

Stock markets as for-profit regulators: A legal analytics approach

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Abstract

Stock exchange demutualization in the mid-2000s transformed member-owned utilities into profit-driven entities, fueling debate about whether this shift spurs innovation or creates conflicts between shareholder interests and the quasi-regulatory functions exchanges perform. Some predicted that competition and market incentives would enhance regulatory efficiency, while others questioned whether profit maximization aligns with robust rulemaking. Surprisingly, little empirical work has tested these opposing views.

Our study addresses this gap by examining stock exchange rulemaking over the last quarter-century. We focus on whether these exchanges diverge in their regulations to attract business or instead converge around similar frameworks. Employing natural language processing methods on rule filings previously collected by Tierney (2025b), we draw on STM and recombinant novelty to measure innovation in stock exchange rulemaking. Building on Grajzl and Murrell (2024b) and related work, this methodology captures the degree of topics being combined anew in regulatory filings, as a proxy for innovation in exchange rules over time.

By comparing patterns in rulemaking behavior, we offer empirical evidence informing the debate about the effects of demutualization on regulatory innovation, or if alternative competitive dynamics—such as fee strategies or technology—have to come to predominate. This empirical analysis refines the theoretical debate on how profit incentives interact with the governance responsibilities of modern stock exchanges.

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Note to Conference Organizers 1: Hello!

This draft is for submission to the Data Science & Law call for papers. The project is also being presented at Law and Society Association in May and the National Business Law Scholars Conference in June. We plan to build out the empirical section ahead of these conferences.

In addition, we intend for this to be part of a larger project that builds on Tierney (2025a), presented at Data Science & Law in 2023; Jin and Min (2021) and Tierney (2025b); and additional work in progress of ours targeted for peer-review and law-review audiences. This fits in the former category, and is partly why the literature review is more about the empirical substantiation than the “theoretical” payoff for stock-exchange regulation, which we address in a later, companion law-review piece.

1 Introduction

Our project examines the conventional wisdom about the transformation of the stock exchange industry by examining how industrial organization and regulatory output relate across time. In the 2000s, the stock exchange industry transformed through a deregulatory approach that enabled “demutualization,” or the shift from a member-owned to shareholder-owned structure.

The shift to for-profit models in the mid-2000s generated competing theoretical predictions about regulatory outcomes: some scholars anticipated increased innovation and efficiency (Mahoney 1997; Karmel 2002; Gadinis and Jackson 2007), while others predicted potential conflicts between profit motives and stakeholder interests. In our view, the theoretical framework supporting demutualization rests upon a presumed alignment between profit maximization imperatives and optimal regulatory outcomes—a presumption that warrants closer inspection. This presumption appears to privilege a reductive understanding of institutional incentives that may not fully capture the full nature of exchange governance.

As the stock exchange environment has evolved post-demutualization—and in the wake of major legal transformations like Sarbanes-Oxley and Dodd-Frank—there is a clear need to interrogate the debate about the effects of demutualization on stock exchange innovation. The lively debate from 20 years ago has not been revisited to ask whether the predictions that deregulation would beget innovation have indeed manifested.

In companion work targeted for a law journal audience, we consider several theoretical and doctrinal interventions that merit intervention in this debate, discussed more in the footnote.¹

¹ Consider two general thoughts. First, the model potentially understates the inherent tension between shareholder wealth maximization and the quasi-regulatory function that exchanges necessarily perform. The transformation

The present project addresses the surprising lack of empirical inquiry into theoretical claims about the demutualization hypothesis. Our study addresses this gap by analyzing recent rule-making activities within NYSE and NASDAQ, set against the backdrop of a transformed regulatory environment post-Sarbanes-Oxley and Dodd-Frank Acts. The core question is whether NYSE and NASDAQ are competing by diverging in their rule-making or by converging towards similar regulatory frameworks. We leverage empirical methods and data not available at the time (e.g. Frankenreiter and Livermore 2020) to revisit the claim that stock exchanges have incentives to promote innovation and efficient rule design.

In particular, our methodology measures “recombinant novelty” in regulatory filings, providing empirical evidence regarding whether demutualization has yielded the predicted benefits. At its core, our framework operationalizes innovation through the identification of novel combinations of regulatory elements across time. Each filing submitted to the Securities and Exchange Commission (SEC) is conceptualized as a mixture of regulatory “topics”—discrete conceptual units representing particular domains of exchange rulemaking such as listing requirements, corporate governance provisions, fee structures, or technological infrastructure. The appearance of previously uncombined topics within a filing signals potential regulatory innovation. This approach aligns with theoretical perspectives on innovation that emphasize recombination of existing elements (Weitzman 1998; Fleming 2001).

We take the universe of published stock exchange rules from the Federal Register—the daily digest of the regulatory output of the federal government—from 2000 to 2023. After cleaning, stemming, lemmatizing, and tokenizing, we produce a corpus of 28,580 documents and 35,437 word vocabulary. Building upon the approach and methods of Grajzl and Murrell (2024b), as well as the broader pioneering work of Grajzl and Murrell (e.g., 2021b, 2022, 2024a), we develop a natural language processing (NLP) approach to analyze regulatory innovation in stock exchange rulemaking following demutualization. Fitting a 100-topic structural topic model (STM) on the corpus, allowing the measurement of which topics are statistically prominent in a given filing. For each filing, we identify the pairs of prominent topics (t_i, t_j) that are novel in that they do not appear as a prominent topic pair in any document within a preceding time window. We use the presence of these novel topic pairs as a measure of innovation, discounting them (as discussed in 3.3.2) with a cosine-similarity approach that seeks to ascertain the ease with which these topics otherwise appear

from member-owned utility to profit-seeking entity introduces novel principal-agent dynamics that complicate the presumed efficiency of regulatory innovation (with thanks to discussion on this point at the 2023 Data Science & Law conference). The theoretical architecture supporting demutualization may insufficiently account for these emergent governance challenges (Tierney 2025a). Second, the competitive dynamics predicted by the model warrant reexamination through a more nuanced analytical lens. The assumption that exchanges would primarily compete on regulatory quality appears to overlook alternative competitive vectors, such as fee structures and technological infrastructure. This suggests a potential limitation in the model’s capacity to fully theorize the complexity of inter-exchange competition.

together in the corpus.

2 Background

2.1 Institutional background

Stock exchanges play a central role in contemporary capitalist economies, serving several critical functions that sustain financial markets and corporate governance. Primarily, exchanges offer listing services through which corporations gain access to capital from public markets. By enforcing listing standards—such as transparency, disclosure, and corporate governance rules—stock exchanges significantly influence the quality and credibility of publicly traded companies (Coffee 2002). Beyond governance, exchanges provide trading infrastructure that facilitates efficient price discovery, enhances market liquidity, and promotes investor participation (e.g., Cumming, Johan, and Li 2011; Mahoney 2020). Equally important is their role as major producers of market data, supplying real-time trade information, pricing benchmarks, and analytics to investors and financial intermediaries (e.g., Mahoney and Rauterberg 2018; Mahoney 1997). This combination of governance, trading, and data dissemination underscores stock exchanges' function within the global financial markets and their substantial influence over market efficiency and integrity.

Due to their important functions, stock exchanges are often characterized as quasi-public utilities.² While privately operated and typically profit-driven, exchanges under the federal securities laws nonetheless maintain a public-regarding responsibility because their operations directly affect the public interest in many ways.³ For instance, stock exchanges not only provide direct economic services to their members and counterparties; their conduct also has broad-reaching effects on investor confidence, market fairness, and economic stability (Macey and O'Hara 2002; Booth 2014). Historically, this quasi-public status has justified regulatory oversight intended to ensure exchanges balance private profitability with broader societal goals.

