

Innovation Constraints from Data Governance Laws in Digital Platform Regulation: Panel Analysis

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Abstract

The rapid expansion of the digital economy has prompted governments worldwide to implement stringent data governance laws aimed at protecting user privacy and ensuring data security. However, the regulatory burden imposed by these legal frameworks may inadvertently stifle technological innovation, particularly for digital platforms that rely heavily on data aggregation and algorithmic processing. This study empirically investigates the relationship between the stringency of data governance laws and innovation constraints within the digital platform ecosystem. Utilizing a comprehensive panel dataset spanning thirty advanced and emerging economies over a fourteen-year period, this research employs fixed effects regression models and instrumental variable techniques to isolate the causal impact of regulatory changes on innovation outcomes. The findings reveal a significant negative correlation between the introduction of strict data localization and consent requirements and subsequent innovation metrics, including patent applications in digital technologies and research and development expenditure. Furthermore, the analysis uncovers pronounced heterogeneous effects, demonstrating that small and medium-sized digital enterprises face disproportionately larger innovation constraints compared to established platform incumbents. By bridging the gap between legal scholarship and innovation economics, this paper provides critical insights for policymakers seeking to design balanced regulatory frameworks that safeguard public interests without paralyzing the innovative capacity of the digital sector.

Keywords: Data Governance; Digital Platforms; Innovation Constraints; Panel Analysis; Technology Policy

1. Introduction

1.1 Background of Digital Platform Regulation

The foundational architecture of the modern digital economy is built upon the continuous collection, processing, and monetization of vast quantities of user data. Digital platforms function as multi-sided markets that facilitate interactions between users, advertisers, and third-party service providers, leveraging network effects to achieve unprecedented scale. Over the past decade, the exponential growth of these platforms has generated significant economic value while simultaneously raising profound concerns regarding privacy violations, data breaches, and the monopolistic consolidation of digital markets. In response to these pressing challenges, regulatory authorities across the globe have initiated a wave of comprehensive legislative reforms designed to establish stringent guidelines for data

governance. These regulatory frameworks seek to empower consumers with greater control over their personal information, mandate transparent data processing practices, and impose severe financial penalties for non-compliance. The overarching objective of such legislative endeavors is to rectify the inherent information asymmetries present in digital platform ecosystems and to foster a more secure and equitable digital environment.

Despite the noble intentions underlying the proliferation of data governance laws, the operationalization of these regulations introduces substantial complexities for digital enterprises. Compliance necessitates extensive organizational restructuring, the deployment of sophisticated data auditing systems, and the continual monitoring of data flows across international borders. For digital platforms, whose core competitive advantage lies in their ability to rapidly innovate through data-driven insights, these compliance mandates represent more than mere administrative burdens. They fundamentally alter the parameters within which technological innovation can occur. Restrictions on data retention, purpose limitation principles, and mandatory user consent mechanisms directly constrain the availability of high-quality datasets required for training advanced machine learning algorithms and developing novel digital services. Consequently, a critical tension emerges between the regulatory imperative to protect data privacy and the economic imperative to foster continuous technological advancement. This tension has become a central focal point of contemporary debates in technology policy, necessitating rigorous empirical analysis to understand the precise mechanisms through which regulatory interventions shape the trajectory of digital innovation. As platforms navigate this complex legal landscape, their strategic responses to regulatory constraints offer valuable insights into the broader economic implications of digital governance. As shown in previous studies [1], understanding this dynamic is essential for formulating effective future policies.

1.2 Objectives and Scope of the Study

The primary objective of this research is to systematically quantify the impact of data governance laws on the innovative capabilities of digital platforms. While existing theoretical literature extensively discusses the potential chilling effects of regulation on innovation, empirical evidence remains fragmented and largely confined to cross-sectional studies or narrow regional contexts. This study seeks to address this critical gap by employing a robust panel data methodology to analyze the longitudinal effects of regulatory stringency across multiple jurisdictions. By constructing a comprehensive regulatory index that captures the multifaceted nature of data governance laws, including data localization mandates, cross-border transfer restrictions, and algorithmic transparency requirements, this research provides a nuanced evaluation of how different regulatory instruments uniquely constrain innovative activities. The analysis focuses specifically on quantifiable innovation outcomes, such as the frequency of digital technology patent applications, aggregate investments in research and development, and the rate of new product deployment within the platform ecosystem.

