Learning to Disclose: Disclosure Dynamics in the 1890s Streetcar Industry *

Thomas Bourveau[†] **Matthias Breuer**[‡] **Robert Stoumbos**[§]

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Abstract

We study the descriptiveness of the "unravelling" prediction in the 1890s streetcar industry. In this historical setting, capital-intensive streetcar companies gain the opportunity to disclose their earnings to dispersed investors via a new, quarterly newspaper supplement. We document that a quarter of the companies withhold their earnings from the first supplement, inconsistent with the "unravelling" prediction. However, almost all these companies start disclosing within the next couple of supplements, with the relatively-better companies among the remaining non-disclosers initiating disclosure and leaving the pool of non-disclosers each quarter. We interpret these stylized facts through the lens of a disclosure model featuring level-k thinking. Our model estimates that a substantial share of the companies employs a lower level of strategic thinking in the first supplement. This deviation from rational expectations appears to explain the initial failure of the "unravelling" prediction. Over time, companies appear to adopt higher levels of thinking, contributing to the rapid convergence to an (almost) full disclosure equilibrium. Collectively, our evidence is consistent with market forces yielding an (almost) full disclosure equilibrium in the medium to long run through repetition and learning.

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[†]Columbia University, Graduate School of Business - tb2797@columbia.edu
[‡]Columbia University, Graduate School of Business - mb4468@gsb.columbia.edu
[§]Columbia University, Graduate School of Business - rcs2188@gsb.columbia.edu

1 Introduction

Corporate disclosure mandates are pervasive. Yet, the need for these mandates is often challenged (e.g., Ben-Shahar and Schneider, 2014; Loewenstein et al., 2014; Leuz and Wysocki, 2016). Most prominently, the "unravelling" result of Ross (1979), Grossman (1981), and Milgrom (1981) suggests that companies find it worthwhile to disclose even absent mandates. The descriptiveness of this analytical result, however, remains unclear. For one, it relies on a number of strong assumptions (e.g., Beyer et al., 2010). For another, it is challenging to test, as most relevant corporate disclosures have been mandated since the Securities Exchange Act (SEC) of 1934 (e.g., Greenstone et al., 2006).

To learn about the descriptiveness of the "unravelling" result, we examine the disclosure behavior of companies in an unregulated environment, before the SEC era. We focus on the streetcar industry in the 1890s, a capital-intensive industry that experienced a boom during that decade due to electrification. The electrification and expansion made it the chief mode of urban transport and created investment opportunities for national and even international investors. To satisfy investors' demand for information about the new investment opportunities, the *Commercial & Financial Chronicle* (the *Chronicle*, hereafter), the main source for financial news at the time, started issuing a quarterly supplement dedicated to reporting company-specific information on almost all existing streetcar companies. This new publication outlet allows studying the beginning of the streetcar industry's disclosure game *and* its evolution, a rare feat in real-world settings outside of controlled lab experiments.

The "unravelling" result predicts that streetcar companies, even absent a disclosure mandate, would willingly disclose their types to investors via the *Chronicle's* supplement, because they expect sceptical investors to take non-disclosure as the worst possible signal about a company's type. The streetcar industry with its new publication outlet constitutes a suitable real-world testbed for this "unravelling" prediction. It provides an early setting in which capital-intensive companies issued securities to a broad set of external investors absent any disclosure mandates. Moreover, it allows investigating the voluntary disclosure of earnings,

a key measure of companies' types, in a comprehensive and central publication outlet. Early investment advice for streetcar investors singled out earnings relative to invested capital as a fundamental ratio for assessing type among streetcar companies (e.g., Thompson, 2017). Given the homogeneous nature of the industry, this ratio is particularly useful for comparing streetcar companies' relative types.

The "unravelling" prediction rests on the assumptions that (a) investors know that companies possess private information about their types; (b) disclosures are costless; (c) disclosures are credible; and (d) companies and investors have rational expectations about each others' disclosure and valuation decisions.[1] The institutional details of the streetcar industry plausibly approximate several of these assumptions. Investors can expect streetcar companies to know such basic information as their earnings (supporting (a)). The direct costs of disclosures are borne by the subscribers of the *Chronicle*, not the companies providing disclosures, and the indirect costs of disclosures (e.g., political and proprietary costs) are likely limited (supporting (b)).[2] Finally, the disclosures are likely credible as the *Chronicle*, known as a trusted source of financial information at the time (e.g., Dewing, 1914; Bernheim and Schneider, 1935), put substantial effort into obtaining information that was not only comprehensive, but also accurate (supporting (c)). In support of this argument, we document that earnings (scaled by invested capital) reported in the *Chronicle* were highly value relevant, explaining a remarkable 58% of the cross-section of investors' stock price valuations.

The descriptiveness of the "unravelling" prediction in the streetcar industry accordingly hinges on the assumption of rational expectations. Unlike the assumptions about private information endowment (e.g., Dye, 1985; Jung and Kwon, 1988), disclosure costs (e.g., Jo-

[1] Beyer et al. (2010) spells out a number of further model primitives, including the assumption that companies care about investors' valuation and that investors interpret disclosures in a homogeneous way. These primitives align with our setting, which features capital-intensive companies disclosing earnings—a pivotal piece of information with a clear mapping into value—to their dispersed investors.

[2] Several institutional features suggest indirect disclosure costs were of limited concern. The *Chronicle*, which commanded a relatively high price from its subscribers, was specifically targeted at investors, not regulators or competitors. In addition, local regulators and competitors, unlike more distant investors, could already assess the profitability of streetcar companies given the simple business models and locally observable utilizations, rendering the disclosures in the *Chronicle* redundant for regulators and competitors.

vanovic, 1982; Verrecchia, 1983), and disclosure credibility (e.g., Crawford and Sobel, 1982; Stocken, 2000), the rational expectations assumption, albeit quite stark, has received little attention in the corporate disclosure literature to date. It requires that companies and investors, in equilibrium, correctly anticipate each others' disclosure and valuation decisions.[3] This assumption appears particularly demanding for the streetcar companies in our setting, which are experimenting with public disclosure for the first time upon the *Chronicle's* initiation of its supplement. For these companies, the best disclosure policy crucially depends on their beliefs over what the other companies and investors will do. This higher-order belief formation is challenging for a decision which has not been made or observed before, according to lab evidence in the economics literature (e.g., Bosch-Domènech et al., 2002; Camerer et al., 2004; Crawford et al., 2013).[4] The lab evidence documents an initial failure of rational expectations and subsequent belief revisions in games like the streetcar companies' disclosure game (e.g., Nagel, 1995; Stahl, 1996). According to this literature, a violation of the rational expectations assumption can lead to a breakdown of the "unravelling" result, at least initially, while the companies are still trying to understand the disclosure game and update their beliefs.

To examine the evolution of the disclosure equilibrium in the streetcar industry, we collect information on streetcar companies covered in the *Street Railway Journal*'s first annual supplement from June 1894 and the *Chronicle's* first eight quarterly supplements from March 1895 to November 1896. We obtain information on companies' earnings disclosures, invested capital, and location using a combination of automatized optical-character recognition and manual checking and collecting of scans of the historical documents archived by the Federal

[3]Rational expectations require both rationality and common knowledge. Rationality means that companies and investors are utility maximizers. Common knowledge means that all companies and investors know that everyone is a utility maximizer and correctly anticipate each other's best responses (Reny, 1988).

[4]In contrast to the disclosure decision of streetcar companies, the rational expectation assumption is likely more descriptive for the valuation decision of investors. The investors have prior experiences regarding the relation of disclosure and valuation from railroad companies. Moreover, their valuation decision is less strategic and more straightforward. As long as they have a sense for the distribution of types, they can value disclosing companies according to their disclosed types and non-disclosing companies according to the average type of non-disclosing companies.

Reserve Bank of St. Louis (available on FRASER) and university libraries (available on HathiTrust Digital Library). The time-series dimension of our data allows us to investigate potential dynamics in companies' disclosure decisions, which are possibly due to deviations from rational expectations and belief revisions.

The historical streetcar data reveal three striking descriptive findings. First, about 75 percent of companies disclose in the first supplement. Second, the disclosure rate increases rapidly to reach almost 100 percent by the time the eighth *Chronicle* supplement is issued (i.e., within two-and-a-half years).[5] Third, there is a steady decline over time in the average company type among non-disclosing companies, where each company's type is proxied by the earnings-over-capital ratio reported in the eighth *Chronicle* supplement.[6] These findings are inconsistent with *immediate* "unravelling," but suggest that the "unravelling" prediction may be descriptive in the medium to long run, as relatively better companies appear to successively leave the pool of non-disclosing companies.

To better understand the aggregate disclosure dynamics, we estimate a discrete choice model which allows for, but does not impose, deviations from rational expectations. As a specific version of deviations from rational expectations, we use level-k thinking, an iterative best response model, following an extensive behavioral game theory literature (e.g., Nagel, 1995; Crawford et al., 2013; Crawford, 2019). Under level-k thinking, some companies may fail to form rational expectations because they stop short of iterating through other companies' best disclosure responses and investors' best valuation responses. Companies employing level 0 thinking, for example, neglect any strategic behavior of other companies and investors. Accordingly, they act as if they randomize their disclosure decision. Level 1 com-

[5]The sample for this stylized fact includes companies that never report their earnings in our sample period. We know of these companies since they are reported in the newspaper supplements. Both the *Street Railway Journal* and the *Chronicle* listed companies for which they lacked earnings information. For both newspapers, their stated goal was to cover all streetcar companies in America, and to that end they would list companies for which they had very little information.

[6]We use the earnings-over-capital ratio (i.e., return on invested capital, where capital includes stocks and bonds outstanding) as reported in the eighth *Chronicle* supplement as a cross-sectional measure of companies' types. Any change in the average type among the non-disclosing companies over time accordingly reflects changes in the composition of the pool of non-disclosing companies.

panies, by contrast, understand that, if all companies randomize their disclosures, strategic investors expect non-disclosing companies to be of average type. Accordingly, level 1 companies disclose only if their type is above average. Level 2 companies further understand that, if above-average companies disclose, strategic investors expect non-disclosing companies to be of below-average type. As a result, level 2 companies even disclose if they are of below-average type, but of higher type relative to the average of the below-average types. Following this iterative thinking, the disclosure threshold that companies use declines with their level of strategic thinking. The highest level of thinking ($k = \infty$) iterates through all levels of best responses, ultimately arriving at the familiar "unravelling" response.

The estimates from our model uncover evidence consistent with lower levels of strategic thinking contributing to the failure of full "unravelling" in the *Chronicle's* first supplement. The model further shows evidence of learning over time (e.g., Stahl, 1996), estimating that the streetcar companies adopted higher levels of thinking in the later supplements and adjusted their thinking toward levels that, for the previous supplement, implied disclosure thresholds closer to the ex post optimal threshold. This apparent learning is consistent with evidence from lab experiments (e.g., Nagel, 1995). Strikingly, it is also consistent with the *Chronicle's* assessment of the situation (*Commercial & Financial Chronicle*, 1894, p. 1):

> "*The newly-organized 'traction companies'* [i.e., streetcar companies] *to some degree partake of the* ***disinclination*** *of the old companies* ***to give to the public the information*** *to which it is properly entitled. Eventually, most of the companies will* ***learn*** *that it is of incalculable value to them to possess the full* ***confidence of the investing public****, and that such confidence can never be secured so long as full and intelligible reports and* ***frequent statements of earnings*** *are withheld. At present not a few organizations treat requests for data respecting their finances in a manner that shows a* ***lack of knowledge*** *regarding their best interests. [W]e believe the policy adopted is* ***short sighted****.*" (emphasis added)

Our estimates and inferences are robust to accounting for a common disclosure cost, random company-time varying disclosure benefits, and controls for time-varying competition and capital raising. This robustness allays concerns that our level-k thinking and learning estimates capture omitted differences in disclosure costs and benefits, or changes in funding

needs and investment opportunities over time. We further compare the fit of our model, allowing for deviations from rational expectations and learning over time, with the fit of a nested model restricting companies to rational expectations at all times. Compared to the rational expectations model, our model exhibits a significantly higher model fit (log-likelihood), even after accounting for differences in the number of model parameters. This comparison suggests that heterogeneity in beliefs and learning appear relevant for understanding the disclosure dynamics in the streetcar industry.

Our paper contributes to the disclosure literature by examining the seminal "unravelling" result in a real-world setting. Prior literature investigates the impact of uncertainty over companies' information endowment (e.g., Dye, 1985; Bertomeu et al., 2020b), disclosure costs (e.g., Verrecchia, 1983; Berger, 2011; Li et al., 2018), and disclosure credibility (e.g., Stocken, 2000; Rogers and Stocken, 2005; Ball et al., 2012) on their voluntary disclosure decisions. We complement this literature by focusing on another important assumption underlying the "unravelling" result: rational expectations. While lab experiments consistently show that deviations from rational expectations can lead to an (initial) breakdown of the "unravelling" result (e.g., Nagel, 1995), we document some of the first evidence of the impact of deviations from rational expectations on disclosure in a real-world corporate setting. In this vein, our paper adds to the growing literature on the impact of informational constraints on companies' disclosure behaviors (e.g., Gassen and Muhn, 2018).

Our paper provides a new explanation for disclosure dynamics. Several empirical papers document changes in disclosure rates over time (e.g., Heitzman et al., 2010; Berger et al., 2019; Gassen and Muhn, 2018). Theoretical work on disclosure dynamics, however, is still scarce (for notable exceptions, see, e.g., Einhorn and Ziv, 2008; Bertomeu and Liang, 2008; Guttman et al., 2014; Bertomeu et al., 2015; Zhou, 2020). We propose and test a novel explanation for disclosure dynamics based on deviations from rational expectations and learning. While we use a particular model of boundedly rational expectations, we explicitly rely on an established model with "strong experimental support, which allays the concern

that once one departs from equilibrium, 'anything is possible'" (Crawford and Iriberri, 2007, p. 1724). We acknowledge that other models with similar ingredients, including rational Bayesian updating with heterogeneous priors, could provide similar predictions. Accordingly, we do not purport to estimate the *one* true model. We rather propose one novel way of looking at the data through the lens of a workhorse model in the behavioral game theory literature.

Our paper is related to and borrows from several strands of the literature. It is related to the burgeoning literature using structural estimation with the goal of assessing the descriptiveness of seminal disclosure theories and uncovering fundamental parameters of interest (e.g., companies' private information endowment, disclosure costs, or beliefs) (e.g., Bertomeu et al., 2015, 2020a; Beyer et al., 2019; Bertomeu et al., 2020b; Zhou, 2020). It is also related to the growing literature on the importance of bounded rationality (e.g., Hortaçsu et al., 2019; Farhi and Werning, 2019; García-Schmidt and Woodford, 2019) and learning (e.g., Fudenberg and Levine, 2016; Doraszelski et al., 2018; Freedman and Jin, 2018) for understanding the evolution of equilibrium outcomes in real-world markets. Finally, our paper follows the example of studies using historical settings to learn about how fundamental market forces shape companies' actions (e.g., Pownall and Waymire, 1989; Ely and Waymire, 1999; Sivakumar and Waymire, 2003; Barton and Waymire, 2004; Anderson, 2015; Koudijs, 2015, 2016; Steinwender, 2018).[7] Our historical setting is characterized by stark information asymmetries and limited regulation. As a result, the advent of the *Chronicle's* supplements provides a unique opportunity to study the beginning of the disclosure game of a new industry and its evolution in a real-world setting. Unlike in today's world characterized by extensive disclosure mandates, alternative information sources, and instantaneous information dissemination (e.g., via the internet), in our historical setting, voluntary reports of earnings via the *Chronicle*'s quarterly supplements were companies' primary way to dis-

[7]Closely related to our paper, Barton and Waymire (2004), in a historical setting, find that, absent regulation, companies voluntarily increase the quality of their disclosures in response to investor demand. For an overview of historical research on accounting, see Waymire and Basu (2008).

close to dispersed investors and, likewise, dispersed investors' primary source of financial information about the companies. These features of our historical setting improve the fit between our empirical setting and the theory of interest. The flip side of this benefit is the potentially-limited generalizability of our findings. We note, however, that the tested theory should generalize to other settings and that limited strategic thinking and informational constraints appear to matter even in today's world (e.g., Levine et al., 2017; Gassen and Muhn, 2018; Drake et al., 2019; Blankespoor et al., 2020).

2 The "Unravelling" Prediction

Information asymmetries between companies and investors can hamper the allocation of capital. If investors cannot discern the type of companies at the time of their investment, they are concerned that only low-type companies would accept their investment terms (e.g., Akerlof, 1970). This adverse selection concern can lead to a breakdown of capital markets. This breakdown is unfavorable for both investors and companies. Accordingly, Ross (1979), Grossman (1981), and Milgrom (1981) demonstrate that companies have an incentive to disclose their type to investors to allay adverse selection concerns. Notably, they show that all, but possibly the worst companies will disclose their type. This so-called "unravelling" result suggests market forces can solve the information asymmetry issue.

The "unravelling" result obtains because investors are sceptical about companies' types. Absent any disclosures, they at most bid a value corresponding to the value of the average company type. This value is below the value of the best company type. The best company type, accordingly, has an incentive to disclose its type to obtain its actual value. Anticipating the best company's disclosure decision, the next best company also has an incentive to disclose, because, absent disclosure, it would be pooled with the remaining non-disclosing companies, which are of *relatively* lower type. This "unravelling" process continues until everyone, but possibly the worst company type, discloses. Notably, even bad company types

disclose, because they anticipate this "unravelling" behavior of other companies, leaving them with no better option than to also disclose to not be pooled with the worst type.

This "unravelling" result rests on the assumptions that (a) investors know that companies are privately informed about their types; (b) disclosures are costless; (c) disclosures are credible; and (d) companies and investors have rational expectations about each others' disclosure and valuation decisions.

The robustness of the "unravelling" result to violations of its central assumptions has been studied extensively in the literature. The literature documents that both uncertainty about information endowment (e.g., Dye, 1985; Jung and Kwon, 1988) and disclosure costs (e.g., Jovanovic, 1982; Verrecchia, 1983) limit the extent of "unravelling." Both violations provide a rationale for companies to abstain from disclosing even if they are not the worst type. This non-strategic rationale for non-disclosure reduces investors' scepticism about the type of non-disclosing companies, creating scope for some lower company types to pool with the higher company types abstaining from disclosure for non-strategic reasons. Accordingly, uncertainty about information endowment and disclosure costs lead to a threshold equilibrium where higher types disclose, but some lower types do not.

With respect to disclosure credibility, the cheap talk literature documents that companies can communicate information to investors via disclosures even if their disclosures are not perfectly credible or verifiable (e.g., Crawford and Sobel, 1982; Stocken, 2000). The amount of information companies can communicate, though, declines in the extent of non-credibility/verifiability of disclosures and the incentive misalignment between companies and investors. In the extreme case of non-credible disclosures and severe misalignment, any disclosures of companies are uninformative to investors ("babbling" equilibrium).