As Brummer (2008, p. 1452) notes, “exchanges are not only venues for trading; they also help regulate the markets they organize” (cf. Harcourt 2011). This unique position also means their regulation tends toward a lighter-touch approach compared to federal or state regulators. The present set of federal securities laws reflects the outcome of a long historical process by which the SEC has accreted regulatory powers over the SROs, though it remains up to debate the extent to which the SEC superintends that relationship effectively today (e.g., Edwards 2017). Federal law requires the SROs, including the exchanges, to submit their proposed rules to the SEC for review and either

² This raises similar questions as the LPE-adjacent (cf. Britton-Purdy et al. 2020) networks, platforms, and utilities literature (e.g., Ricks et al. 2022; Fox 2019; Rahman 2018; Bamberger and Lobel 2017).

³ For discussion of the exchanges' resistance to being regulated as public utilities, see Ott (2009).

approval or disapproval. Assessing the SEC’s process of reviewing SRO rules, Tierney (2025a) observes that section 19(b)(2) of the Securities Exchange Act of 1934 (“Exchange Act”) leaves little discretion to the regulator that oversees exchanges; the SEC must approve exchange rules unless the agency can make a finding that the statutory requirements are not met (cf. Tierney 2025c). It is the regulatory filings produced in this rule-review process that make up the corpus we study.

Regulators typically grant exchanges substantial latitude to innovate, develop competitive market practices, and self-regulate their own markets, provided such latitude is exercised in ways that do not undermine public interest or market stability (e.g., Mahoney 1997). In particular, we are interested in the effect of deregulation and the switch to a profit-seeking model on the regulatory output and discourse of stock exchanges as regulators.

In recent decades, global deregulation of financial markets has significantly transformed the structure and operations of stock exchanges. Beginning in the late twentieth century, policymakers embraced a deregulatory agenda (e.g., Fleckner 2006; Karmel 2006; Dombalagian 2004; Mahoney 1997). This deregulatory agenda built upon the assumption that privatizing and demutualizing stock exchanges—transforming exchanges from mutually owned, member-run institutions into publicly listed, shareholder-driven corporations—would spur greater innovation and intensified competition in listing standards, trading technology, and market data offerings (e.g., Aggarwal 2006; Movsesyan 2007). Exchanges were expected to become more entrepreneurial, responsive to market demands, and proactive in enhancing financial market efficiency through innovation and technological advancement. These deregulatory moves coincided with broader global trends towards financial market liberalization (cf. Britton-Purdy et al. 2020).

Concurrent with deregulation, many exchanges underwent consolidation, becoming part of larger, multinational exchange families through mergers and acquisitions (e.g., Di Noia 2001). Prominent examples include the Intercontinental Exchange’s acquisition of the New York Stock Exchange (ICE/NYSE), NASDAQ’s international expansion, and the integration of Bats Global Markets with CBOE and CME’s expanding global derivatives markets.

Note to Conference Organizers 2: Figure 1

Note, we are still working on the TikZ code and timing data for the timeline of corporate consolidations appearing as Figure 1, but consider it a proof of concept.

Such consolidation has created exchange conglomerates that span multiple markets, asset classes, and jurisdictions, dramatically reshaping global market structures and competitive dynamics. The rise of these exchange groups has implications not only for traditional competitive concerns but also for regulatory policy, as larger, more diversified exchanges may exert significant market power, influencing rule-setting processes, market pricing strategies, and industry-wide standards.

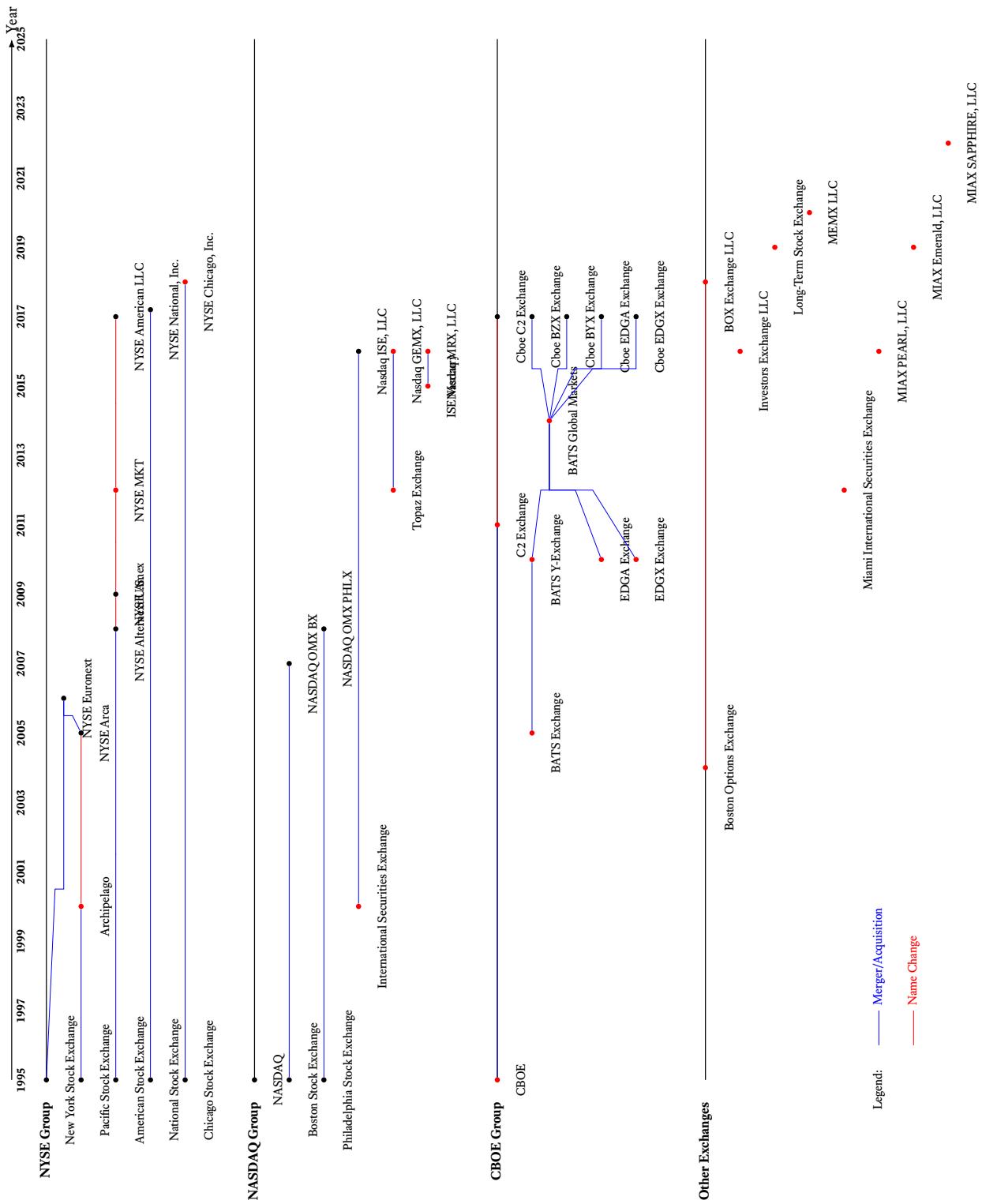


Figure 1: Consolidation in the market for control of stock exchanges

2.2 Prior literature

2.2.1 The exchange literature

Regulatory competition among stock exchanges and other market institutions has long attracted scholarly attention due to the inherent tension between regulatory stringency and market attractiveness (e.g., Fischel 1987; Macey and Kanda 1990; Kahan 1997; Poser 2001; Bradley 2002; Dom-balagian 2004; Seligman 2004; Karmel 2006; Fleckner and Hopt 2013). Exchanges continually face strategic decisions regarding how strictly to regulate companies listed on their platforms: stringent regulation may signal quality and stability, attracting long-term investors, but it might simultaneously deter firms seeking flexibility and lower compliance costs. Conversely, lenient standards may draw more issuers and traders in the short term, increasing profitability, but can risk undermining investor trust and long-term market legitimacy (Macey and O’Hara 2002; Coffee 2002; Jin and Min 2021).

