

REALISTIC ASSUMPTIONS, ECONOMIC MODELS, AND THE ADMISSIBILITY
OF EXPERT TESTIMONY IN THE CLASS ACTION LAWSUIT
DOVER V. BRITISH AIRWAYS

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ABSTRACT

The “Assumptions Controversy” is a historical debate among economics methodologists regarding whether simplifying assumptions must be realistic for a model to be valid.

Nobel Prize-winning economists have occupied both extremes: Milton Friedman claimed that predictive accuracy is the only relevant criterion for a model’s validity, while realists such as Paul Samuelson view realistic assumptions as intrinsically valuable and desirable.

This debate also has implications in the context of litigation. Economics expert testimony is key to establish causation and estimate damages in cases involving antitrust violations, employment discrimination, toxic torts, and more. Experts use idealizations and omissions to transform complex data into a simplified model whose conclusions can be understood by non-experts. These simplifying assumptions are often targeted by opponents as “unrealistic,” prompting motions to exclude the testimony. Judges act as “gatekeepers,” deciding whether the model-based testimony is reliable enough to be admitted to the jury, who weighs the credibility of evidence. Legal precedent and scholarship have failed to provide clear admissibility guidelines, resulting in inconsistent decisions that define multimillion-dollar cases.

Recent developments in the assumptions debate provide a dynamic approach by classifying different types of assumptions and realisticness. A synthesis of these typologies potentially offers courts a pragmatic solution to admissibility rulings that is based in theory from economics methodologists. This research applies the theoretical framework to Judge Dearie’s admissibility decision in the class action lawsuit *Dover v. British Airways*, where experts testified regarding whether the airline’s fuel surcharges were correlated with the market price of jet fuel.

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I. INTRODUCTION

Dover v. British Airways is a breach of contract suit brought by lead plaintiff Russell Dover on behalf of an estimated 160,000 class members¹ who were part of the airline's frequent flyer program, the Executive Club.² Members of the club alleged that the airline imposed illegitimate fuel surcharges on rewards-redeemed flights, and thus violated the Executive Club contract.³ While the airline's right to levy fuel surcharges ("YQ charges") was explicitly stated in the contract, plaintiffs asserted that the level of charges was not reasonably related to the actual cost of jet fuel.⁴ Each party enlisted the testimony of economics experts to answer the central question of whether there existed a strong correlation between these YQ charges and the market price of jet fuel.⁵ Econometricians Jonathan Arnold (representing the plaintiffs) and Andrew Hildreth (representing British Airways) reached opposite conclusions regarding whether this relationship existed.⁶ In addition, plaintiff's expert Arnold proffered multiple damages models that estimated the class members' entitlement if British Airways was found to have breached the contract.⁷ Cross-motions were filed to dismiss the expert testimony, involving challenges to the reliability of the expert's method and the "realisticness" of his model's assumptions.⁸

¹ 321 F.R.D. 49, 54 (E.D.N.Y. 2017).

² *Id.* at 52.

³ *Id.* at 52-53.

⁴ *Id.*

⁵ *Dover v. British Airways*, 254 F. Supp. 3d 455, 457 (E.D.N.Y. 2017).

⁶ *Id.* at 460, 463.

⁷ *Id.* at 461-62.

⁸ *Id.* at 457-65.

The use of economics experts—along with these challenges to their testimony and underlying models— is increasingly common in suits involving employment discrimination, business torts, fraud, antitrust violations, and property damage.⁹ Experts use statistical techniques such as regression analysis to establish correlation between the defendant’s harmful act and the plaintiff’s injury.¹⁰ Econometric models also help experts perform complex valuation of assets and corporations as well as estimate the amount of damages.¹¹

The intended audience for this expert testimony is the jury.¹² As “factfinders,” jurors determine how much weight to give to evidence, which involves “questions of credibility and choice among competing inferences.”¹³ When confronted with these models showing causation, discrimination, or damages, the jury evaluates them in the context of other evidence and lay witness testimony.¹⁴ The economic models and accompanying narrative therefore represent a key thread in the jury’s understanding of the dispute.¹⁵

⁹ Rebecca Haw Allensworth, *Law and the Art of Modeling: Are Models Facts?*, 103 GEO. L.J. 825, 835 (2015).

¹⁰ John E. Lopatka & William H. Page, *Economic Authority and the Limits of Expertise in Antitrust Cases*, 90 CORNELL L. REV. 617, 687-88 (2005).

¹¹ Anthony J. Casey & Julia Simon-Kerr, *A Simple Theory of Complex Valuation*, 113 MICH. L. REV. 1175, 1178 (2015).

¹² Jeff Todd, *An Interdisciplinary Perspective on Economic Models in Complex Litigation*, 46 HOFSTRA L. REV. 971, 1019-23 (2018).

¹³ *Id.* at 988 (citing GEOFFREY C. HAZARD, JR. ET AL., CIVIL PROCEDURE 478, 485 (6th ed. 2011)); David L. Faigman et al., *Gatekeeping Science: Using the Structure of Scientific Research to Distinguish Between Admissibility and Weight in Expert Testimony*, 110 NW. U. L. REV. 859, 861, 884 (2016).

¹⁴ Jennifer L. Mnookin, *Atomism, Holism, and the Judicial Assessment of Evidence*, 60 UCLA L. REV. 1524, 1577 (2013).

¹⁵ John W. Hill et al., *Increasing Complexity and Partisanship in Business Damages Expert Testimony: The Need for a Modified Trial Regime in Quantification of Damages*, 11 U. PA. J. BUS. L. 297, 334 (2009).