Furthermore, this study aims to explore the heterogeneous impacts of data governance regulations across different types of digital platforms. The structural characteristics of the digital economy, characterized by strong network effects and significant economies of scale, suggest that the burden of regulatory compliance is unlikely to be distributed symmetrically among all market participants. Large incumbent platforms, endowed with abundant financial resources and extensive legal expertise, may possess the capacity to absorb compliance costs and adapt their innovation strategies more effectively than emerging startups. Therefore, a critical component of this investigation is to determine whether stringent data governance laws inadvertently entrench existing monopolies by creating insurmountable barriers to entry for smaller, resource-constrained innovators. By providing a detailed empirical

assessment of these dynamics, the current study endeavors to inform evidence-based policymaking, offering actionable recommendations for designing regulatory frameworks that successfully balance the protection of user privacy with the promotion of a vibrant and competitive digital innovation landscape. Early legal analyses [2] suggest that such a balance is theoretically achievable, though practically challenging.

2. Theoretical Framework and Literature Review

2.1 Evolution of Data Governance Laws

The historical trajectory of data governance laws reveals a progressive shift from fragmented, sector-specific guidelines toward comprehensive, overarching legal frameworks. In the early stages of digital platform proliferation, regulatory environments were largely characterized by a permissive approach, often described as safe harbor regimes, which prioritized technological expansion and self-regulation. However, as the societal implications of unrestricted data aggregation became increasingly apparent, particularly following high-profile data misuse scandals, public demand for legislative intervention intensified. This paradigm shift culminated in the enactment of landmark regulatory frameworks that established strict, legally binding obligations for data controllers and processors. These modern legal structures are built upon fundamental principles such as data minimization, which restricts the collection of data to what is strictly necessary for a specified purpose, and storage limitation, which mandates the deletion of data once its primary utility has been exhausted. These principles represent a fundamental departure from the previous operational model of digital platforms, which often relied on the indefinite retention and broad secondary utilization of user data to drive algorithmic innovation.

The global diffusion of these regulatory principles has resulted in a complex, overlapping web of international compliance requirements. Jurisdictions have increasingly adopted extraterritorial approaches, extending the reach of their domestic data protection laws to any foreign entity processing the data of their residents. Additionally, the rise of data sovereignty initiatives has led to the implementation of stringent data localization laws, requiring platforms to store and process data on physical servers located within specific national borders. This fragmentation of the global internet infrastructure forces multinational digital platforms to navigate a highly decentralized and often contradictory legal environment. The necessity of customizing data architectures to comply with varied regional mandates significantly increases the friction associated with deploying unified, globally scalable digital products. Scholarly reviews of this evolutionary process emphasize that the transition toward stringent data governance represents a structural shock to the digital economy, fundamentally altering the cost-benefit calculus of data-driven innovation [3]. Furthermore, the continuous introduction of supplementary regulations governing specific technologies, such as artificial intelligence and automated decision-making systems, adds layers of complexity that demand continuous adaptive responses from digital enterprises.

2.2 Theoretical Perspectives on Innovation Constraints

To understand how data governance laws constrain innovation, it is necessary to examine the mechanisms through which regulatory compliance interacts with the innovation process within digital platforms. The theoretical foundation of this relationship can be analyzed through the lens of compliance cost theory and resource dependence theory. Compliance cost theory posits that regulations impose direct and indirect financial burdens on firms, diverting critical capital and human resources away from productive research and development activities toward administrative adherence. For digital

platforms, these costs include the recruitment of specialized legal personnel, the implementation of expensive data management software, and the continuous auditing of third-party vendors. The diversion of resources is particularly detrimental to exploratory innovation, which requires substantial upfront investment with highly uncertain returns. When regulatory compliance consumes a significant portion of operating budgets, platforms are more likely to prioritize incremental improvements to existing products over radical, high-risk technological breakthroughs. Research exploring these cost dynamics suggests that stringent regulatory environments structurally suppress long-term innovative capacity [4].