These strategic trade-offs are particularly pronounced in rules governing the disclosure practices required from listed firms (e.g., Jin and Min 2021). But they are no less present, even if less well known, in rules shaping market structure, transparency, and data provision. For instance, the debates around market data fees and co-location services (e.g., McNamara 2018; Mahoney and Rauterberg 2018; Mahoney 2020) illustrate how exchanges leverage regulatory frameworks both to generate revenue and to strengthen their competitive positions, raising important questions of fairness and market integrity (see also, e.g., Tierney 2025a).

Such dynamics inevitably shape rule-making behavior, where exchanges frequently recalibrate rules to attract liquidity providers—entities whose active participation enhances market depth and efficiency—or to secure issuers whose listings bolster an exchange’s status and profitability. Competition between for-profit regulators thus can be characterized simultaneously by rule mimicry among exchanges—driven by market pressures toward similarity—and regulatory innovation, spurred by the need to differentiate and excel.

2.2.2 Regulatory competition

Regulatory competition sparks vigorous debate, and scholarship examining regulatory competition has traditionally oscillated between two opposing theoretical views. Some argue that profit-driven rivalries among jurisdictions push standards downward, stripping away meaningful safeguards to entice business (Bebchuk 1992).⁴ Others insist that competition fosters better rules, as reputational

⁴ Similarly, Cary (1974) famously articulated the “race to the bottom” thesis, arguing that competition among jurisdictions or regulators, when driven primarily by short-term profit incentives, tends toward minimal regulatory standards, compromising overall quality and effectiveness. Cary (1974)’s argument was grounded in observations of corporate law, but the logic applies broadly to regulatory domains: if market participants value minimal oversight, competition among regulatory entities may lower standards to attract business.

concerns, market discipline, and investor demands steer regulators toward heightened credibility and effectiveness (Kahan and Kamar 2002).⁵ These contrary visions capture the same tension: whether short-term profit motives degrade regulatory quality or spur innovation.

In addition, evolutionary economics and cultural diffusion theories provide another conceptual lens through which we can understand how regulatory ideas emerge, spread, and become entrenched across institutions.⁶ For example, Grajzl and Murrell (2021b, 2021a) apply these theories to show diffusion of ideas in written culture. Evolutionary perspectives layer on a dynamic lens: rules function as cultural variants subject to selective pressures. In a competition-focused environment, regulation itself transforms into a product, competing for legitimacy and profit-driven interest—an interplay that continuously reshapes the market for legal and institutional frameworks (e.g., Tiebout 1956; Peltzman 1976). Exchanges may adopt rules through imitation (mimicking successful standards observed elsewhere) or innovate new practices that diffuse outward if proven successful. Borrowing, adapting, or pioneering novel approaches may become a survival mechanism for institutions seeking advantage. The result is a market for regulatory services—a market for law—shaped through competition and evolution-like selection and diffusion processes.

3 Variables: Data and methodology

The empirical core of our study consists of regulatory rule texts published by major stock exchanges. These texts primarily include official documentation of listing standards, trading protocols, and policies governing market data dissemination.

3.1 Text as Data

For legal scholars, regulatory rules and related documents represent not merely prescriptive norms, but structured *discourses* that evolve over time, encoding regulatory priorities, institutional norms, and cultural contexts (e.g., Riles 2011). So complementing these econometric tools, recent scholarship increasingly turns to text mining and NLP methods to analyze regulatory documents as valuable textual data (e.g. Livermore and Rockmore 2019; Grimmer, Roberts, and Stewart 2022; Ash, Chen, and Galletta 2022; Stoltz and Taylor 2023). Legal scholars have historically done close readings

⁵ In the same vein, the “race to the top” perspective, articulated by Winter (1977) and Romano (1985), among others, posits that competition can incentivize regulators and regulated entities to adopt superior standards voluntarily. Under this view, market discipline and informed investor preferences pressure regulators toward innovative, effective, and robust regulatory frameworks that, over time, enhance market efficiency and legitimacy.

⁶ Regulators may also benchmark peers’ policies for cues on success or failure, as the economic literature on yardstick competition suggests (e.g. Shleifer 1985; Salmon 1987). Systematically comparing oneself to peer regulators can encourage creative adaptations, but also may fuel mimetic tendencies when the safe route is to copy established models.

of case decisions to glean meaning under common law interpretive methods (e.g., Pritchard and Thompson 2023). Introducing big data sets and computational methods from the social sciences might allow scholars to undertake what the digital humanities refers to as “distant reading” (Jockers and Thalken 2020), bringing a new perspective on these questions (e.g. Livermore, Riddell, and Rockmore 2017; Ruhl, Nay, and Gilligan 2018; Varsava 2020; Nay 2021; Alexander and Iannarone 2021; Davalos and Feroz 2022).

Techniques such as topic modeling—including Latent Dirichlet Allocation (LDA) and Structural Topic Modeling (STM)—can systematically identify and track these evolving themes in large bodies of regulatory texts (Blei, Ng, and Jordan 2003; Roberts et al. 2014). Topic modeling algorithms identify latent thematic structures within textual corpora, revealing shifts in the prominence or framing of regulatory concepts, allowing scholars to examine how particular regulatory language emerges, gains prominence, or fades away over time (Grajzl and Murrell 2024a). For legal scholars, this approach resonates with longstanding interests in law as discourse, enabling quantitative empirical investigations that complement traditional qualitative analyses of regulatory texts and jurisprudence (Livermore and Rockmore 2019; Grajzl and Murrell 2024a).

3.2 Data sources

3.2.1 Textual corpus in institutional and legal context

Our study uses NLP techniques to address some pivotal questions surrounding the production of regulatory rules by for-profit rulemakers. The study builds on previous work by Tierney (2025a, 2025b), who compiled a comprehensive dataset from the Federal Register, encompassing the plain text and metadata of every filing in every daily issue from 2000 to 2023, parsed from the GPO’s bulk XML data files (cf. Dolin 2021). As Tierney (2025a) surveys, relying on the same corpus to study the oversight of SRO rulemaking, the SEC considers whether to adopt SRO rules and must publish proposals for public comment akin to that for APA rulemaking. Each SRO rule proposal is assigned a file number representing the single proposal’s docket, and more than one document may be associated with a given rule proposal. The corpus includes initial notices of proposed rules as well as final rule notices.

We take Tierney (2025b)’s Federal Register corpus, focusing on a subset of 32,822 of these filings from the SROs. These SROs include the stock exchanges like New York Stock Exchange (NYSE) and NASDAQ Stock Exchange, two primary competitors in the market for listing services, as well as other categories of SRO such as clearing agencies and FINRA. As reflected in Section § 4 for discussion of the narrower corpus for this draft’s purposes—and its proof-of-concept for the conference proposal—we limit our analysis to 28,580 documents involving the stock exchanges with FINRA as a comparison “group,” though we expect to re-run the production model on the full

set of SRO filings.