In addition to the increasing necessity of economic models,¹⁶ motions to exclude these models are becoming “routine” due to the high returns that exclusion can bring for the opposing party.¹⁷ Experts and their models often comprise the only proof of causation and damages, so plaintiffs are far less likely to prevail without them.¹⁸ Partial exclusion can “devastate” a plaintiff’s case by increasing the relative strength of the defendant’s evidence,¹⁹ while full exclusion often results in summary judgement since the plaintiff has no proof of damages.²⁰

Following motions to exclude expert testimony, judges engage in admissibility determinations that aim to establish the relevance and reliability of the testimony.²¹ However, judges struggle to evaluate economic models for objective scientific validity because models are both science and art.²² Economists wield substantial discretion in the construction of their models by choosing which variables to include and exclude, as well as what idealizations and omissions to make.²³ The realism of a model’s simplifying assumptions are frequent points of attack, placing the judge in a position to weigh

¹⁶ *Id.* at 317-18 (noting that “expert testimony is highly desirable in cases involving business damages” and that some courts will not accept damages estimates from non-experts).

¹⁷ Roger D. Blair & Jill Boylston Herndon, *The Implications of Daubert for Economic Evidence in Antitrust Cases*, 57 WASH. & LEE L. REV. 801, 802 (2000).

¹⁸ *Id.*

¹⁹ Todd, *supra* note 12, at 996-97 (citing *In re Am. Booksellers Ass’n v. Barnes & Noble, Inc.*, 135 F. Supp. 2d 1031 (N.D. Cal. 2001)).

²⁰ Mnookin, *supra* note 14, at 1569.

²¹ FED. R. EVID. 401-403; FED. R. EVID. 702.

²² *See infra* Part III.C.; *see also* Allensworth, *supra* note 9, at 829-34; *id.* at 830 (stating that this “straddle between art and science has made for the awkward and at times inconsistent treatment of modeling as factual in the eyes of the law”); Mark Klock, *Contrasting the Art of Economic Science with Pseudo-Economic Nonsense: The Distinction Between Reasonable Assumptions and Ridiculous Assumptions*, 37 PEPP. L. REV. 153, 196-99 (2010).

²³ Allensworth, *supra* note 9, at 829; *id.* at 832 (noting that “like a mapmaker, a modeler makes choices about what are the essential elements (and what are inessential, such as mailboxes and trees) with reference to the task the model is to perform.”).

competing notions of realisticness.²⁴ This evaluation becomes problematic when the judge encroaches upon the jury's role by deciding the credibility of the testimony.²⁵

Existing legal precedent provides little guidance for admissibility decisions on model-based testimony.²⁶ The vague language of FRE 702²⁷ and the misapplication of scientific standards to the non-scientific aspects of a model²⁸ leads to unpredictable and often unfounded decisions.²⁹ These admissibility determinations are high-stakes, often defining the outcome of multimillion-dollar cases such as *Dover v. British Airways*.³⁰

Legal scholars have attempted to fill in the gaps by contextualizing models in the current legal framework, classifying them as issues of law to be decided by the judge or issues of fact to be weighed by the jury, or a combination of the two.³¹ However, comments to FRE 702 advise courts to consider the relevant standards of an expert's field, so these paradigms are misguided because they do not consider economic models in the context of their own discipline.³²

Heeding these instructions, Todd surveyed the methodological literature to arrive at an understanding of how economic models are built and used within a rhetorical

²⁴ Hill et al., *supra* note 15, at 330-32.

²⁵ See Faigman et al., *supra* note 13, at 862 (noting how the complexity of scientific evidence creates confusion among courts regarding the boundary between admissibility and weight).

²⁶ Joni Hersch & Blair Druhan Bullock, *The Use and Misuse of Econometric Evidence in Employment Discrimination Cases*, 71 WASH. & LEE L. REV. 2365, 2377 (2014).

²⁷ *Id.*

²⁸ Jeff Todd, *Realistic Assumptions in Economic Models*, 47 HOFSTRA L. REV. 231, 252 (2018).

²⁹ Allensworth, *supra* note 9, at 863-64; see also Hill et al., *supra* note 15, at 311.

³⁰ Todd, *supra* note 12, at 989-95 (citing, *inter alia*, *Nebraska Plastics, Inc. v. Holland Colors Americas, Inc.*, 408 F.3d 410 (8th Cir. 2005); *Polymer Dynamics, Inc. v. Bayer Corp.*, 67 Fed. R. Serv. 201 (E.D. Pa. 2005)).

³¹ Ronald J. Allen & Michael S. Pardo, *The Myth of the Law-Fact Distinction*, 97 NW. U. L. REV. 1769 (2003); Allensworth, *supra* note 9; Casey & Simon-Kerr, *supra* note 11; Hill et al., *supra* note 15; D.H. Kaye, *The Dynamics of Daubert: Methodology, Conclusions, and Fit in Statistical and Econometric Studies*, 87 VA. L. REV. 1933 (2001); Robert M. Lloyd, *Proving Lost Profits After Daubert: Five Questions Every Court Should Ask Before Admitting Expert Testimony*, 41 U. RICH. L. REV. 379 (2007).

³² See FED. R. EVID. 702 Committee Notes on Rules—2000 Amendment.

context, and how this knowledge can inform admissibility decisions on model-based testimony in complex litigation.³³ In a subsequent article, he surveyed the literature on how the realisticness of simplifying assumptions affects a model's validity, a frequent point of contention among both economics methodologists and litigants.³⁴ This survey revealed that all models necessarily involve false or unrealistic assumptions, such as "assuming away" a factor that exists but is negligible in the real world.³⁵ However, targeting these assumptions as unrealistic disregards the reasons for which they are imposed, which may be justified for the purposes of isolation and abstraction.³⁶ Todd proposes a theoretical framework that synthesizes typologies from economics methodologists that classify different types of assumptions and realisticness.³⁷ The framework prescribes that judges evaluate the realism of assumptions relative to their context and purpose, rather than in isolation.³⁸

In principle, the framework guides judges' decision-making regarding model-based testimony, which may lead to greater consistency and coherence of admissibility rulings.³⁹ Application to the judge's rulings in the British Airways class action lawsuit can show whether the framework is effective in practice. Further, *Dover* presents an opportunity to explore the unique dynamic of competing experts, a need that has been expressed in legal scholarship.⁴⁰

³³ Todd, *supra* note 12.