The rational expectations assumption has received less attention in the disclosure literature (e.g., Sunder, 2002). The behavioral game theory literature, however, documents systematic deviations from rational expectations in games resembling the cognitive tasks

faced by companies and investors (e.g. Crawford, 2019).[8] In guessing games, players (akin to companies), tasked with guessing a quantity which depends on other players' guesses, tend to fail to correctly anticipate other players' responses (e.g., Nagel, 1995). In disclosure games, players (akin to investors), tasked with valuing the assets of players who can disclose their type, tend to be insufficiently sceptical about the type of non-disclosing players (e.g., Jin et al., 2015). These deviations are attributed to the difficulty of forming higher order beliefs about other players' actions. They lead to less disclosure than predicted by the "unravelling" result, especially in initial rounds of play. In repeated rounds, players appear to update their belief, ultimately resulting in an equilibrium more closely resembling the cognitively demanding "unravelling" equilibrium.

Given these potential deviations from the "unravelling" result, its descriptiveness for the amount (full vs. partial) and timing (immediate vs. delayed) of disclosure in a real-world setting is an empirical question.

3 The Streetcar Industry

3.1 Institutional Background

In the late 1880s and early 1890s, electrification enabled the rise and expansion of streetcar companies, making them the chief mode of urban transport (Gordon, 2017). A streetcar company (also referred to as a "street railway" or a "traction company") would lay track on a city's streets, and provide transportation to the city's residents by running streetcars—typically powered by overhead wires—along these tracks. (Figure 1 shows what a streetcar looked like.) The electrification and expansion was financed by "enormous amounts of

[8]For formal exactness, we note that the "unravelling" result does not require the full force of Nash-equilibrium reasoning, as a strategy based on the iterative elimination of weakly dominated responses is sufficient to arrive at the "unravelling" result, *given* knowledge about the payoffs. The knowledge of the payoffs depends on the correct anticipation of other players' actions though. This requirement (i.e., common knowledge) is likely to be quite demanding in the initial rounds of play.

capital" (*Commercial & Financial Chronicle*, 1895a, p. 4).[9] A substantial part of this financing—roughly a quarter of all money invested in American streetcar systems—was raised from dispersed investors in the East of the United States and even abroad, from England, Scotland, and Germany (Higgins, 1895, pp. 1-2).[10]

Absent disclosure mandates, dispersed investors' demand for information was served by business newspapers such as the *Commercial & Financial Chronicle*.[11] The *Chronicle*, founded in New York City in 1865 following the example of *The Economist* in England, published weekly issues summarizing general economic news, reporting railroad and other company earnings and financial statements, and tabulating stock, bond, and commodity market data. It was was regarded as the premier source for financial information in the United States of the time.[12] In 1895, the *Chronicle* charged readers twice as much as the *Wall Street Journal* for a subscription, and it had twice the circulation (N.W. Ayer & Son, 1895, pp. 539 and 557).

In March 1895, the *Chronicle* started publishing quarterly supplements focused exclusively on the streetcar industry (Figure 2). These supplements, which were motivated by frequent investor requests, aimed at providing a comprehensive overview of all available streetcar companies and their financials.[13] Only one other publication before had dedicated

[9] The 1890s was a period of economic depression in the United States. However, it seems that the street railways were a bright spot in this depression, which might explain why they were able to raise capital, and why the *Chronicle* decided to devote an entire supplement to them. According to the *Chronicle* (*Commercial & Financial Chronicle*, 1895a, p. 4): *"It is thus clear that there are various ways in which the traffic of the street railways may diminish in a period of depression. But thus far certainly these roads—speaking of them as a whole—have done remarkably well. Through the change in their motive power which so many of them have made during the last few years they have been able to add so very largely to their traffic that the effects of the depression in trade do not appear to any great extent in the results of their operations."*

[10] "*Within a very brief period, horse railroads of small earnings capacity have been supplanted by rapid-transit lines commanding a largely increased income. The former were of merely local interest, but the latter appeal to capitalists everywhere.*" (*Commercial & Financial Chronicle*, 1895a, p. 3).

[11] Streetcar companies in Massachusetts, New Hampshire, and Connecticut were required to report to regulators. We discuss the implications of this regulatory requirement and assess the robustness of our findings to the exclusion of companies from these states in section 5.2.1.

[12] Dewing (1914, p. 12) says, "*Distinctly the most useful publication that we have is the Commercial and Financial Chronicle. Its accuracy is striking. Over and over again the present writer has compared original reorganization plans and corporate reports with the Chronicle digests, and almost without exception no important error has been discovered.*" Bernheim and Schneider (1935, p. 619) describe the *Chronicle* as a carefully prepared, relatively complete source of financial news.

[13] "*Frequently of late we have been urged to give more attention to this subject, until at last we have deter-*

an issue to the financials of the streetcar industry (the *Street Railway Journal*'s supplement from June 1894, which is included in our sample), and no other publication produced such an issue as frequently as the quarterly supplement provided by the *Chronicle*.

The key financials provided in the supplements were companies' earnings and their invested capital (i.e., both stock and bonds outstanding). This information was obtained directly from companies or indirectly from related sources. Notably, investment advice at the time singled out earnings relative to invested capital or miles of track as the most relevant ratios for assessing the quality or type of streetcar companies (e.g., Thompson, 2017). These ratios were particularly useful for assessing the *relative* type of streetcar companies given the industry's basic and homogeneous business model. In support of this argument, we document that streetcar companies' reported earnings relative to invested capital were strongly positively related to stock prices, explaining a remarkable 58% of the cross-section of stock prices (Figure 3).[14] The ability of return on invested capital to explain so much of the stock price allays potential concerns that investors did not view the earnings as credible, or that they did not view the invested capital reported in the supplements as a correct representation of the amount actually invested.[15]

The *Chronicle's* supplements on the streetcar industry provide a unique testbed for the "unravelling" prediction in the real world. They provided an important industry, which relied heavily on external capital, with a heretofore unavailable way to disclose key financials to dispersed investors on a regular basis.[16] This feature not only allows us to examine the

mined to do so, limiting our efforts only by what we may discover to be the requirement of our subscribers." (*Commercial & Financial Chronicle*, 1894, p. 1).

[14]The close relationship between the reported ratio and stock prices highlights the relevance and credibility of companies' accounting information for investors at the time. Unlike today's accounting information, which explains about 20% of stock price variation (e.g., Shao et al., 2020), the accounting information disclosed in the *Chronicle* was one of the main sources of information for dispersed investors.

[15]The stock outstanding reported in the supplements is reported at par value. Par was often set higher than the amount actually invested in the companies, meaning that the denominator of our return on invested capital measure could be viewed as inflated (e.g., *Commercial & Financial Chronicle*, 1896, p. 8). The concern would be that our measure does not reflect how investors measured company performance, and therefore does not provide a good measure of company type for our analysis. This concern is allayed by the fact that return on invested capital, even with this possible distortion, explains so much of the stock price—indicating that investors likely *did* use a measure like it to assess performance.

[16]The *Chronicle* was available to investors in both Europe and the U.S., and it was likely one of the main

extent of disclosures at the initiation of the supplements, but also its evolution over time.

Another important feature of the streetcar setting is its arguably close approximation of key assumptions underlying the "unravelling" result, which include: (a) that investors know that companies possess private information about their types, (b) that disclosures are costless, and (c) that disclosures are credible. First, investors could confidently expect companies to know such basic financial information as their earnings (supporting (a)). Second, the costs of disclosure to the streetcar companies were limited (supporting (b)). The direct cost of disclosure was borne by the *Chronicle* itself, not the disclosing companies. Any indirect proprietary costs, from competitors or public officials reading the disclosures in the *Chronicle*, were unlikely to be substantial. For one, the supplements were explicitly targeted at dispersed investors, not local competitors or regulators. For another, local competitors and regulators could already gauge companies' earnings capacity by observing streetcar companies' utilization and fare tickets, even absent disclosures in the supplements.[17] Lastly, the disclosures could be expected to be credible (supporting (c)). The *Chronicle* had a reputation for being a credible source of financial information.[18] The extent of misrepresentation of earnings, moreover, was limited by local observers' ability to check and verify the companies' profitability, given the visible utilization by passengers, known fares, and the basic business model. In support of these arguments, we document the value relevance of compa-

sources of information for most investors. As late as 1935, Bernheim and Schneider (1935, p.615) assert that, "*It is very largely through the financial press in its various aspects that the mass of data having a direct and definite bearing upon investment and speculative policies reaches the public. Even customers' men in the brokerage houses, investment counselors and others who give advice on investment and kindred subjects are in very large degree dependent upon the press for much of their information.*"

[17]In 1895, President Noyes of the Maine Savings Bank Association, asserted that local observers could learn "all the facts" needed to value a streetcar company (*Commercial & Financial Chronicle*, 1895b, p. 9): *"The great reason, he [Mr. Noyes] said, why he thought so highly of street railways [as investments for savings banks] was because the value of the property is more easily ascertained than the value of the bonds of a trunk line. It can be more easily comprehended. "A few hours' walk through the streets of a prosperous city, the examination of the books showing the earnings of the property, the examination by a street railway expert of the equipment and motors, etc., puts one in possession of all the facts that are necessary to judge of the value of a street railway property.""*

[18]While the *Chronicle* was the best information source for the period, it did not (to the best of our knowledge) audit the companies' disclosures, so it is possible that it inadvertently reported fraudulent numbers occasionally. However, by their own account, they did attempt to screen out untrustworthy sources (*Commercial & Financial Chronicle*, 1894, p. 2): *"We [at the Chronicle] cannot publish what is not trustworthy in character nor what is not respectably complete in detail."*

nies' earnings disclosures in Figure 3. Similarly, prior work shows that investors reacted to earnings disclosures in the pre-SEC era, indicating that investors viewed them as credible (e.g., Sivakumar and Waymire, 1993, 1994; Porter et al., 1995).

3.2 Historical Data

We collect our data from the first nine supplements that covered the financial results of the streetcar industry. A scan of the first supplement, produced by the *Street Railway Journal* in June 1894, is available on HathiTrust Digital Library. Scans of the next eight supplements, produced by the *Commercial & Financial Chronicle* from March 1895 to November 1896, are available on FRASER, the digital library maintained by the St. Louis Federal Reserve.[19] Using a combination of automated optical character recognition (OCR) and manual collection, we obtain the full list of streetcar companies covered in the supplements, along with companies' locations, their stock and bonds outstanding, their decisions to disclose net earnings, and (for the last supplement in our sample) their reported net earnings.

We code companies as "disclosing" in a given supplement if they disclosed net earnings in this supplement or in any of the previous supplements.[20] We calculate companies' types as net earnings over invested capital, a widely used measure of the return on invested capital (*ROIC*) (Thompson, 2017). We use the earnings and invested capital information as of the last supplement to achieve a comprehensive and consistent cross-sectional measure of the type of companies (Figure 4).[21] (For a detailed description of the *ROIC* measure, along with the other variables, refer to the Internet Appendix.)

[19]The *Street Railway Journal* produced its supplement on an annual basis. We only collected the first issue of this supplement since the *Chronicle*, which was a more respected and timely source of financial news, had already started producing its quarterly supplement by the time the second issue came out.

[20]We choose the cumulative coding, because we conceptually consider companies' type to be revealed as soon as they reported once. In support of this coding, we find substantial persistence in disclosures over our short sample period.

[21]We use the last supplement, because at this point we can observe the *ROIC* for the greatest number of companies. We consider companies' types to be reasonably persistent for our sample, since the sample period only runs from June 1894 to November 1896, and for most of the companies the earnings number we collect relates to fiscal 1895. In line with this reasoning, we find that net earnings, for the subset of companies reporting in the first and last *Chronicle* supplements, are highly persistent (Pearson correlation: 0.97; Spearman correlation: 0.89).

We impose three important sample restrictions. First, we restrict our sample to streetcar companies in the Northeast of the United States. These companies operated in a reasonably homogeneous and established regional and economic environment. They also constituted the main investment targets for dispersed investors. These features increase the comparability of companies' earnings capacity, limit the impact of frontier expansions, and allay concerns that variation in investor demand or information collection costs (e.g., distance between companies and the *Chronicle*) explain companies' coverage in the supplements. Second, we restrict our sample period to the first nine supplements (i.e., the first supplement from the *Street Railway Journal* and the first eight from the *Chronicle*), a relatively short period that covers 30 months from June 1894 to November 1896. By restricting our data to a narrow, though comparable, sample and time period, we aim to eliminate confounding factors (e.g., changes in business models, investment opportunities, financing needs) and better approximate the setup of the theory of interest.[22] Third, we restrict the sample to a balanced panel of companies, which ensures that all companies existed since the first supplement.[23] This restriction avoids conflating companies' disclosure decisions with their decisions to start operating or raise capital for the first time, or with the *Chronicle's* expansion of its coverage. Related to this restriction, for most of our analyses below, we must further restrict the sample to companies that disclose their earnings in the last supplement of our sample, which we use to calculate our cross-sectional measure of company type: the company's return on invested capital. Table 2 contains descriptive statistics for the sample we use in our empirical analysis. (For a detailed description of our sample restrictions, as well as our data collection

[22] Our narrow-sample approach mirrors the approach taken in much of the industrial organization literature (e.g., Syverson, 2004; Greenwood and Hanson, 2014). It contrasts with the broad-sample approach taken in the typical disclosure studies in the accounting and finance literature. Christensen (2019), however, recently stresses the benefits of the narrow-sample approach over the broad-sample one for studying disclosure issues.

[23] Companies can be reported in the supplements even though very little information is available for them. For example, in the first supplement in our sample, there is an entry for the Electric Railway, Light & Power Co. of Anaconda, Montana; the only information available for this company is the type of capital equipment it uses and the names of its officers (*Street Railway Journal*, 1894, p. 6). Similarly, in the second supplement in our sample, there is an entry for the Cleveland & Akron Electric Railway of Akron, Ohio; for this company, the only information given is where the company is allowed to build according to its charter (*Commercial & Financial Chronicle*, 1895a, p. 9).

and coding, refer to the Internet Appendix.)

3.3 Stylized Facts

We summarize the disclosure equilibrium in the early streetcar industry and its evolution in two figures. Figure 5 plots the share of disclosing companies across the supplements, while Figure 6 plots the average type ($ROIC$) of the remaining non-disclosing companies across the supplements. The sample for Figure 6 is the one whose descriptives are depicted in Table 2; this sample only includes companies for which we have $ROIC$ data. For Figure 5, we augment this sample with companies that never disclose, but otherwise satisfy our sample restrictions.

The figures uncover three stylized facts characterizing the streetcar industry's disclosure equilibrium. First, Figure 5 documents that about 75 percent of streetcar companies disclosed in the first supplement. Second, Figure 5 further documents that the share of disclosing companies significantly increased over time to reach a high of 95 percent by supplement 7. The increase was particularly strong for the three supplements (i.e., the year) following the initial supplement. Third, Figure 6 documents that the average type ($ROIC$) of the remaining non-disclosing companies declined over time.[24]

Collectively, these stylized facts suggest full disclosure is not immediately descriptive, inconsistent with the "unravelling" prediction. Yet, full disclosure appears to be descriptive of the disclosure equilibrium reached after just a couple of periods (i.e., supplements). The (almost) full disclosure equilibrium appears to be reached over time because, each period, the *relatively* better companies among the remaining non-disclosers start to disclose and leave the pool of non-disclosers, as evidenced by the declining average type among the remaining non-disclosers.

[24]Figure 6 omits the last two supplements (8 and 9), because we need to know a company's $ROIC$ to include it in the plot. All company's for which we have $ROIC$ data have disclosed by supplement 7, leaving us with no additional disclosers and $ROIC$ information for supplements 8 and 9.

4 A Structural Interpretation

4.1 Model Motivation

To uncover some of the forces behind the observed evolution of the disclosure equilibrium, we use a simple structural model of companies' disclosure decisions which allows them to deviate from rational expectations.

We allow, but do not impose, non-equilibrium thinking as a potential force behind the disclosure evolution. For one, the stylized facts in the streetcar industry strikingly resemble the lab evidence in the behavioral game theory literature. This literature rationalizes the initial failure of and subsequent convergence to full "unravelling" with non-equilibrium thinking and learning.

For another, the institutional details in the streetcar industry provide support for the importance of non-equilibrium thinking and learning of streetcar companies. First, many of the companies were newly founded, dealt with dispersed investors for the first time, and had no prior experience with disclosure to investors via business newspapers.[25] These circumstances make it plausible that some companies did not fully reason through the cognitively demanding "unravelling" logic. Unlike companies, investors already had experience with valuing companies and assessing disclosures from the preceding railroad era; motivating our focus on companies' cognitive boundaries and learning instead of that of investors.[26]

[25] It appears likely that the streetcar companies would be dealing with dispersed investors for the first time even in cases where they had long existed, before electrification, as horse-drawn streetcars. According to the *Chronicle*, the horse streetcars were only of interest to local investors, whereas the electrified streetcars were of interest to a dispersed investor base (*Commercial & Financial Chronicle*, 1894, p. 1): *"Our American readers will not need to be told of the sudden growth in importance, as regards the general public, of street railway securities. Foreign readers, however, can hardly realize the metamorphosis which has taken place, and which is still at work, consolidating and transforming the street railways of each city of the Union from companies of local, and generally of insignificant, position into powerful corporations, operating many miles of road and having their securities held by investors in all parts of the country. The process of consolidation is usually accompanied by a change in motive power from horses to electricity and by the building of numerous extensions."* (See also the the quote from the *Chronicle* in Footnote 10, above.)

[26] Differences in companies' strategic sophistication could explain why companies of similar type make distinct disclosure decisions (e.g., Levine et al., 2017). Differences in individual investors' strategic sophistication, by contrast, would not provide an immediate explanation for this empirical fact. For one, the investor clientele (e.g., the share of unsophisticated investors) is unlikely to vary substantially across streetcar companies with similar types. For another, individual investors' biases have a muted impact on

Second, other forces that might normally explain a breakdown of the "unravelling" result (e.g., uncertainty about information endowment, disclosure costs, non-credible disclosure) appear a priori to have limited importance in the streetcar industry. Such forces would also have to decline relatively rapidly (i.e., within a couple months) to explain the medium-run convergence observed in Figure 5. Lastly, the *Chronicle* itself, plausibly one of the most informed witnesses of the time, conjectured that the non-disclosing companies acted in a "short sighted" manner, reflecting "lack of knowledge" regarding the importance of disclosure for ensuring investors' confidence. But they would ultimately "learn" to disclose, the *Chronicle* speculated (*Commercial & Financial Chronicle*, 1894, p. 1).[27]

To allow for deviations from rational expectations, we use level-k thinking, an iterative best response model of non-equilibrium thinking with strong experimental support (e.g., Crawford and Iriberri, 2007). It permits companies to exhibit different levels of sophistication, k. Companies with the lowest level of sophistication ($k = 0$) neglect any strategic implications of other companies' disclosure decisions and/or investors' valuation decisions for their own decision. Accordingly, they act *as if* they make their disclosure decision at random (i.e., unrelated to their type). Companies with higher levels of sophistication ($k > 0$) take other companies' disclosure decisions and investors' valuation decisions into account. They may, however, fail to correctly anticipate all the best responses of other companies and investors. Level 1 companies, for example, understand that, if all companies randomize their disclosure, strategic investors expect non-disclosing companies to be of average type. Hence, they disclose if their type is above average. Similarly, level 2 companies understand that, if above-average companies disclose, strategic investors expect non-disclosing companies to

streetcar companies' valuations due to the capital market's aggregation of various investors' valuations (e.g., sophisticated investors' arbitrage).

