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ECONOMIC ANALYSIS IN ANTITRUST LAW: AN AUTOMATED APPROACH APPLIED TO US APPELLATE COURTS

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Abstract. Economic analysis has shaped the development of antitrust law – both agency enforcement and judicial interpretation – over the past century. Here, I apply a dictionary-based approach to algorithmically identify and measure the use of economic analysis in US appellate courts. Analyzing judicial opinions extracted from the Trade Regulation Reporter, I demonstrate that my method can detect judges' reliance on economic concepts and arguments when applying and interpreting legal rules. Textual analysis also reveals nuanced differences in the way circuit courts engage with economic reasoning as opposed to district courts. Tracing the evolution of economic analysis since the 1940s, I show an overall increasing trend and a marked rise around the 1970s. In a sample of district court cases during 1990-2016, I find substantial and persistent differences in the extent that economic analysis is used across price fixing and conspiracy, monopolization, and mergers.

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I. Introduction

The application of AI technology combined with big data is rapidly changing how antitrust policy is implemented in many parts of the world. As several papers in this journal point out, the adoption of computational methods can contribute to maintaining and improving antitrust agencies' ability to detect anomalies in market behavior – which may be indicative of antitrust violations – and to analyze extensive data sets to flag suspicious mergers, usually under time constraint.[1] For successful enforcement, legal analytics powered by machine learning and big data also provide companies with the tools to assess and ensure compliance with antitrust law. For example, in retrospective merger studies, agencies can build a machine learning algorithm that predicts anticompetitive harm (e.g., price increase) based on past case facts.[2] Knowing what type of mergers are most likely to have anticompetitive effects can inform agencies' pre-merger notification and merger review procedure.[3]

Unfortunately, predictive modeling will not spit out whether a specific case under investigation constitutes a violation of antitrust law. In an evidence-based antitrust regime, which many countries have gradually converged to, the key to that question is inferring the *causal* effect of an alleged practice based on all the facts available. Here, economic analysis offers a framework to think about the welfare implication of a class of firm behavior, both in theory and empirically. This framework also suggests what variables to look out for in determining the existence (or the lack) of anticompetitive harm, thereby aiding the agencies in structuring their data collection and analysis efforts. In the absence of an analytical framework, big data will be very much useless.

In fact, economic thinking has long shaped the development of antitrust law in the US at the level of agency enforcement and court litigation.[4] Regardless of what the policy goals of antitrust are, countries worldwide since the 1990s have increasingly embraced economic principles as a foundation for sound antitrust policy.[5]

This paper applies the methodology developed in the author's earlier work[6] to identify and measure the use of economic reasoning in US federal *appellate* court antitrust adjudication at scale. I first created a dataset of all appellate antitrust cases

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[1] Daryl Lim, *Can Computational Antitrust Succeed?*, 1 STAN. COMPUTATIONAL ANTITRUST 39 (2021); Jay L. Himes et al., *Antitrust Enforcement and Big Tech: After the Remedy Is Ordered*, 1 STAN. COMPUTATIONAL ANTITRUST 65 (2021); Anthony J. Casey & Anthony Niblett, *Micro-Directives and Computational Merger Review*, 1 STAN. COMPUTATIONAL ANTITRUST 133 (2021).

[2] See Oliver Budzinski & Isabel Ruhmer, *Merger Simulation In Competition Policy: A Survey*, 6 Journal of Competition Law & Economics 277 (2010).

[3] Lim, *supra* note 1, at 49–50.

[4] Jonathan Baker & Timothy Bresnahan, *Economic Evidence in Antitrust: Defining Markets and Measuring Market Power* (Stan. Law and Econ. Olin Working Paper No. 328, 2006), https://ssrn.com/abstract=931225. *See also* William Kovacic & Carl Shapiro, *Antitrust Policy: A Century of Economic and Legal Thinking*, 14 J. ECON. PERSP. 43 (2000).

[5] *See* Anu Bradford et al., *The Chicago School's Limited Influence on International Antitrust*, 87 U. CHI. L. REV. 297, 310-311 (2020). *See also* Conference Report, U.N. Conference on Trade and Development in English, *The Use of Economic Analysis in Competition Cases: Study / by the UNCTAD Secretariat* (Apr. 28, 2009), https://digitallibrary.un.org/record/653822?ln=en.

[6] Siying Cao, *Quantifying Economic Reasoning in Court: Judge Economics Sophistication and Pro-business Orientation*, (Stigler Center Working Paper No. 321, 2022).

spanning from 1932 to 2016. In the companion paper, I show that the pattern-based sequence matching algorithm (i.e., dictionary-based method), which is based on occurrences of words from a pre-specified vocabulary, can indeed identify when district court judges in written opinions discuss economic evidence on factual questions or resort to economic principles to interpret the law. The way in which appellate courts adopt economic reasoning is quite different – questions of facts that economists testify in courts on are seldom reconsidered. Yet, it turns out that the methodology can still pinpoint when judges adopt economic analysis for antitrust doctrinal issues.[7] In addition, I find that this dictionary-based approach has advantages over topic modeling, which is arguably the most widely used machine learning algorithm in computational legal studies to date. Through a distant reading of the law, we gain a holistic understanding of how precisely economic analysis is being utilized in courts and how this has changed over years.

The measurement exercise produces insights that are both consistent with and expand on our prior qualitative knowledge about antitrust adjudication.[8] As part of the validation process, I verify whether landmark cases in recent decades involve heavy reliance on economic analysis when the alleged conduct concerns monopolization or mergers. Furthermore, appellate judges known to advocate economic approaches to law – Judge Richard Posner, Frank Easterbrook, Douglas Ginsburg, and Robert Bork – author opinions featuring greater use of economic reasoning.

On the aggregate, like what I find with district courts, I observe a rise in economics language associated with modern industrial organization (IO) in appellate opinions since the 1940s, with an acceleration around the 1970s when the Chicago School came of age. Within each category of antitrust violations, there is a substantial and consistent gap in the quotient of economic analysis between price fixing and conspiracy cases on the one hand, and merger and monopolization cases on the other. I also measure whether the courts respond to agency revisions of merger guidelines and pay more attention to current economic learnings in merger litigation.

Besides shedding light on the academic debate about the extent to which economics has been used in antitrust law over a century, this paper demonstrates that a dictionary-based approach to texts can be a helpful addition to the

[7] The logic of antitrust law is thoroughly infused with economics, so legal doctrines generally have rationales based on economic analysis, and many rules themselves invoke economic concepts or analysis. An example of the former is a shift from per se to rule-of-reason for vertical restraints and tying thanks to advances in economic thinking, particularly the subfield of industrial organization. An example of the latter is the requirement for a proof of market power in an increasing range of contexts; *see* Louis Kaplow, *Antitrust, Law & Economics, and the Courts*, 50 LAW & CONTEMP. PROBS. 181, 195 (1987). The legal rule concerning the determination of relevant product market considers the economic concept called "cross-elasticity of demand". JEFFREY R. CHURCH & ROGER WARE, INDUSTRIAL ORGANIZATION: A STRATEGIC APPROACH (2000) describes (modern) industrial organization as the study of "creation, exercise, maintenance, and effects of market power." (In economics, market power is understood as the ability to profitably raise price above marginal cost.) This naturally provides the intellectual foundation for determining when and why firms conduct warrant antitrust scrutiny and prohibition. Under the narrow legal interpretation that is the current antitrust doctrine, the intent of competition policy is to prevent firms from creating, enhancing, or maintaining market power, thereby curbing the harm to consumer welfare.

[8] THE ANTITRUST REVOLUTION: ECONOMICS, COMPETITION, AND POLICY (John E. Kwoka & Lawrence J. White eds., 5th ed. 2009).

computational antitrust toolbox. [9] From the perspective of enforcement, agencies in one jurisdiction can use the automated approach to quickly identify economic analysis in other jurisdictions' administrative or court decisions and learn from each other when the facts are similar.[10] Currently, there is a lot of variation across jurisdictions in terms of agency sophistication with economic reasoning, a major indicator of institutional capacity in modern antitrust regimes.[11] When agencies need to present evidence to courts, knowing how judges handle economic evidence and interpret the law based on economic principles is crucial to the success of agencies' enforcement action. The same can be said about lawyers who can benefit from the dictionary-based Natural Language Processing (NLP) technology when preparing economic expert testimony in court litigation or drafting economic arguments during administrative proceedings.