³⁴ See *infra* Part II.B., Part III.C.

³⁵ Todd, *supra* note 28, at 270-75.

³⁶ Uskali Mäki, *On the Method of Isolation in Economics*, 26 POZNAN STUD. PHIL. SCI. & HUMAN. 316, 328-30 (1992).

³⁷ Todd, *supra* note 28.

³⁸ *Id.* at 273, 275.

³⁹ See *id.* at 292.

⁴⁰ Jeff Todd & R. Todd Jewell, *Dubious Assumptions, Economic Models, and Expert Testimony*, 42 DEL. J. CORP. L. 279, 320 (2018) (concluding that "Additional articles could explore assumptions in such multi-expert situations and what role argumentation and evidence play in resolving that battle.").

Part II of this article summarizes the multi-decade debate among economics methodologists about what models are and how economists use them.⁴¹ This Part also charts the parallel debate within the discipline regarding whether the realism of assumptions is relevant to a model's validity, as well as recent contributions to this "assumptions controversy" that classify types of assumptions and realisticness.⁴² Part III describes the current legal framework for admissibility decisions, how these standards are lacking, and proposed solutions in legal scholarship.⁴³ Part IV describes the framework proposed by Todd and applies it to the competing expert testimony in *Dover v. British Airways*.⁴⁴ Part V evaluates the framework's applicability and usefulness for each expert's testimony.⁴⁵ Application to explicit assumptions that are challenged as unrealistic demonstrates a straightforward application of the framework, providing greater depth and precision to the judge's analysis.⁴⁶ Application to tacit assumptions such as choice of methodology requires more inference, but reveals that the framework is also useful for evaluating choices that are external to a model.⁴⁷ However, this sort of application requires an understanding of the often ill-defined boundary between the scientific and artistic aspects of a model, a distinction that would need to supplement the framework in order to be applicable to a wide range of challenges to expert testimony.⁴⁸ This article concludes in Part VI.⁴⁹

II. ECONOMIC MODELS IN THE METHODOLOGICAL LITERATURE

⁴¹ See *infra* Part II.

⁴² See *infra* Part II.

⁴³ See *infra* Part III.

⁴⁴ See *infra* Part IV.

⁴⁵ See *infra* Part V.

⁴⁶ See *infra* Part IV.B.

⁴⁷ See *infra* Part IV.C.

⁴⁸ See *infra* Part V.

⁴⁹ See *infra* Part VI.

A. Models are Analogical Devices and Economists are Storytellers

Economic models are simplified representations of a more complex system,⁵⁰ but there is substantial methodological debate regarding the metaphysical relationship between models and the real-world systems they represent. A survey of the economics literature will illustrate how there is no single conception of what models are or how they should be built. This lack of consensus is not fatal, however, because one may distill general points of agreement which will help inform an analysis of economic models in the context of litigation.

Some methodologists posit a high degree of similarity between economics and other sciences. Founder of neoclassical economics Alfred Marshall noted that economic inquiries, like those in other sciences, aim to study an essential cause-and-effect relationship, under the condition that all other things are equal.⁵¹ Mäki extends this reasoning to something more concrete, likening theoretical modelling to the material experiments that are characteristic of natural sciences.⁵² The essential similarity between the two lies in the notion of manipulation.⁵³ Reality is so complex that the *ceteris paribus* condition, i.e., other things being equal, is not naturally occurring.⁵⁴ Thus, in order to isolate a certain causal relationship and examine its properties, investigators must impose a series of controls to craft an “artificial world” that is “free from [the] complications . . . of the rest of the world.”⁵⁵ Scientists in laboratories impose these controls through

⁵⁰ Robert M. Solow, *How Did Economics Get that Way and What Way Did It Get?*, 126 DAEDALUS 39, 43 (1997).

⁵¹ Mäki, *supra* note 36, at 317.

⁵² Uskali Mäki, *Models are experiments, experiments are models*, 12:2 J. ECON. METHODOLOGY 303, 308-9 (2005).

⁵³ *Id.* at 306.

⁵⁴ Mäki, *supra* note 36, at 317.

⁵⁵ Mäki, *supra* note 52, at 308.

material manipulation, whereas economists use idealizing assumptions to achieve the same effect, that is, of neutralizing or standardizing the myriad elements in a complex system.⁵⁶ As a result, Mäki sees models as “surrogate systems,” the properties of which are examined directly in order to indirectly gain knowledge about the systems they represent.⁵⁷ This relationship is akin to animal subjects functioning as surrogates for human beings.⁵⁸

Sugden disagrees with the isolationist approach, and instead aims to construct an autonomous model-world that parallels rather than simplifies the real world.⁵⁹ For this reason, Sugden’s method is sometimes described as the constructionist approach, since it does not aim to mirror reality but instead crafts from scratch an explicitly counterfactual yet credible world.⁶⁰ More succinctly, these model-worlds are “imaginary but imaginable.”⁶¹ A model’s credibility derives from the coherence of its assumptions and whether they construct a world that could be true, given our understanding of how the real world works.⁶² Sugden also compares models to novels.⁶³ Realistic novels do not claim to be anything other than fiction, but they contain certain characters and situations that could conceivably be true.⁶⁴ Perhaps most importantly, the story and its characters’ behaviors (like a good model’s assumptions) are coherent and consistent.⁶⁵

⁵⁶ *Id.*

⁵⁷ Mäki, *supra* note 52, at 304.