3.2.2 Cleaning and processing data

Once we collect our corpus, the next but most extensive steps in legal analysis of textual data require preprocessing and cleaning (e.g. Bommarito 2021). The goal of these cleaning steps is to standardize linguistic content and facilitate computational text analysis. All of this is in service of dimension reduction.

Text preprocessing follows established NLP protocols but is adapted to the specialized legal-regulatory context. Initially, regulatory documents are cleaned to remove extraneous formatting, special characters, numerical identifiers, and non-informative text such as headers or non-English words, numerals, and so forth.

We tokenize documents. We remove so-called “stop words”—common language terms that provide minimal informational value—further streamlining the corpus for computational analysis. Subsequently, words are standardized through stemming or lemmatization, which reduce inflectional variations to their root forms, helping to consolidate semantically identical terms. The result is a corpus with a 35,437 word dictionary.

Finally, we integrate the cleaned textual corpus with document-level metadata (category, current name, date, and index), ensuring we can join the output of our structural topic model to other measures in our dataset, discussed next.

3.2.3 Additional metadata

In addition to the metadata that informs the STM, each document identified by an index number in our corpus is accompanied by rich metadata that provides important context for analysis. This structured metadata allows us to track the chronological evolution of regulatory ideas across exchanges and compare practices systematically within and across institutional settings.

Note to Conference Organizers 3: Next steps

To complement textual analysis, we plan during Summer 2025 to collect detailed quantitative data that bears on the nexus between industrial organization, regulatory policy, and shareholder wealth maximization. For instance, we intend to hand collect measures of listing, trading, and data market shares that will allow calculation the overall market concentration index, such as Herfindahl-Hirschman Indices (HHI), that quantifies the extent of market power and competitive intensity. These metrics enable us to assess empirically how regulatory rule changes influence exchanges' market positions and financial outcomes, providing concrete measures of competitive pressures and market performance. We are further compiling a timeline of significant regulatory and deregulatory events—for instance, major rule revisions, exchange mergers and acquisitions, and legislative interventions—that may affect the behavior of market participants.

3.3 Methodological framework

Grajzl and Murrell (2024b)'s framework of applying “recombinant novelty” to topic proportion data is pertinent here. It provides a way of quantifying how new regulatory ideas come about and whether different exchanges are truly diverging or converging in their approaches to rulemaking.

In other work (e.g., Grajzl and Murrell 2021b, 2022, 2024a) the authors look at the development of the common law by studying the distribution of ideas across a major legal corpus, the English Reports, containing the reports of case decisions from the United Kingdom from the 13th–19th centuries. They run a STM on a cleaned, digitized corpus of these case decisions, allowing for the estimation of document-level topic proportions as well as aggregate measures of topic proportions across time.⁷ In Grajzl and Murrell (2024b)'s original historical setting, each report of a case decision is represented mathematically as a distribution across multiple topics.

These methods permit derivative measurements, such as of a topic's prominence or novelty. For instance, a common-law decision about a creditor's attempt to attach a dowery might be reflected by a pair of underlying topics (t_i, t_j) found to co-exist in the document with relatively high theta (ϑ),⁸ such as “Marriage” and “Lien.”

Applying the method works in two steps, as the rest of this section elaborates. In the first step, we estimate an STM to identify the distribution of topics in the corpus. Here, “topics” can be understood as specific rulemaking elements in stock exchange proposals, such as listing standards,

⁷ Grajzl and Murrell (2022) address the estimation and identification of the topics from the corpus of case reports in the English Reports, putting the corpus in historical and cliometric context.

⁸ According to the STM package documentation, ϑ “captures the modal estimate of the proportion of word tokens assigned to the topic under the model”.

corporate governance requirements, or fee structures.

In the second step, because each document is a distribution of topic distributions, we follow the Grajzl and Murrell (2024b) framework for measuring topic prominence and document-level novel pairs of prominent topics not seen together recently. In this way, their framework identifies allows for the identification of novelty through the emergence of new combinations of topical elements that have not appeared together in a prior time window. By modeling each SEC filing as a mixture of “topics,” we can systematically identify when pairs of topics—or clusters of regulatory concepts—co-occur in ways that have not been seen before (e.g., a new combination of corporate governance rules and market data provisions), as an innovation measure.

3.3.1 Methodological approach to topic model and prominence measures

STM treats each regulatory text as a mixture of multiple topics, with each topic defined statistically as a distinct distribution over words within the entire corpus (Roberts et al. 2014). In practice, STM algorithmically identifies clusters of words that frequently co-occur across documents, revealing thematic groupings embedded within exchanges’ regulatory texts.

Importantly, unlike simpler methods such as LDA, STM explicitly incorporates document-level metadata—such as publication dates, exchange identifiers, and business line categorizations—directly into the estimation process (Roberts et al. 2014). This allows for the estimation of topics that meaningfully reflect both textual content as well as external contextual factors. Given our interest in tracking both thematic and temporal variations in exchanges’ regulatory discourse, STM is ideally suited to the analytical objectives of our study.

Note to Conference Organizers 4: Next steps

We pick $K = 100$ for this early draft but plan, for a conference draft, to determine an optimal number of topics K by using widely accepted statistical criteria and interpretative guidelines common in this kind of research, including goodness-of-fit measures and interpretive considerations.

Once STM has statistically identified latent topics $t \in K$, we qualitatively interpret each topic using its associated “key words” and exemplar texts—specific regulatory documents in which the topic is most prominent. Each topic produces two distinct lists of words used for interpretation: “highest probability” words, which occur most frequently within the topic, and “score” words, which uniquely characterize the topic compared to others. The “highest probability” words reflect terms most commonly associated with each topic, offering initial insight into its thematic substance. The “score” words, meanwhile, reflect terms particularly distinctive of that topic, helping further sharpen its interpretation.

Note to Conference Organizers 5: Next steps

As noted below at the end of § 5, we will also eventually categorize topic pairs into broader regulatory domains (D) such as corporate governance, market structure, fee arrangements, and technological systems. An appendix will include a list of the K number of topics and the subject labels we assign to them. This will also enable subject-matter-specific summation of topic-dependent novelty scores, as in Grajzl and Murrell (2024b).

This interpretive approach ensures that topic labels are substantively meaningful, enabling subsequent analysis to reflect clearly defined regulatory themes rather than abstract statistical constructs. By reviewing these word lists alongside the actual regulatory texts most strongly associated with each topic, we assign labels that succinctly and intuitively reflect each topic's thematic essence:

1. Listing standards encompass criteria such as required disclosures, corporate governance rules, and minimum financial thresholds companies must meet to list publicly on the exchange. A topic whose key words prominently include terms like “disclosure,” “governance,” “audit,” and “listing” might be labeled under a broad domain D of listing standards.
2. Trading rules articulate the operational aspects of securities transactions, including transparency requirements, order execution priorities, and restrictions on trading activities. Similarly, a topic characterized by words such as “execution,” “order,” “transparency,” and “speed” would appropriately be under D of trading rules.
3. Policies related to fees and market data cover pricing, distribution practices, and terms governing co-location and data access. Topics centering around “fees,” “data,” “access,” and “fairness” might be identified under D of market data.

Generating time series of topic prevalence constitutes the core analytical advantage of STM for our purposes. Using the document-level metadata we estimate how each topic's prevalence evolves across our study period. Specifically, STM calculates the proportion of the regulatory discourse devoted to each topic in each temporal interval, yielding time series that visualize the shifting importance of different regulatory themes. These prevalence time series provide concrete measures of when and how particular regulatory ideas gain prominence or decline, and we return to them in discussing novelty and mimicry below.