II. A qualitative primer

While modern antitrust law regimes embrace diverse policy goals, such as market integration and the protection of small businesses, the majority have economic goals of promoting economic efficiency (or consumer welfare) through market competition.[12] In this paper, I focus on US antitrust law since it has the longest history and has witnessed a dynamic interplay of economic learning and legal doctrines over more than half a century that culminated in the modern regime taking shape in the 1970s. The US antitrust statutes leave it to the court to fashion out the details of antitrust law and, in the process, give economists remarkable power to influence antitrust policy.[13] As Herbert Hovenkamp argues, "antitrust policy has been forged by economic ideology since its inception."[14] Tracing a historical controversy about state versus federal responsibility for determining the structure of US industry and the firms in it, he finds that an economic approach derived from the common law of contracts and combinations in restraint of trade triumphed over the noneconomic model derived from state corporate law in combating mergers at the turn of last century. The latter approach had been

[9] William M. Landes & Richard A. Posner, *The Influence of Economics on Law: A Quantitative Study*, 36 J.L. & ECON. 385 (1993); Kaplow, *supra* note 7, at 184-187 ("The proposition that economics has long been accepted in antitrust, although contrary to much of current commentary, is really quite familiar. After all, the most prominent works in the 1950s took a decidedly economic approach, even if one omits the work of the Chicago School").

[10] One concern is that countries entertain different languages in antitrust legislation and rules and regulations (Bradford et al. 2019). Some (e.g., Switzerland) even intentionally avoid using economic jargons in enforcement guidelines. According to a survey by the UNCTAD in 2009, however, just like legislation, the US and the EU take dominant positions in the use of economic analysis, and other states have largely cited documents and papers that have originated in those regions. The EU has also converged with the US on consumer welfare and economic rationales in merger regulation since the 1990s. Both jurisdictions see a prominent presence of economic consultancy firms and professional economists staffing enforcement agencies (Neven 2006).

[11] OECD Policy Brief, PRESENTING COMPLEX ECONOMIC THEORIES TO JUDGES (2008), https://www.oecd.org/daf/competition/abuse/41776770.pdf.

[12] Baker & Bresnahan, *supra* note 4, at 3 ("Most modern competition law regimes have economic goals, such as promoting economic efficiency or consumer welfare, in whole or substantial part"). *See also* Anu Bradford et al., *The Global Dominance of European Competition Law over American Antitrust Law*, 16 J. EMPIRICAL LEGAL STUD. 731, 736-37 (2019). Even in regions with multiple policy objectives, e.g., public interest, these concerns seldom limit the use of economic analysis. *See* UNCTAD, *supra* note 5, at 12.

[13] In EU and other jurisdictions that started off in 1990s with detailed formalistic antitrust rules, it is now widely accepted that the proper interpretation of these rules and regulations requires an understanding of how markets actually work and how various firm behavior can alter their efficient functioning (PAOLO BUCCIROSSI, HANDBOOK OF ANTITRUST ECONOMICS, 2008).

[14] Herbert Hovenkamp, *Antitrust Policy, Federalism, and the Theory of the Firm: An Historical Perspective*, 59 Antitrust L. J. 75 (1990).

successful until it was no longer able to distinguish mergers with anticompetitive consequences from those without. Nevertheless, direct evidence of courts' explicit and active engagement with economic teachings (or economists) In this early period is lacking.

Before the 1970s, efficiency rationales for challenged firm conduct were deemed irrelevant or at best marginal in antitrust litigation. In fact, prior to 1936, significant direct effects of economic thinking and research on judicial antitrust decisions were hardly discernible.[15] Courts treated market share as an indicator of market power, yet their market definition was so broad that enforcement of antitrust law was lax during this period.

This changed dramatically in 1938 when President Franklin D. Roosevelt appointed Thurman Arnold to the Antitrust Division – the following four decades were an era of robust antitrust enforcement. In this era, *per se* rules were revived and extended beyond price-setting conspiracies to ban various conducts, such as tying, non-price vertical restraints, and exclusive sales territories.[16] For rule of reason tests in monopolization and mergers, US antitrust jurisprudence followed strict "structuralist" rules that focused on market structures and their level of concentration, which were often assessed using industry and firm output data. It is worth noting that this practice closely paralleled the intellectual development of IO during the same period. Unsatisfied with the overly abstract and deductive approach taken by theoretical economists and the descriptive and "excessive" institutionalism, Harvard economist Edward Mason advocated a new approach to the study of price policies, which later became known as the structure-conduct-performance (SCP) paradigm.[17]

While it is not well understood how the SCP paradigm diffused into the judiciary, several features might have contributed to its appeal. First, it broke away from the (hypothetical) representative firm theory and combined actual market structures with existing measures of performance. Second, the SCP paradigm was a new mode of analysis based on the classification of market structures, and it identified potentially relevant variables (either endogenous to the firm or external factors) in the study of price analysis.[18] This analytical framework was especially attractive to judges as it provided clearer rules for evaluating idiosyncratic facts.

The fact that many landmark decisions during the 1940s, 50s, and 60s were later heavily criticized by the Chicago School advocates for the lack or misuse of economic reasoning speaks to the sea changes in the adoption of economic learning

[15] Kovacic & Shapiro, *supra* note 4, at 43–49 (Also noting that the Supreme Court first cited an economist's work in an antitrust decision in *Maple Flooring Manufacturers' Ass'n v. United States*, 268 U.S. 563 (1925) to emphasize how shared information among members of a trade association might enable producers to make efficient output and pricing decisions).
[16] *Id.* at 50.
[17] Almarin Phillips & Rodney E. Stevenson, *The Historical Development of Industrial Organization*, 6 HIST. OF POL. ECON. 324, 335-340 (1974).
[18] Edward Mason and his students, notably D. H. Wallace and Joe Bain, have conducted numerous industry studies. It remains to be seen whether and how such efforts influenced the antitrust law of its time.

in antitrust jurisprudence.[19] Courts in the 1970s began to pay careful attention to the economic literature based on neoclassical price theory, which was, to a great extent, facilitated by the appointment of judge-scholars associated with Chicago School law and economics to key positions of antitrust policy. Conducts that were previously deemed *per se* illegal (e.g., non-price vertical restraints) were now subject to rule of reason analysis; efficiency justifications for many phenomena were received by courts as conceptually valid and even determinant of the ruling. Citing Chicago School treatises and commentary, courts sought analysis of *economic effects* beyond market share data when it came to evaluating dominant firm conduct or mergers.[20] The legacy of the Chicago School is most evident in the fact that the "consumer welfare" standard based on the notion of economic efficiency remains the single most important, if not the only, goal of US antitrust policy, unchallenged until the Neo-Brandeisian antitrust theorists started to advocate more expansive goals only a few years ago.[21]

Since the 1990s, the incorporation of economic learnings from game theory and information economics into antitrust law provided flexible analytical models of firm behavior, which also adapted to the increasingly dynamic and innovative marketplace. Judges ruling on antitrust cases today are acquainted with economic concepts such as strategic entry deterrence, imperfect information, and network effects.[22] New empirical tools in IO have fueled the detection and measurement of market power, a fundamental concept in antitrust law, regardless of the type of violation involved. Economic evidence on market definition is now almost indispensable to any substantive evaluation of alleged antitrust violations.[23] It is the prerequisite for calculating market shares and concentration measures, which are key indicators for cartels and the basis of further analysis of the market structure and firm conduct.

Summing up the role of economic thinking in antitrust enforcement, it is helpful to conceptually distinguish between two channels through which economic reasoning influences antitrust adjudication in court: i) as evidence to resolve factual questions and ii) as a non-binding authority that affects the framing of legal rules.[24] At the appellate level, the re-examination of questions of facts (and the economic evidence therein) is infrequent. However, questions of law, such as

[19] United States v. Aluminum Co. of Am., 148 F.2d 416 (2d Cir. 1945); United States v. E.I. Du Pont De Nemours & Co., 351 U.S. 377 (1956); Brown Shoe Co. v. United States, 370 U.S. 294 (1962) are notable cases that have been frequently and heavily criticized in the law and economics movement. See, e.g., R. Bork, *infra* note 56, at 200-08, 210-16; R. Posner, *infra* note 56, at 100-05, 129-30.

[20] United States v. Baker Hughes, Inc., 908 F.2d 981 (D.C. Cir. 1990); Continental TV Inc. v. GTE Sylvania Inc., 433 U.S. 36 (1997). Kovacic and Shapiro, *supra* note 4, at 53–54.

