>Epic Games v. Google</i> , and <i>United States v. Google</i> ; together with state-level portability and choice protections under the California Consumer Privacy Act and California Privacy Rights Act.
Turkey	E-Commerce Law No. 6563 as amended by Law No. 7416; implementing e-commerce regulation; and the Regulation on Commercial Advertising and Unfair Commercial Practices.
Japan	Smartphone Software Competition Promotion Act, Act No. 58 of 2024; implementing rules and guidance issued by the Japan Fair Trade Commission; and the Act on Improving Transparency and Fairness of Digital Platforms.
Korea	Telecommunications Business Act, including the app-market payment-method provisions; Personal Information Protection Act, Article 35-2; and amended electronic-commerce consumer-protection rules.
China	Anti-Monopoly Law; Anti-Unfair Competition Law; E-Commerce Law; SAMR Platform Antitrust Guidelines; SAMR Interim Provisions on Anti-Unfair Competition on the Internet; CAC Algorithmic Recommendation Provisions; MIIT rules concerning pre-installed applications; and the Personal Information Protection Law.
United Kingdom	Digital Markets, Competition and Consumers Act, Parts 1 and 4; firm-specific conduct requirements imposed under the Strategic Market Status regime; and UK GDPR portability provisions.
Australia	Consumer Data Right under Part IVD of the Competition and Consumer Act. The proposed Digital Competition Regime and proposed unfair-trading rules are recorded in the pipeline but are not treated as operative obligations in the June 2026 snapshot.

A.4 *De Jure* Obligation Categories

Table A.4 reports the sixteen standardized *De Jure* obligation categories used in the jurisdiction-level coding. Each category operationalizes one contestability mechanism. The legal provision establishing an obligation is recorded separately and does not itself constitute the obligation category or the underlying economic mechanism.

Table A.4: *De Jure* Obligation Categories

No.	Obligation Category	Contestability Mechanism Supported
D1. User Mobility and Switching		
1	Active choice	Reduce default bias and enable users to make an active choice among competing services.
2	Default-setting restrictions	Ensure that users retain control over defaults and can change them through simple procedures.
3	Service removal	Allow users to remove or replace pre-installed platform applications and services.
4	Data portability	Reduce switching costs by allowing users to transfer relevant data across providers.
5	Choice integrity	Prevent manipulative interface design or behavioral techniques that distort autonomous user choice.
D2. Rival Access and Distribution		
6	Alternative distribution	Enable rivals to reach users outside channels controlled exclusively by the incumbent platform.
7	Anti-steering	Allow business users to communicate, promote offers, and transact directly with customers.
8	Commercial independence	Prevent contractual restrictions on competitive pricing, terms, and commercial freedom across channels.
9	Platform access	Ensure that rivals and business users can access essential platform services on fair and non-discriminatory terms.
D3. Platform Neutrality and Non-Discrimination		
10	Ranking neutrality	Prevent platforms from favoring their own services over competing services in ranking, placement, indexing, or related treatment.
11	Service neutrality	Prevent tying, bundling, or forced use of the gatekeeper's ancillary services.
12	Business-user protection	Prevent platforms from using non-public business-user information to gain a competitive advantage over those users.
D4. Data, Interoperability, and Infrastructure Access		
13	Technical interoperability	Enable rivals to interoperate with core platform functions, interfaces, hardware, software, and infrastructure.
14	Network interoperability	Reduce network-effect barriers by enabling cross-platform communication and connectivity.

Table A.4 continued

No.	Obligation Category	Contestability Mechanism Supported
15	Data accessibility	Enable rivals and business users to access and use competitively relevant data generated through platform interactions.
16	Data accumulation and combination restrictions	Limit structural advantages arising from exclusive data accumulation or the combination of data across platform services.

A.5 Application of Jurisdiction-Level Records to Markets

Market-level *De Jure* measures are derived from the jurisdiction-level records rather than constructed through a separate legal-research exercise. Each record contains a coverage field identifying the firms, services, markets, sectors, or activities governed by the relevant obligation. The market application first identifies the contestability mechanisms that operate in the defined market and then determines whether the jurisdiction’s legal framework contains an operative obligation supporting each mechanism.

The Scope factor is interpreted relative to the level of analysis. A sector-specific statute may cover only part of a mechanism’s broader economic domain in the jurisdiction-level comparison but cover the full domain of that mechanism within the sector it directly regulates. A firm-specific order continues to receive limited Scope because it binds only the named addressee. An obligation concerning a mechanism that does not operate in the defined market is classified as Not Applicable under Section 3.3.3; an applicable mechanism for which no operative obligation exists receives a score of zero.

The standardized market taxonomy includes mobile app distribution, mobile operating systems, browsers, online search, messaging, social networks, marketplaces and other online intermediation services, online advertising, video-sharing services, cloud services, and virtual assistants. For a given market comparison, the definition and applicability rules are held constant across jurisdictions and observation periods.

B *De Facto* Indicator Set

The *De Facto* layer uses sixteen observable indicators aligned with the same contestability mechanisms as the *De Jure* obligation categories. The indicator set is stable, but applicability and the evidence through which an indicator is observed may vary across markets. An indicator is scored only when its underlying mechanism operates in the defined market and sufficient evidence is available.

Table A.5: *De Facto* Indicators

Code	Indicator	Contestability Mechanism Observed
D1. User Mobility and Switching		
D1.1	User switching behavior	Reduce default bias and enable active user choice.
D1.2	Default switching behavior	Ensure that users retain control over defaults.

Table A.5 continued

Code	Indicator	Contestability Mechanism Observed
D1.3	Application replacement behavior	Allow users to remove or replace pre-installed platform services.
D1.4	Data portability usage	Reduce switching costs by allowing users to transfer data across providers.
D1.5	Autonomous user decision-making	Prevent manipulative interface design that impedes switching or distorts user choice.
D2. Rival Access and Distribution		
D2.1	Alternative distribution adoption	Enable rivals to reach users outside platform-controlled channels.
D2.2	Off-platform transactions	Allow business users to communicate and transact directly with customers.
D2.3	Commercial pricing flexibility	Prevent contractual restrictions on competitive pricing and commercial freedom.
D2.4	Rival participation	Ensure that rivals can access essential platform services on fair and non-discriminatory terms.
D3. Platform Neutrality and Non-Discrimination		
D3.1	Relative visibility of rival services	Prevent platforms from favoring their own services over competing services.
D3.2	Independent service adoption	Prevent platforms from leveraging one service to advantage another through tying, bundling, or forced adoption.
D3.3	Protection of business-user information	Prevent platforms from using non-public business-user data to gain a competitive advantage.
D4. Data, Interoperability, and Infrastructure Access		
D4.1	Technical interoperability	Enable rivals to interoperate with core platform functions and infrastructure.
D4.2	Cross-platform messaging connectivity	Reduce network-effect barriers by enabling cross-platform communication.
D4.3	Rival and business-user data utilization	Enable rivals and business users to access and use data generated through platform interactions.
D4.4	Extent of incumbent data accumulation and combination	Measure structural advantages arising from exclusive data accumulation or cross-service data combination.

Not every indicator applies in every market. For example, cross-platform messaging connectivity is Not Applicable to online search and mobile app distribution. The applicable set is fixed before scoring and held constant across gatekeepers and observation periods within the same market.