3.3.2 Measures of topic prominence and novelty

Unlike Grajzl and Murrell (2024b), who study common-law courts that operate within a collaborative/jurisdictional structure, our study focuses on stock exchanges in their role as regulators that are

nonetheless direct market competitors. This intensifies incentives for strategic behavior in rulemaking. Grajzl and Murrell (2024b)'s approach can be adapted to capture these competitive dynamics, however, by linking the appearance of novel regulatory concepts to the presence of alternative profit or listing motives. For instance, if the New York Stock Exchange (NYSE) introduces a novel governance rule, we can track whether NASDAQ quickly follows suit—or if each exchange seeks a distinct, “niche” path of novel innovation to attract different types of companies. Consequently, the measure of novelty is not only about identifying new combinations of rule elements but also about detecting whether one competitor's novel combination appears soon after the other's, suggesting imitation or convergence—a topic we return to in 5.

Defining prominence involves setting a threshold that highlights the top “core” themes of a filing, recognizing that a single proposal may address multiple regulatory dimensions—in an update to the listing manual might include discussion about fees, board governance, compliance obligations, and so on. This approach may identify a handful of prominent topics per filing, representing the core regulatory domains addressed.

For each f_d , or filing f submitted at time d ,⁹ we first identify its set of “prominent topics” $P(f, d)$ and then construct all unique pairs of prominent topics $\{t_i, t_j \in P(f, d)\}$. For example, if a filing's prominent topic set is $\{4, 12, 15\}$, the resulting pairs will be: $(4, 12)$, $(4, 15)$, $(12, 15)$. Following Grajzl and Murrell (2024b), we define topic prominence through a statistical threshold approach, classifying topic i as “prominent” within filing t if their proportion theta ($\vartheta_{t,i}$) exceeds two standard deviations (2σ) above the mean topic proportion ($\bar{\vartheta}_i$) for documents across the corpus.

Applying Grajzl and Murrell (2024b)'s concept of “recombinant novelty,” we then look at pairs of prominent topics in each filing and test whether those pairs have appeared in the preceding time window (w). A pair of prominent topics (t_i, t_j) is flagged as novel if it has not appeared in any filing in the preceding w days, i.e., in the lookback window $[t - w : t]$. Formally, we define T_d as the set of all pairs of novel topics in $P(f, d)$. A pair $(t_i, t_j) \in P(f, d)$ is flagged as novel if it is absent in the collection:

$$C_{t-w:t} = \{(t_i, t_j) \text{ observed in filings with dates in } [t - w : t]\}.$$

In practice, we filter documents using a cutoff date so that only pairs with no prior appearance within the w -day lookback window are retained for further processing. To avoid false positive indicators of novelty by ensuring we have a full window w , we exclude the first w days observed in the dataset.

Note to Conference Organizers 6: Data analysis

We choose a value of w equal to 180 days, but plan to do sensitivity testing as part of the broader project.

⁹ We use d to denote timing to avoid confusion with topics $t \in K$.

We further incorporate cosine-similarity-based discounting to account for how “natural” or “easy” it is for these topics to appear together. The framework discounts each new topic pair’s contribution based on how naturally the topics tend to co-occur within the past lookback window w . For each novel topic pair $(t_i, t_j) \in P(f, d)$, we evaluate the extent to which the co-occurrence of t_i and t_j is expected, based on historical co-occurrence with other topics ($q \in Q$) over a predefined topic range (e.g., $\{K \in 1 : 100\}$). Let the set of all other topics be

$$Q = \{1, 2, \dots, T\} \setminus \{t_i, t_j\},$$

where T is the total number of topics (e.g., 100). In other words, for each topic $q \in Q$, we are looking at the count of co-occurrence of t_i and t_j with q over the lookback period $[t-w:t]$. We define co-occurrence counts as follows:

$$v_i(q) = \sum_{d \in D(t-w:t)} \mathbb{I}\{t_i \in T_{f_d} \wedge q \in T_{f_d}\},$$

$$v_j(q) = \sum_{d \in D(t-w:t)} \mathbb{I}\{t_j \in T_{f_d} \wedge q \in T_{f_d}\},$$

where:

- $D(t-w:t)$ is the set of filings (documents) in the lookback window,
- T_{f_d} denotes the set of prominent topics in filing f_d ,
- $\mathbb{I}\{\cdot\}$ is an indicator function that returns 1 if the condition is true and 0 otherwise.

These counts form two vectors:

$$\vec{v}_i = (v_i(q))_{q \in Q}$$

$$\vec{v}_j = (v_j(q))_{q \in Q}$$

The cosine similarity between these vectors is then given by:

$$\cos(\vec{v}_i, \vec{v}_j) = \frac{\vec{v}_i \cdot \vec{v}_j}{\|\vec{v}_i\| \|\vec{v}_j\|} = \frac{\sum_{q \in Q} v_i(q) v_j(q)}{\sqrt{\sum_{q \in Q} (v_i(q))^2} \sqrt{\sum_{q \in Q} (v_j(q))^2}} \quad (1)$$

And the discounted novelty measure N for the set of prominent topics T_{f_d} for each filing f on date d is then defined as:

$$N(T_{f_d}) = 1 - \cos(\vec{v}_i, \vec{v}_j). \quad (2)$$

The cosine-similarity discounting approach addresses a key methodological challenge: distin-

guishing genuinely innovative recombinations from predictable extensions of existing regulatory patterns. The cosine similarity between these vectors, $\cos(\vec{v}_i, \vec{v}_j)$, provides a measure of how naturally these topics tend to appear together given their associations with other regulatory concepts. The discounted novelty score for each pair is then computed as $1 - \cos(\vec{v}_i, \vec{v}_j)$, with higher values indicating less predictable combinations. If one or both topic vectors are zero (i.e., $\|\vec{v}_i\| = 0$ or $\|\vec{v}_j\| = 0$) because there is no historical co-occurrence information found, $\cos(\vec{v}_i, \vec{v}_j) = 0$, making novelty set to 1—reflecting maximum novelty and no discount. By contrast, if a pair of topics already shares a great deal of similarity in prior proposals (e.g., they are often discussed with the same related pairs of topics in earlier filings), then the discounted novelty measure allows us to de-weight the perceived novelty of that combination. As Grajzl and Murrell (2024b) note, this discounting step helps separate “truly new” regulatory innovations from predictable, incremental changes in overlapping rule areas.

We aggregate filing-level novelty scores to derive a periodic measure of each exchange’s cumulative novelty. By summing up the “new” topic-pairs introduced within a specific time period, we obtain a measure of the overall level of regulatory innovation. This allows us to compare the trajectory of novelty not just between NYSE and NASDAQ, but also to track whether there has been a systematic rise or fall in rulemaking innovation following certain reforms (e.g., after Dodd-Frank). Moreover, by disaggregating those novelty scores by “type” of rule—for example, distinguishing corporate governance proposals from fee filings or order-type proposals—we can gauge whether competition leads to differentiation in some areas (like listing standards) but convergence in others (like operational market rules). We compute an exchange’s total quarterly novelty index $N_e(Q)$ by summing the discounted filing-level scores:

$$N_e(Q) = \sum_{f_t \in F_e(Q)} N(T_{fd}) \quad (3)$$

We also calculate the weighted average quarterly novelty index $\bar{N}_e(Q)$ by taking the average discounted filing-level score by exchange e during quarterly period Q , where S is the count of $F_e(Q)$:

$$\bar{N}_e(Q) = \sum_{f_t \in F_e(Q)}^S \frac{N(T_{fd})}{S} \quad (4)$$

4 Preliminary Results

Applying the recombinant-novelty approach to our corpus, we first estimate an STM with $k = 100$. We return summary statistics on the \bar{v}_i values for the topics, which are reported in table 1.