[21] A recent op-ed in the Wall Street Journal reaffirms the importance of commitment to this standard and warns against the perils for not doing so: Alden Abott, *Why Consumer Welfare Remains the Standard for Antitrust,* WALL STREET JOURNAL (Apr. 7, 2022, 1:59 PM), https://www.wsj.com/articles/antitrust-competition-consumer-welfare-standard-rule-law-ftc-11649284057. *See also In Defence of the Consumer Welfare Standard,* THE ECONOMIST (Jan. 29, 20222), https://www.economist.com/leaders/2022/01/29/in-defence-of-the-consumer-welfare-standard.

[22] Eastman Kodak Co. v. Image Tech. Servs., Inc., 504 U.S. 451 (1992). (The Court extensively cited game-theoretic commentary and relied heavily on notions such as imperfect information and lock-in as sources of market power).

[23] Economists have played a crucial role in developing the hypothetical monopolist test (HMT), critical loss analysis, and other analysis relying on consumer surveys or market studies for defining the relevant antitrust market.

[24] John E. Lopatka & William H. Page, *Economic Authority and the Limits of Expertise in Antitrust Cases*, 90 CORNELL L. REV. 617 (2004).

the correct approach to market definition and whether *per se* rules apply to vertical restraints, or mixed questions of law and fact entail significantly revisiting economic theories and analysis.[25] By tracing the co-evolution of economic and legal thinking in antitrust law, I show in this section that economic reasoning has indeed played an important role in shaping legal rules and presumptions. For the rest of the paper, it is precisely this notion that I set out to quantitatively measure in a data-driven way.

III. Methodology

A. Data

To measure the use of economic reasoning in appellate court decisions, I collect the written opinions of all federal antitrust cases decided in the circuit courts of the United States from 1932 to 2016 from the CCH Trade Regulation Report.[26] Unlike earlier statistical studies of antitrust enforcement, my data set contains not only agency enforcement actions but also private litigations. To further ensure that the cases are brought for violation of antitrust statutes, I exclude cases that do not mention "Sherman Act", "Clayton Act", or "FTC Act".

Apart from the opinions written by judges, I also gathered, for each case, meta-data including case name, the court, the authoring judge, decision date, and headnotes created by the editors.[27] When three judges sitting on a panel disagree with each other and decide to publish concurring or dissenting opinions, each opinion is treated as a separate data point. In my empirical analysis, the unit of observation is an opinion and there can be multiple opinions associated with a single case. The sample consists of 7,296 unique cases opinions.[28]

In the analysis of economic reasoning in mergers versus price fixing and conspiracies, I additionally parse the headnotes to extract the alleged violation(s) associated with a case. Unfortunately, due to editorial formatting issues, I was not able to do this systematically for my main sample of appellate cases. Instead, I perform such parsing on the sample of all *district* cases from 1990 to 2016 to analyze the pattern, which I believe holds equally well for the appellate cases. Specifically,

[25] One prominent example is U.S. v. Microsoft Corp., 253 F.3d 34 (D.C. Cir. 2001) in which judges referred to new economic research that casted doubt on the Supreme Court's dominant rule of per se illegality for tying practices. They also cited heavily to new economic learnings on network effects when discussing whether monopolization doctrines should be amended to account for competition in technologically dynamic markets characterized by network effects. In another landmark case (838 F.3d 179, 2nd Cir. 2016), circuit judges found that the lower court erred in applying the HMT in market definition, which was fatal to its final decision. The opinion relied on the economic concept of "two-sided markets" and past economic learnings about the procompetitive effect of vertical restraints. Even though direct reference to economic experts were not as frequent as in district court opinions, the heavy use of economic terms and analysis clearly reflects the significant role of economist amici briefs and the economic literature.

[26] Legal databases have different coverages of cases under antitrust law, including both reported and unreported cases. Compared to Westlaw or LexisNexis, CCH specializes in the topic area of antitrust law and features the most comprehensive coverage of antitrust cases.

[27] These are done through web-scraping and python programs to parse the relevant variables.

[28] The case sample used in this study is available at https://drive.google.com/file/d/1vdklFv-oq2gcAW_vPCp56N5jh-guNzFN/view?usp=sharing. As noted in detail in Richard A. Posner, *A Statistical Study of Antitrust Enforcement*, 13 J.L. & ECON. 365–419 (1970) and Joseph C. Gallo et al., *Department of Justice Antitrust Enforcement, 1955-1997: An Empirical Study*, 17 REV. INDUS. ORG. 75–133 (2000), several CCH cases may be the result of a single antitrust investigation. In this paper, it is appropriate to treat them as separate.

I follow the convention and create three main categories of violations: price fixing and conspiracies, monopolization, and horizontal mergers.[29] For a fair comparison, I further exclude cases that are not ruled on antitrust substance – for instance, venue and jurisdiction – and those that are consent decrees or settlement agreements entered in courts.

To prepare for the analysis of opinion texts using NLP tools, I perform standard text pre-processing, which includes normalization, lemmatization, and stop words removal.[30] In the topic modeling analysis, I additionally reduce dimensionality by keeping only the 10,000 most frequently appearing words from the vocabulary (adjusted by term-frequency-inverse-document-frequency). The methodology I currently adopt to analyze texts relies on a simple bag-of-word representation of texts. Therefore, an opinion that contains multiple paragraphs, which are in turn composed of multiple sentences, is reduced to a list of word tokens (single-word or two-word combinations, a.k.a. bigrams) – dependency structures and term ordering are not preserved after data cleaning and pre-processing.

B. Topic modeling approach and potential drawbacks

To measure the use of economic analysis in judicial opinions, one obvious approach would be to use unsupervised learning methods to uncover hidden factors, one (or more than one) of which I would hope to label as "economic analysis". Topic modeling (i.e., Latent Dirichlet Allocation or LDA) is a natural candidate as it allows us to learn about themes without much human intervention.[31] The idea is to represent each topic as a probability distribution over a vocabulary and to summarize each document as a mix of such topics. Crucially, all the probability distributions are estimated from the corpus rather than specified by humans. In this way, it creates a compact but descriptive representation of the semantic content of documents.

It is perhaps for the ease of use that topic models have become popular in computational law and social sciences.[32] Scholars have applied LDA to understand

[29] A headnote contains a heading with a list of key words, followed by a body of texts explaining in more detail the legal rules and findings of the court. Types of violations are identified using information from the main opinion text as well as the headnote. For example, a case is classified as price fixing and conspiracy violation if the headnote contains "price fixing" (or variants of the term) and the main text contains "Sherman Act section 1". A case is coded as monopolization if the headnote contains "monopolize" and the main text contains "Sherman Act section 2". A case is coded as merger if "acquisition and merger" appears in the headnote and "Clayton Act section 7" appears in the main opinion. To ensure accuracy in coding, the author combines fuzzy matching with manual inspection to identify variants of a given term.

[30] These steps would break up strings into constituent parts (e.g., words, punctuations, numbers), convert all strings to lower case, drop extremely common words like "the", "and", and "it", bring words into linguistic root, and drop punctuation and numbers.

[31] *See* David M. Blei et al., *Latent Dirichlet Allocation*, 3 J. MACH. LEARNING RES. 993 (2003).

[32] For example, *see* Daniel Taylor Young, *How Do You Measure a Constitutional Moment: Using Algorithmic Topic Modeling to Evaluate Bruce Ackerman's Theory of Constitutional Change*, 122 YALE L.J. 1990 (2012) (employs topic modeling to quantify the constitutional discourse in U.S. newspaper texts throughout the debate over ratification of the Fourteenth Amendment between 1866 and 1884). *See also* Margaret E. Roberts et al., *The Structural Topic Model and Applied Social Science*, 4 Advances in Neural Information Processing Systems Workshop on Topic Models: Computation, Application, and Evaluation 1–20 (2013); Justin Grimmer et al., *Machine Learning for Social Science: An Agnostic Approach*, 24 ANN. REV. POL. SCI. 395–419 (2021).

agenda formation on the US Supreme Court,[33] determinants of control rights as reflected in labor union contracts,[34] and central bank communications.[35]

However, this statistical technique has its limitations. As an unsupervised learning algorithm, topic modeling requires researchers' expertise within the relevant fields to interpret the model outputs. In a recent paper published in this journal, Felix B. Chang et al. recount the peril of over-interpreting or mis interpreting estimated topics.[36] It is as much an art to properly label the topics based on the contexts, position, syntax, and semantics in regard to which the words appear. Robustness and reproducibility are other commonly raised concerns since multiple topic model runs can lead to multiple different interpretations.[37]

In line with the initial intent of topic modeling (including both LDA and latent semantic analysis in the 1990s) as an indexing and information retrieval algorithm, I employ topic modeling to explore the content of a large collection of appellate antitrust case opinions. I trained LDA models using Gensim,[38] a powerful python library, and experimented with different numbers of topics – 20, 30, 40, and 50.