⁵⁸ *Id.*

⁵⁹ Robert Sugden, *Credible Worlds: The Status of Theoretical Models in Economics*, 7 J. ECON. METHODOLOGY 1, 25 (2000) (arguing that the “model world is not constructed by starting with the real world and stripping out complicating factors: although the model world is simpler than the real world, the one is not a simplification of the other.”).

⁶⁰ *Id.* at 25, 28.

⁶¹ Robert Sugden, *Credible Worlds, Capacities and Mechanisms*, 70 ERKENNTNIS 3, 5 (2009).

⁶² Sugden, *supra* note 59, at 25.

⁶³ *Id.*

⁶⁴ *Id.*

⁶⁵ *Id.* at 26.

Cartwright writes that “models are like fables, and the lesson derived from the model is its moral.”⁶⁶ The key is to translate the concrete, specific results of the model into abstract results that can be more generally applied to other cases.⁶⁷ In this way, the model is both true to reality and useful for inductive inference.⁶⁸ Gibbard and Varian use similar literary language, describing some models as “caricatures” that do not purport to approximate the real world.⁶⁹ Instead, the model is a “deliberate distortion” of reality that aims to exaggerate or illuminate a particular feature of that reality.⁷⁰ This magnification helps the economist to “tell a simple story” about select aspects of the real world, rather than attempt to recount reality in all its complexity.⁷¹

Finally, Morrison and Morgan see models as “autonomous instruments” that nevertheless help mediate between theory and the real world.⁷² Like any other tool, models must be “put to work, used, or manipulated” by an external entity in order to be useful.⁷³

Clearly, economists lack a single conception of what model-building entails. Nevertheless, a few points of similarity may be gleaned from the divergent literature. Perhaps most importantly, models are tools that explain real-world phenomena through the mechanism of analogy. Whether they are called surrogate systems, parallel worlds,

⁶⁶ Nancy Cartwright, *Models: Parables v Fables*, in BEYOND MIMESIS AND CONVENTION: REPRESENTATION IN ART AND SCIENCE 19, 26 (Roman Frigg & Matthew C. Hunter eds., 2010).

⁶⁷ *Id.* at 28.

⁶⁸ *See id.* at 29-30 (concluding that increasing the level of abstraction permits “generalizable conclusions” that are “true of new target situations”).

⁶⁹ Allan Gibbard & Hal R. Varian, *Economic Models*, 75 J. PHIL. 664, 673 (1978).

⁷⁰ *Id.*

⁷¹ *Id.* at 674.

⁷² Margaret Morrison & Mary S. Morgan, *Models as Mediating Instruments*, in MODELS AS MEDIATORS: PERSPECTIVES ON NATURAL AND SOCIAL SCIENCE 10, 10 (Mary S. Morgan & Margaret Morrison eds., 1999).

⁷³ *Id.* at 32.

fables, or caricatures, economists clearly see models as inherently metaphorical devices that help shed light on real-world processes.⁷⁴ Though there may be gaps between the model-world and the real world it represents (due to isolation, distortion, and abstraction), the bridge between the two lies in inductive inference.⁷⁵ This process of induction requires taking the specific propositions of a model—say, a certain factor R causes a change in factor F—and generalizing those to more general situations, inferring that the same causal relationship exists in the real world.⁷⁶

Crucially, models cannot make these “inductive leaps” themselves and require human interpretation to be useful.⁷⁷ In addition to interpretation, economists must communicate the quantitative results of a model as a qualitative, coherent narrative. The explanations that accompany models are essentially stories, with the modeler as a storyteller.⁷⁸ The modeler must communicate the model and its results to a particular audience, whether they be other economists, academics from other disciplines, or lay audiences.⁷⁹ There is also a rhetorical aspect to these stories, wherein economists aim to convince the audience of the model’s credibility and its similarity with the real world.⁸⁰

⁷⁴ See Cartwright, *supra* note 66 (fables); Gibbard & Varian, *supra* note 69 (caricatures); Mäki, *supra* note 52, at 304 (surrogate systems); Sugden, *supra* note 59 (parallel worlds).

⁷⁵ Sugden, *supra* note 61, at 4.

⁷⁶ Sugden, *supra* note 59, at 20.

⁷⁷ *Id.*

⁷⁸ Mäki, *supra* note 36, at 330-31; see also Mary S. Morgan, *Models, Stories and the Economic World*, 8 J. ECON. METHODOLOGY 361, 361 (2001) (describing how economists use models “to explain or to understand the facts of the world by telling stories about how those facts might have arisen.”); see *id.* at 366 (writing that models and stories “go hand in hand”).

⁷⁹ See Mäki, *supra* note 36, at 330-31 (holding that the story attached to a model “may vary somewhat from audience to audience.”).

⁸⁰ See Itzhak Gilboa et al., *Economic Models as Analogies*, 124 ECON. J. F513, F518 (2014) (stating that “the similarity judgement is often hinted at by the economist,” but the audience or “readers” of a model may not necessarily agree with these judgements).