[27] Another method, apart from disclosure, by which the streetcar companies could gain investor trust could be through engaging an underwriter with a good reputation. Our model omits any considerations of underwriter reputation. First of all, we lack data on the underwriters for the streetcar companies. Secondly, it is unclear how the underwriter's reputation would affect disclosure. On the one hand, a high-reputation underwriter might act as a substitute for disclosure in terms of helping a company gain investor trust. On the other hand, a high-reputation underwriter might be a complement for disclosure. A high-reputation underwriter could, for example, inform companies about the benefits of disclosure and/or provide implicit or explicit certification of companies' disclosures.

be of below-average type. Hence, they disclose even if their type is below average, as long as their type is above the average of the below-average types. This disclosure threshold is lower than the threshold for level 1 companies. As the level of sophistication increases, the disclosure threshold declines, until it reaches the lowest type (for level $k = \infty$ sophistication). At this point, everyone but possibly the lowest type discloses, consistent with rational expectations and the "unravelling" equilibrium. (See Figure 7 for an illustration.)

The level-k model does not take a stance on why companies may fail to iterate through all best responses. It may be that companies incorrectly anticipate the actions of other companies (e.g., they may expect other companies to be one level less sophisticated than themselves). Or it may be that companies fail to anticipate the strategic response of investors to their own best response. Irrespective of which of these shortcomings leads companies to deviate from rational expectations, we expect that companies can learn about other companies' disclosure decisions and investors' valuation decisions from feedback provided by past supplements showing companies' disclosure decisions and investors' corresponding reactions.[28]

4.2 Model Setup

We embed level-k thinking into a discrete choice model. This model setup allows us to uncover companies' latent disclosure utility and sophistication levels from their disclosure decision, while controlling for other disclosure determinants (e.g., common and idiosyncratic net benefits of disclosure, competition, and capital raising).

In our model, a company i decides whether to disclose its type θ_i (i.e., its $ROIC$). Once the company discloses, its type is known to investors and it remains a disclosing company.[29]

[28] Unfortunately, price data is limited, stale, and noisy in our setting. While it allows us to assess the value relevance of reported $ROIC$ numbers for a subset of streetcar companies (Figure 3), it does not permit examining short-window investor reactions around supplement publication dates for our broad sample of streetcar companies. In our later tests for learning, we accordingly focus on feedback about other companies' disclosure decisions provided by past supplements.

[29] The decision to disclose appears to be reasonably sticky. Of the 169 companies we identify as disclosing in any of the supplements during our sample period, 145 (i.e., 86%) are still disclosing as of the last supplement.

Hence, a company, which has not disclosed up until time t, makes its disclosure decision at time t by comparing its expected utility ($u_{i,k,t}^{d_{i,t}}$) given disclosure ($d_{i,t} = 1$) with its expected utility absent disclosure ($d_{i,t} = 0$). This comparison depends on the company's level of thinking or sophistication, k.

For a company with non-zero sophistication ($k > 0$), we model the expected utility given disclosure as:

$$u_{i,k,t}^{1} = \alpha^{1} + \beta\theta_i + \gamma^{1} X_{i,t} + \epsilon_{i,t}^{1} \tag{1}$$

where α^1 denotes a utility level common to all disclosing companies; β captures the sensitivity of the company's expected utility with respect to its disclosed type θ_i; $\gamma^1 X_{i,t}$ captures the influence of other factors (e.g., capital raising) on the company's expected utility given disclosure; and $\epsilon_{i,t}^1$ is an incremental utility shock, idiosyncratic to company i at time t, if it discloses.[30]

Absent disclosure, company i's expected utility is given by:

$$u_{i,k,t}^{0} = \alpha^{0} + \beta E_{k,t}[\theta] + \gamma^{0} X_{i,t} + \epsilon_{i,t}^{0} \tag{2}$$

where α^0 denotes a utility level common to all non-disclosing companies; β captures the sensitivity of the company's expected utility with respect to its expected type $E_{k,t}[\theta]$, which depends on the company's level of sophistication, k; $\gamma^0 X_{i,t}$ captures the influence of other factors on the company's expected utility absent disclosure; and $\epsilon_{i,t}^0$ is an incremental utility shock, idiosyncratic to company i at time t, if it does not disclose.

The company discloses if the expected utility given disclosure exceeds its expected utility

For more discussion of these companies, refer to the Internet Appendix.

[30] The sensitivity, β, essentially captures the combination of (i) the expected valuation multiple applied by investors to the company's type and (ii) the sensitivity of the company's expected utility to the investors' valuation.

absent disclosure:

$$u^1_{i,k,t} - u^0_{i,k,t} = \alpha + \beta\big(\theta_i - E_{k,t}[\theta]\big) + \gamma X_{i,t} + \epsilon_{i,t} \geq 0 \tag{3}$$

where α $(= \alpha^1 - \alpha^0)$ denotes a common net benefit of disclosure; β captures the sensitivity of the company's expected utility with respect to its disclosed type θ_i *relative* to its expected type $E_{k,t}[\theta]$; $\gamma X_{i,t}$ $(= (\gamma^1 - \gamma^0)X_{i,t})$ captures the incremental influence of other factors given disclosure; and $\epsilon_{i,t}$ is an incremental net benefit of disclosure specific to company i at time t.

This formulation of a company's disclosure choice takes an intuitive and familiar form. It is intuitive, because it essentially suggests that the company's disclosure incentive increases in its *relative* type $\big(\theta_i - E_{k,t}[\theta]\big)$. It is familiar, because it resembles a logit regression under the standard assumption that the idiosyncratic utility shocks follow an extreme value distribution:

$$\begin{aligned} \epsilon^1_{i,t} &\sim EV(0, \upsilon) \\ \epsilon^0_{i,t} &\sim EV(0, \upsilon) \\ \epsilon^1_{i,t} - \epsilon^0_{i,t} = \epsilon_{i,t} &\sim Logistic(0, \upsilon) \end{aligned} \tag{4}$$

Following the behavioral game theory literature, we allow for four different levels of sophistication which are characterized by varying disclosure threshold values, $E_{k,t}[\theta]$. The threshold for level 1 companies is the average type of those companies $(\mathcal{N}_t)$ that have not disclosed up until time $t-1$ (with company $j \in \mathcal{N}_t$ if $d_{j,t-1} = 0$):

$$E_{1,t}[\theta] = E\big[\theta_j | j \in \mathcal{N}_t\big]. \tag{5}$$

This threshold value reflects that level 1 companies understand that investors expect non-disclosing companies to be of average type if companies stay silent at random. Accordingly, level 1 companies disclose if their type is above the average type of the companies that have

not disclosed yet.

The threshold value for level 2 companies is the average type of the below-average companies that have not disclosed yet (i.e., the *conditional* average):

$$E_{2,t}[\theta] = E\big[\theta_j | j \in \mathcal{N}_t, \theta_j < E_{1,t}[\theta]\big]. \tag{6}$$

It reflects that level 2 companies understand that investors anticipate above average companies to disclose and hence expect non-disclosing companies to be of the average type among the below-average companies.

The threshold for level 3 (or ∞) companies, the highest level of sophistication in our setup, is the minimum type of the companies that have not disclosed yet:

$$E_{3,t}[\theta] = \min\big(\theta_j | j \in \mathcal{N}_t\big) \tag{7}$$

This threshold corresponds to the "unravelling" threshold, according to which everyone but possibly the worst type has an incentive to disclose. We jump from level 2 to level ∞ for reasons of parsimony and because prior lab evidence suggests that players who engage in more sophisticated thinking than level 2 tend to successfully reason through all the higher levels of thinking, arriving at the equilibrium action predicted under rational expectations.[31]

In contrast to companies of level $k > 0$, level 0 companies do not take other companies' disclosure decisions and/or investors' valuation decisions into account. We model this non-strategic disclosure decision as follows:

$$u^1_{i,0,t} - u^0_{i,0,t} = \alpha + \delta + \gamma X_{i,t} + \epsilon_{i,t} \geq 0 \tag{8}$$

where the only change from before is that level 0 companies' relative type does not feature

[31] Bosch-Domènech et al. (2002), for example, survey various experiments of Keynesian beauty contests. They observe spikes in the distribution of subjects' responses corresponding to level 1 and level 2 thinking, or the actual unique Nash equilibrium.

in their disclosure decisions. Instead, level 0 companies are modelled as potentially having an incremental net benefit of disclosure, δ. This parameter allows for a generally different attitude toward disclosure relative to more sophisticated companies. Importantly, this difference is *not* related to level 0 companies' type. Accordingly, their disclosure decision is random (i.e., unrelated to their type) and, hence, uninformative about their type.

Given our setup, the probability that a company i with sophistication level $k > 0$, which has not disclosed yet ($d_{i,t-1} = 0$), starts disclosing at time t is:

$$\begin{aligned} Pr(d_{i,t} = 1 | b_{i,t} = k, \theta_i, X_{i,t}, \mathcal{N}_t) &= Pr(u^1_{i,k,t} - u^0_{i,k,t} \geq 0) \\ &= Pr(\alpha + \beta\big(\theta_i - E_{k,t}[\theta]\big) + \gamma X_{i,t} \geq -\epsilon_{i,t}) \\ &= \frac{e^{\alpha + \beta(\theta_i - E_{k,t}[\theta]) + \gamma X_{i,t}}}{1 + e^{\alpha + \beta(\theta_i - E_{k,t}[\theta]) + \gamma X_{i,t}}} \end{aligned} \tag{9}$$

where $b_{i,t}$ captures the level of sophistication, k, of company i at time t. Similarly, this probability for a company with sophistication level $k = 0$ is:

$$Pr(d_{i,t} = 1 | b_{i,t} = 0, \theta_i, X_{i,t}, \mathcal{N}_t) = \frac{e^{\alpha + \delta + \gamma X_{i,t}}}{1 + e^{\alpha + \delta + \gamma X_{i,t}}} \tag{10}$$

Taken together, the disclosure probability of a company i with sophistication level k at time t is given by:

$$f(d_{i,t} = 1 | b_{it}, \theta_i, X_{i,t}, \mathcal{N}_t, d_{i,t-1}) = \begin{cases} Pr(d_{i,t} = 1 | b_{i,t}, \theta_i, X_{i,t}, \mathcal{N}_t) & \text{if } d_{i,t-1} \neq 1 \\ 1 & \text{if } d_{i,t-1} = 1 \end{cases} \tag{11}$$

The disclosure probability is conditional on companies' unobserved sophistication level, k. We denote the unobserved share of companies using a given sophistication level k in a given period t as $s_{k,t}$ (with $\sum_{k=0}^{K} s_{k,t} = 1$).

The unconditional probability of company i's disclosure at time t is thus given by:

$$p(d_{i,t} = 1|\theta_i, X_{i,t}, \mathcal{N}_t, d_{i,t-1}) = \sum_{k=0}^{K} s_{k,t} f(d_{i,t} = 1|b_{i,t} = k, \theta_i, X_{i,t}, \mathcal{N}_t, d_{i,t-1}) \tag{12}$$

4.3 Model Estimation

We estimate the latent disclosure utility parameters (α, β, δ, γ) and sophistication shares ($\{\mathbf{s}_t\}_{t=1}^{T}$ with $\mathbf{s}_t = [s_{0t}, s_{1,t}, ..., s_{K,t}]$) via maximum likelihood. The log-likelihood we maximize takes the following form:

$$\begin{aligned} &LL\left(\{\mathbf{s}_t\}_{t=1}^{T}, \alpha, \beta, \delta, \gamma\right) \\ &\qquad = \sum_{i=1}^{N} \sum_{t=1}^{T_i} \log\big(p(d_{i,t}|\theta_i, X_{i,t}, \mathcal{N}_t, d_{i,t-1})\big) \\ &\qquad = \sum_{i=1}^{N} \sum_{t=1}^{T_i} \log\left(\sum_{k=0}^{K} s_{k,t} L_{i,t,d_{i,t}}(\alpha, \beta, \delta, \gamma|b_{i,t} = k)\right) \end{aligned} \tag{13}$$

where N is the number of companies and T_i is the last period in the sample where company i makes a disclosure decision. $p(d_{i,t}|\theta_i, X_{i,t}, \mathcal{N}_t, d_{i,t-1})$ is the unconditional likelihood of company i's observed disclosure at time t, which can be decomposed into the sophistication shares and the conditional disclosure likelihood, $L_{itd_{it}}(\alpha, \beta, \delta, \gamma|b_{it} = k)$. The conditional disclosure likelihood is given by the standard logit form:

$$L_{i,t,d_{i,t}}(\alpha, \beta, \delta, \gamma|b_{i,t} = k) = \left(\frac{e^{y_{i,k,t}}}{1 + e^{y_{i,k,t}}}\right)^{d_{i,t}} \left(1 - \frac{e^{y_{i,k,t}}}{1 + e^{y_{i,k,t}}}\right)^{1-d_{i,t}} \tag{14}$$

where

$$y_{i,k,t} = \alpha + \beta(\theta_i - E_{k,t}[\theta])(1 - \mathbb{1}_{k=0}) + \delta \mathbb{1}_{k=0} + \gamma X_{i,t} \tag{15}$$

As controls ($X_{i,t}$), we include period-by-period growth in invested capital (*Invested Capital Growth*) to control for time-varying investment opportunities and financing needs; the num-

ber of competitors in the company's city at the time (*Number of Competitors*) to control for proprietary cost concerns; and individual time effects to account for common changes in the net benefit of disclosure over time (e.g., a general decline in proprietary costs or increase in financing needs). (For more detail on how we measure *Invested Capital Growth* and *Number of Competitors*, refer to the Internet Appendix.)

To implement the maximum likelihood estimation, we use the iterative expectation maximization (EM) algorithm described in Train (2009).[32] Following Train (2009), we start the iterative process with equal sophistication shares. To obtain initial values for the disclosure utility parameters, we randomly assign companies to each sophistication level and estimate the corresponding logit regression parameters. We assess the robustness of our estimation to the choice of initial values in section 5. We calculate bootstrapped standard errors for our estimated parameters.[33]

Our estimation recovers the latent utility parameters and the share of companies using a given sophistication level in a given period. By estimating separate shares in each period, we allow for aggregate trends in companies' sophistication levels. To infer which sophistication level a specific company adopted in a given period, we use Bayes' rule to determine the posterior probability of each sophistication level for company i at time t given its observed disclosure decision. This posterior probability for sophistication level k, for example, is given by:

$$\phi_{i,k,t} = \frac{s_{k,t} L_{i,t,d_{i,t}}(\alpha, \beta, \delta, \gamma | b_{i,t} = k)}{\sum_j s_{j,t} L_{i,t,d_{i,t}}(\alpha, \beta, \delta, \gamma | b_{i,t} = j)} \tag{16}$$

We calculate these posterior probabilities for each belief of each company at each point in

[32] In principle, equation (13) could be maximized by other methods, but it is much easier to instead maximize it via the EM algorithm. Train (2009) summarizes the EM algorithm as follows (see page 348 of his book): *"The procedure consists of defining a particular expectation and then maximizing it (hence the name). This expectation is related to the LL [i.e., log-likelihood] function ..., but it differs in a way that facilitates maximization. The procedure is iterative, starting at some initial value for the parameters and updating the values in each iteration. The updated parameters in each iteration are the values that maximize the expectation in that particular iteration. ... [R]epeated maximization of this function converges to the maximum of LL function itself."*

[33] We generate 1,000 bootstrapped samples to calculate the standard errors.

time, allowing us to explore how company-specific sophistication levels, not just aggregate shares of sophistication levels, evolved over time.

The estimated sophistication levels, by assumption and construction, are independent of companies' types. The idea is that these two constructs, companies' sophistication and type, are distinct constructs. The sophistication level captures companies' strategic intelligence with respect to the disclosure game, whereas their type captures the profitability of their operations (e.g., driven by the size of the population in their location). While it appears reasonable to expect that sophistication and type could be positively correlated (e.g., greater strategic intelligence is a competitive advantage; Levine et al. (2017)), we note that several high-type firms appear to disclose late, whereas several low-type companies disclose early. (For a detailed breakdown of when disclosure first occurred for the various companies, sorted by *ROIC*, refer to the Internet Appendix.) Moreover, we note that we not only focus on companies' sophistication level at a point in time, but also the evolution of the levels over time. Accordingly, even if the estimated levels are distorted due to a violation of our identifying assumption (i.e., independence of sophistication and type), the within-company *evolution* of sophistication levels is less likely to be confounded by this issue as companies' type is held fixed over our short sample period.

4.4 Model Findings

4.4.1 Expected Utility of Disclosure

Table 3 reports the estimates for the parameters of our model of companies' expected disclosure utilities. Panel A summarizes the estimates of the model's main parameters. The estimate for α is negative and statistically significant. It implies that companies with non-zero levels ($k = 1, 2, 3$) of strategic thinking expect to incur a common (net) cost of disclosure, independent of their type. The estimate for β is strongly positive and highly significant (coefficient: 29.83; z-statistic: 25.75). It suggests that companies with non-zero levels of thinking expect the benefits of disclosure to increase in their type, in line with the

positive relationship between companies' $ROIC$ and investors' valuation observed in Figure 3. Lastly, The estimate for δ is slightly positive, but not statistically significant. It implies that companies with level 0 thinking do not appear to exhibit a significantly higher or lower common net benefit (or cost) than the companies with non-zero levels of thinking.

These estimates make two important points. They document that companies' relative type is a key determinant of disclosure for companies with non-zero level of thinking. In addition, they document that companies with non-zero levels of thinking and those with level 0 thinking do not exhibit different disclosure behavior because they face significantly different (perceived) net benefits or costs (irrespective of their type). Rather, their disclosure behavior differs because sophisticated companies understand that disclosure benefits increase in their relative type, whereas unsophisticated companies do not make this connection.

Panel B summarizes the estimates of the control variables included in our model. The parameter estimate for capital raising (percentage change of invested capital), γ_1, is slightly negative and significant, whereas the estimate for competition (number of companies in the same city), γ_2, is positive and significant. Based on the literature, we would have expected the opposite signs if companies' disclosure choices were chiefly driven by external financing needs or discouraged by existing competition.[34] Importantly, the alternative explanations (capital raising and competition) for companies' disclosure choices and dynamics, while statistically significant, appear substantially less important than companies' relative type (see, e.g., differences in coefficient magnitudes and z-statistics). Lastly, the parameter estimates for γ_3 to γ_8, capturing the coefficients on our supplement (i.e., time) indicators, are typically negative, and in some cases significant. They imply that the net benefit of disclosure common to all companies appears to decline over time (especially until the sixth supplement). This temporal pattern is inconsistent with declining costs (e.g., proprietary costs) or increasing

[34]The positive relation between the number of competitors and disclosure could indicate that monopolistic incumbents are concerned about entry competition (e.g., Darrough and Stoughton, 1990). Overall, however, we caution against reading too much into the parameter estimates for the capital raising and competition controls given that their magnitudes and significance levels are not robust to alternative estimation choices, unlike the parameter estimate for the relative type.

benefits (e.g., investment opportunities) of disclosure as an alternative explanation for the increasing disclosure rate observed in the streetcar industry over time.