In my default model with 20 topics, I manually label the following topics after carefully examining the key words and the opinions that have the highest share of each topic: merger, expert testimony admissibility, procedure, tying/exclusive dealing/predatory pricing, class action settlement, labor union antitrust exemption, motion picture antitrust suit, patent immunity, discovery and production of evidence, healthcare monopolization, etc. The topics discovered are a mix of legal rules, fact patterns, and antitrust claims. While several topics have economic terms such as "marginal", "elasticity", and "concentration" with non-trivial estimated probability, those topics are indistinguishable from the types of alleged antitrust violations. In other words, while not completely unhelpful as an exploratory device, topic modeling does not give us "economic analysis" as a well-separated topic.

C. Dictionary-based approach

In light of the challenges of using topic modeling to measure economic analysis, I turn to my preferred dictionary-based approach that circumvents these drawbacks. The prototype method would specify a list of words and phrases that are indicative of economic reasoning, and opinions that contain many occurrences of such words would receive high scores, whereas those that contain few economic terms would receive low scores. In my companion paper,[39] I provided a detailed account of the methodology based on predefined training libraries to measure

[33] Keith Carlson et al., *Style and Substance on the US Supreme Court*, *in* LAW AS DATA: COMPUTATION, TEXT, & THE FUTURE OF LEGAL ANALYSIS (Michael A. Livermore & Daniel N. Rockmore eds., 2019).
[34] Elliott Ash et al., *Unsupervised Extraction of Workplace Rights and Duties from Collective Bargaining Agreements*, 2020 International Conference on Data Mining Workshops (ICDMW) 766–774 (2020).
[35] Stephen Hansen et al., *Transparency and Deliberation Within the FOMC: A Computational Linguistics Approach*, 133 Q. J. ECON. 801 (2018).
[36] Felix B. Chang et al., *Doctrinal Implications of Computational Antitrust*, 1 STAN. COMPUTATIONAL ANTITRUST 118 (2021).
[37] *See* Matthew Gentzkow et al., *Text as Data*, 57 J. ECON. LITERATURE 535 (2019).
[38] Gensim 4.2.0, PYTHON PACKAGE INDEX, https://pypi.org/project/gensim/ (May 2, 2022 data release) (last accessed July 6, 2022).
[39] Cao, *supra* note 6, at 17-23.

economic reasoning in district court opinions.[40] This measure builds on the simple frequency count, but additionally adjusts for the length of opinions as well as how strongly a given word in the training library is associated with the object of interest. It also has a nice interpretation of document similarity – the use of economic reasoning is greater if the opinion is more textually similar to a representative economic discourse.[41]

As noted by established scholars, dictionary-based methods are most appropriate when prior information about the mapping from texts to the outcome of interest is strong and reliable, yet the information in the data is weak.[42] This is true in my case since no ground truth exists – I do not observe the true amount of economic analysis in judicial opinions, and the mapping of interest does not match very well to the factor structure of topic models (i.e., fitting a topic model does not pick out the economic analysis as a topic).

To measure the use of economic reasoning in appellate court opinions, I apply the same training libraries as in my earlier work and calculate a score for each opinion in the data set.[43] A widely circulated IO textbook[44] published in 2000 is a reasonable choice of economic discourse considering how much antitrust law has absorbed the learnings developed in this economics sub-field for nearly half a century.[45] I supplement it with a law training library to filter out terms in the economic textbook that are either common language (e.g., "united states", "even though") or generic legal concepts having nothing to do with economic analysis (e.g., "sherman act", "supreme court").

Among the most frequently occurring economic bigrams in the IO textbook are "market power" and "market share". While these terms are nearly omnipresent in the antitrust law of recent decades that we may no longer think of them as signifying a particularly economic argument, historically speaking, they indeed suggested a serious and substantial attempt to apply economics to antitrust.[46] Extensive discussions of market definition and its relation to market power are definitive marks of economic sophistication.[47] Non-economic considerations would

[40] This paper also explains in detail how my measurement methodology surpasses citation analysis typically seen in earlier studies covering the influence of the law and economics movement (Landes and Posner, *supra* note 9) or analysis with a pure focus on law-and-economics vocabulary (Robert C. Ellickson, *Trends in Legal Scholarship: A Statistical Study*, 29 J. LEGAL STUD. 517–543 (2000); Elliott Ash et al., *Ideas Have Consequences: The Impact of Law and Economics on American Justice*, (NBER Working Paper No. 29788, 2022) in capturing the actual, concrete presence of economic analysis in antitrust law. This remains true for my appellate court analysis.

[41] Similarity-based approaches are increasingly adopted to construct novel measures in social sciences. As a recent example, William N. Goetzmann et al., *Crash Narratives* (NBER Working Paper No. 30915, 2022), https://www.nber.org/papers/w30195. develop a measure of "crash narratives" in the media by comparing the texts in current news media to news in the days immediately following two financial crises. Technically, texts are represented as document vectors in a high dimensional semantic space, and cosine similarity is calculated to measure the likeness between current and historical narrative.

[42] Gentzkow et al., *supra* note 37, at 554. See *also* Scott R. Baker, Nicholas Bloom & Steven J. Davis, *Measuring economic policy uncertainty*, 131 Quarterly Journal of Economics 1593 (2016); Tarek A. Hassan et al., *Firm-Level Political Risk: Measurement and Effects*, 134 Quarterly Journal of Economics 2135 (2019).

[43] Cao, *supra* note 6, at 19-20.

[44] Church & Ware, *supra* note 7.

[45] *Infra* note 53.

[46] *See* Kaplow, *supra* note 7, at 185–86.

[47] In the landmark case United States v. Aluminum Co. of America, Judge Learned Hand defines the appropriate market, finds that Alcoa supplied 90 percent of the market, and determines that this control constituted monopoly. In the written opinion, Judge Hand consciously and explicitly bases his final ruling on this economic fact of voluntary action to achieve monopoly, such as the building of new plants,

condemn monopoly on moral grounds – it deadens initiative, discourages thrift, and depresses energy. The other terms that frequently appear in the IO textbook are economic concepts, such as "marginal cost", "elasticity of demand", and "barriers [to] entry". Like district courts, appellate courts have heavily relied on these economic notions when interpreting legal rules.[48] I confirm this observation from qualitative studies of landmark cases in my case opinion dataset,[49] covering the universe of recorded appellate decisions. Below is an example of text excerpts from opinions with high and low scores, with distinctively economic bigrams highlighted in red.

Of all opinions from 1932 to 2016, the following is an excerpt from the opinion with the highest score (0.00328), Maris Distrib. Co. v. Anheuser-Busch, Inc., 302 F.3d 1207 (11th Cir. 2002):

> *In an attempt to provide the type of "connection" that would justify the imputation of Anheuser-Busch's* ***market share*** *in the beer market to the market for distributorships, Maris alludes to* ***economic literature*** *bearing on this question. Maris states that its experts relied on "****economic literature*** *on* ***vertical restraints*** *which supports the determination of the defendant manufacturer's* ***market power*** *based on its* ***market share*** *in manufacturing."*

Of the same set of opinions, the following is an excerpt from one of the opinions with the lowest score (0), Novation Ventures, LLC v. J.G. Wentworth Co., LLC, 711 Fed. Appx. 402 (9th Cir. 2017):

> *As the district court pointed out, Novation could not merely rely upon* ***harm to consumers****, if any there was, to establish its own standing to sustain an antitrust claim. See, e.g., Big Bear Lodging Ass'n v. Snow Summit, Inc., 182 F.3d 1096, 1102 (9th Cir. 1999); see also Am. Ad Mgmt., 190 F.3d at 1056. Moreover, if a lack of competition among the Wentworth Entities precluded one or more of them from offering consumers a better price, that did not plausibly harm competition; indeed, it most likely would have benefited Novation.*

This example highlights the benefit of using a dictionary-based methodology to identify the use of economic analysis. It operationalizes two important cues for detecting economic reasoning in antitrust cases: 1) reliance on economic concepts; 2) engagement with key components of legal doctrines (e.g., determination of market power) that are substantially informed by economic literature.