As part of this persuasion, the modeler engages in “storied idealizations” to describe the reasons behind his simplifications and omissions.⁸¹

B. Simplifying Assumptions and Realisticness

While the metaphysical relationship between the real world and the model-world can be described in a variety of ways, it is undisputed that unrealistic assumptions are a ubiquitous and inescapable component of these model-worlds.⁸² Simplification and idealization transform a complicated reality into a tractable, useful model that ignores irrelevant elements to shed light on a particular relationship or phenomenon.⁸³ Since the model-world is supposed to inform us about the real-world in some way, the issue of realisticness is perhaps the “most chronic ongoing methodological controversy in economics.”⁸⁴ Historical approaches to this dispute have generally tended towards two methodological camps: instrumentalism and realism.⁸⁵ Instrumentalists are concerned with the realism of outputs, and posit that the accuracy of predictions is the only criterion by which a model should be judged.⁸⁶ Conversely, realists are focused on inputs and see verisimilitude or “truthlikeness” of assumptions as intrinsically valuable and desirable.⁸⁷

⁸¹ Mäki, *supra* note 36, at 330-31 (writing that “storied idealizations” are particularly important for audiences of non-economists).

⁸² David H. Kaye & David A. Freedman, *Reference Guide on Statistics*, in FED. JUDICIAL CTR., REFERENCE MANUAL ON SCIENTIFIC EVIDENCE 211, 272 (3d ed. 2011) (noting that from a certain perspective, models are simply a “set of assumptions”); Uskali Mäki, *Reorienting the Assumptions Issue*, in NEW DEVELOPMENTS IN ECONOMIC METHODOLOGY 236, 241 (Roger Backhouse ed., 1994).

⁸³ Uskali Mäki, *Aspects of Realism about Economics*, 13 THEORIA 301, 308 (1998).

⁸⁴ Mäki, *supra* note 36, at 318.

⁸⁵ Bruce J. Caldwell, *A Critique of Friedman’s Methodological Instrumentalism*, 47 S. ECON. J. 366, 367 (1980).

⁸⁶ *Id.*

⁸⁷ See Mäki, *supra* note 82, at 240.

1. The Origins of the Assumptions Controversy

The most notable contribution to this debate is staunch instrumentalist and Nobel Prize laureate Milton Friedman and his essay, *The Methodology of Positive Economics*.⁸⁸ In the essay Friedman proclaims that unrealistic assumptions are not an unfortunate byproduct of simplification, but rather a necessary and welcome element of important theories.⁸⁹ Important theories should “explain much by little,” he says, and in general, “the more significant the theory, the more unrealistic the assumptions.”⁹⁰ Accordingly, whichever assumptions yield those predictions—no matter their degree of “conformity [] to reality”⁹¹—have proven themselves to be “sufficiently good approximations for the purpose at hand.”⁹²

This bold thesis provoked the response of Nobel Prize winner and realist Paul Samuelson, who dubbed Friedman’s “principle of unreality” the “F-Twist,” and used deductive logic to show that false assumptions necessarily imply false conclusions.⁹³ While Samuelson concedes that models cannot perfectly mirror reality, he sees lack of realism as a defect rather than a virtue and denounces Friedman’s flagrant disregard for realism in the name of parsimony.⁹⁴ Samuelson feared that the tolerance (or celebration) of unrealistic assumptions could be a slippery slope into complete neglect of empirical

⁸⁸ MILTON FRIEDMAN, *The Methodology of Positive Economics*, in *ESSAYS IN POSITIVE ECONOMICS* 3 (1953).

⁸⁹ *See id.* at 14

⁹⁰ *Id.*

⁹¹ *Id.*

⁹² *Id.* at 14-15 (asserting that the appropriate test for an assumption’s realism is the accuracy of predictions it yields).

⁹³ Paul Samuelson, *Problems of Methodology—Discussion*, 53 *AM. ECON. REV.* 227, 232-36 (1963).

⁹⁴ Paul Samuelson, *Theory and Realism: A Reply*, 54 *AM. ECON. REV.* 736, 736 (1964) (arguing that “the doughnut of empirical correctness in a theory constitutes its worth, while its hole of untruth constitutes its weakness.”); *see id.* at 736 (calling it a “monstrous perversion of science to claim that a theory is *all the better for its shortcomings*”) (emphasis in original).

validity.⁹⁵ He admits that some abstract models may have a certain “psychological usefulness” for understanding some latent patterns of reality, however, this usefulness is entirely different from the empirical accuracy that Friedman claimed to achieve with his instrumentalist models.⁹⁶

2. A “Reorientation” of the Assumptions Controversy

Following the polarized debate between Friedman and Samuelson, the assumptions controversy has evolved beyond the binary issue of whether or not assumptions need to be realistic. More recent developments recognize that assumptions should be evaluated relative to their context and purpose, rather than in isolation.⁹⁷ As a result, several methodologists have attempted to categorize assumptions based on this more nuanced understanding.⁹⁸

Alan Musgrave aimed to “un-twist” Friedman’s F-Twist by specifying three main types of assumptions: negligibility, domain, and heuristic.⁹⁹ Negligibility assumptions are statements that a certain factor X has no effect—or at least no detectable effect—on Y, the phenomenon under study.¹⁰⁰ As a result, the omission of factor X from the model will not substantially change its results.¹⁰¹ An example would be Galileo’s assumption of zero air resistance when investigating the motion of free-falling objects.¹⁰² It would be “plain

⁹⁵ Samuelson, *supra* note 93, at 236.

⁹⁶ *Id.*

⁹⁷ E.g., Yew-Kwang Ng, *Are Unrealistic Assumptions/Simplifications Acceptable? Some Methodological Issues in Economics*, 21 PAC. ECON. REV. 180, 181-182 (2016).

⁹⁸ E.g., Frank A. Hindriks, *Tractability Assumptions and the Musgrave-Mäki Typology*, 13 J. ECON. METHODOLOGY 401 (2006); Uskali Mäki, *Kinds of Assumptions and Their Truth: Shaking an Untwisted F-Twist*, 53 KYKLOS 317 (2000); Alan Musgrave, “Unreal Assumptions” in *Economic Theory: The F-Twist Untwisted*, 34 KYKLOS 377 (1981).