Taken together, the parameter estimates of our disclosure-utility model highlight the importance of companies' relative type for the disclosure decisions of more sophisticated companies, in line with the iterated-best response logic underlying level-k thinking. Accordingly, the estimates support the idea that the initial deviation of the streetcar industry's disclosure equilibrium from the "unravelling" prediction and its subsequent convergence toward an (almost) full disclosure equilibrium could be due to some companies employing lower levels of thinking. (We explore the estimated sophistication levels in the next section.) By contrast, our parameter estimates provide little support for prominent alternative explanations for the observed disclosure dynamics unrelated to companies' type and their level of strategic sophistication (or thinking).

4.4.2 Evidence of Level-k Thinking

Table 4 reports the estimated levels of sophistication employed by our sample companies. Panel A shows the sophistication-level shares for each period using all companies that have not disclosed in any of the previous periods yet. It provides evidence of significant deviations from the highest level of thinking, which corresponds to rational expectations (level $k = 3$ in our notation). In the first period (i.e., the first supplement), about 49 percent of companies appear to use the highest level of thinking. The other half of the companies appears to have used lower levels of thinking. About 27 percent appear to have used level 2 thinking and 24 percent even appear to have acted *as if* they randomized their disclosure decision (i.e., their disclosure decision appears unrelated to their type). This finding provides an explanation for the initially incomplete "unravelling." It is consistent with some companies being uninformed about the strategic aspects of the disclosure game. To learn about it, they appear to start out by randomizing in the first period of disclosure.

In subsequent supplements, the share of randomizing companies declines, whereas the

share of companies using level 1 or 2 thinking increases. This pattern is particularly evident in Panel B, which shows the sophistication-level shares for each period using only companies that have not disclosed yet (i.e., companies that remained silent in a given period). This evidence, while again consistent with several companies using lower levels of thinking, suggests a potential role of learning from past rounds of play in explaining the disclosure dynamics in the streetcar industry (i.e., the increasing propensity to disclose).

4.4.3 Evidence of Learning

We explicitly test for evidence of companies' learning. Explicit tests for learning are necessary, because the fact that the observed disclosure equilibrium converges (approximately) to the "unravelling" equilibrium does not *per se* imply that companies are learning. Even absent learning, level-k thinking (e.g., level 1 thinking) would ultimately lead to full "unravelling" as *relatively* better types successively leave the pool of non-disclosing companies over time.

To explicitly test for learning, we investigate the evolution of companies' sophistication levels over time. In Panel A of Table 5, we test for a time trend in companies' expected sophistication levels, defined as the probability weighted level k. In both pooled and within-company regressions, we find a significantly positive time trend: companies in latter rounds exhibit, on average, more sophisticated levels of thinking than they did in earlier rounds. Figure 8 illustrates this point for companies that did not disclose in the first round. It plots the distribution of these companies' sophistication levels in the first round (light gray bars to the left) and their respective levels in the second round (dark gray bars to the right). While more than 70 percent of the companies used level 0 thinking in the first round, this share drops to less than 30 percent in the second round, as many of the companies who initially used level 0 thinking transitioned to higher levels of thinking (especially level 1) in the second round. This shift exemplifies the estimated trend toward higher levels of sophistication, which is consistent with learning over time.

Next, we specifically test whether some learning occurs in response to feedback from previous periods. In the spirit of learning in boundedly rational models (e.g., Selten, 1991; Fudenberg and Levine, 1993; Selten and Buchta, 1994; Stahl, 1996; Fudenberg and Levine, 2016), we examine whether companies change their levels of thinking away from levels that performed poorly in the previous period. Consistent with such directed learning, we find, in three out of four specifications in Panel B of Table 5, that the probability (and log odds) of companies using a given level of thinking in the current period is lower when that level of thinking performed worse in the previous period. We measure the performance of a level of thinking in the previous period by comparing the disclosure threshold from that level of thinking to the ex post correct threshold that the company would have chosen if it had had perfect foresight (e.g., about other companies' disclosure decisions). The farther from the ex post correct threshold, the worse that level of thinking performed. In a similar vein, in Panel C of Table 5, we find that companies' types relative to the ex post observed threshold of the previous round significantly predicts their disclosure decisions in the current round. Companies' types relative to their (probable) threshold used in the previous round, by contrast, is substantially less predictive.[35] This result is consistent with companies paying attention to the ex post correct threshold from last period and abandoning their previously used disclosure threshold when determining their disclosure decisions.

Collectively, these findings provide evidence consistent with companies upgrading their levels of thinking toward better-performing and higher levels of thinking over time and in response to feedback. This evidence suggests the medium-run convergence to a disclosure equilibrium which resembles the "unravelling" result was likely sped up by companies learning how to think about their disclosure decision and its relation to other companies' decisions.

[35] We calculate the probable threshold in the previous period by weighting the thresholds implied for each of the three sophistication levels $k > 0$ with companies' posterior probabilities for their sophistication levels in the previous period. We divide this value by the sum of the probabilities for levels 1 to 3 to rescale the probabilities to sum to one, as the lowest level of sophistication ($k = 0$) is left out because it does not imply any threshold.

5 Robustness

5.1 Alternative Models

5.1.1 Nested Models

We compare the model fit of our base model with the fit of three important alternatives: a model without controls, a model allowing for the "unravelling" (or rational expectations) sophistication level only, and a model with constant shares of sophistication levels over time. Table 6 documents that our base model exhibits the greatest log-likelihood of all these model variants. To investigate whether this superior model fit is statistically significant after accounting for the larger number of free parameters in our base model, we perform likelihood ratio tests among the nested models.

We find that our base model exhibits a significantly better fit than the model without controls (at the 1 percent significance level). The importance of including controls reflects the strong negative time trend in company's disclosure utility, accounted for by the time effects included among the controls. The capital raising and competition controls, by contrast, are likely of lesser importance, given their comparably limited coefficient magnitudes and significance levels.

We also find that our base model exhibits a significantly better fit than the model which restricts companies to the "unravelling" ($k = 3$) sophistication level (at the 5 percent significance level). This significant difference suggests it is important to allow for heterogeneous and lower levels of sophistication to explain the observed disclosure choices, supporting the use of level-k thinking.

Finally, we find that our base model, allowing for time-varying level-k shares, also provides a significantly better fit than a model with constant shares of sophistication levels, albeit at the 10 percent significance level only. The limited statistical significance of the model difference is at least in part explained by the large difference in free parameters across those models. Accordingly, the raw difference in the fit between the two models suggests that

allowing for *some* changes in sophistication shares increases the model fit. Allowing for separate shares in *each* period, however, does not appear to greatly improve model fit. This limited improvement reflects the scarce data availability in later rounds, which hampers the identification of separate shares in those rounds. Accordingly, we consider the dynamics in the shares in earlier rounds as more informative.[36] It is notable though that even under constant aggregate shares, companies would still be able to change their sophistication levels over time. As such, the limited statistical support for the model with time-varying shares does not suggest that companies do not learn over time.

5.1.2 Other Models

We chose one particular model to interpret the stylized facts in the streetcar industry. This model is motivated by its apparent fit to the institutional details, its parsimony, and prior evidence on the robustness of level-k thinking. Yet, we acknowledge that there are multiple other models one could have chosen to look at the data.

A simple, though quite distinct dynamic model could feature time-varying uncertainty about companies' information endowment or net benefits of disclosure, maintaining the rational expectations assumption. Such model would predict a declining threshold equilibrium over time, consistent with an increasing disclosure rate. It could also predict that better companies disclose earlier, because they may be more informed, exhibit lower proprietary costs, or experience investment opportunities or funding needs earlier than worse types. While we ultimately cannot rule out this model, it does not appear to match the institutional details of our setting, nor our findings. Uncertainty about whether companies know their earnings, for example, is unlikely to be substantial in levels and changes, and the net benefits of disclosure, if anything, appear to decrease over time (as suggested by the estimated time effects) rather than increase. In addition, the simple time-varying-threshold model does not appear to provide an immediate explanation for our evidence on companies' directed learning. Its

[36] Table 4 documents that the shares in latter rounds often do not move far from initial values due to lack of data.

explanations for dynamics are also not specific to the start of the disclosure game. Our setting, however, focuses precisely on such a start, to learn about initial play and its subsequent evolution.[37]

Another plausible model, more specific to initial play and equilibrium evolution, could feature perfectly rational Bayesian companies and investors with prior heterogeneity in the initial round and subsequent learning (e.g., Bray and Kreps, 1981; Blume and Easley, 1982; Kandori et al., 1993). Such a model would maintain the rational expectations assumption. Otherwise, it would exhibit similar features as our model (e.g., different beliefs or sophistication levels and learning) and promise to yield similar predictions, in line with the data. Given these similarities, we chose to rely on a simple and established workhorse model which allows for non-equilibrium thinking and directed or adaptive learning rather than a model with prior heterogeneity and perfectly rational Bayesian learning. While the origin of heterogeneous sophistication levels or Bayesian priors remains unexplained in both models, our reduced-form model comes with the advantage of simplicity and robustness, as it imposes lower cognitive demands and appears more descriptive in lab experiments (e.g. Nagel, 1995; Crawford, 2001). These advantages are particularly useful given that we use our model to interpret real-world data. Interestingly, our model and evidence suggests market forces push companies, whether rational Bayesian or not, to converge to an equilibrium which is consistent with rational expectations (e.g., Becker, 1962; Blume and Easley, 1993).

Ultimately, we stress that we do not purport to identify the one true model which exclusively explains the disclosure equilibrium and its evolution observed in the 1890s streetcar industry. Instead, we use a simple and robust model which captures central features of the unique institutional details of the time and industry—according to our judgement—to better understand the disclosure dynamics. The model highlights a so-far little studied reason

[37] Bederson et al. (2018) document that failure to observe full disclosure could also be due better types abstaining from disclosure to signal quality. Such countersignaling, however, does not appear to fit the observed disclosure dynamics in the streetcar industry. For one, we observe that relatively better companies tend to disclose more readily than worse companies, opposite to the prediction of countersignaling models. For another, the countersignaling model does not make predictions for the evolution of play after the initial round.

for initial non-disclosure and uncovers novel evidence consistent with initial differences in sophistication levels and subsequent learning in a real-world disclosure setting.

5.2 Sample and Estimation Choices

5.2.1 Excluding States with Railroad Commission Reporting Requirements

Our estimates and inferences are largely robust to excluding streetcar companies located in states with requirements to report to local Railroad Commissions (i.e., Massachusetts, New Hampshire, and Connecticut). Companies in these states, unlike the other sample companies, were required to report their earnings to the state's railroad commission (a state level government regulator). As this requirement does not per se imply that the *Chronicle* or dispersed investors in different states or abroad were privy to the information, we include these companies in our main sample.[38] However, in robustness tests, we exclude the companies from each of these states to alleviate concerns that the observed disclosure dynamics and our estimates are confounded by regulatory requirements. The Internet Appendix provides a detailed discussion of the reporting requirements and robustness.

5.2.2 Initial Values

Our EM algorithm estimates are sensitive to the initial values assigned to the model parameters. In our main analysis, we report results obtained using initial values as suggested by Train (2009). To alleviate concerns that our reported estimates capture an unrepresentative local optimum, we run a grid search, initializing our parameters at various values. The model with the maximum log-likelihood obtained from this grid search produces similar results for the latent utility parameters and sophistication shares as our reported model. The grid-search model's estimates also produce similar evidence of learning over time and in

[38]Recent evidence documents that, even today, the publication outlet and target audience matter for investors' awareness of the information (e.g., Christensen et al., 2017; Kim and Kim, 2020). Another reason for inclusion is the fact that, due to the requirement to report to a regulator, the companies in the states with railroad commission reporting do not need to fear political costs from disclosure in the *Chronicle*, supporting the assertion that the cost of disclosure to investors via the *Chronicle* were likely limited.

response to feedback. These results provide some comfort that our reported estimates and inferences are not merely an artifact of our particular initial values.

6 Conclusion

Can market forces resolve information asymmetries between companies and investors? The answer is a resounding 'yes' according to the seminal "unravelling" result (e.g., Ross, 1979; Grossman, 1981; Milgrom, 1981). Whether this analytical result is descriptive of companies' actual disclosure behavior, however, is unclear, as it relies on a number of strong and cognitively demanding assumptions.

We examine the descriptiveness of the "unravelling" prediction in a real-world setting: the 1890s streetcar industry in the U.S. This historical setting features capital-intensive companies that heavily relied on dispersed investors to finance their operations. In the absence of disclosure mandates and modern information technology, a business newspaper, the *Commercial & Financial Chronicle*, stepped in to satisfy investor information demands by issuing quarterly supplements that reported streetcar companies' net earnings.

We find that about 75 percent of the streetcar companies in our sample disclosed their earnings in the first supplement. While this is a high percentage, it clearly falls short of the full disclosure equilibrium predicted by the "unravelling" result. However, we also find that the disclosure rate increased rapidly over the following quarters, reaching almost 100 percent within just a couple of quarters. This convergence toward an (almost) full disclosure equilibrium appears to occur as *relatively* better companies in each quarter leave the pool of remaining non-disclosing companies.

To better understand the forces behind these striking patterns, we fit a model of companies' disclosure choices to the streetcar data. Following the behavioral game theory literature (e.g., Crawford, 2019), our model features level-k thinking, which accommodates the possibility that some companies deviate from the cognitively demanding rational expectations

assumption underlying the "unravelling" result.

Our model estimates suggest that a substantial share of companies indeed appears to have relied on lower levels of thinking, especially at the time of the initiation of the supplements. In particular, many companies seem to have acted as if they made their disclosure decisions at random, neglecting the strategic implications of other companies' disclosure decisions and investors' valuation decisions. This lower level thinking provides an explanation for the initial failure of the "unravelling" prediction.

We further find evidence that non-disclosing companies appear to have adopted higher levels of thinking over time and in response to observing other companies' decisions in the previous supplement and, possibly, investors' corresponding reactions. This evidence is consistent with learning contributing to the rapid increase of the disclosure rate over time.

Collectively, the stylized facts in the streetcar industry and our corresponding model estimates suggest that the "unravelling" result may fail in the real world, at least in the short run, due to the cognitive demands of the rational expectations assumption and the inexperience of companies. The facts and estimates, however, also document that, even despite the cognitive demands and absent disclosure mandates, an (almost) full disclosure equilibrium can arise in the medium to long run as a result of repetition and learning. In this vein, our study informs the recent debate about the need for realistic model assumptions (Pfleiderer, 2020). It suggests that even seemingly unrealistic assumptions (e.g., rational expectations) can be descriptive if one allows for repetition and learning (Friedman, 1953).

Our study finds that market forces yield an (almost) full disclosure equilibrium in an important real world setting, consistent with the "unravelling" prediction. This finding contrasts with the incomplete or partial disclosure equilibria often documented in prior disclosure studies (e.g., Beyer et al., 2010). This difference may arise because important assumptions underlying the "unravelling" result (e.g., uncertainty about information endowment), other than the rational expectations assumption, are reasonably descriptive in this historical setting, while they may not be in other settings. It, however, may also occur because, in our

historical setting, we focus on a major item of financial disclosure—companies' earnings—in an environment characterized by high information demand. Studies using more recent settings, by contrast, often are bound to focus on less prominent items (e.g., management forecasts) in an information environment where the most relevant corporate information is already mandated and plenty of alternative information sources exist.[39]

In closing, we acknowledge that the (almost) full unravelling equilibrium observed in our select sample should not be expected to generalize to other settings (e.g., those characterized by elevated uncertainty about information endowment or notable disclosure costs). We contend though that our explanation for the observed disclosure dynamics—initial deviations from equilibrium thinking and subsequent convergence through repetition and learning—should generalize to other settings, even if the convergence is toward a threshold instead of a full disclosure equilibrium.

[39]Similarly, seminal work on voluntary disclosure of product quality documents incomplete "unravelling" in the restaurant and healthcare sector (e.g., Jin and Leslie, 2003; Jin, 2005; Dranove and Jin, 2010). The incomplete "unravelling" could at least in part be explained by the focus on disclosures regarding a particular aspect of quality (e.g., hygiene) which is not necessarily the core aspect (e.g., food quality) of interest to the target audience (e.g., customer). By contrast, companies' disclosures of earnings relative to invested capital can be expected to be the core aspect of interest to investors in our setting.

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Figure 1: Example of Streetcar Trolley

The figure shows an electric streetcar trolley.

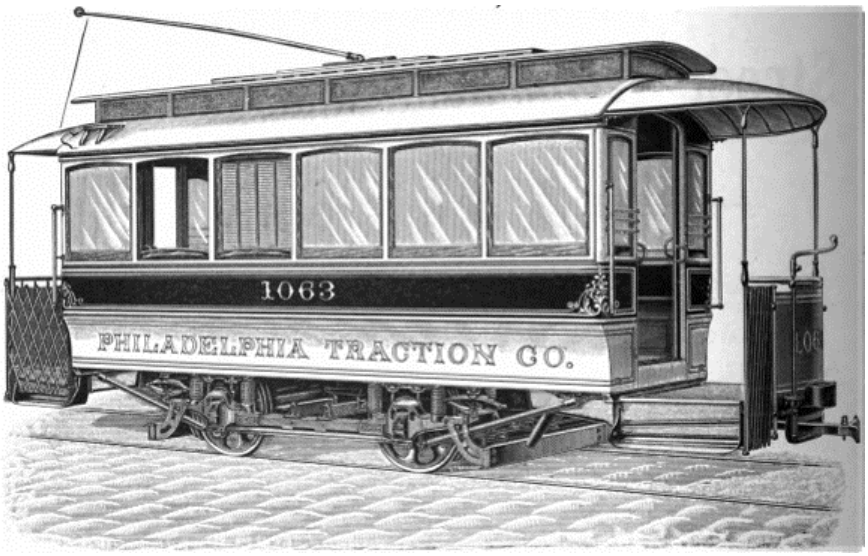
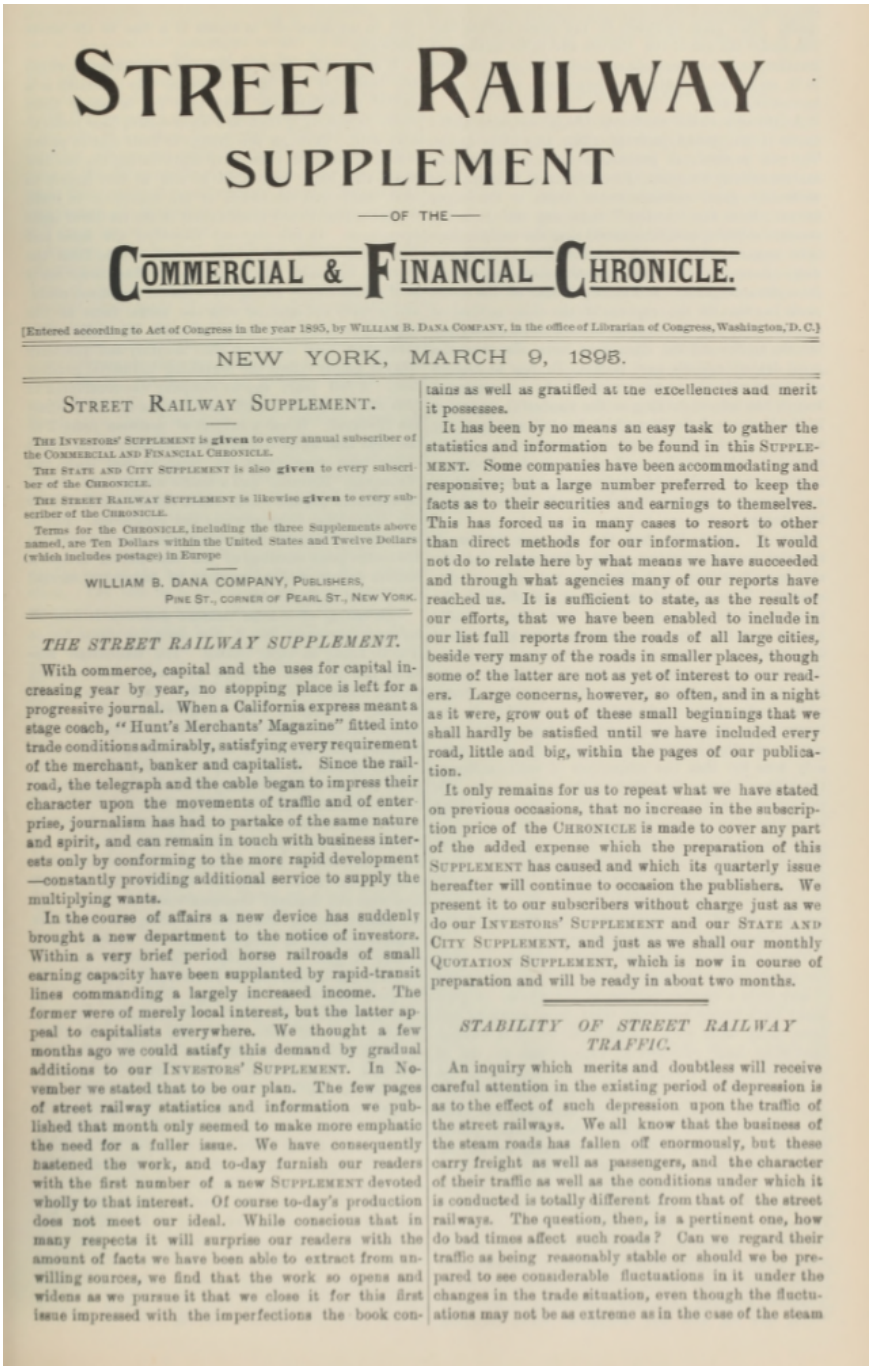


Figure 2: Excerpt from *Chronicle*'s Supplement

The figure shows the first content page of the *Chronicle*'s first streetcar supplement of March 1985. The supplement contains information on general trends in the streetcar industry and company-specific reports.