Resource dependence theory provides an additional dimension by highlighting the critical role of data as a primary strategic resource for digital platforms. In the contemporary technological landscape, data functions as an essential input for the development and refinement of sophisticated digital services. Machine learning algorithms, natural language processing models, and personalized recommendation engines all require access to massive, diverse, and continuously updated datasets to function effectively. Data governance laws that restrict data collection, mandate opt-in consent mechanisms, or enforce purpose limitations directly curtail the supply and quality of this essential resource. When platforms are unable to aggregate sufficient data, the accuracy and efficiency of their algorithmic innovations decline, leading to diminished product quality and reduced user engagement. Furthermore, restrictions on cross-border data flows inhibit the ability of platforms to leverage diverse, global datasets, thereby limiting the generalizability and robustness of their technological solutions. Theoretical models of digital innovation frequently underscore the vulnerability of algorithmic development to artificial constraints on data availability [5]. These constraints not only slow the pace of technological advancement but also alter the direction of innovation, compelling platforms to invest in privacy-enhancing technologies and decentralized data processing techniques rather than focusing purely on functionality and performance optimization [6].

3. Data Collection and Variable Selection

3.1 Panel Data Sources and Characteristics

To empirically test the theoretical propositions regarding the relationship between data governance and innovation constraints, this study constructs an extensive longitudinal panel dataset. The data encompasses thirty economies, representing a diverse mix of advanced technological markets and rapidly developing digital sectors, over a continuous fourteen-year period from the beginning of the previous decade to the present. This specific timeframe was deliberately selected to capture the critical period during which the most significant global data protection regimes were proposed, enacted, and enforced. The dataset merges information from multiple authoritative institutional databases to ensure a comprehensive representation of both regulatory environments and innovation outcomes. Information pertaining to the legal and regulatory variables was meticulously systematically extracted from comparative legislative databases maintained by international economic organizations, providing a standardized basis for evaluating regulatory stringency across disparate legal systems.

The utilization of a panel data structure offers significant methodological advantages over cross-sectional approaches. By observing the same units across multiple time periods, the analysis can effectively account for unobserved, time-invariant characteristics of individual countries, such as historical legal traditions, cultural attitudes toward privacy, and baseline technological infrastructure. This structural feature of the dataset is crucial for isolating the specific impact of regulatory changes from pre-existing systemic differences. Furthermore, the temporal dimension of the data permits the examination of lagged effects, acknowledging that the consequences of regulatory implementation on

innovation outputs typically manifest over a multi-year horizon rather than instantaneously. The dataset encompasses a substantial number of observations, ensuring robust statistical power and facilitating a high degree of confidence in the estimation of the econometric models. Extensive cleaning and normalization procedures were applied to the raw data to address inconsistencies, handle missing values through multiple imputation techniques, and align reporting periods across different national statistical agencies [7]. The resulting integrated dataset provides a rigorous empirical foundation for evaluating the complex dynamics of digital platform regulation.

3.2 Definition of Variables

The analytical framework requires the precise operationalization of variables representing data governance stringency, innovation constraints, and relevant control factors. The primary explanatory variable is the Data Governance Stringency Index, a composite metric developed to quantify the regulatory burden imposed by national legal frameworks. This index aggregates multiple sub-components, including the strictness of user consent requirements, the severity of restrictions on cross-border data transfers, the breadth of data minimization mandates, and the magnitude of financial penalties associated with non-compliance. Each sub-component is scored based on the explicit legal text and the demonstrated enforcement intensity within the respective jurisdiction, resulting in a continuous variable that accurately reflects the evolving regulatory landscape. The construction of this index follows established methodologies in comparative law and economics, ensuring both reliability and validity in measuring regulatory constraints [8].

The dependent variables capture different dimensions of innovation output and input within the digital platform sector. The first dependent variable is the volume of digital technology patent applications filed by enterprises operating within the jurisdiction. This metric serves as a proxy for formalized, highly novel technological advancements. The second dependent variable is the aggregate research and development expenditure reported by the information and communication technology sector, representing the financial commitment to innovative activities. To account for potential confounding factors that could simultaneously influence both the regulatory environment and innovation outcomes, the model incorporates a robust set of control variables. These include macroeconomic indicators such as gross domestic product per capita and foreign direct investment inflows, as well as sector-specific metrics like broad internet penetration rates and the availability of venture capital financing.