⁹⁹ Musgrave, *supra* note 98, at 378-82.

¹⁰⁰ *Id.* at 378.

¹⁰¹ See *id.* at 380 (describing how the truth of negligibility assumptions becomes apparent by “examining the consequences of the theory in which they are embedded.”).

¹⁰² *Id.* at 378.

silly,” Musgrave says, to discount Galileo’s theory simply because air resistance does exist and the objects were not, in fact, falling through a vacuum.¹⁰³ Instead, the proper focus should be on Galileo’s statement about the *negligibility* of air resistance on the object of study, which is a potentially true statement.¹⁰⁴

Domain assumptions specify where a theory may be applied.¹⁰⁵ In contrast to the previous type, factor X admittedly has non-negligible effects on Y, so the theory only applies when the factor is absent.¹⁰⁶ Musgrave states that domain assumptions should be true of as many actual situations as possible, because if domain assumptions are never true, they can never be tested and the theory or model loses its utility.¹⁰⁷

Finally, heuristic assumptions are early simplifications that ease the logical development of a theory.¹⁰⁸ Musgrave provides an example from physics: Newton’s early approximations assumed that only one planet orbited the sun and did not take into account the effects of inter-planetary gravitational forces.¹⁰⁹ Implicit in these assumptions is a promise to relax them later on, as they are only intermediate steps towards more precise predictions.¹¹⁰ Since they are only temporary, some descriptively false assumptions are permissible.¹¹¹

¹⁰³ *Id.* at 379.

¹⁰⁴ *Id.* at 380 (writing that negligibility assumptions are true descriptions of reality because they “do not assert that present factors are absent but rather that they are ‘irrelevant for the phenomena to be explained’”).

¹⁰⁵ *Id.* at 381.

¹⁰⁶ *Id.*

¹⁰⁷ *Id.* at 382 (negating Friedman’s claim that “the more significant the theory, the more unrealistic the assumptions” because the significance of a theory is dependent on how widely it can be applied, *i.e.* how often its domain assumptions are true).

¹⁰⁸ *Id.* at 383.

¹⁰⁹ *Id.*

¹¹⁰ *Id.* (naming this process “a *method of successive approximation*”) (emphasis in original).

¹¹¹ *See id.*

To understand how each of these assumptions functions, consider how the same idealization of factor X can take on various interpretations:

An economist who says ‘assume the government has a balanced budget’ may mean that any actual budget imbalance can be ignored because its effects on the phenomena he is investigating are negligible. But he may also mean precisely the opposite: that budget imbalance would have significant effects, so that his theory will only apply where such an imbalance does not exist.¹¹²

A heuristic assumption would be to assume the government has a balanced budget at first, with a subsequent theory that takes the possibility of budget imbalance into account.¹¹³ In all three cases, the status of the government’s budget is “assumed away,” (factor X is absent) but the implications of each type of assumption represent critical differences that are often imperceptible.¹¹⁴ If a successor theory were to build upon this economist’s model, it is crucial that he know whether continuing to assume a balanced budget is appropriate.¹¹⁵ An applicability assumption that is misconstrued as a negligibility assumption may cause a violation of the proper domain, resulting in an invalid theory.¹¹⁶ Therefore, Musgrave urges economists to be explicit regarding which type of assumptions they are imposing.¹¹⁷

Uskali Mäki supplemented this typology, with improvements that were both semantic and material.¹¹⁸ Musgrave’s heuristic assumption was replaced by an essentially identical “early-step” assumption.¹¹⁹ Mäki also clarified that Musgrave’s domain

¹¹² *Id.* at 381 (emphasis in original).

¹¹³ *Id.* at 386.

¹¹⁴ *Id.* at 381 (noting that identical phrasing for the different types of assumptions can mask their divergent implications).

¹¹⁵ *See id.*

¹¹⁶ *See id.* at 385 (speculating on whether changes in the status of assumptions (*e.g.*, from negligibility to domain) have gone unnoticed in the development of economic theory at large).

¹¹⁷ *Id.*

¹¹⁸ Mäki, *supra* note 98, at 317-18.

¹¹⁹ *Id.* at 325.

assumption is simply one component of what is in fact an applicability assumption.¹²⁰ He notes that the domain assumption merely identifies the relevant domain, while the higher-level applicability assumption does the work in restricting the theory to only that domain.¹²¹ As a result, applicability assumptions typically involve an if-then formulation: *If the domain assumption is true, then the theory applies.*¹²² As for the third class of assumptions, Mäki cautioned against the conflation of negligibility with undetectability, the latter of which he feared Musgrave was actually referencing.¹²³

On the topic of realism, Mäki feared that Musgrave's artful paraphrasing is too flexible, to the point where nearly any statement can become "a potentially true assertion if it is suitably 'meta-paraphrased.'"¹²⁴ Mäki aims to limit the powers of meta-statements by requiring that they transform a statement into a "factual claim" about economic reality.¹²⁵

In the latest contribution to the assumptions typology, Frank Hindriks introduces the notion of a tractability assumption, the successor of "heuristic" or "early-step" assumptions.¹²⁶ However, this change was not mere re-packaging of the previous methodologists' terminology. Instead, Hindriks' addition better encompasses a third primary reason why an economist might impose a given assumption. Tractability assumptions arise when a problem is unmanageable but-for a certain simplification.¹²⁷

¹²⁰ *Id.*

¹²¹ *Id.*

¹²² *See id.* at 323.

¹²³ *Id.* at 320.

¹²⁴ *Id.* at 331.

¹²⁵ *Id.* at 331-32.

¹²⁶ Hindriks, *supra* note 98, 411-14.