STREET RAILWAY SUPPLEMENT

—OF THE—

COMMERCIAL & FINANCIAL CHRONICLE.

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NEW YORK, MARCH 9, 1895.

STREET RAILWAY SUPPLEMENT.

THE INVESTORS' SUPPLEMENT is **given** to every annual subscriber of the COMMERCIAL AND FINANCIAL CHRONICLE.

THE STATE AND CITY SUPPLEMENT is also **given** to every subscriber of the CHRONICLE.

THE STREET RAILWAY SUPPLEMENT is likewise **given** to every subscriber of the CHRONICLE.

Terms for the CHRONICLE, including the three Supplements above named, are Ten Dollars within the United States and Twelve Dollars (which includes postage) in Europe

WILLIAM B. DANA COMPANY, PUBLISHERS,
PINE ST., CORNER OF PEARL ST., NEW YORK.

THE STREET RAILWAY SUPPLEMENT.

With commerce, capital and the uses for capital increasing year by year, no stopping place is left for a progressive journal. When a California express meant a stage coach, "Hunt's Merchants' Magazine" fitted into trade conditions admirably, satisfying every requirement of the merchant, banker and capitalist. Since the railroad, the telegraph and the cable began to impress their character upon the movements of traffic and of enterprise, journalism has had to partake of the same nature and spirit, and can remain in touch with business interests only by conforming to the more rapid development —constantly providing additional service to supply the multiplying wants.

In the course of affairs a new device has suddenly brought a new department to the notice of investors. Within a very brief period horse railroads of small earning capacity have been supplanted by rapid-transit lines commanding a largely increased income. The former were of merely local interest, but the latter appeal to capitalists everywhere. We thought a few months ago we could satisfy this demand by gradual additions to our INVESTORS' SUPPLEMENT. In November we stated that to be our plan. The few pages of street railway statistics and information we published that month only seemed to make more emphatic the need for a fuller issue. We have consequently hastened the work, and to-day furnish our readers with the first number of a new SUPPLEMENT devoted wholly to that interest. Of course to-day's production does not meet our ideal. While conscious that in many respects it will surprise our readers with the amount of facts we have been able to extract from unwilling sources, we find that the work so opens and widens as we pursue it that we close it for this first issue impressed with the imperfections the book contains as well as gratified at the excellencies and merit it possesses.

It has been by no means an easy task to gather the statistics and information to be found in this SUPPLEMENT. Some companies have been accommodating and responsive; but a large number preferred to keep the facts as to their securities and earnings to themselves. This has forced us in many cases to resort to other than direct methods for our information. It would not do to relate here by what means we have succeeded and through what agencies many of our reports have reached us. It is sufficient to state, as the result of our efforts, that we have been enabled to include in our list full reports from the roads of all large cities, beside very many of the roads in smaller places, though some of the latter are not as yet of interest to our readers. Large concerns, however, so often, and in a night as it were, grow out of these small beginnings that we shall hardly be satisfied until we have included every road, little and big, within the pages of our publication.

It only remains for us to repeat what we have stated on previous occasions, that no increase in the subscription price of the CHRONICLE is made to cover any part of the added expense which the preparation of this SUPPLEMENT has caused and which its quarterly issue hereafter will continue to occasion the publishers. We present it to our subscribers without charge just as we do our INVESTORS' SUPPLEMENT and our STATE AND CITY SUPPLEMENT, and just as we shall our monthly QUOTATION SUPPLEMENT, which is now in course of preparation and will be ready in about two months.

STABILITY OF STREET RAILWAY TRAFFIC.

An inquiry which merits and doubtless will receive careful attention in the existing period of depression is as to the effect of such depression upon the traffic of the street railways. We all know that the business of the steam roads has fallen off enormously, but these carry freight as well as passengers, and the character of their traffic as well as the conditions under which it is conducted is totally different from that of the street railways. The question, then, is a pertinent one, how do bad times affect such roads? Can we regard their traffic as being reasonably stable or should we be prepared to see considerable fluctuations in it under the changes in the trade situation, even though the fluctuations may not be as extreme as in the case of the steam

Figure 3: Companies' Reported Type and Investors' Pricing

The figure shows the relationship between companies' reported type (θ), measured as net earnings over invested capital ($ROIC$, in percent), and investors' pricing. It is based on the cross-section of streetcar companies with net earnings reported in the *Chronicle's* November 1896 streetcar supplement and bid prices (as a percentage of par) collected from the *Chronicle's* quotations supplement of December 5, 1896. The sample comprises 33 streetcar companies (due to limited price availability). Each black dot represents a streetcar company. The black line represent the regression line and the gray area plots the corresponding 90 percent confidence interval. The slope coefficient (β) and explanatory power (R^2) of the regression of bid prices on $ROIC$ is provided in the lower right corner of the figure. *** indicates statistical significance at the 1% level.

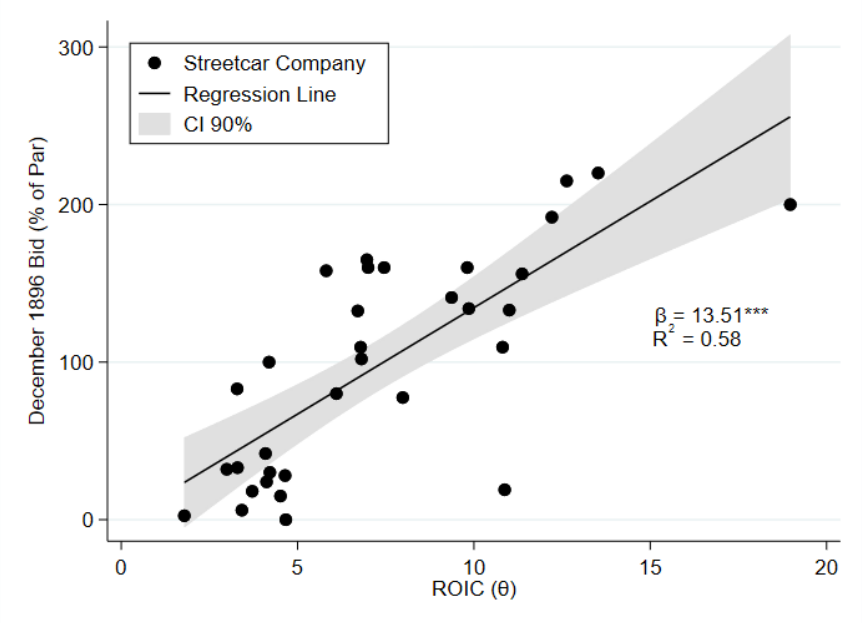


Figure 4: Distribution of Company Types

The figure plots the cross-sectional distribution of streetcar companies' types (θ) as proxied by their return on invested capital ($ROIC$). Return on invested capital is the ratio of net earnings to invested capital as reported on November 28, 1896, the last supplement for which we collected disclosure data.

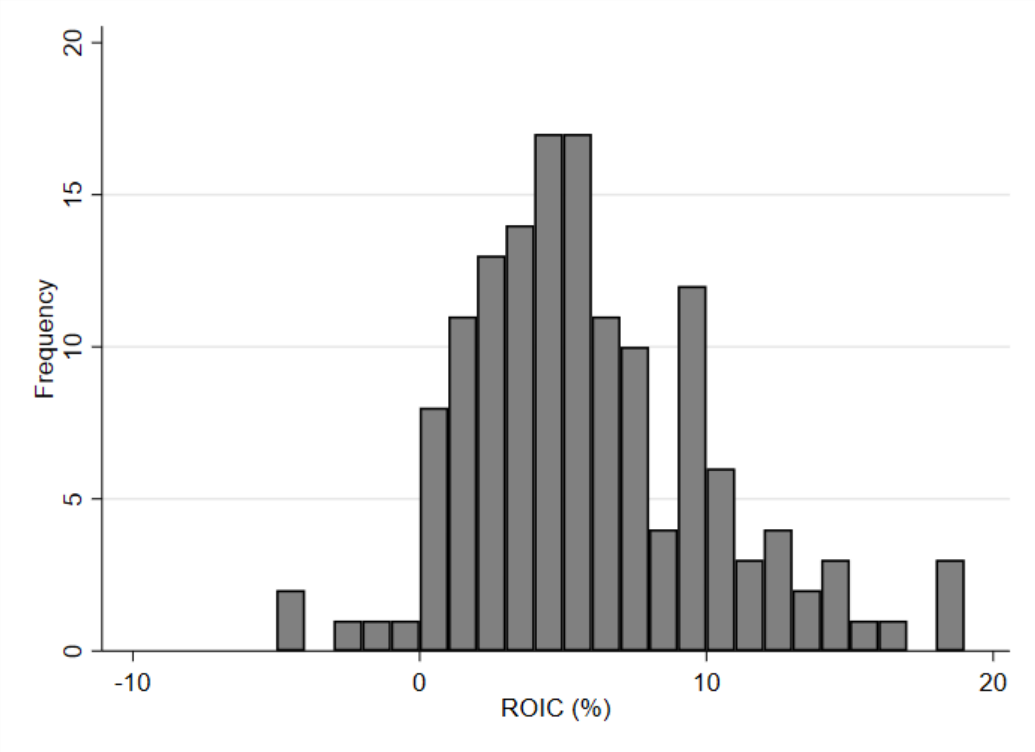


Figure 5: Fraction of Companies Disclosing

The figure plots the fraction of disclosing companies over time. A company is a disclosing company if it provided its net earnings in the current supplement or any of the previous supplements. Supplement "0" depicts the time before the first supplement came out. Supplement 1 is the first supplement, which was produced by the *Street Railway Journal* in June 1894. Supplements 2 through 9 are the following supplements, which were produced by the *Commercial & Financial Chronicle* between March 1895 and November 1896. The gray area depicts the 90 percent confidence interval.

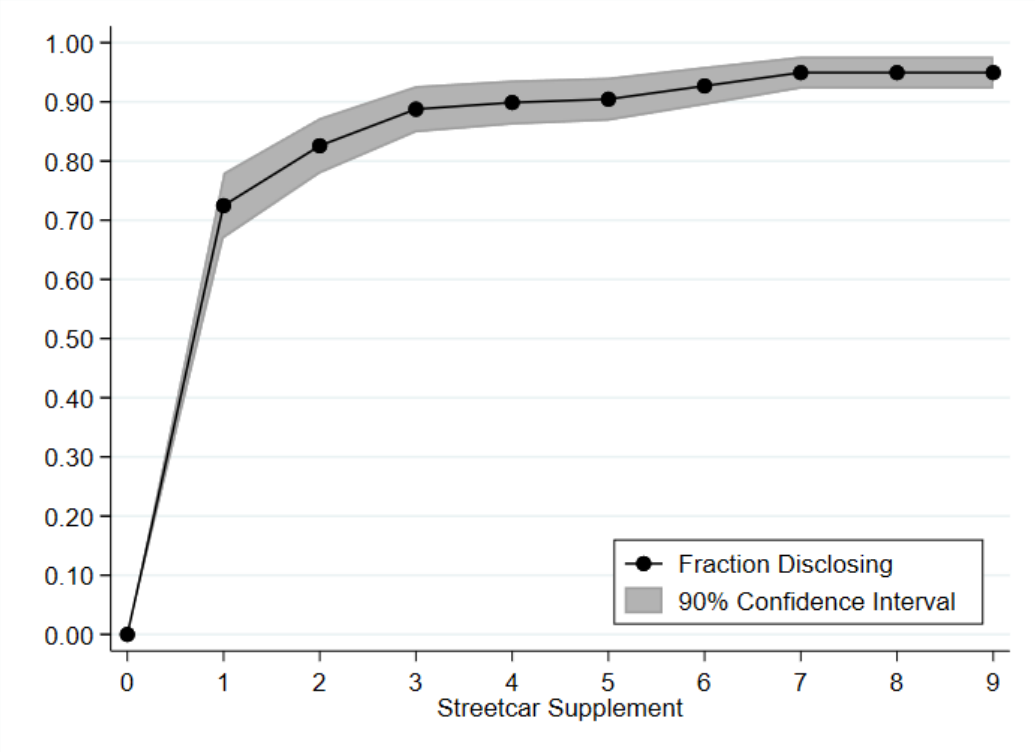


Figure 6: Average Type of Non-Disclosing Companies

The figure plots the average type among companies that, as of the current supplement, have not yet disclosed net earnings in any of the previous supplements. We proxy for companies' types using their returns on invested capital ($ROIC$), measured as the ratio of net earnings to invested capital on November 28, 1896, the last supplement for which we collect disclosure data. Since $ROIC$ is a cross-sectional measure from one point in time, the changes in $ROIC$ depicted in the figure reflect changes in the composition of non-disclosing companies (i.e., the remaining pool) from one supplement to the next. They do not reflect changes in a given company's $ROIC$ over time (which are unknown in the periods before a company first discloses). Supplement 1 is the first supplement, supplement 2 is the second, and so on. The plot ends at supplement 7, since that is the last supplement in which any of the sample companies start disclosing earnings. The gray area depicts the 90 percent confidence interval.

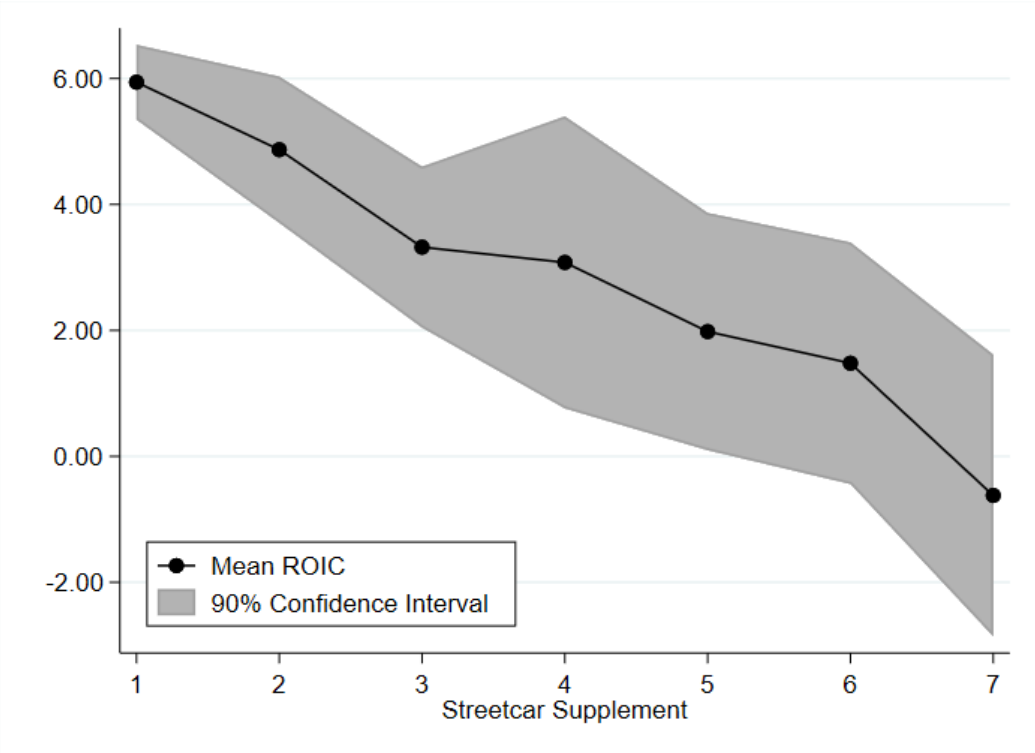
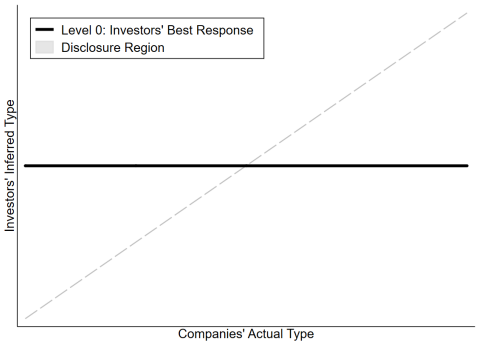


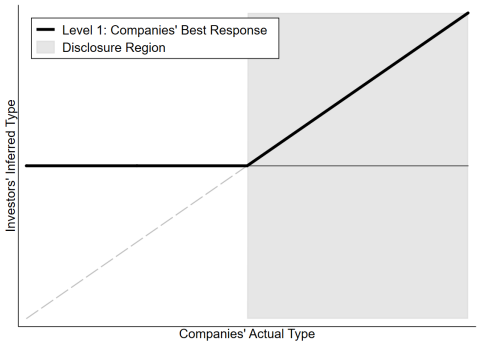
Figure 7: Illustration of Iterative Best Responses

The figure illustrates the iterative best responses of investors' to companies' disclosure decisions, and vice versa. The y-axis plots the type of companies as inferred by investors. The x-axis plots companies' actual type. The gray area shows the range of disclosing company types. Subfigure (a) starts with the best response of investors' to companies staying silent at random (i.e., level 0 companies). The following subfigures show the iterative best responses by companies and investors. The last subfigure (f) shows the ultimate "unravelling" equilibrium.