We report the time series of these quarterly novelty indices $\bar{N}_e(Q)$ for NYSE and NASDAQ

	Topic i 's theta ($\bar{\vartheta}_i$)	Topic SD ($\sigma_{\vartheta,i}$)
Minimum	.00205	.01831
1Q	.00517	.02848
Median	.006609	.03786
Mean	.010000	.04086
3Q	.010357	.04683
Max	.095754	.14156

Table 1: Summary statistics from the 100 topics estimated in the STM

(comparing them to FINRA, the non-exchange association of broker-dealers) in figure 2, and for all exchanges e in appendix figure 5. The appendix also includes time series of the unweighted novelty indices $N_e(Q)$ for the subset and full panel in figures 3 and 4 respectively. Finally, we sum and report in appendix table 2 the total and weighted scores for each exchange e during all quarters $Q \in 2000 : 2023$.

5 Next steps: Measuring rulemaking convergence and divergence

Note to Conference Organizers 7: Next steps

The rest of this paper is a bit speculative, depending on how much can be completed by the Law and Society Association conference in Chicago in late May. We do expect to complete a substantial part of this analysis before Data Science & Law in August.

The Grajzl and Murrell (2024b) framework could also help illuminate whether competition yields convergence (when both exchanges adopt a similar set of novel ideas) or divergence (when they pursue distinct innovative pathways). When each exchange's novelty score is analyzed in conjunction with measures of textual similarity (e.g., pairwise cosine similarities among filings), we can empirically map patterns of competition: Are both NYSE and NASDAQ simultaneously introducing the same new governance topics? Or is one focusing on novel corporate oversight provisions, while the other invests in new fee or data arrangements?

To analyze competitive dynamics, we plan to extend the Grajzl and Murrell (2024b) framework by incorporating exchange-specific measures and inter-exchange comparisons. We plan to take the quarterly novelty indices, $N_e(Q)$, allowing us to test whether demutualization is associated with increased regulatory innovation, as predicted by Mahoney (1997), by comparing pre- and post-demutualization novelty rates through interrupted time series analysis with controls for exogenous

Time Series of Exchange-Level Quarterly Novelty Scores by Current Exchange Name
 Limited to subset of NYSE and NASDAQ, Weighted by Filings Per Exchange Per Quarter

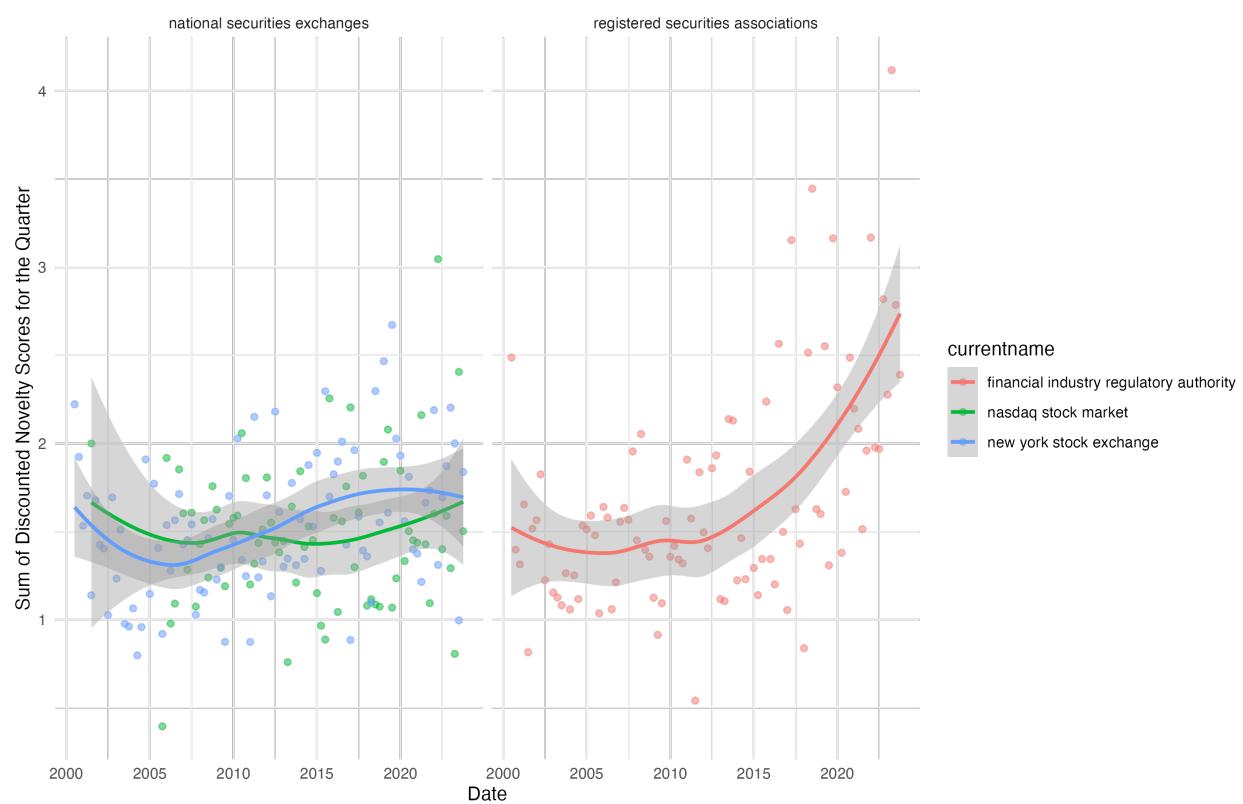


Figure 2: Weighted time series of the derived quarterly novel indices $N_e(Q)$, limited to NYSE and NASDAQ

regulatory shocks (e.g., Sarbanes-Oxley implementation, Dodd-Frank provisions).

Economists and political scientists studying regulatory competition and market structure have extensively used econometric methods to understand market responses to regulatory shifts. Panel data econometrics, in particular, offers powerful tools such as “diff-in-diff” methods to identify the causal impacts of regulatory events on market outcomes, including profitability, market share, and competitive behavior among exchanges. Difference-in-differences methods leverage naturally occurring experiments—such as regulatory changes implemented at specific points in time—to compare market outcomes before and after the introduction of new regulations across treated and control groups (Bertrand, Duflo, and Mullainathan 2004).

For statistical inference, we could use diff-in-diff methods to isolate the causal effect of demutualization on regulatory innovation, using exchanges that demutualized at different times as comparison groups. It seems we could implement a staggered adoption design with two-way fixed effects to account for exchange-specific characteristics and temporal trends:

$$N_e(Q) = \alpha_e + \gamma_Q + \delta D_{e,Q} + \beta X_{e,Q} + \epsilon_{e,Q} \quad (5)$$

where $N_e(Q)$ is the novelty score for exchange e in period Q , α_e and γ_Q are exchange and time fixed effects, $D_{e,Q}$ is a demutualization indicator, and $X_{e,Q}$ is a vector of time-varying controls including exchange trading volume, market capitalization, and regulatory environment indicators.

To test hypotheses regarding domain-specific patterns of innovation, we could categorize topic pairs into broader regulatory domains (D) such as corporate governance, market structure, fee arrangements, and technological systems. For each domain $d \in D$, we compute domain-specific novelty scores $N_e^d(Q)$ by filtering topic pairs based on their domain classification. This approach should enable nuanced analysis of whether competition yields innovation across all regulatory dimensions equally or differentially impacts specific domains—a question central to evaluating demutualization’s effects.