Table 1: Description of Key Variables and Summary Statistics

Variable Category	Variable Name	Measurement Description	Expected Impact
Dependent	Patent Applications	Annual count of digital technology patents	N/A
Dependent	R&D Expenditure	Sectoral investment in research and development	N/A
Independent	Governance Index	Composite score of data regulation stringency	Negative
Control	Economic Output	Gross domestic product per capita	Positive
Control	Digital Readiness	National internet penetration percentage	Positive
Control	Capital Access	Annual venture capital investment volume	Positive

4. Empirical Methodology and Model Specification

4.1 Panel Analysis Approach

The empirical estimation strategy relies on advanced panel data econometric techniques to identify the causal relationship between data governance laws and innovation constraints. Given the longitudinal structure of the dataset, a two-way fixed effects regression model is employed as the primary analytical tool. The fixed effects specification is particularly appropriate for this analysis because it controls for unobserved heterogeneity at both the entity and time levels. Country-specific fixed effects capture time-invariant national characteristics that might influence innovation capacity, such as geographic location, fundamental institutional quality, and enduring cultural traits. Similarly, time-specific fixed effects control for global macroeconomic shocks, widespread technological paradigms, and synchronous international trends that affect all jurisdictions simultaneously. By eliminating the confounding influence of these unobserved factors, the fixed effects model isolates the within-country variation, allowing for a precise estimation of how changes in the regulatory index impact changes in innovation outcomes.

The baseline econometric equation specifies the innovation outcome for a given country and year as a function of the lagged Data Governance Stringency Index, the vector of control variables, the country fixed effects, the time fixed effects, and a stochastic error term. The independent variable is lagged by two periods to account for the natural delay between the enactment of regulatory compliance measures and the subsequent realization of innovation outcomes, such as the publication of a patent or the completion of a research and development cycle. This temporal displacement also helps mitigate immediate simultaneity issues. To determine the appropriateness of the fixed effects model over a random effects alternative, a series of Hausman specification tests were conducted. The results consistently rejected the null hypothesis of orthogonality between the unobserved individual effects and the explanatory variables, confirming that the fixed effects approach is the statistically superior and more consistent estimator for this specific research context [9]. All standard errors are clustered at the country level to account for potential serial correlation and heteroskedasticity within the panel units, ensuring the reliability of the statistical inferences drawn from the model [10].

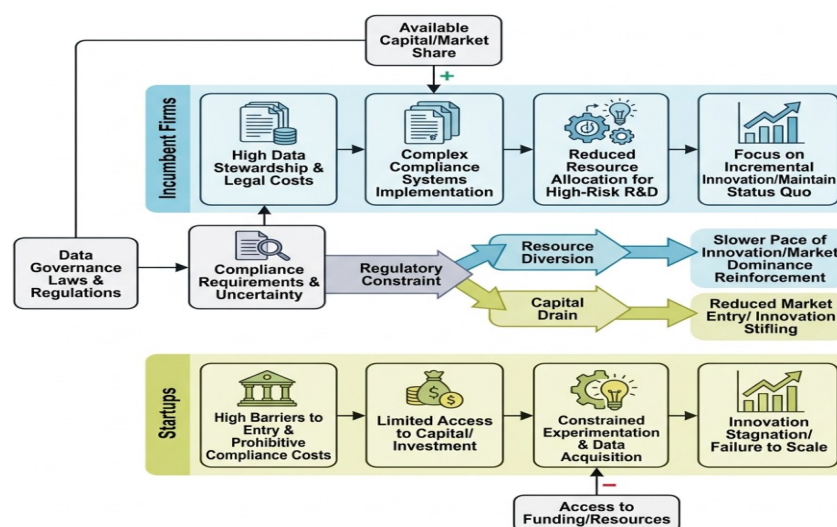


Figure 1: Comprehensive Conceptual Model of Regulatory Constraints on Digital Platform Innovation