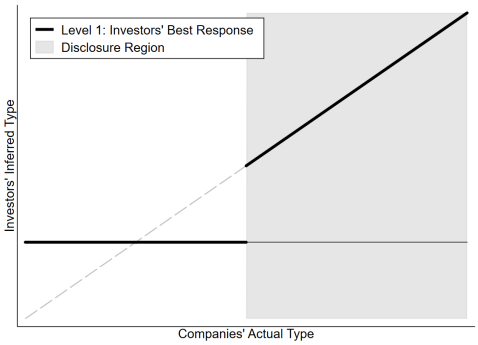
(a) Investors' Response to Level 0



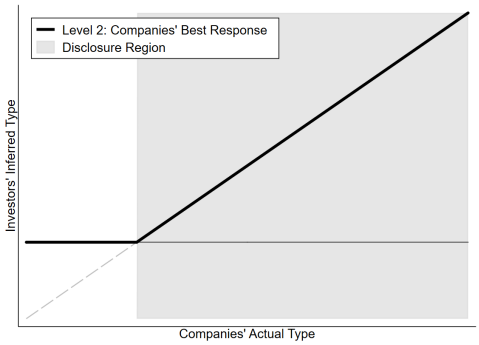
(b) Level 1 Companies' Response



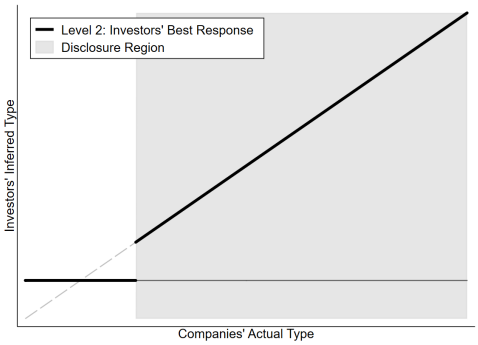
(c) Investors' Response to Level 1



(d) Level 2 Companies' Response



(e) Investors' Response to Level 2



(f) Level 3 (∞) Companies' Response

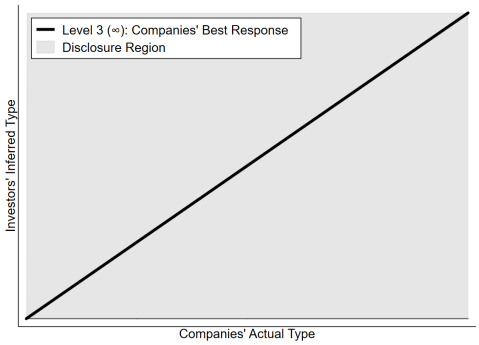


Figure 8: Transition in Level-k Thinking

The figure plots the share ($s_{k,t}$) of companies using a given level of thinking (k) in the first and second supplement. The shares are calculated for a constant sample of companies: companies that abstain from disclosure in the first supplement and, hence, make another disclosure decision in the second supplement. The depicted changes in shares from the first to the second supplement, accordingly, represent changes in companies' level of thinking over time. They do not reflect changes in the composition of companies over time. The dashed whiskers provide 90 percent confidence intervals for the estimated shares.

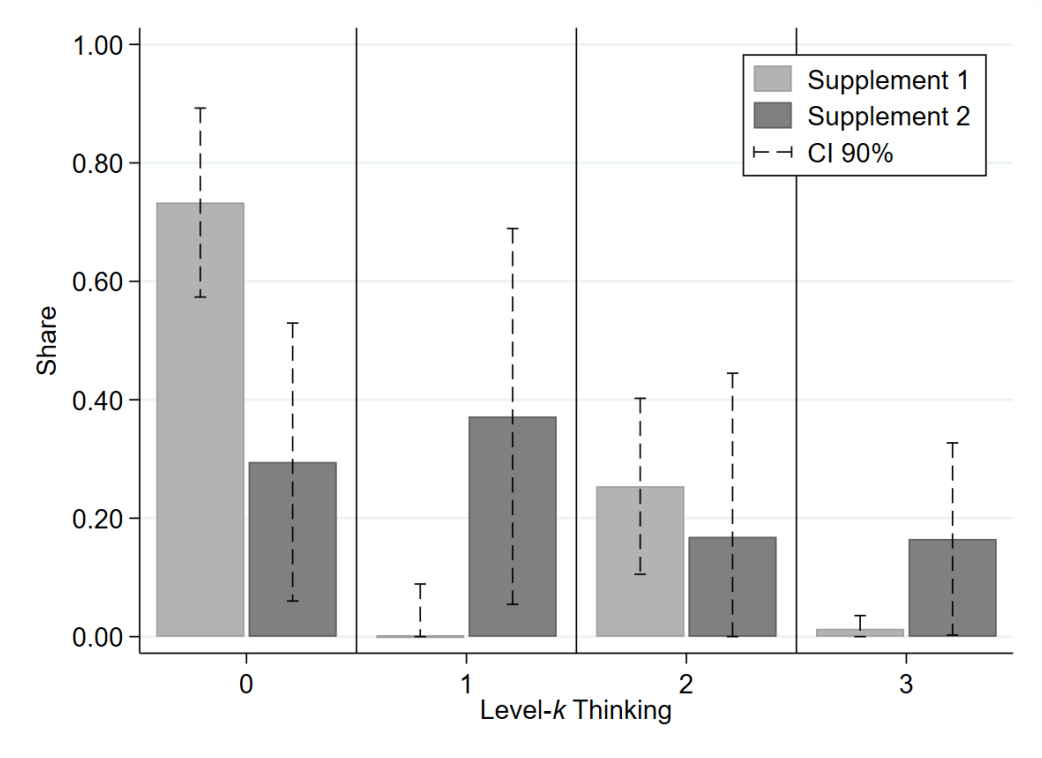


Table 1: Variable Definitions

The table provides definitions of the variables used in our empirical tests.

Variable	Definition
Disclosure	An indicator taking the value of 1 for companies that disclose their net earnings in the current or any of the previous supplements (see the Internet Appendix for more detail)
ROIC (θ)	Net earnings over invested capital as reported in the last supplement (see the Internet Appendix for more detail)
$E_{k,t}[\theta]$	Disclosure threshold for companies using level-k thinking
$(\theta - E_{k,t}[\theta])$	Relative type, calculated as the difference between companies' *ROIC* and their disclosure threshold
$E_{1,t}[\theta]$	Disclosure threshold for companies using level-1 thinking, calculated as the mean of the *ROIC* distribution of companies that have not disclosed yet (before the current supplement)
$E_{2,t}[\theta]$	Disclosure threshold for companies using level-2 thinking, calculated as the mean of the *ROIC* distribution of companies that have not disclosed yet (before the current supplement) *and* fall below the mean of the *ROIC* distribution of all the companies that have not disclosed yet
$E_{3,t}[\theta]$	Disclosure threshold for companies using level-3 thinking (i.e., unravelling), calculated as the minimum of the *ROIC* distribution of companies that have not disclosed yet (before the current supplement)
Invested Capital Growth	Percentage growth in invested capital from one supplement to the next (see the Internet Appendix for more detail)
Number of Competitors	Number of streetcar companies in the same city (see the Internet Appendix for more detail)
Probability (ϕ)	Posterior probability that a given company is using level-k thinking when deciding on disclosure in a given supplement
Log Odds ($\frac{\phi}{1-\phi}$)	Log odds transformation of posterior probability of a given company using level-k thinking
Expected Level ($E[k]$)	Expected level of thinking of a given company, calculated as the posterior probability weighted sum of level k ($\sum_{k=0}^{K} \phi_{i,k,t} k$)
$E_t[\theta]$	Ex post disclosure threshold, calculated as the average of companies that have not disclosed yet (after the current supplement)
$\lvert E_{k,t-1}[\theta] - E_{t-1}[\theta] \rvert$	Deviation of level-k disclosure threshold from ex post disclosure threshold in previous supplement, calculated as the absolute difference between the two thresholds
$(\theta - E_{t-1}[\theta])$	Relative type compared to the ex post threshold observed in the previous supplement, calculated as the difference between companies' *ROIC* and the ex post threshold of the previous supplement
$E[E_{k,t-1}[\theta]]$	Expected threshold used by a given company in the previous supplement, calculated as the posterior probability weighted level-k thresholds (rescaled to account for the lack of a level-0 threshold) ($\sum_{k=1}^{K} \frac{\phi_{i,k,t}}{\sum_{k=1}^{K} \phi_{i,k,t}} E_{k,t-1}[\theta]$)
$(\theta - E[E_{k,t-1}[\theta]])$	Relative type compared to the expected level-k threshold used in the previous supplement, calculated as the difference between companies' *ROIC* and the expected level-k threshold of the previous supplement

Table 2: Descriptive Statistics

The table presents descriptive statistics. Panel A summarizes the distribution of the main observable variables (company-period observations for *Disclosure*, *Invested Capital Growth*, and *Number of Competitors*; and company-level observations for *ROIC*). Panel B presents the number of companies and the mean of the main observable variables across periods (supplements), separately for the pool of companies that have disclosed in previous supplements versus the pool of companies that have not.

Panel A: Distribution

Variable	N	Mean	Standard Deviation	Min	p25	p50	p75	Max
Disclosure	1,015	0.911	0.284	0.000	1.000	1.000	1.000	1.000
ROIC (θ)	145	5.940	4.345	-4.627	2.993	5.269	8.716	18.972
Invested Capital Growth	1,015	8.393	55.006	-71.719	0.000	0.000	0.000	1,100.000
Number of Competitors	1,015	3.859	5.300	1.000	1.000	1.000	3.000	25.000

Panel B: Means by Supplement for Companies That Have and Have Not Disclosed

	Companies That Have Disclosed Before				Companies That Have Not Disclosed Before			
Supplement	N	ROIC	Invested Capital Growth	Number of Competitors	N	ROIC	Invested Capital Growth	Number of Competitors
1	0	-	-	-	145	5.940	0.000	4.400
2	108	6.308	29.502	4.120	37	4.868	80.792	2.703
3	124	6.384	1.041	4.016	21	3.321	5.067	2.048
4	134	6.175	5.761	3.963	11	3.079	11.528	2.182
5	136	6.202	3.189	3.816	9	1.981	0.000	2.333
6	137	6.201	3.791	3.847	8	1.479	10.233	2.625
7	141	6.127	1.130	3.858	4	-0.621	3.747	1.500

Table 3: Disclosure Model Estimates

The table presents maximum-likelihood estimates of the parameters governing the latent disclosure utility model obtained via the expectation-maximization (EM) algorithm described in Train (2009). Panel A presents the estimates of the main parameters (α, β, δ). Panel B presents the estimates for the control parameters (γ). The estimation sample spans the first seven periods (supplements). We limit the sample to those companies that disclose within these periods, because we observe their types (θ) (unlike for the few companies that never disclose). In any given period, the sample includes companies that did not disclosed in any of the previous periods. The z-statistics (in parentheses) are based on bootstrapped standard errors. *, **, *** denote statistical significance at the 10, 5, and 1 percent level (two-tailed), respectively.

Panel A: Main Parameters

Description	Variable	Parameter	Estimate (z-stat)
Common Disclosure Benefit	Intercept	α	-4.768^{***} (-3.38)
Slope of Disclosure Benefit wrt Relative Type	$(\theta - E_{k,t}[\theta])$	β	29.833^{***} (25.75)
Incremental Disclosure Benefit ($k = 0$)	$\mathbb{1}_{k=0}$	δ	0.348 (0.20)

Panel B: Controls

Description	Variable	Parameter	Estimate (z-stat)
Financing Explanation	Invested Capital Growth	γ_1	-0.205^{**} (-2.36)
Competition Explanation	Number of Competitors	γ_2	0.809^{***} (3.65)
Incremental Disclosure Benefit (Supplement 2)	$\mathbb{1}_{t=2}$	γ_3	-8.199^{**} (-2.41)
Incremental Disclosure Benefit (Supplement 3)	$\mathbb{1}_{t=3}$	γ_4	-10.556^{***} (-4.61)
Incremental Disclosure Benefit (Supplement 4)	$\mathbb{1}_{t=4}$	γ_5	-194.193 (-0.01)
Incremental Disclosure Benefit (Supplement 5)	$\mathbb{1}_{t=5}$	γ_6	-284.335 (-0.59)
Incremental Disclosure Benefit (Supplement 6)	$\mathbb{1}_{t=6}$	γ_7	-60.262^{***} (-4.78)
Incremental Disclosure Benefit (Supplement 7)	$\mathbb{1}_{t=7}$	γ_8	133.662^{***} (5.88)

Table 4: Estimated Shares of Level-k Thinking

The table presents the estimated shares ($s_{k,t}$) of companies using a given level of thinking (k) in a given period (supplement). In Panel A, the shares in each period are calculated for companies that have not disclosed in any of the previous periods. Companies that disclose in a given period leave the pool of companies for which the shares are calculated in the next period. In Panel B, the shares in each period are calculated for the subset of companies that also remained silent in the given period (not only in all previous periods). We caution that the share estimates are more informative in earlier periods, as more companies have yet to make their disclosure choice in those periods compared to later ones (where the estimated shares either take extreme values or do not depart from the initial values). Bootstrapped standard errors (in parentheses) are reported below the respective shares.

Panel A: Shares Among Previously Non-Disclosing Companies

		Level-k Thinking			
Supplement		0	1	2	3
1	Share	0.241	0.000	0.272	0.487
	(SE)	(0.045)	(0.023)	(0.092)	(0.085)
2	Share	0.295	0.372	0.168	0.165
	(SE)	(0.142)	(0.192)	(0.167)	(0.098)
3	Share	0.333	0.238	0.178	0.250
	(SE)	(0.158)	(0.209)	(0.213)	(0.181)
4	Share	0.000	0.752	0.059	0.188
	(SE)	(0.000)	(0.182)	(0.037)	(0.192)
5	Share	0.112	0.197	0.191	0.500
	(SE)	(0.078)	(0.138)	(0.133)	(0.346)
6	Share	0.000	0.000	1.000	0.000
	(SE)	(0.000)	(0.000)	(0.000)	(0.000)
7	Share	0.256	0.231	0.256	0.256
	(SE)	(0.029)	(0.086)	(0.029)	(0.029)

Panel B: Shares Among Still Non-Disclosing Companies

		Level-k Thinking			
Supplement		0	1	2	3
1	Share	0.733	0.000	0.254	0.013
	(SE)	(0.097)	(0.054)	(0.090)	(0.014)
2	Share	0.479	0.407	0.106	0.008
	(SE)	(0.202)	(0.220)	(0.124)	(0.010)
3	Share	0.636	0.260	0.081	0.023
	(SE)	(0.239)	(0.245)	(0.115)	(0.034)
4	Share	0.000	0.836	0.066	0.098
	(SE)	(0.000)	(0.147)	(0.037)	(0.152)
5	Share	0.126	0.222	0.215	0.438
	(SE)	(0.079)	(0.139)	(0.134)	(0.350)
6	Share	0.000	0.000	1.000	0.000
	(SE)	(0.000)	(0.000)	(0.000)	(0.000)

Table 5: Level-k Thinking and Learning

The table presents evidence on companies' level-k thinking and learning. Panel A presents estimates of a linear time trend in companies' expected level of thinking ($E[k]$) using a pooled and a company-fixed-effects regression (with observations at the company-period level). Panel B presents estimates from pooled and company-level-k-fixed-effects regressions of companies' posterior probabilities (ϕ) and log odds ($\frac{\phi}{1-\phi}$) on the absolute distance between a given level-k's disclosure threshold and the ex post observed disclosure threshold in the previous period (with observations at the company-level-k-period level). Panel C presents estimates from company-fixed-effects regressions of disclosure on companies' types relative to the ex post observed disclosure threshold in the previous period and relative to the expected threshold based on companies' level-k thinking in the previous period (with observations at the company-period level). All regressions include only company-period observations for companies that did not disclose in any of the previous periods (i.e., those companies that can still make the decision to disclose). In fixed effects regressions, we drop companies with just one observation (singletons). The t-statistics (in parentheses) are based on standard errors clustered at the company level. *, **, *** denote statistical significance at the 10, 5, and 1 percent level (two-tailed), respectively.

Panel A: Linear Trend

Y_t	Expected Level ($E[k]$)	Expected Level ($E[k]$)
t	0.291^{***}	0.206^{***}
	(11.97)	(6.85)
Fixed Effects	Intercept	Company
Observations	90	74
Companies	37	21
R^2	0.402	0.713

Panel B: Directed Learning

Y_t	Probability (ϕ)	Probability (ϕ)	Log Odds ($\frac{\phi}{1-\phi}$)	Log Odds ($\frac{\phi}{1-\phi}$)
$\lvert E_{k,t-1}[\theta] - E_{t-1}[\theta]\rvert$	-0.013^{***}	-0.073^{***}	-10.336^{***}	8.038
	(-2.83)	(-3.41)	(-4.32)	(0.68)
Fixed Effects	Intercept	Company-Level-k	Intercept	Company-Level-k
Observations	270	222	255	206
Companies	37	21	37	21
R^2	0.059	0.209	0.168	0.255

Panel C: Previous Thresholds versus Thinking

Y_t	Disclosure	Disclosure
$(\theta - E_{t-1}[\theta])$	0.239^{***}	0.190^{***}
	(9.27)	(5.82)
$(\theta - E[E_{k,t-1}[\theta]])$		0.031
		(0.84)
Fixed Effects	Company	Company
Observations	74	54
Companies	21	14
R^2	0.542	0.537

Table 6: Model Fit and Comparison

The table reports the fit (log-likelihood) of our model in Panel A and compares it with the fit of nested models via likelihood-ratio tests in Panel B. The nested models include a model without an intercept or controls ($X_{i,t}$), a model restricted to the unravelling level of thinking ($k = 3$), and a model restricted to constant shares of level-k thinking ($s_{k,t} = s_k$) across supplements. The likelihood ratio is given by $LR = -2(LL_2 - LL_1)$, where LL_1 denotes the log-likelihood of our model and LL_2 denotes the log-likelihood of a nested model. The degrees of freedom represent the difference in free parameters compared to our base model. The likelihood-ratio test yields a χ^2 distributed test statistic. We provide one-tailed p-values for the test statistics under the null hypothesis (H_0) that our model does not exhibit a significantly better model fit than the nested models.