¹²⁷ *Id.* at 412 (stating that because tractability assumptions involve non-negligible factors, "one would prefer to avoid relying on it, if it were not for the fact that it makes the problem under investigation (more) tractable."); Frank A. Hindriks, *Unobservability, Tractability and the Battle of Assumptions*, 12 J. ECON.

Hindriks distinguishes between two types of tractability: theoretical and empirical.¹²⁸ The former is reminiscent of Musgrave's heuristic assumption and refers to the logical development of a theory.¹²⁹ Certain "exogenous constraints," such as the level of sophistication of mathematics, may necessitate a theoretical tractability assumption.¹³⁰ Such an assumption may also be imposed due to limitations on cognitive capacity, both of the theorists and their audiences alike.¹³¹

Empirical tractability, on the other hand, concerns more pragmatic constraints.¹³² Frequently, data are not available for a given variable or factor X, either due to non-collection or confidentiality reasons.¹³³ Even when data are available, their method of collection may be inconsistent across time, making their use in an empirical model problematic.¹³⁴ Another empirical tractability concern is unobservability, which is often the case when theoretical constructs in economics have no corresponding real-world data.¹³⁵ As such, both theoretical and empirical models frequently incorporate these assumptions in order to reduce the number of unknown variables and make models more tractable.¹³⁶

METHODOLOGY 383, 399 (2005) (asserting that despite their potentially "distorting effects," the imposition of tractability assumptions is "usually unavoidable").

¹²⁸ Hindriks, *supra* note 98, at 413.

¹²⁹ *Id.*

¹³⁰ *Id.* at 414.

¹³¹ *Id.*

¹³² *Id.*

¹³³ *Id.*

¹³⁴ *Id.*

¹³⁵ Hindriks, *supra* note 127, at 399 (2005) (providing an example: "The value of marginal cost cannot easily be computed from cost data that are reported. Economists often assume that the relation between marginal cost and the number of products produced is nonlinear. This means that marginal cost is not the same as average cost").

¹³⁶ *Id.* at 392 (emphasizing that "tractability is a matter of solubility or of the efficiency of a solution.").

Both Musgrave and Mäki recognize that the content of an assumption and its purpose constitute two separate concepts whose “truth values . . . behave differently.”¹³⁷ While Musgrave and Mäki hint at the dual identity of assumptions, Frank Hindriks articulates this distinction by introducing first-order and second-order assumptions.¹³⁸ The first-order assumption is an idealization statement concerning factor X – whether it is absent, constant, or infinite in the model.¹³⁹ The second-order assumption is a meta-statement that identifies the purpose of imposing the first-order assumption.¹⁴⁰ While the first-order assumption concerns only the model-world, the second-order assumption is a statement about the real-world.¹⁴¹ For example, a negligibility assumption might take the following form:

[A] Factor F is absent or has no effect on the phenomenon under investigation.

[N] The factor F mentioned in first-order assumption A has a negligible effect on the phenomenon under investigation relative to the purpose for which the theory is used.¹⁴²

This formulation demarcates the instances in which the truth-value of an assumption is an important concern.¹⁴³ First-order assumptions are often false or unrealistic, but this is unproblematic so long as the second-order assumption is approximately true relative to its purpose.¹⁴⁴ For example, assuming that air resistance is absent is a descriptively false first-order assumption.¹⁴⁵ The second-order assumption stating that air resistance has a

¹³⁷ Mäki, *supra* note 98, at 325; Musgrave, *supra* note 98, at 380 (differentiating between the absence of a factor as a “descriptively false” statement versus the negligibility of that factor as a “descriptively realistic” statement).

¹³⁸ Hindriks, *supra* note 98, at 406.

¹³⁹ *Id.* at 407.

¹⁴⁰ *Id.*

¹⁴¹ *Id.*

¹⁴² *Id.*

¹⁴³ *See id.* at 421.

¹⁴⁴ *See id.* at 410 (rephrasing Musgrave’s argument).

¹⁴⁵ *See* Musgrave, *supra* note 98, at 378 n.2.

negligible effect may be approximately true, as in the case of a falling baseball.¹⁴⁶

However, this negligibility assumption may be a false in other contexts, such as a falling feather.¹⁴⁷

The assumptions typology demonstrates how a lack of overt realism in face-value assumptions need not be in conflict with a realist approach to economics.¹⁴⁸ The framework thus offers a sort of reconciliation between the realist and instrumentalist camps; on one hand, economists may use simplifying first-order assumptions as the tool that they are, and models will not be held to the impossible standard of being “photographic reproduction[s]” of reality.¹⁴⁹ On the other hand, realistic second-order assumptions ensure that a model is still meaningfully connected to reality. The requirement that the second-order assumption be at least approximately true may allay Samuelson’s fears concerning the descent of economic science into empirical invalidity.¹⁵⁰ It also prevents indiscriminate acceptance of unrealistic assumptions, a concern had by many following Friedman’s seminal essay.¹⁵¹ Most importantly, these methodologists approach the realisticness of assumptions as a dynamic phenomenon rather than a “dichotomous notion.”¹⁵² This analysis can be further developed by an

¹⁴⁶ *See id.*

¹⁴⁷ *See* Gibbard & Varian, *supra* note 69, at 671.

¹⁴⁸ Tarja Knuuttila, *Isolating Representations versus Credible Constructions? Economic Modelling in Theory and Practice*, 70 ERKENNTNIS 59, 61; *see also* Todd, *supra* note 28, at 269 (summarizing that “Although idealization involves some false assumptions, that does not undermine the truth of the model”).

¹⁴⁹ Friedman, *supra* note 88, at 35 (contrasting the instrumentalist and realist approaches); Mäki, *supra* note 52, at 308 (emphasizing that “Unrealistic assumptions are the indispensable tools of the experimental theorist.”).