Note to Conference Organizers 8: Additional measures

There are additional ways of investigating convergence versus divergence in regulatory approaches, including (1) Jaccard similarity and (2) a lagged imitation measure that identifies the degree to which exchanges are introducing similar regulatory innovations simultaneously (proportion of exchange e_1 ’s novel combinations in period $T - 1$ that appear in exchange e_2 ’s filings in period T). We are also exploring (3) a sliding-window hash function approach as an additional measure of mimicry as a robustness check on these Jaccard similarity and lagged imitation measures. We otherwise set these aside for today’s purposes.

6 Discussion

Note to Conference Organizers 9: Next steps

We want to be a bit circumspect about the discussion and theoretical implications until the rest of the results are in, but this is a general way of thinking about our next steps.

This project draws on NLP methods to help illuminate the scholarly understanding of regulatory competition dynamics in the market for stock exchange services. Profit incentives often encourage exchanges to adopt minimal or established regulatory standards to attract immediate business and boost short-term profitability, consistent with classic “race-to-the-bottom” arguments. Simultaneously, powerful network effects, especially pronounced in market data and trading services, and reputational bonding effects in listing markets, incentivize exchanges to converge around widely accepted regulatory practices, reinforcing institutional isomorphism and “regulatory stickiness.”

Methodologically, this study demonstrates the substantial value of integrating textual analysis, econometric techniques, and evolutionary modeling into a coherent analytical framework for examining regulatory and institutional dynamics. This methodological integration is broadly applicable beyond the financial regulatory context studied here, offering powerful analytical tools for scholars investigating regulatory behavior in diverse institutional settings and policy arenas. Future research should extend this approach by undertaking cross-jurisdictional comparisons to assess how regulatory competition dynamics differ across national and international contexts.

7 Conclusion

This study set out to investigate how regulatory competition among modern stock exchanges influences the evolution of rule-making practices, with attention to novelty, innovation, and mimicry. We ask how exchanges—operating in competitive, profit-driven environments—develop and diffuse regulatory ideas across different business lines, and how these processes affect broader market outcomes.

To answer these questions, we use an innovative methodological framework that combines STM of regulatory texts, with planned panel econometric analysis of financial performance and market structure. Our approach allows us to track the prevalence of regulatory ideas over time, and identify relationships between regulatory shifts and market practice.

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8 Tables and Figures

Category	Current Name	Total Novelty	Weighted Novelty
Reg. Sec. Ass'n	Financial Industry Regulatory Authority (FINRA)	1971.47	157.92
Stock Exchange	new york stock exchange	1541.81	144.81
	chicago board options exchange	1321.58	105.28
	nyse arca	1234.30	109.60
	nasdaq phlx	1154.69	135.18
	nasdaq stock market	1128.06	110.06
	nyse american	1112.49	131.94
	nasdaq ise	710.69	137.42
	cboe bzx exchange	660.06	91.40
	nasdaq bx	619.02	125.64
	cboe exchange	372.61	40.18
	cboe edgx exchange	342.99	81.12
	nyse chicago	340.95	117.08
	box exchange	329.02	79.75
	miami international securities exchange	322.97	70.19
	pacific exchange	286.82	31.74
	nyse national	230.96	119.07
	cboe byx exchange	227.49	74.70
	cboe edga exchange	204.12	70.87
	miax pearl	182.57	55.85
	investors exchange	163.43	45.13
	nasdaq gemx	151.03	50.01
	c2 options exchange	110.58	34.37
	miax emerald	103.75	28.25
	nasdaq mrx	85.10	37.87
	memx	59.99	26.15
	cboe c2 exchange	52.05	31.82
	long-term stock exchange	12.52	10.49
	cincinnati stock exchange	5.31	5.31
	pacific stock exchange	3.91	3.91

Table 2: Total novelty scores for SROs observed in this run

Time Series of Exchange-Level Quarterly Novelty Scores by Current Exchange Name
 Limited to subset of NYSE and NASDAQ, Not Weighted by Filings Per Exchange Per Quarter

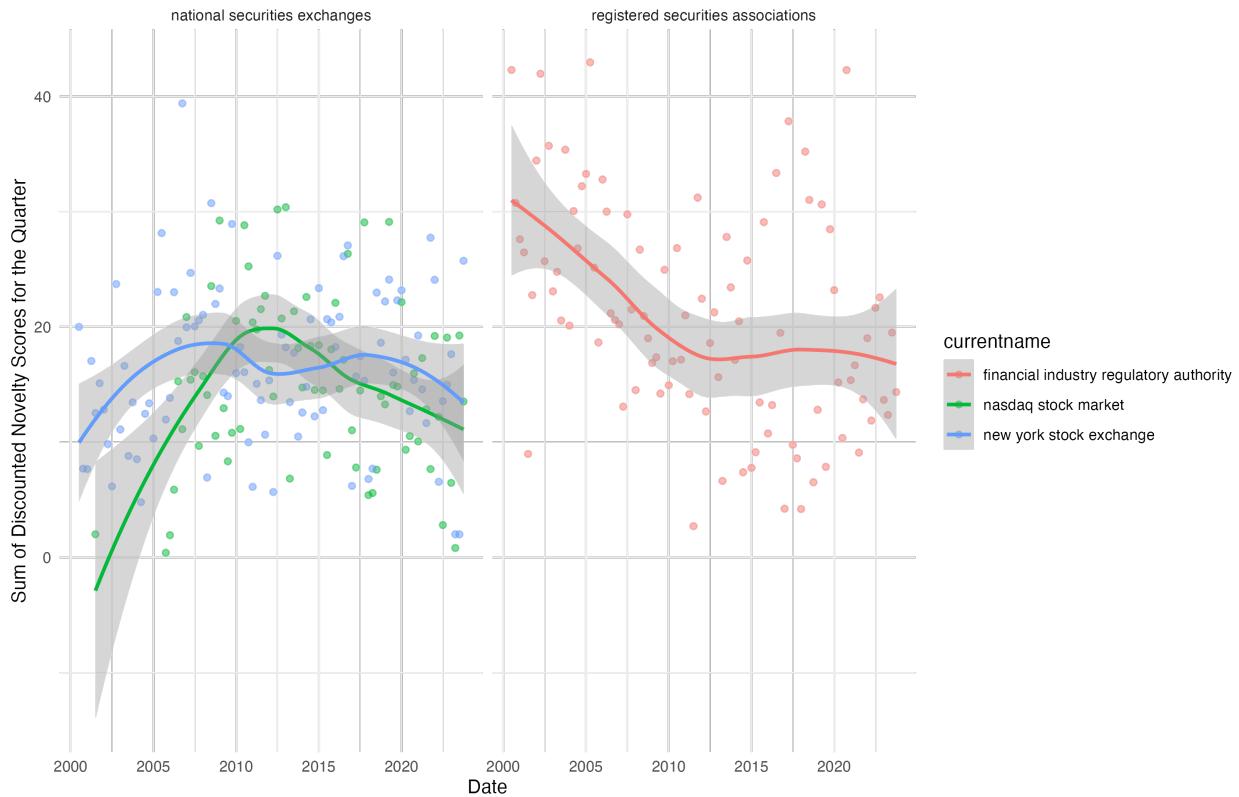


Figure 3: Unweighted time series of the derived quarterly novel indices $N_e(Q)$, limited to NYSE and NASDAQ