That said, it is important to acknowledge the limitations of this method and offer caveats regarding the interpretation of the constructed measure. First, judges may draw economic terms that have already been translated by legal scholarship, and therefore the terms are not being used by the judges in the same way as in the

rather than charging the firm with moral derelictions. *See* United States v. Aluminum Co. of Am., 148 F.2d 416, 431 (2d Cir. 1945).

[48] In United States v. E.I. Du Pont De Nemours & Co., the Supreme Court made a most extensive and prominent discussion of market definition for cellophane, and relies heavily on economic concepts, such as cross-elasticity of demand. Both the majority and dissenting opinion cited considerably. George W. Stocking & Willard F. Mueller, *The Cellophane Case and The New Competition*, 45 AM. ECON. REV. 29–63 (1955) (discussing United States v. E.I. Du Pont De Nemours & Co., 118 F. Supp. 41 (D. Del. 1953)).

[49] Kaplow, *supra* note 7.

IO textbook. Auditing random samples from my dataset suggests that this is not a major concern.[50] The more disconcerting issue is that by taking a modern IO textbook as the training library, I fail to account for the influence of earlier economic learnings in IO, most notably the SCP framework that was pervasive in industrial organization from 1940s to early 1970s,[51] on contemporary legal reasoning. Early opinions might extensively discuss market definition issues without mentioning the words "relevant market" or "market definition" or following the current legal framework for defining the relevant antitrust market based on economic evidence of consumer substitution patterns.[52] Therefore, I can only interpret my measure as the use of *modern* economic analysis in judicial opinions. [53]

To be sure, the methodology introduced in this section does not allow me to draw a conclusion to the debate of whether economic analysis in general has been used to a greater extent since the 1970s than before. Nevertheless, I believe it is still a valuable contribution to quantify the diffusion of economic learnings in modern antitrust regimes, which took shape around 1970 for the US and 1990 for EU and the rest of the world. I am also able to venture beyond measuring the influence of Chicago School economics[54] to include post-Chicago School developments in game theory and empirical methods.

IV. Analysis and discussion

A. Validation of the measure

In text-as-data applications, it is crucial that researchers validate the empirical model used to map raw texts to the main variable of interest.[55] Manual audits are one very effective approach for validating the measure construction methodology, especially for dictionary-based methods. In this subsection, I present several pieces of evidence validating my measure of the use of economic analysis in appellate antitrust case opinions.

[50] It is also straightforward to expand the dictionary of terms by algorithmically detecting synonyms, for instance through word2vec models. In a law-as-data application where the goal is to identify frequently cited legal doctrines in summary judgment decisions, Charlotte S. Alexander et al. Use word2vec to pull additional terms from the context in which keywords of doctrines were used. *See* Charlotte S. Alexander et al., *Using Text Analytics to Predict Litigation Outcomes*, *in* Law as Data: Computation, Text, & the Future of Legal Analysis (Michael A. Livermore & Daniel N. Rockmore eds., 2019).

[51] Paradigm shift in the sense that Thomas Kuhn defines applies to industrial organization and economics in general since Adam Smith. *See* THOMAS KUHN, THE STRUCTURE OF SCIENTIFIC REVOLUTIONS (1962).

[52] *Alcoa* is well known for the court's extensive discussion of market definition and its relation to market power. *See* United States v. Aluminum Co. of Am., 148 F.2d 416, 424-26 (2d Cir. 1945). However, the language Judge Hand uses to demarcate the aluminum market by no means resembles the prevailing empirical approach that DOJ and FTC have put forth in the merger guidelines since 1980 for analyzing and defining markets.

[53] To be more precise, it is the economics in modern industrial organization. While my chosen IO textbook reflects the accumulation of past learnings, including certain traces of the SCP paradigm, it nevertheless exhibits learnings from the new industrial organization emphasizing game-theoretical models of firm behavior and empirical methods based on such well-founded models.

[54] Landes and Posner, *supra* note 9; and Ash et al., *supra* note 34, at 15-16.

[55] Justin Grimmer & Brandon M. Stewart, *Text as Data: The Promise and Pitfalls of Automatic Content Analysis Methods for Political Texts*, 21 POL. ANALYSIS 267–297 (2013). *See also* Gentzkow et al., *supra* note 37.

As the first step of validation, I focus on selected appellate judges and circuits that are known to endorse an economic approach to law and show that they indeed author opinions featuring greater use of economic analysis as measured by my methodology. It is well-established that Judge Robert Bork's writing on antitrust law, together with those of Judge Richard Posner and other Chicago School thinkers, has been influential in causing a shift in the Supreme Court's approach to antitrust law since the 1970s.[56] They brought in new learning in antitrust economics and advanced the initially controversial proposal that the antitrust laws should promote economic efficiency and consumer welfare rather than shielding inefficient "small dealers" from competitive market forces.[57]

For comparison, I rank all the opinions by their measured economic reasoning. In my dataset, within the District of Columbia Circuit, judge Bork authors two opinions out of the top 10 opinions. The other two are written by Judge Douglas Ginsburg, who is a renowned law and economics judge-scholar and attended the University of Chicago Law School, where he co-edited the University of Chicago Law Review along with future Judge Frank Easterbrook. Manual auditing of the top 10 opinions confirms that each contains substantial use of economic reasoning. In the sample of cases decided in the Seventh Circuit, Judge Posner and Easterbrook contributed each 8 among the 30 top-ranking opinions. The number becomes 13 and 14 if I examine the top 50 opinions, which together account for more than half of the antitrust decisions.

Turning to cross-circuit comparison, I first note that among the top 10 opinions in my entire sample, half of them are written by judges in the Seventh Circuit. This is not surprising given the influence of Judge Posner in causing a progression by the Seventh Circuit toward adopting the Chicago School approach.[58] In Table 1, I tabulate the distribution of top 30 opinions across all circuits along with the baseline distribution, which is what I would expect had all opinions been written with the same amount of economic reasoning.[59] Here, I see that the Seventh Circuit produces the most economics-heavy opinions, and this is not a mere artifact of it hearing more antitrust cases.

[56] *See* ROBERT H. BORK, THE ANTITRUST PARADOX (1978); RICHARD A. POSNER, ECONOMIC ANALYSIS OF LAW (1973); RICHARD A. POSNER, ANTITRUST LAW – AN ECONOMIC PERSPECTIVE (1976).
[57] *See*, e.g., Maurice Stucke and Ariel Ezrachi, *The Rise, Fall, and Rebirth of the U.S. Antitrust Movement,* HARVARD BUSINESS REVIEW (Dec. 15, 2017), https://hbr.org/2017/12/the-rise-fall-and-rebirth-of-the-u-s-antitrust-movement. See also Richard A. Posner, The Chicago School of Antitrust Analysis, 127 U. Pa. L. Rev. 925 (1978).
[58] Jerry M. Santangelo, *Changing Configurations of Antitrust Law: Judge Posner's Applications of His Economic Analysis to Antitrust Doctrine*, 32 DEPAUL L. REV. 839 (1983) examines the antitrust jurisprudence in the Seventh Circuit after the appointment of Professor Richard Posner to the bench. It argues that the Seventh Circuit rapidly diminished the scope of protection provided by section 1 of the Sherman Act and underwent an ideological shift toward embracing the Chicago School understanding of economic efficiency as the sole criterion for evaluating anticompetitive effect.
[59] This is just the relative case frequency in my sample.