Panel A: Model Fit

Model	Log-Likelihood
Our Model	-108.234

Panel B: Model Comparison

Alternative Models	Log-Likelihood	Likelihood Ratio	Degrees of Freedom	p-value
No Controls	−120.407	24.346	9	0.004
Unravelling Only	−126.761	37.055	21	0.017
Constant Level-k Shares	−121.655	26.843	18	0.082

Internet Appendix

Learning to Disclose:

Disclosure Dynamics in the 1890s Streetcar Industry

Thomas Bourveau[*] **Matthias Breuer**[†] **Robert Stoumbos**[‡]

This version: December 2020

[*]Columbia University, Graduate School of Business - tb2797@columbia.edu
[†]Columbia University, Graduate School of Business - mb4468@gsb.columbia.edu
[‡]Columbia University, Graduate School of Business - rcs2188@gsb.columbia.edu

A.1 Data Sources

We collected all the disclosure data used in this paper from two sources. The first source is the *Commercial & Financial Chronicle*, a respected financial newspaper, for which we collected data from their first eight quarterly streetcar supplements (the supplement was called the *Street Railway Supplement*). These eight supplements were published on the following dates:

- March 9, 1895
- May 25, 1895
- August 31, 1895
- November 30, 1895
- February 29, 1896
- May 30, 1896
- August 29, 1896
- November 28, 1896

We accessed digital copies of these supplements through FRASER, a digital library maintained by the Federal Reserve Bank of St. Louis. (For our pricing test, we further collected bid prices from the *Commercial & Financial Chronicle's Quotations Supplement* of December 5, 1896.)

The second source is the *Street Railway Journal*, for which we collected data from their first streetcar supplement (the supplement was called *American Street Railway Investments*), which was published on June 15, 1894. We accessed a digital copy of this supplement, provided by the University of Michigan, through the HathiTrust Digital Library. The *Street Railway Journal* published this supplement on an annual basis. The second issue came out on May 1, 1895. We did not collect data from it, since it came out after the *Commercial & Financial Chronicle* had already published its first quarterly supplement.

We hired a company specialized in data collection from archives to hand-collect the data. We heavily checked this data—sometimes with code, often by hand—to fix any errors in the initial hand-collection. The specific collection procedure will be discussed separately below for each variable.

A.2 Detailed Description of Variables

We describe the following variables in detail:

- *Disclosure*
- *ROIC*
- *Invested Capital Growth*
- *Number of Competitors*

A.2.1 Disclosure

The variable *Disclosure* is an indicator variable that equals 1 for the first supplement in which a company, or one of its subsidiaries, reports net earnings.[1] The indicator continues to equal 1 in all future periods, since the company has already disclosed.

To collect this data, we had a third party hand-collect an indicator variable for whether or not each company reported net earnings in each supplement. We instructed the third party to mark a company as reporting net earnings if it either reported net earnings or reported gross earnings and then listed expenses, since net earnings can typically be calculated as gross earnings minus the reported expenses.[2] To check the hand collection, we had a research assistant write a program to automatically identify (based on the original texts) which of the companies reported net earnings each supplement. The research assistant then hand-checked the cases where the code disagreed with the third-party hand-collected data.

A.2.2 ROIC

ROIC, our cross-sectional measure of each company's type, is measured as the company's net earnings divided by its invested capital, all multiplied by 100 to put it in percentage terms. We measure ROIC on a "consolidated" basis. This means we sum up net earnings and invested capital across a company and all its subsidiaries, if it has any, when we calculate *ROIC*.[3]

Net earnings for all the companies is measured at one point in time, using the dollar number reported on November 28, 1896, the last supplement we collected for our sample. We collect it as a snapshot at one point in time because we want *ROIC* to be a cross-sectional measure of company type. We collect it from the last supplement in our sample to maximize the number of companies included in the snapshot, since we cannot collect a company's net earnings in periods before it first discloses. We hand-collected the net earnings reported in that last supplement for each company.[4] Net earnings is usually reported for a 12-month period, but occasionally it is reported for a different number of months. In such cases, we re-scale the net earnings to a 12-month period (i.e., if the company reports net earnings for a 3-month period, we divide the net earnings by the fraction 3/12).

[1] The subsidiaries are dropped from the sample for our tests. Thus, for each supplement, we keep only one observation for each affiliated group, where an affiliated group includes the parent company and its subsidiaries, if it has any subsidiaries.

[2] We instructed the third party that a company's net earnings is typically reported in a section titled "EARNINGS" or "ANNUAL REPORT," and it might have any of the following names: "net earnings," "net income," "net," "net inc. after int.," "Railway net.," "net receipts," "net revenue," "deficit," or "loss from operating."

[3] Thus, for each company, $ROIC = \frac{\sum NetEarnings}{\sum InvestedCapital}$, where the sums in the numerator and denominator are over the parent company and all of its subsidiaries. Net earnings and invested capital are both measured separately for each parent and subsidiary, according to the procedures described below, before being summed up in the numerator and denominator of *ROIC*.

[4] For all but one of the companies, net earnings was clearly labeled in the company's entry in the supplement. For the one remaining company, net earnings was not reported as a separate line item, but gross earnings and operating expenses were both reported, so we calculated net earnings as the difference between the two.

We measure invested capital as the average capital invested in the company at the beginning of the sample period, on June 15, 1894, and the end, on November 28, 1896. Since, for most of the companies, the net earnings in the numerator is for fiscal 1895, scaling by the average of beginning and ending invested capital is similar to the standard practice, when calculating *ROIC* today, of scaling operating earnings by the average of beginning and ending capital for the year. We measure invested capital as the sum of the company's dollar values of stock outstanding and bonds outstanding, as reported in the supplements. To preserve observations, in cases where stock outstanding is missing for the company in either June 1894 or November 1896, we just measure invested capital as of the date when it is not missing. If bonds outstanding is missing, we assume that there are zero dollars of bonds outstanding.

A.2.3 Invested Capital Growth

Invested Capital Growth is a variable with separate values for each company and supplement, and it is measured as the percentage growth in the company's stocks and bonds outstanding from the previous supplement to the current one.

For the *Invested Capital Growth* variable, a company's capital in a given supplement is equal to the sum of its stock and bonds outstanding reported in that supplement. To calculate growth, capital must be non-missing for both the previous and current supplements. If bonds outstanding is missing in either of these supplements, then only stock outstanding is used to calculate *Invested Capital Growth* for the company. Similarly, if stock outstanding is missing in either of them, then only bonds outstanding is used.

Invested Capital Growth is measured at the "consolidated" level. Thus, the percentage capital growth is measured separately for the parent company and each of its subsidiaries, if any (ignoring subsidiaries with missing data), and then taking a weighted average across these entities, with the weight being each entity's capital as of the previous supplement.

To preserve observations, *Invested Capital Growth* is set to zero percent whenever the data needed to calculate it is missing.

A.2.4 Number of Competitors

Number of Competitors is equal to the number of companies that operate in a city at the time of each streetcar supplement. It is a time-varying variable at the city level, changing for each city from supplement to supplement. If a company has subsidiaries, both it and the subsidiaries together are counted as one company (i.e., subsidiaries do not add to the count of competitors in the city). Companies are included in the count for *Number of Competitors* even if they are excluded from the sample for the tests (see Section A.4 for the list of sample exclusions).

A.3 Merging the Panel of Company Observations Across the Supplements

To create our panel data, we merged the data from the eight *Chronicle* supplements and the one *Street Railway Journal* supplement together by company.

The supplements give the city of the company and the company's name. Frequently, these names change slightly (e.g., in some quarters, the word "Railway" will be abbreviated "Ry."). Thus, we chose to hand-match each company's observations across the nine supplements. We assign the company a single name for the entire sample period, which we call "unique_name." Frequently, two different companies in different cities will have the same name. Thus, a company is uniquely identified by its city and its "unique_name." We can tell that the two companies are different from each other, even though they have the same name. In the handful of cases where a single company is listed as operating in multiple cities, only one city will contain an entry with the company's information. In the other cities, the company's name will be listed, with a note to refer to the other city where the information is listed.

The supplements typically show separate entries for a parent company and its subsidiaries, which operate within the same city. We assign both the parent and its affiliated subsidiaries a common identifier, which we call "consol_name." The variable "consol_name" is unique to each affiliated group within each city (since two different parent companies in different cities can have the same name). Thus, an affiliated group is uniquely identified by city and "consol_name." In the paper, all of our analysis is done at the "consolidated" level, meaning we keep only one observation per affiliated group for each supplement (where an affiliated group includes the parent and all of its subsidiaries).

A.4 Sample Construction

Our sample consists of streetcar companies that operate in the Northeast, by which we mean Pennsylvania, New Jersey, New York, Massachusetts, Rhode Island, Connecticut, Maine, Vermont, and New Hampshire. If a company has subsidiaries, we count the parent and its subsidiaries collectively as a single company. We apply the following restrictions to the population of companies, from these Northeastern states, that appear in at least one of the nine supplements from June 1894 to November 1896:

- Number of companies from Northeastern states (PA, NJ, NY, MA, RI, CT, ME, VT, and NH) that appear in at least one of the nine supplements: 481
- Number remaining after keeping only those that are present in the first supplement (i.e., the one from June 15, 1894): 346
- Number remaining after keeping only those that are present in the last supplement (i.e., the one from November 28, 1896): 178
- Number remaining that ever disclose net earnings in any of the nine supplements: 169
- Number remaining that disclose net earnings in the last supplement (i.e., the one from November 28, 1896): 145

We keep only companies that existed as of the first supplement, which was published on June 15, 1894. This restriction avoids conflating companies' disclosure decisions with their decisions to start operating or raise capital for the first time, or with the *Chronicle's* expansion of its coverage.

We keep only companies that existed as of the last supplement, which was published on November 28, 1896. This restriction is necessary, since we collect net earnings from that supplement in order to determine each company's type. This restriction drops our sample by 168 companies, from 347 to 179. The vast majority of the drop in companies appears to come from a drop in coverage by the supplements in our sample. Of the 168 dropped companies, 128 only appear in the first supplement, and are missing from all later ones. This seems to occur because the first supplement, which was published by the *Street Railway Journal*, has greater coverage than the later supplements, which were published by the *Commercial & Financial Chronicle*. Among the remaining 40 companies, some became subsidiaries of other companies,[5] and others likely went out of business. The disclosure rate is still reasonably high for these remaining 40 companies: 67.5% of them disclose their net earnings before they disappear from the supplements.

For our main analysis (*not* for our disclosure graph (Figure 5) though), we must restrict the sample to companies that disclose net earnings, since we use net earnings to determine each company's type. Restricting to companies that ever disclose net earnings drops the sample by 10 companies, from 179 to 169. Restricting it further to companies that report net earnings in the last supplement drops it by another 24 companies, from 169 to 145. These 24 companies disclose net earnings at some point in the sample period, but no longer disclose as of the last supplement.

The remaining 145 companies constitute our final sample. Since these companies exist throughout our entire sample period, the full sample is a balanced panel of company-period observations, where each "period" is an issue of the newspaper supplements.

A.5 Detailed Disclosure Data Over Time

Figure A.1 plots a histogram for each of the streetcar supplements in the sample, showing the number of disclosers and non-disclosers among the companies who have not yet disclosed in any of the previous supplements. The histograms show that disclosure is more common among companies at the high end of the distribution each period. This is consistent with our aggregate finding of a declining average ROIC among the remaining silent companies.

A.6 States that Require Streetcar Companies to Report to the State Railroad Commission

The streetcar industry in the 1890s allows studying companies' voluntary disclosure to investors due to the absence of securities regulation mandating public disclosure to protect investors. Streetcar companies' financial reporting, however, was not completely unregulated.

[5] For example, the Brooklyn Queens County & Suburban Railroad became a subsidiary of Brooklyn Rapid Transit partway through the sample period.

In three Northeastern states (Massachusetts, New Hampshire, and Connecticut), streetcar companies were required to report to state railroad commissions, which were state regulators tasked primarily with making sure rates were fair and transportation lines were safe for consumers.[6] In the following, we provide more detail on these reporting requirements and discuss their impact on our inferences.

In the main tests reported in our paper, our sample includes streetcar companies from Massachusetts, New Hampshire, and Connecticut because we expect that the requirement to report to state regulators did not immediately imply that dispersed investors were privy to the streetcar companies' reports. In addition, anecdotes from the period indicate that state regulations were only weakly enforced, and that the railroad commissions were ineffective regulators.[7] Consequently, even in cases when the companies were supposed to report to the state regulator, their public disclosures to investors appear to have been de facto voluntary.

To examine the impact of this sample selection choice on our inferences, we re-examine the stylized facts of the streetcar industry, excluding each of the three states with reporting requirements separately as well as all three states at once. We find that the stylized facts that motivated our study continue to hold in the subsamples excluding the respective states. Figure A.2 shows that we continue to see initially incomplete disclosure followed by a rapid convergence to full disclosure when the sample excludes companies from, respectively, either (a) Massachusetts, (b) New Hampshire, (c) Connecticut, or (d) all three of these states. (Excluding companies from all three states drops the number of companies from 145 to 95.) Similarly, we continue to observe a decline in the average *ROIC* among the remaining non-disclosing companies over time in Figure A.3 when the sample excludes companies from, respectively, either (a) Massachusetts, (b) New Hampshire, (c) Connecticut, or (d) all three of these states. Collectively, Figures A.2 and A.3 show that the states with requirements to

[6]This information comes from a 1903 report by the Interstate Commerce Commission on state statutes related to railways (Interstate Commerce Commission, 1903). The report describes, for each state in the United States, the statutes in effect as of 1890 and 1902, and it describes when changes occurred in the intervening years. In Part IV of the report, Table IV describes what entities other than railroads were required to report to the state railroad commissions. Among the states in our sample, only three required streetcar companies to report to the state railroad commission during the period between 1890 and 1902: Connecticut, which introduced its requirement in 1893; Massachusetts, which had its requirement in place as of 1890; and New Hampshire, which introduced its requirement in 1895. (In panel A of Table IV, titled "Powers of Railroad Commissions: Powers relative to conditions of business administration," see the column titled "To require or receive reports from what besides railroads?")

[7]An article at the time from the American Economic Association said the following of the state railroad commissions (Clark, 1891, pages 49-50): *"The commission system in its present state, handed down from a past near in time but remote in means and methods, is utterly inefficient and unable to meet the needs of the expanded trade and commerce of today. We have convincing evidence of this in the fact that destructive rate wars frequently occur, extending through a long period of time and covering a vast territory; that complaints pour in by the hundred to some of our state commissions and to the interstate commission; that these complaints are increasing so rapidly that already the commissions as well as the courts are burdened with overwork; that secrecy, double dealing and many other evil practices flourish so luxuriantly in the railroad industry; and that a sort of smothered jealously and ungovernable fear run through society toward the great railroad corporations. ... The machinery in the form of commissions, created by a large number of the states of the Union for the purpose of administering the laws in respect to the railroads is not effective. If it were, repeated violations of the law would become less frequent. That it is not effective is due in part to the construction of commissions themselves, more largely perhaps to the need of power, and behind the power a strong public sentiment on the part of the people."*

report to state regulators do not appear to exhibit an undue influence on our stylized facts, supporting the inclusion of companies from Massachusetts, New Hampshire, and Connecticut in our main sample.

In line with the robustness of the stylized facts, we also find that our main disclosure-utility-parameter estimates are widely unaffected by the exclusion of companies from states with reporting requirements. Similarly, we continue to find evidence of lower levels of thinking in initial rounds and a subsequent increase in the level of thinking (in terms of level-k shares). Our explicit tests regarding learning, however, are not fully robust to the exclusion of streetcar companies from states with reporting requirements (especially Connecticut), as a result of a notable decline in sample size.

Overall, our inferences regarding the dynamics of companies' disclosure and learning are least affected by dropping Massachusetts, the state with the most stringently enforced requirements (Clark, 1891), or New Hampshire. This makes sense, since Massachusetts and New Hampshire contribute little to the dynamics in the model. Only 3 companies from Massachusetts and 2 companies from New Hampshire fail to disclose in the first supplement, and thus contribute to the dynamics. Note that, in the case of Massachusetts, the 3 companies failing to disclose in June 1894 were already subject to the requirement to report to the state railroad commission, since this requirement was imposed in Massachusetts before 1890. Either the newspaper lacked the reports received by the Massachusetts Railroad Commission, or it chose not to pass the information along to the investors in its readership. In the case of New Hampshire, its requirement was introduced in 1895. One New Hampshire company waited until the May 1896 supplement (i.e., the seventh supplement) to disclose—it is possible that this disclosure is related to the new requirement to report to the state railroad commission. However, this late first-time disclosure also suggests that the earlier disclosures were voluntary for New Hampshire companies.[8]

Our inferences regarding the dynamics of companies' disclosures and learning are sensitive to dropping Connecticut. When we drop Connecticut, many of the structural model comparisons and explicit learning results lose significance. It makes sense that dropping Connecticut would have a larger impact than dropping the other two states, since Connecticut contributes greatly to the dynamics in the model. Fifteen of the seventeen Connecticut companies stay silent in the first supplement, and 3 of them wait until the sixth supplement (i.e., February 1896) before disclosing earnings for the first time.

Given the sensitivity of some of our results to the exclusion of companies from Connecticut, we have investigated the disclosures and requirements of Connecticut companies in detail. Our investigation indicates that disclosure to dispersed investors was effectively voluntary for Connecticut companies up to, and including, the fifth supplement in November 1895. The three companies that had failed to disclose by November 1895 might have been forced to disclose in the next supplement, in February 1896. Connecticut passed a law in 1893 requiring streetcar companies to report to the state railroad commission by October 1, 1894, and then once per year thereafter.[9] Thus Connecticut's railroad commission received

[8]One New Hampshire company never disclosed, even though it had existed since June 1894. However, we are uncertain whether this indicates that disclosure remained voluntary for New Hampshire companies up to the end of our sample period, since this company was in receivership in November 1896, and thus might represent a special case.

[9]The Connecticut statute, An Act Concerning Street Railways, was passed in 1893. The relevant part

reports from the streetcar companies before the second newspaper supplement came out in March 1895. However, it appears that the commission did not at first make these reports available to the newspapers. Its annual report for 1894, published in December of that year, does not contain the earnings information of the streetcar companies (Connecticut Railroad Commissioners, 1894). This would explain why 6 of the Connecticut companies remain silent in the March 1895 supplement. In the annual report for the next year, published in December 1895, Connecticut's railroad commission chose to include earnings information for the state's streetcar companies (Connecticut Railroad Commissioners, 1895). This seems to have ended the companies' ability to withhold their earnings from the newspapers. In the very next newspaper supplement, in February 1896, earnings disclosures appeared for the last 3 Connecticut companies that had remained silent up to that point. And in that supplement, the *Chronicle* mentioned that it had access to the Connecticut railroad commissioners' annual report (*Commercial & Financial Chronicle*, 1896).

In summary, our paper's sample of streetcar companies includes companies that were required to report to their state railroad commissions during the sample period, since it appears that reporting to dispersed investors through the newspapers remained voluntary for these companies. If we remove all of these companies from the sample, the empirical facts which motivate our study still hold. And the results from our model are widely robust to removing the companies from two of the three states, either Massachusetts or New Hampshire. In the case of the third state, Connecticut, further investigation reveals that disclosure to investors likely remained voluntary up until December 1895, indicating that only 3 of the 17 Connecticut companies were possibly forced to disclose.

of the statute was section 14, which reads as follows: *"All street railway companies or trustees operating street railways within this state, shall, on or before the first day of October, 1894, and annually thereafter, make a return to the railroad commissioners in such form as said railroad commissioners shall prescribe, which form shall substantially follow the requirements of section 3586 of the general statutes in so far as they are applicable to the business and affairs of street railways, with such additional matters as shall render said returns as complete, as to the business, property, and affairs of street railways, as were required from steam railroads under said section 3586, which said returns shall be signed and sworn to by the president and treasurer of the company, or by a majority of the trustees making the same. And the railroad commissioners shall annually, on or before the first day of August, furnish to the officers or trustees of every street railway company blank forms which shall conform to the requirements of this section. The provisions of sections 3589 and 3590 of the general statutes shall apply to street railways. Every company, whose president and treasurer or trustees shall refuse or neglect to make such returns, shall forfeit to the state twenty-five dollars for each day of such neglect or refusal, and said commissioners shall report such forfeiture to the treasurer, and the books of every railway company shall at all times be open to the inspection of any committee of the general assembly appointed for that purpose."*

References

Clark, Frederick Converse, 1891, *State railroad commissions, and how they may be made effective*, volume 6 (American Economic Association).