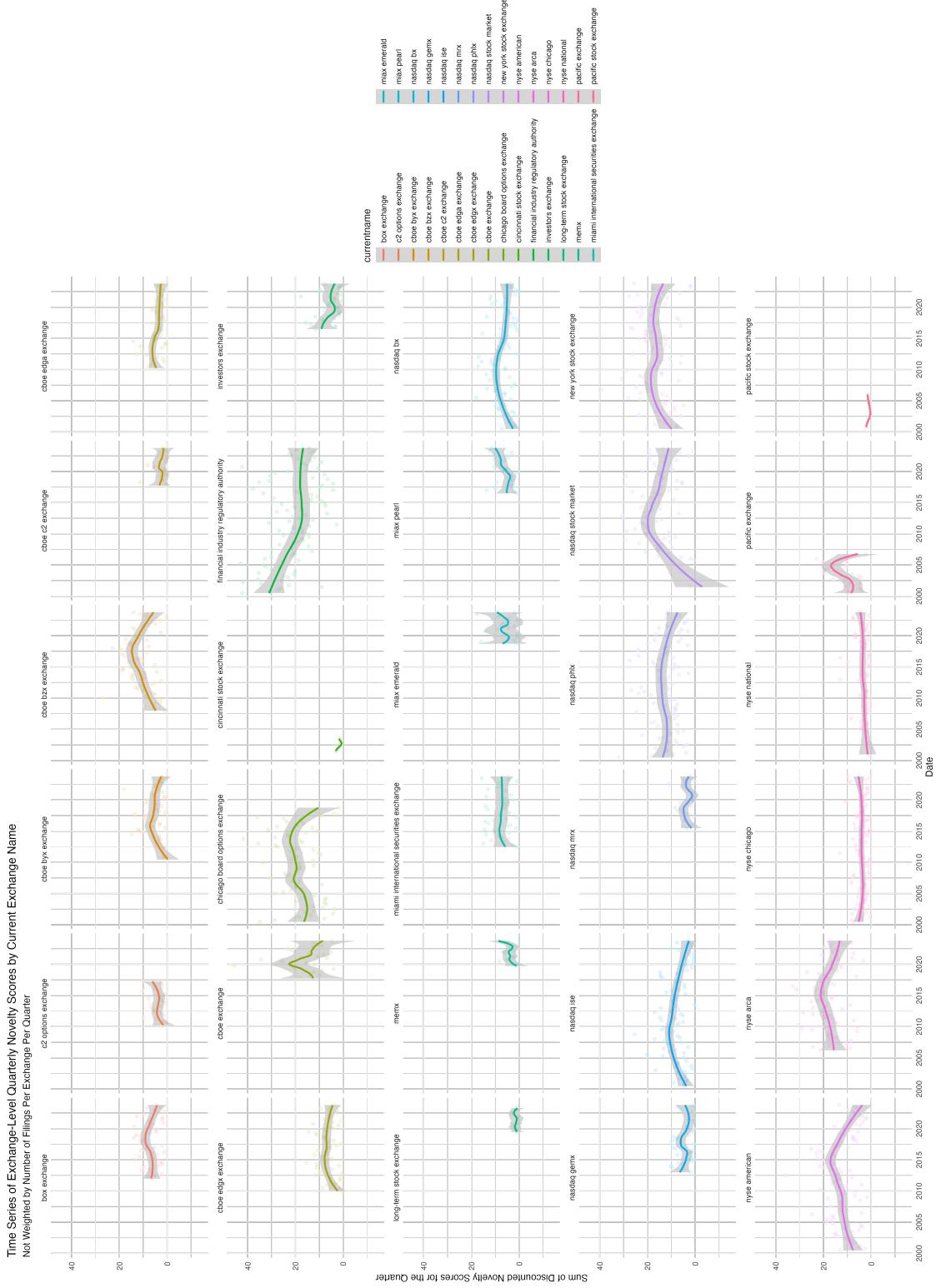


Figure 4: Unweighted time series of the derived quarterly novel indices $N_e(Q)$

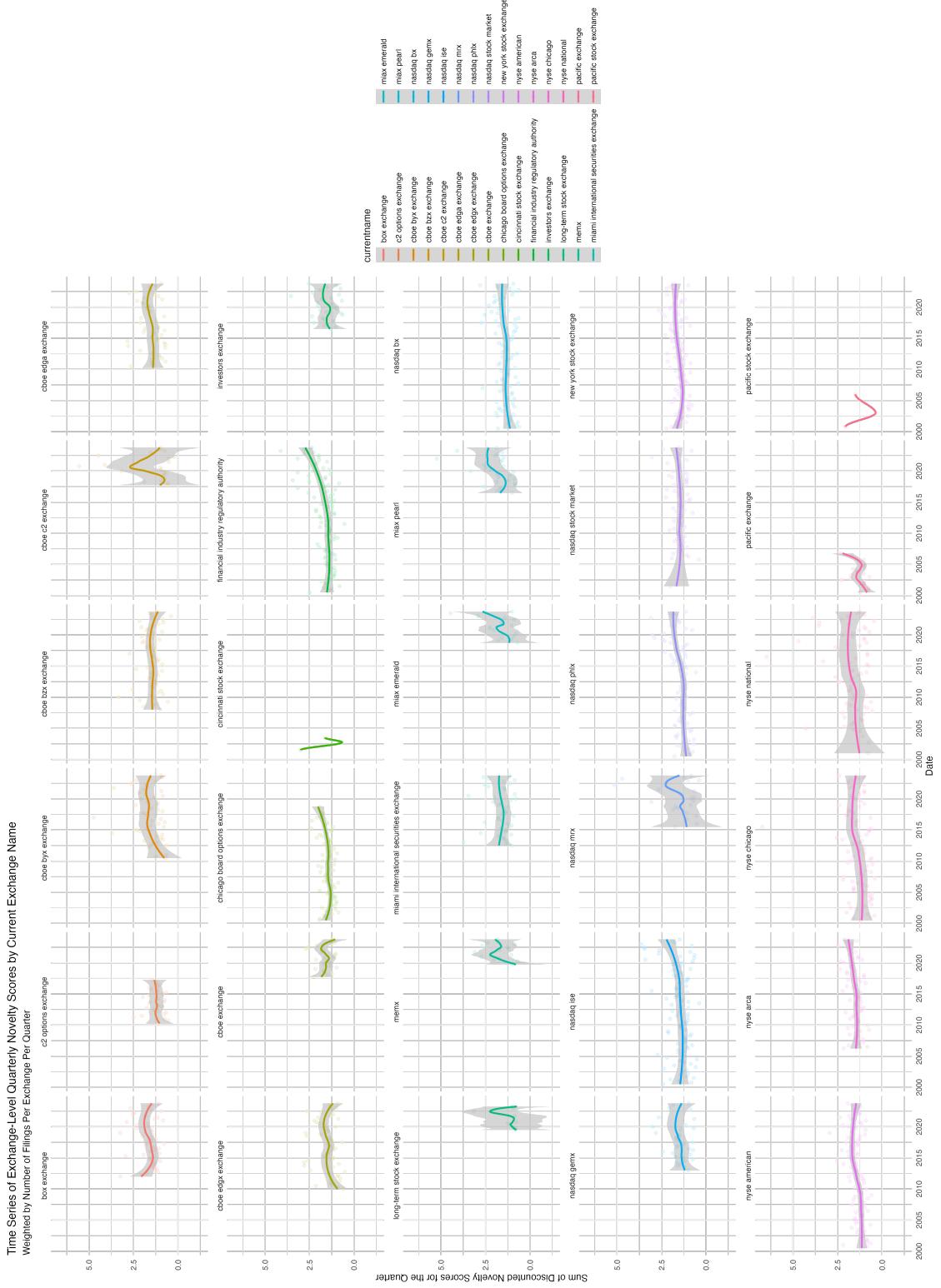


Figure 5: Weighted time series of the derived quarterly novel indices $N_e(Q)$