Circuit	Number of cases	Relative frequency	Baseline percentage
Seventh	7	0.23	0.13
Second	5	0.17	0.13
Tenth	3	0.10	0.06
Eleventh	3	0.10	0.04
District of Columbia	3	0.10	0.05
Sixth	2	0.07	0.08
First	1	0.03	0.04
Third	1	0.03	0.10
Fourth	1	0.03	0.07
Fifth	1	0.03	0.12
Eighth	1	0.03	0.08
Ninth	1	0.03	0.09
Federal	1	0.03	0.01

Table 1: Distribution of top 30 opinions across circuit

In results not shown in the table, this pattern remains when I vary the threshold from top 10 to top 700 (roughly 10 percent of all) opinions. It is worth noting that among the top 200 opinions in my entire sample, 8 are authored by Judge Posner and Easterbrook respectively, placing them at the very top among all judges in my dataset. See Table II for a detailed breakdown of the top opinions by authoring judges. This is even more pronounced when I tabulate the top 500 opinions. These two judges lead the dashboard by a good margin, and interestingly, the third highest ranking judge, Stephen Breyer (later appointed to the Supreme Court) is also well-known for his economic sophistication.[60]

In my second validation exercise, I center on important cases that are *ex-ante* known to feature significant economic analysis. This is a useful manual audit since I sort of know the ground truth for such cases. A particularly helpful source that provides the "validation set" is *The Antitrust Revolution: Economics, Competition, and Policy.*[61] It contains case studies written by prominent economists who participated in the proceedings of the cases at stake.[62] I augment this set of cases with recent high-profile cases that later reach the Supreme Court. I show that my methodology

[60] Stephen Breyer, *Economic Reasoning and Judicial Review*, 119 ECON. J. F123-35 (2009).
[61] Kwoka & White, *supra* note 8.
[62] As the authors state in the preface, these cases have been carefully selected on the basis of the importance of their economic content as well as their contribution to the growth of economics in antitrust. Some cases are settled after agency investigation and administrative proceedings; I only consider cases that are heard in appellate courts.

assigns a very high score of economic reasoning to these cases, which attests to the validity of this approach.[63]

	A. Top 200 Case Opinions			B. Top 500 Case Opinions		
Rank	Authoring Judge	Circuit	N	Authoring Judge	Circuit	N
1	easterbrook	Seventh	8	posner	Seventh	21
2	posner	Seventh	8	easterbrook	Seventh	16
3	cardamone	Second	4	per curiam	Ninth	9
4	higginbotham	Fifth	4	breyer	First	6
5	sloviter	Third	4	sloviter	Third	6
6	per curiam	Ninth	4	heaney	Eighth	6
7	gibson	Eighth	3	aldisert	Third	6
8	moore	Tenth	3	per curiam	Sixth	6
9	suhrheinrich	Sixth	3	tjoflat	Eleventh	6
10	merritt	Sixth	3	wood	Seventh	5

Table II: Distribution of top 200 (500) opinions by judges, only displaying the first 10

The three cases extensively discussed in *The Antitrust Revolution* all rank high according to my measure of economic analysis. *Trident v. Independent Ink* is the 9-th highest ranking case opinion among all 7296 appellate opinions in my dataset.[64] In this case, the appellate court wrestles with the legal presumption of market power arising in patent tying practice, which the court recognizes as receiving little support from the economic literature. It also discusses the lack of a rigorously defined relevant market for tying and tied products. *MCI v. AT&T* and *Spirit Airlines* rank at the 76th and 104th respectively.[65] Both cases are raised on the count of predatory pricing. In *MCI v. AT&T*, the judge discusses extensively the appropriate cost definition to be considered in determining predatory pricing. The judge notes that the choice of a cost-based standard for evaluating claims of predatory pricing is a question of law to be decided by the judge. In the lengthy majority opinion, economic concepts, such as "marginal cost", "average variable cost", and "average total cost" are carefully distinguished based on the economic theory of predatory pricing. In *Spirit v. Northwest*, Judge Haynes emphasizes the consideration of market structure and barriers to entry in the case of above-cost pricing when

[63] I also verify by manual audit that opinions receiving low scores on economic analysis according to my measure indeed feature little to no economic reasoning upon close reading of the case. These antitrust opinions are typically written on non-substantive issues, including venue and jurisdiction, discovery, pleading standards, criminal sentencing, state immunity, and Lanham Act action.

[64] Trident v. Independent Ink, 396 F.3d 1342 (Fed. Cir. 2006).

[65] MCI Communications v. American Tel. & Tel. Co., 708 F.2d 1081 (7th Cir. 1983); Spirit Airlines, Inc. v. Northwest Airlines, Inc., 431 F.3d 917 (6th Cir. 2005). Landmark cases with heavy economics and important contribution to antitrust law and economics do not necessarily receive a higher score than a case that addresses market definition and market power but is without much precedential value. This is because the former may contain lengthy discussion of other non-substantive aspects of the law, such as procedural issues, which under my similarity measure gets discounted.

determining antitrust liability. [66] The court also reviews and discusses amply the economic experts' reports from both sides before concluding that the district court errs in granting summary judgment.

Besides being successful with the cases that are *ex-ante* known to involve lots of economics, my dictionary-based approach can also identify significant use of economic analysis in antitrust cases that are later appealed to the Supreme court in recent decades. *US v. Amex* achieves a rank as high as 37 among all 7296 opinions in the dataset.[67] Following *Weyerhaeuser* and *US v. Apple* on appeal, economists submitted amicus briefs to the Supreme Court, highlighting the unsound economics in appellate judges' interpretation of current legal standards.[68] Regardless of the quality of economic reasoning, both appellate decisions exhibit the substantial influence of economic analysis on antitrust law. In the former, appellate judges discuss the determination of buyer-side monopoly power (i.e., monopsony power) in predatory pricing, whose legal rule is thoroughly infused with economic concepts, such as below-cost pricing and allocative efficiency. In the latter, the discussion revolves around the applicability of the *per se* rule or rule of reason to vertical contracting structure, which is heavily reliant on the different economic effects between vertical and horizontal agreements.

In my companion paper, I plot the frequency of economic bigrams used in judicial opinions against their occurrences in the IO textbook.[69] This exercise sheds light on the scenarios where judges find it suitable to engage with economic reasoning.[70] I replicate the analysis for the appellate case sample, and a careful comparison between the appellate court and lower court in terms of the economic terms used and their relative frequency turns out to be highly revealing. In particular, I find that district courts tend to use economic terms when evaluating factual economic evidence whereas circuit courts are more likely to rely on economic bigrams to introduce economic principles key to articulating legal doctrines.

Economic terms that do not appear at all in appellate courts but multiple times in district courts include the following: *log-log, simulation model, measurement error, econometric technique, reduced form*. Economic bigrams that appear disproportionally more often in district court opinions include *statistical analysis, increase hhi, model estimate, availability data, economic modeling*, etc. [71] On the other hand, economic bigrams that show up much more often in circuit opinions are those indicative of citations of notable economics or of the law and economics literature: *principle [of] economics, areeda turner, areeda[-]turner test, antitrust paradox,*

[66] Spirit Airlines v. Northwest Airlines, 431 F.3d 917 (6th Cir. 2005).
[67] US v. American Exp. Co., 838 F.3d 179 (2d Cir. 2016).
[68] Confederated Tribes v. Weyerhaeuser Co., 411 F.3d 1030 (9th Cir. 2005); US v. Apple, Inc., 791 F.3d 290 (2d Cir. 2015).
[69] Cao, *supra* note 6, at 25.
[70] As pointed out in Chang et al., *supra* note 36, interpreting words and topics from topic models requires paying close attention to the contexts in which they appear. Likewise, in my examination of economic bigrams, I manually inspect the parts of opinions in which the economic bigram of interest appears. This helps to ascertain the circumstances under which those economic bigrams occur.
[71] When comparing the frequency count of bigrams in district and circuit courts, I need to account for the total number of words (i.e., length) in the two corpora. Back of the envelope calculation suggests that the baseline ratio is 2.8. In my analysis, I take the threshold of 10 and treat any bigram whose number of occurrences in district court is at least 10 times that in circuit courts as being overly represented in district court opinions.

landes posner, economic perspective.[72] Appellate judges revisit economic theory on questions of law: "scp paradigm" and "see stigler" appear twice and seven times accordingly in circuit opinions but are never used in district opinions.[73] Terms that are characteristic of Chicago School's influence on antitrust law are also used relatively more often in circuit court opinions. This includes *efficiency justification, procompetitive efficiency, consumer welfare, welfare [of] consumer.*[74]

This exercise together with the other pieces of evidence assures me that my dictionary-based approach can identify the parts in judicial opinion where appellate judges resort to economic analysis to address antitrust doctrinal issues, which over the years have modernized the antitrust policies.

B. Evolution of economic analysis over time

In this section, I focus on the time series dimension of my measure and probe the trend of economic analysis in judicial opinions. I first replicate the overall time trend in my companion paper analyzing district court opinions on the new sample of appellate antitrust opinions.[75] Figure 1 plots the times series of the average measured use of economic analysis across all opinions written each year. Mirroring what happens in the lower courts, there has been a steady increase in the use of modern economic analysis since the 1950s, along with an accelerated adoption around the 1970s, which coincided with heightened Chicago School influence on antitrust jurisprudence.