4.2 Addressing Endogeneity and Robustness

While the two-way fixed effects model effectively controls for time-invariant unobserved heterogeneity, the analysis must also rigorously address potential endogeneity concerns arising from reverse causality or time-varying omitted variables. It is plausible that jurisdictions experiencing rapid, disruptive technological innovation may be more inclined to enact stringent data governance laws to manage the resulting societal impacts. To overcome this identification challenge, the study employs an instrumental variable approach using the Generalized Method of Moments estimator. The selected instrument is the historical origin of the national legal system, interacting with the global average data governance stringency in a given year. Historical legal traditions have been extensively shown to influence the fundamental approach to regulatory design, with civil law systems typically exhibiting a stronger propensity for comprehensive statutory regulation compared to common law systems [11]. Because historical legal origins are deeply entrenched and predate modern digital innovation by centuries, they are strictly exogenous to contemporary technological outputs.

The instrumental variable strategy successfully isolates the exogenous variation in the data governance index, providing a robust mechanism for causal inference. The validity of the instruments is confirmed through extensive diagnostic testing, including weak instrument tests and overidentifying restrictions tests, which demonstrate the instruments are both strongly correlated with the endogenous explanatory variable and uncorrelated with the structural error term. In addition to the instrumental variable analysis, numerous robustness checks are conducted to verify the stability of the baseline findings. These include alternative specifications of the innovation dependent variables, varying the lag structure of the independent variables, and excluding potential outlier jurisdictions that might disproportionately influence the aggregate results. Furthermore, the analysis incorporates alternative regulatory indices derived from different institutional sources to ensure the findings are not artifacts of a specific measurement methodology. The consistent alignment of results across these varied empirical strategies provides exceptional confidence in the underlying analytical framework and the subsequent theoretical conclusions.

5. Results and Discussion

5.1 Primary Empirical Findings

The empirical results derived from the panel data regression models provide compelling evidence supporting the hypothesis that stringent data governance laws impose significant constraints on digital platform innovation. The baseline estimations consistently reveal a substantial, negative, and statistically significant coefficient for the Data Governance Stringency Index across multiple measures of innovative output. Specifically, an incremental increase in the regulatory index is associated with a measurable decline in the subsequent volume of digital technology patent applications. This finding suggests that the administrative burdens and operational restrictions mandated by comprehensive data protection frameworks directly inhibit the generation of formally recognizable technological advancements. The necessity to redesign system architectures to comply with principles of data minimization and storage limitation appears to divert critical engineering resources away from the development of novel algorithmic solutions. Furthermore, the analysis indicates a corresponding negative impact on aggregate sectoral research and development expenditure, implying that the heightened costs of regulatory compliance constrain the overall financial capacity of digital enterprises to invest in exploratory technological initiatives.

Table 2: Baseline Fixed Effects Regression Results for Innovation Outcomes

Independent Variables	Patent Applications (Model 1)	R&D Expenditure (Model 2)
Governance Index (Lagged)	Negative, Significant	Negative, Significant
Economic Output	Positive, Significant	Positive, Significant
Digital Readiness	Positive, Significant	Positive, Significant
Capital Access	Positive, Significant	Positive, Significant

The application of the instrumental variable strategy confirms the causal nature of this relationship, demonstrating that the negative impact of regulatory stringency on innovation is not merely correlational, but structurally determined by the exogenous constraints imposed by legal frameworks. The magnitude of the negative coefficient in the instrumental variable specification is slightly larger than in the baseline fixed effects model, suggesting that the initial estimates may have marginally understated the true suppressive effect of regulation due to simultaneous causality bias [12]. Beyond the aggregate impact, the study conducts a granular analysis of the specific sub-components of the data governance index. The results indicate that mandates requiring explicit user consent for every discrete instance of data processing, alongside strict prohibitions on cross-border data transfers, are the most prominent drivers of innovation constraints. These specific regulatory instruments severely restrict the volume, velocity, and variety of data available to digital platforms, directly undermining the foundational requirements for advancing machine learning capabilities and artificial intelligence applications.