Connecticut Railroad Commissioners, 1894, *42d Annual Report of the Railroad Commissioners of the State of Connecticut, to which are added Statistical Tables compiled from the Annual Returns of the Railroad Companies of the State for the Year Ending June 30, 1894* (The Case, Lockwood & Brainard Company, Hartford).

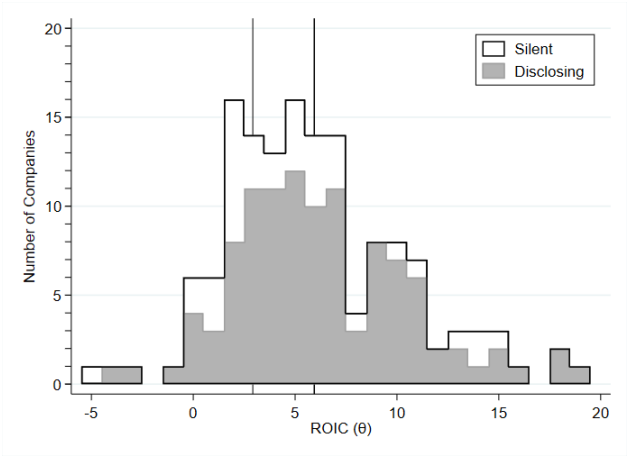
Connecticut Railroad Commissioners, 1895, *43d Annual Report of the Railroad Commissioners of the State of Connecticut, to which are added Statistical Tables compiled from the Annual Returns of the Steam and Street Railroad Companies of the State for the Year Ending June 30, and September 30, 1895, Respectively* (The Case, Lockwood & Brainard Company, Hartford).

Interstate Commerce Commission, 1903, *Railways in the United States in 1902: a twenty-two year review of railway operations; a forty-year review of changes in freight tariffs; a fifteen-year review of federal railway regulation; a twelve-year review of state railway regulation; and a twelve-year review of state railway taxation* (Government Printing Office, Washington).

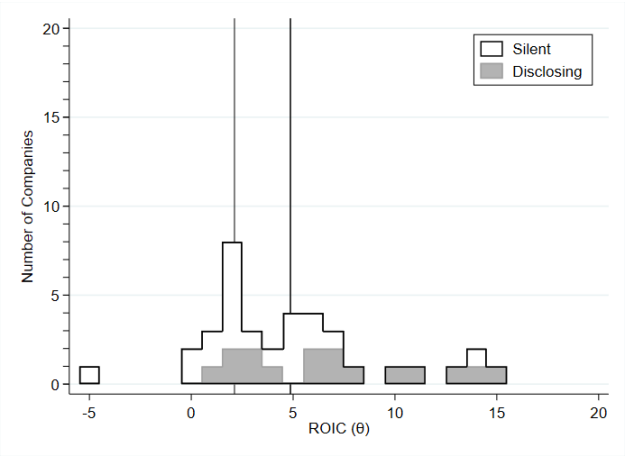
Commercial & Financial Chronicle, 1896, *Street Railway Supplement*, February 29th issue.

Figure A.1: Number of Disclosers and Non-Disclosers by ROIC (θ)

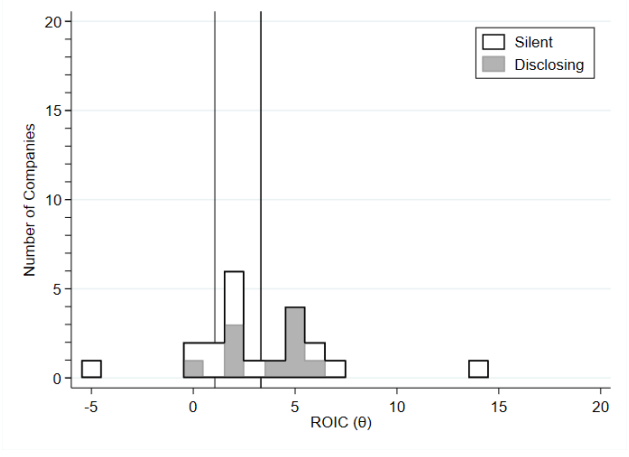
The figure shows, for each streetcar supplement in the sample, the number of disclosers and non-disclosers at each level of ROIC (θ). A separate histogram is plotted for each streetcar supplement. In each histogram, the sample is restricted to companies that have not yet disclosed in any of the previous supplements. In each histogram, the companies are sorted into buckets based on ROIC, rounded to the nearest percentage point. At each ROIC, the number of companies who choose to remain silent in that supplement (the unshaded region) are stacked on top of the number of companies who choose to disclose in that supplement (the shaded region). In each histogram, the Level 1 and Level 2 disclosure thresholds are shown with vertical lines (with a thicker line for the Level 1 threshold).



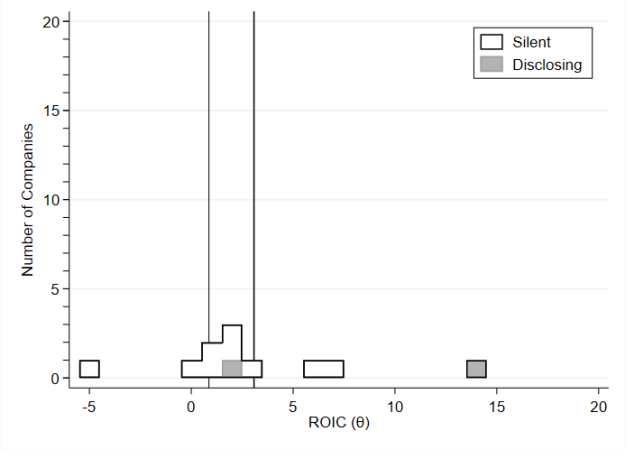
(a) Supplement 1: June 15, 1894



(b) Supplement 2: March 9, 1895

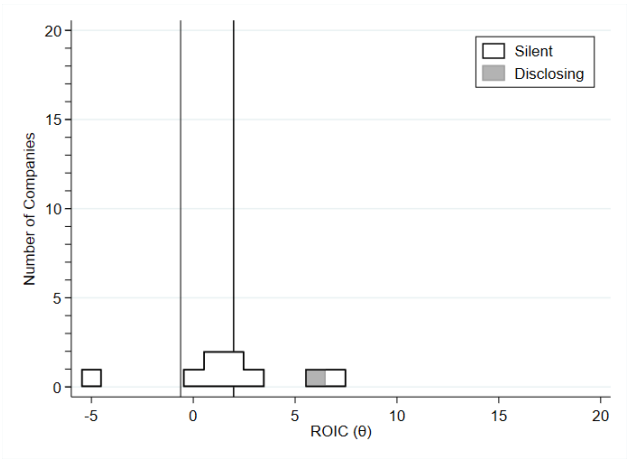


(c) Supplement 3: May 25, 1895

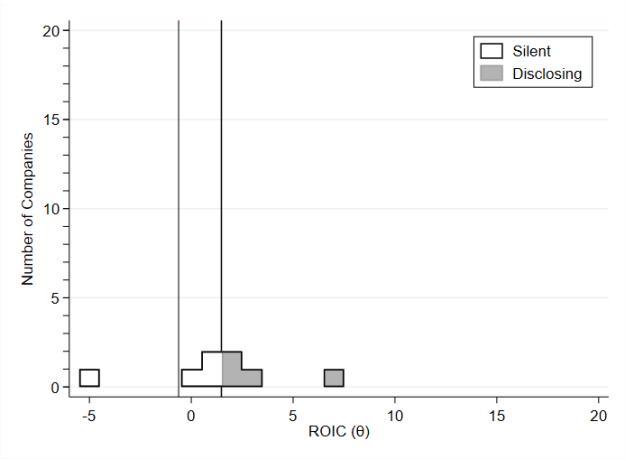


(d) Supplement 4: August 31, 1895

(e) Supplement 5: November 30, 1895



(f) Supplement 6: February 29, 1896



(g) Supplement 7: May 30, 1896

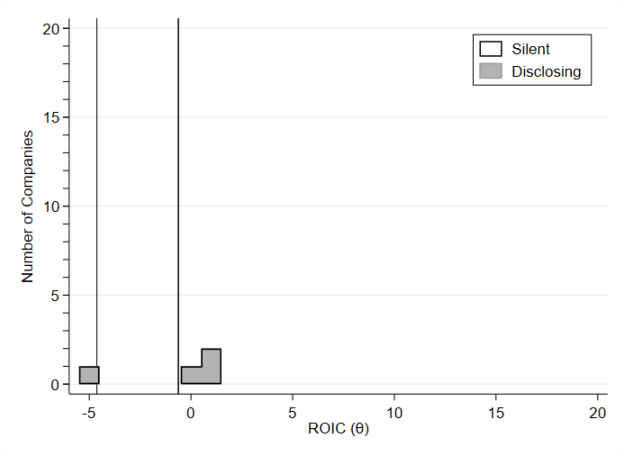
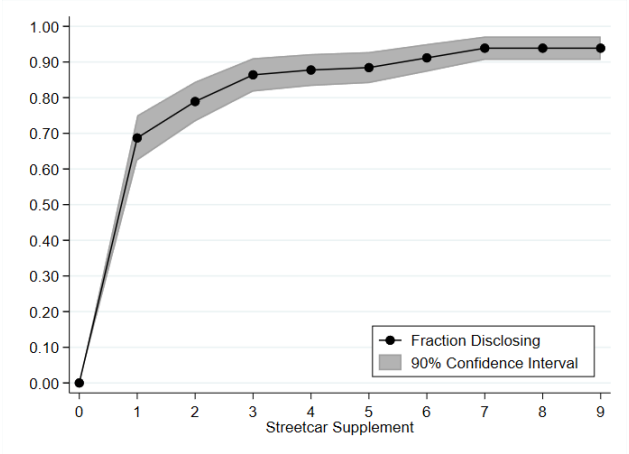


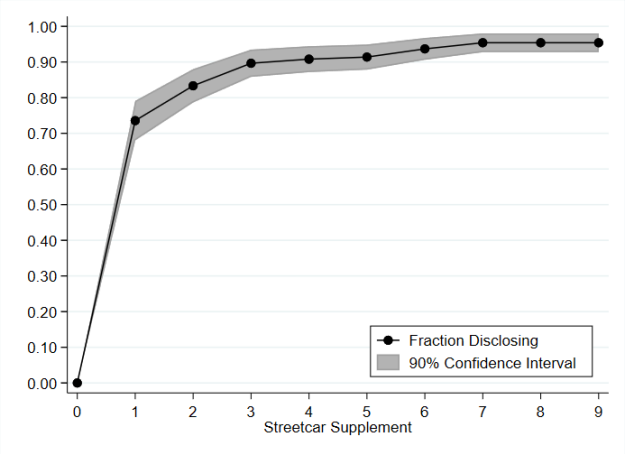
Figure A.2: Fraction of Companies Disclosing

Excluding Massachusetts, New Hampshire, or Connecticut

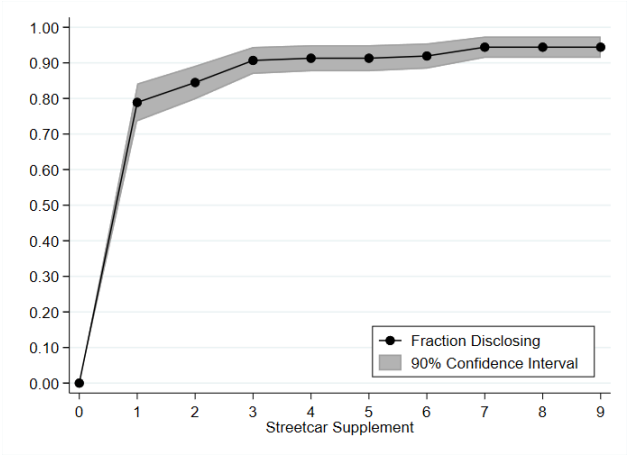
The figure plots the fraction of disclosing companies over time across different subsamples. In each plot, respectively, the sample excludes companies from either (a) Massachusetts, (b) New Hampshire, (c) Connecticut, or (d) all three of these states. A company is a disclosing company if it provided its net earnings in the current supplement or any of the previous supplements. Supplement "0" depicts the time before the first supplement came out. Supplement 1 is the first supplement, which was produced by the *Street Railway Journal* in June 1894. Supplements 2 through 9 are the following supplements, which were produced by the *Commercial & Financial Chronicle* between March 1895 and November 1896. The gray area depicts the 90 percent confidence interval.



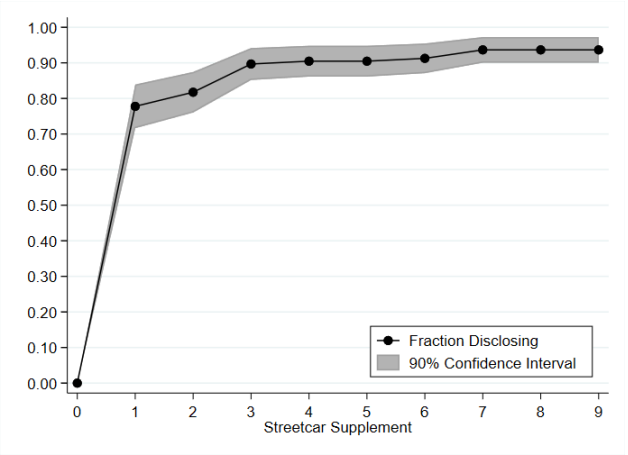
(a) Excluding MA



(b) Excluding NH



(c) Excluding CT

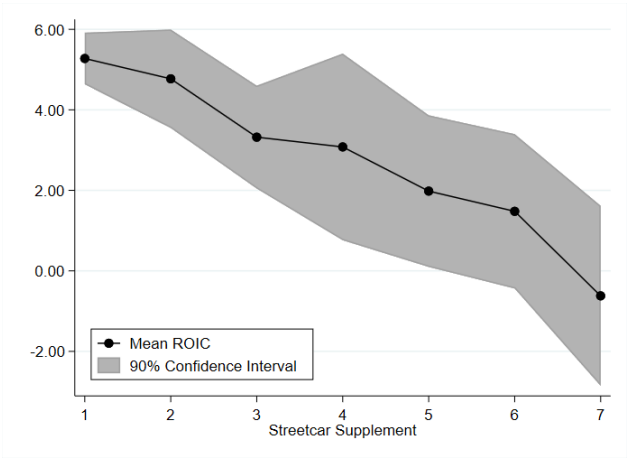


(d) Excluding MA, NH, and CT

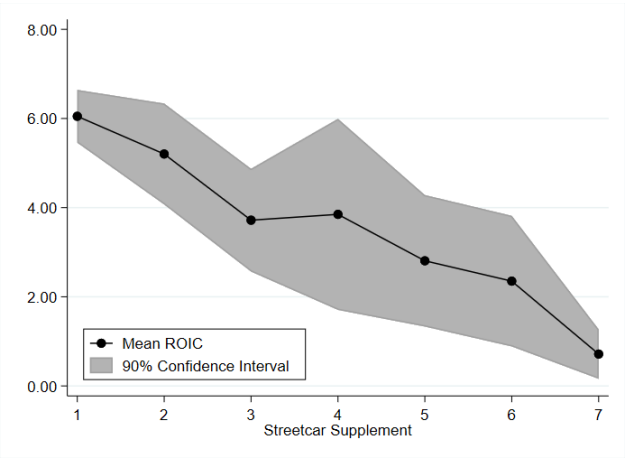
Figure A.3: Average Type of Non-Disclosing Companies

Excluding Massachusetts, New Hampshire, or Connecticut

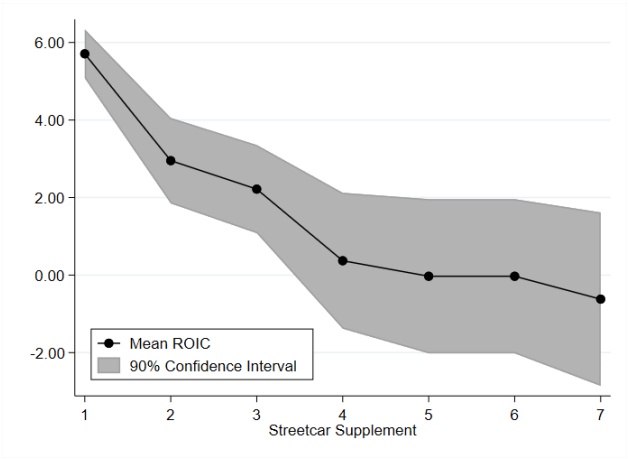
The figure plots the average type among companies that, as of the current supplement, have not yet disclosed net earnings in any of the previous supplements. In each plot, respectively, the sample excludes companies from either (a) Massachusetts, (b) New Hampshire, (c) Connecticut, or (d) all three of these states. We proxy for companies' types using their returns on invested capital ($ROIC$), measured as the ratio of net earnings to invested capital on November 28, 1896, the last supplement for which we collect disclosure data. Since $ROIC$ is a cross-sectional measure from one point in time, the changes in $ROIC$ depicted in the figure reflect changes in the composition of non-disclosing companies (i.e., the remaining pool) from one supplement to the next. They do not reflect changes in a given company's $ROIC$ over time (which are unknown in the periods before a company first discloses). Supplement 1 is the first supplement, supplement 2 is the second, and so on. The plot ends at supplement 7, since that is the last supplement in which any of the sample companies start disclosing earnings. The gray area depicts the 90 percent confidence interval.



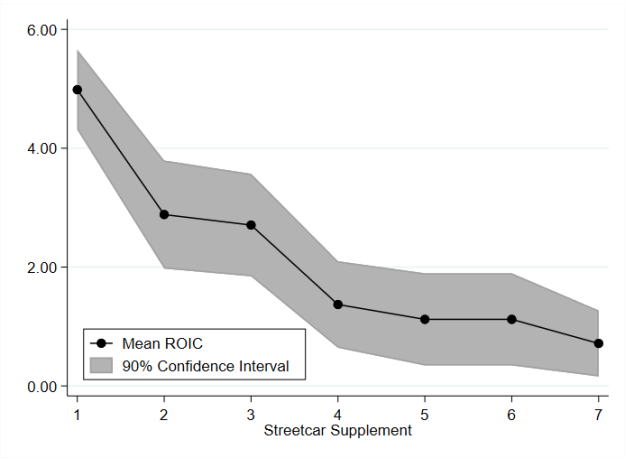
(a) Excluding MA



(b) Excluding NH



(c) Excluding CT



(d) Excluding MA, NH, and CT