While informative of the aggregate trend over time, Figure 1 masks important heterogeneity across different types of antitrust violations. Moreover, I cannot be certain whether the increase reflects an actual change in economic reasoning or a shift in the composition of cases. Given that anti-cartel law has a much lower quotient of economic analysis,[76] the trend shown in the graph can be an artifact of the early years, seeing a large percentage of price fixing and conspiracy cases litigated in court while the level of economic analysis remained constant over years.[77] The appellate case sample contains cases where FTC Section 5 action on false advertising is the dominant issue. Opinions discussing pleading standards in *per se* violation and entry of consent orders are also reported in the CCH Trade

[72] PAUL A. SAMUELSON, ECONOMICS (1948); Phillip Areeda & Donald F. Turner, *Predatory Pricing and Related Practices Under Section 2 of the Sherman Act*, 6 J. REPRINTS ANTITRUST L. & ECON. 219 (1975); William M. Landes & Richard A. Posner, *Market Power in Antitrust Cases*, 27 J. REPRINTS ANTITRUST L. & ECON. 493 (1997).

[73] Vogel v. American Soc. of Appraisers, 744 F.2d 598, 601 (7th Cir. 1984) ("*See* STIGLER, THE THEORY OF PRICE 205–06 (3d ed. 1966)"), Hospital Corp. of America v. FTC, 807 F.2d 1381, 1391 (7th Cir. 1986) ("*See* STIGLER, *A Theory of Oligopoly*, in STIGLER, THE ORGANIZATION OF INDUSTRY, at 43–44 (1968)."), Blomkest Fertilizer Inc. v. Potash Corp., 203 F.2d 1028, 1042 (8th Cir. 2000) ("*See* STIGLER, *A Theory of Oligopoly*, 72 J. POL. ECON. 44, 46 (1964)"

[74] An interesting observation that highlights the different use scenarios of economic analysis between district and circuit courts is "consumer welfare" versus "consumer surplus". "Consumer surplus" appears seven times in total in the district court and does not appear at all in circuit courts. They appear in opinions where the judge refers to an economic expert's testimony on questions of fact. The word "welfare" appears much more frequently in district court, but it rarely is used to address the consumer welfare doctrine.

[75] Cao, *supra* note 6, at 31-33.

[76] *See* UNCTAD, *supra* note 5, at 3.

[77] I do not have a complete tabulation of the number of cases by type of claims for each year since the 1940s. The best that I know is a statistical tabulation of all DOJ enforcement cases by type of alleged violation provided in Gallo et al., *supra* note 28. *See* Table V and VI in the paper. It does not seem like the number of anti-cartel (merger/monopolization) cases is much higher (lower) in earlier decades though.

Regulation Reporter, therefore included in the sample. However, these cases do not demand economic arguments. If an early case sample consists of a bigger share of such non-substantive antitrust cases, interpreting the rise in average economic reasoning as reflecting increased economic sophistication in deciding on substantive antitrust issues would be misleading.

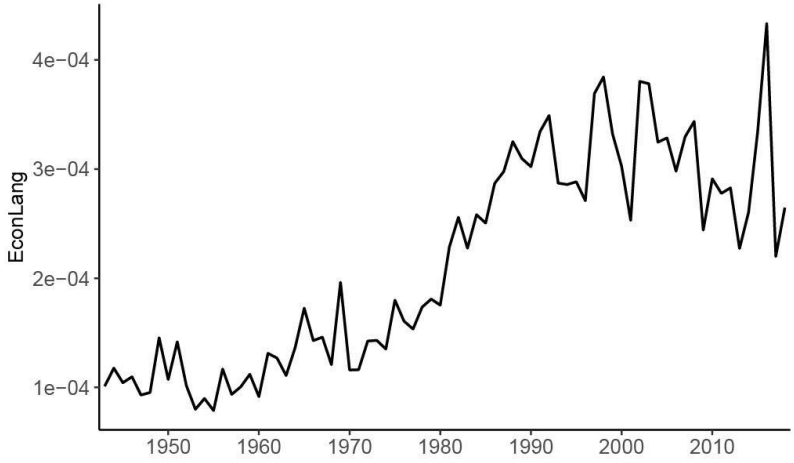

Figure I: Economics language in appellate court antitrust opinions

To circumvent these challenges in reading Figure 1, I zero in on cases that state a clear antitrust claim invoking Sherman Act section 1, Sherman Act section 2, or Clayton Act Section 7 and focus on the within-category variation in economic analysis. They correspond to price fixing and conspiracies (or horizontal *per se* violation), monopolization, and mergers.[78] As explained in the data subsection, systematically extracting alleged violations and identifying substantive antitrust issues is rather difficult for appellate cases. I restrict to the sample of district court cases from 1990 to 2016, which I have made painstaking efforts to clean and parse information from. Despite the shorter time span covered, I believe that the insights on the cross and within-category variation in economic reasoning gleaned from this sample generalize to higher courts as district court adjudication Is legally bound by the circuit court in the same region.

The other reason why I focus on district courts is that the number of mergers litigated in court is simply small – the majority of merger investigations are either dropped or settled. Even fewer reach appellate courts, rendering a statistical analysis almost impossible.

With these data limitations, I compute the average economic reasoning used in judicial opinions each year, separately for different types of claims alleged. See Figure II for the time series plot. It is not uncommon for a case to involve more than one type of antitrust violation. However, to isolate the economic reasoning for each

[78] I use horizontal per se violation (HPSV) and price fixing and conspiracies interchangeably. Firm behavior that belong to this category include collusion, bid rigging, and market allocation. In EU legislation, this is called anticompetitive agreement. The EU equivalent to monopolization is abuse of dominant position. Example practices are price discrimination, predatory pricing, tying, exclusive dealing, and resale price maintenance.

one of the three classes of claims, I drop opinions dealing with multiple claims. This sample restriction leaves us with 1013 monopolization opinions, 675 HPSV opinions, and 101 mergers during the period of 1990-2016.

In Figure II, I use dots of various sizes to show the number of observations in calculating the yearly average for each type of claim. The series for mergers is much more volatile than HPSV or monopolization cases because in some years, for example, the year 2002, 2006, 2013, and 2015, there are only one or two cases litigated in district courts. Despite the noise in estimation, a clear pattern emerges: the use of economic reasoning is consistently more significant in monopolization and merger cases than in price fixing and conspiracies. This is intuitive since *per se* illegal cases do not entail showing of pro- or anticompetitive effect, absolving the need for an extensive discussion of market power or empirical evidence on economic harm.[79]

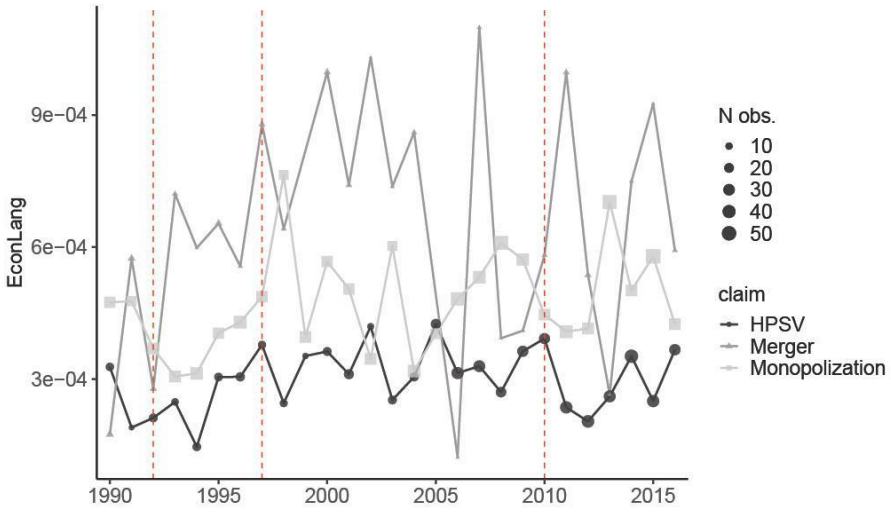

Figure II: Time series plot

Comparing mergers with monopolization cases, I observe overall a higher level of economic analysis in written opinions of the former. This is not unexpected since merger analysis became more heavily economic in the 1990s.[80] Economic concepts now pervade federal merger guidelines, and merger analysis, whether performed by antitrust agencies or merging parties, routinely involves close

[79] A qualification about the relative scarcity of economic analysis in HPSV is due. Even though price fixing, once confirmed, deserves per se illegal treatment, oftentimes a case brought on price fixing claims requires evidentiary proof of collusive behavior, which increasingly draws upon economic evidence to structure the argument. For example, in Blomkest Fertilizer Inc. v. Potash Corp., 203 F.2d 1028 (8th Cir. 2000), the court relies on the economic analysis of factors, such as market structure, that can affect the ability of firms to coordinate successfully to uphold award of summary judgment to defendants in a HPSV case (Baker & Bresnahan, *supra* note 4, at 38). Economics is also used for detection of suspicious bidding patterns, which would be evidence of facilitating practices. Posner (1960) advocates "a shift from present day obsession with proving the fact of a conspiracy to search for evidence, economic in nature, of collusive price behavior in the market." Current section 1 enforcement is a vision come true for him.
[80] Kovacic and Shapiro, *supra* note 4, at 57.

collaboration between economists and attorneys. All these encourage the acceptance of economic methodology by the courts.[81]

An important question in antitrust law is whether the revision of DOJ/FTC merger guidelines could cause the adoption of the respective economic learning in courts. The Horizontal Merger Guidelines (HMG) are based on decades of economic learning and agency practice with respect to the analysis of horizontal mergers.[82] Since the first issue of HMG in 1968, agencies have subsequently revised the merger guidelines in 1982, 1984, 1992, 1997, and 2010 to ensure they reflect current economic realities and empirical learning.[83] The 2010 Guideline states that it "may assist the courts in developing an appropriate framework for interpreting and applying the antitrust laws in the horizontal merger context." Although the guidelines are not binding on the federal courts, it is often the case that courts cite the guidelines as a persuasive authority under the view that they reflect the expertise of agencies tasked by Congress with merger reviews.