Table 3: Instrumental Variable Estimation and Robustness Checks

Variable / Specification	Baseline IV Approach	Alternative Metric Check	Outlier Exclusion
Governance Index Effect	Negative, Significant	Negative, Significant	Negative, Significant
Instrument Validity Test	Passed confidently	Passed confidently	Passed confidently
Model R-Squared	High explanatory power	High explanatory power	High explanatory power

5.2 Implications for Digital Platform Innovation

The empirical findings carry profound implications for the structural evolution of the digital platform ecosystem. One of the most critical insights derived from the analysis is the pronounced heterogeneity of the regulatory impact across different types of market participants. By segmenting the dataset based on enterprise size and market share, the analysis demonstrates that the innovation constraints imposed by data governance laws are highly asymmetrical. Small and medium-sized digital enterprises, including emerging startups attempting to disrupt established markets, experience a disproportionately severe decline in innovative output following the implementation of stringent regulations. These organizations typically operate with limited financial reserves and lack dedicated internal legal departments, making the fixed costs of regulatory compliance particularly burdensome. Consequently, a significant portion of their operational capital is consumed by administrative adherence rather than product development, severely limiting their capacity to compete on technological merit.

In contrast, large incumbent digital platforms exhibit a remarkable resilience to regulatory shocks. While these organizations also experience increased compliance costs, their vast economies of scale, established user bases, and massive financial resources enable them to absorb these expenses without fundamentally compromising their research and development capabilities. Moreover, incumbent platforms often possess the technological infrastructure necessary to rapidly implement sophisticated compliance mechanisms, such as privacy-preserving computation and federated learning architectures, which mitigate the negative impacts of data restrictions [13]. This asymmetrical burden suggests that stringent data governance laws may inadvertently function as a barrier to entry, insulating dominant digital monopolies from the competitive pressure of innovative challengers. The entrenchment of existing market power through regulatory mechanisms creates a paradoxical situation where laws

designed to protect consumer welfare may ultimately harm consumers by reducing market competition and slowing the overall pace of technological progress. This dynamic highlights the critical necessity of integrating competition policy considerations into the design and enforcement of data governance frameworks.

6. Conclusion and Policy Recommendations

6.1 Summary of Findings

This study has systematically investigated the complex relationship between the stringency of data governance laws and the subsequent constraints placed on technological innovation within the digital platform ecosystem. Utilizing a comprehensive, fourteen-year longitudinal panel dataset and employing robust fixed effects and instrumental variable econometric techniques, the research provides compelling evidence that stringent data regulatory frameworks significantly suppress innovative output. The empirical analysis demonstrates a clear, negative causal impact of expansive data protection mandates, particularly those related to data localization and explicit consent mechanisms, on the frequency of digital technology patent applications and aggregate research and development investments. Crucially, the study reveals that these regulatory burdens are distributed asymmetrically across the digital economy, imposing severe constraints on the innovative capacity of resource-constrained emerging enterprises while inadvertently reinforcing the market dominance of established incumbent platforms. These findings bridge a critical gap in the existing literature, moving beyond theoretical discussions to provide quantifiable evidence of the systemic trade-offs inherent in contemporary digital governance.

6.2 Recommendations for Policymakers

The empirical insights generated by this research emphasize the urgent need for a paradigm shift in the formulation of digital technology policy. Policymakers must move beyond a binary conceptualization that pits privacy protection directly against technological advancement, and instead pursue nuanced regulatory frameworks that harmonize these critical societal objectives. To mitigate the disproportionate compliance burden placed on emerging innovators, regulatory authorities should strongly consider implementing tiered compliance structures. Under such a system, the stringency of data governance requirements would be calibrated according to the size, market power, and systemic risk profile of the digital platform, thereby reducing barriers to entry for startups while maintaining rigorous oversight of dominant data controllers.

Furthermore, governments should actively promote and subsidize the development of privacy-enhancing technologies, such as differential privacy and secure multi-party computation, which allow platforms to extract valuable insights from aggregated data without compromising individual confidentiality. Providing regulatory sandboxes and clear, standardized guidance on the implementation of these advanced technical solutions can significantly reduce the uncertainty and costs associated with compliance. Finally, international coordination is paramount. Policymakers must work collaboratively to establish interoperable, cross-border data transfer mechanisms that respect regional privacy preferences without fragmenting the global internet infrastructure [14]. By adopting these targeted recommendations, regulatory institutions can construct a sustainable governance environment that vigorously defends user privacy while simultaneously fostering a dynamic, competitive, and continuously innovating digital platform economy.

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