In a recent commentary in the New York Times, Appelbaum argued that to inject a new perspective into antitrust policy, staffing competition agencies with mavericks may not be as important as picking the right judges.[84] However, if agency guideline revision can change how antitrust law is interpreted in courts, appointment to leadership positions at enforcement agencies will be a promising first step. The sample of merger cases and the associated measure of economic reasoning provides an opportunity to test this hypothesis. In Figure II, I mark the years of merger guideline revision after 1990 with vertical red lines. In the spirit of an event study, the HPSV sample serves as a natural control group so that any difference between the merger and HPSV after the revision can be net of a common time trend.

In Figure III listed in the appendix, I apply a smoothing method to the raw line plot to illuminate the overall trend. Merger and HPSV appear to be on quite different trajectories before the revision in 1992, which continued through several years following the 1997 guideline revision. This casts doubt on the parallel trend assumption in a difference-in-difference design. However, I spot a divergence between the merger and HPSV in the next few years post the most recent revision in 2010 after accounting for the pre-trends. On average, district courts become more economically rigorous in merger analysis following the agency revision of HMG in 2010. The extremely small sample size of litigated merger cases precludes us from making statistical inferences with enough power. In spite of this data limitation, I

[81] Courts over time may demand increasing economic rigor from the parties. This direction of influence is most evident in the EU's revision of agency guidelines, partly in response to court rulings, over the past three decades.

[82] U.S. DEP'T. OF JUSTICE, HORIZONTAL MERGER GUIDELINES, https://www.justice.gov/atr/merger-enforcement.

[83] A new revision is under the way as the agency feels the current guidelines are overly permissive, unable to stand up to the marked concentration in many industries. *See* FED. TRADE COMMISSION, *Federal Trade Commission and Justice Department Seek to Strengthen Enforcement Against Illegal Mergers* (Jan. 18, 2022), https://www.ftc.gov/news-events/news/press-releases/2022/01/federal-trade-commission-justice-department-seek-strengthen-enforcement-against-illegal-mergers.

[84] *See* Binyamin Appelbaum, *When Picking Judges, Democrats Need to Stop Ignoring Economics*, N.Y. TIMES, (June 1, 2022), https://www.nytimes.com/2022/06/01/opinion/judges-democrats-antitrust.html ("To undo their work – to advance a new understanding of antitrust – it is necessary to put a new generation of intellectuals (with deep academic expertise in economic regulatory matters) into black robes").

hope that my analysis exposes an important question on the interaction between the two institutional pillars of antitrust law. Besides, it demonstrates an empirical approach combining textual analysis with event study.

V. Conclusion

Economic analysis has long been an integral part of antitrust law. Its influence on antitrust policy became so pronounced after the 1970s that to speak of an "economic perspective" would be redundant today. [85] In this paper, I apply an automated approach first introduced in my earlier work[86] to measure the use of economic analysis in appellate antitrust opinions in the US. I have found that my dictionary-based approach can identify the parts of opinions where judges rely on economic principles and arguments to apply and interpret the law. My results paint a nuanced view of the differences between appellate and lower courts in how they engage with economic analysis, and how the overall adoption of economic reasoning has changed over time for monopolization, merger, and HPSV cases. In my companion paper, I document significant differences among district judges in their use of economic analysis and find that the judges' economic sophistication is strongly correlated with ruling in favor of businesses in regulatory cases. [87]

While the idea of economic efficiency as the sole purpose of antitrust law is now under fierce attack, and perhaps rightly so, an alternative analytical framework is yet to be articulated.[88] Recent work in economics has begun to incorporate political power into the analysis of market power.[89] Regardless of whether these new learnings are taken into account by courts or shift antitrust doctrines, at the very least, economic analysis remains indispensable to factual questions about firm conduct and market competition.

My training library approach features a semi-automatic selection of dictionary terms, making it an extremely simple yet powerful and flexible method capable of extracting complex information from a large sample of texts. With thoughtful choices of training libraries, scholars and legal practitioners can easily adapt the method to identify and measure the use of economic analysis in agency enforcement *guidelines* or administrative *decisions* in their own jurisdictions.

I believe that this methodology will gain traction and inspire future work in computational legal studies. There is still much we do not know about the diffusion of economic ideas into antitrust law during 1940-1970. Once a qualitative account detailing the mapping of economic ideas to legal reasoning is established, I can adapt the dictionary-based approach to building a historical series of the use of *contemporary* economic analysis in antitrust opinions. This will provide a more

[85] *See* RICHARD A. POSNER, ANTITRUST LAW (2d ed. 2001).
[86] Cao, *supra* note 6.
[87] Cao, *supra* note 6, at 33-53.
[88] See TIM WU, THE CURSE OF BIGNESS: HOW CORPORATE GIANTS CAME TO RULE THE WORLD (2020); Lina Khan, *Amazon's Antitrust Paradox*, 126 YALE L.J. (2017). See also Greg Ip, *Antitrust's New Mission: Preserving Democracy, Not Efficiency*, THE WALL STREET JOURNAL (July 7, 2021, 11:07 AM), https://www.wsj.com/articles/antitrusts-new-mission-preserving-democracy-not-efficiency-11625670424.
[89] Steven Callander et al., *Market Competition and Political Influence: An Integrated Approach*, ECONOMETRICA (forthcoming).

conclusive answer to the debate on whether economic knowledge has played as much of an important role in earlier decades as in modern antitrust since the 1970s.

VI. Appendix

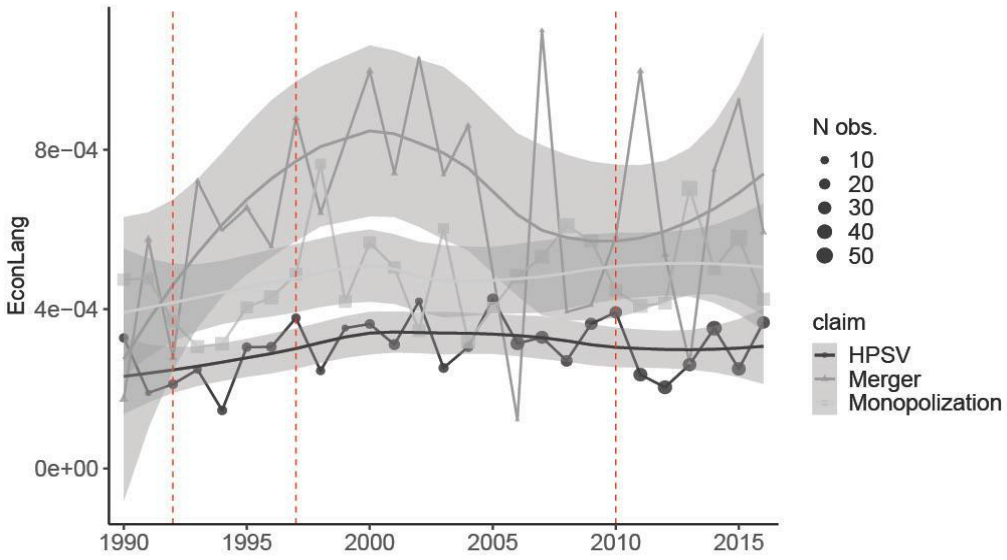

Figure III: LOESS Smoothing applied to Figure II