¹⁵⁰ *See, e.g.*, Mäki, *supra* note 98, at 332 (clarifying that paraphrased assumptions must involve factual claims about economic reality).

¹⁵¹ *See* Hindriks, *supra* note 98, at 410-411 (noting how the truth of second-order assumptions is important for a theory’s validity).

¹⁵² *E.g.*, Mäki, *supra* note 36, at 324.

awareness of the various interpretations that the terms “realistic” and “unrealistic” may take.

Mäki sees the debate about realism of assumptions as “plagued by multiple ambiguity.”¹⁵³ The culprits of this ambiguity, he says, are binary thinking and lack of specificity in language.¹⁵⁴ As a remedy, he catalogs different kinds of realisticness which include truth, confirmability, plausibility and partiality, among others.¹⁵⁵

Perhaps the most obvious conception of realisticness is truth; truth is self-evident and its antithesis is falsehood.¹⁵⁶ In this sense, a statement is realistic if true and unrealistic if false.¹⁵⁷ However, the truth is not always observable and may be difficult to ascertain after-the-fact.¹⁵⁸ Empirical evidence can provide hints about this truth, but belongs to a different type of realisticness, which is confirmation and disconfirmation.¹⁵⁹ This type concerns matters that are not only observable, but testable and confirmed by empirical evidence.¹⁶⁰ Confirmability is often conflated with truth but the two are not synonymous: evidence can speak for a false statement (confirmable but not true) and not all truths are supported by observable evidence (true but not confirmable).¹⁶¹ A third type of realisticness is plausibility, which is a matter of being believed by people.¹⁶² The criterion for realisticness here is not evidence but instead human logic and reasoning, so a representation may be realistic if plausible and unrealistic if implausible.¹⁶³

¹⁵³ *Id.* at 320.

¹⁵⁴ Mäki, *supra* note 82, at 239.

¹⁵⁵ *Id.* at 241-43.

¹⁵⁶ *Id.* at 241-42.

¹⁵⁷ *Id.*

¹⁵⁸ *Id.* at 242.

¹⁵⁹ *Id.*

¹⁶⁰ *Id.*

¹⁶¹ *Id.*

¹⁶² *Id.*

¹⁶³ *Id.*

The final class of realisticness concerns partiality, of which there are a few subtypes. Partiality may refer to isolation, which “focuses on the influence of only one factor . . . to the exclusion of others.”¹⁶⁴ Another subset of partiality is abstraction, where a universal or quasi-universal concept is stripped from its particularities.¹⁶⁵ Partiality can relate to realisticness in two opposite ways. In one sense, a partial representation may be deemed unrealistic because it is not comprehensive (in the case of isolation)¹⁶⁶ or concrete (in the case of abstraction).¹⁶⁷ Alternatively, partiality may help a modeler “attain the truth about the essential features” of economic phenomena, and thus be more “realistic” than a model weighed down by innumerable and irrelevant details.¹⁶⁸ “An isolating theory or statement is true if it correctly represents the isolated essence of the object; otherwise it is false.”¹⁶⁹ Similarly, abstraction can help “facilitate the attainment of truth” by permitting greater scope.¹⁷⁰

Mäki’s enumeration of various types of realisticness provides yet another dimension to the previously superficial controversy surrounding the realism of assumptions. For one, an assumption may be simultaneously realistic in one sense and unrealistic in another, such as a false assumption that may still be plausible.¹⁷¹ Furthermore, realisticness does not always have to be binary as in the case of truth and

¹⁶⁴ *Id.* at 243.

¹⁶⁵ Mäki, *supra* note 36, at 322 (referencing the example of a production function, where an ‘L’ represents the aggregate labor input without any reference to “spatio-temporally specified instances of labor.”).

¹⁶⁶ *Id.* at 321.

¹⁶⁷ *Id.* at 323.

¹⁶⁸ Mäki, *supra* note 83, at 311.

¹⁶⁹ Mäki, *supra* note 36, at 344.

¹⁷⁰ Jack Melitz, *Friedman and Machlup on the Significance of Testing Economic Assumptions*, 73 J. POL. ECON. 37, 41 (1965).

¹⁷¹ See Mäki, *supra* note 82, at 241-43; see also Mäki, *supra* note 36, at 346 (describing how a theory can also be simultaneously realistic (it shows nothing-but-the-truth) and unrealistic (it does not show the whole truth)); Todd, *supra* note 28, at 263, 275, 278-79.

falsehood or confirmation and disconfirmation, as plausibility and partiality can exhibit differences of degree.¹⁷²

These various conceptions of realism are also present in the context of litigation. In the “quest for truth,” juries make plausibility judgments on competing testimony and parse evidence that may confirm or disconfirm certain statements.¹⁷³

II. ECONOMIC MODELS IN LITIGATION

A. The Critical Role of Economics Expert Testimony in Complex Litigation

Economics experts are frequently called upon to certify a class, prove causation, and estimate damages.¹⁷⁴ Their model-based testimony is prevalent in various types of cases involving employment discrimination, business torts, fraud, antitrust violations, and property damage.¹⁷⁵ Proving causation is no straightforward task given the myriad confounding variables that can affect an employment decision or a firm’s share price and profits.¹⁷⁶ Because economists do not have the benefit of controlled experiments,¹⁷⁷ they must use econometrics—the application of statistics to analyze economic data—to study phenomena like correlation and causation.¹⁷⁸ These econometric models therefore help the jury make sense of vast amounts of disorderly data.¹⁷⁹

¹⁷² Mäki, *supra* note 36, at 321.

¹⁷³ Casey & Simon-Kerr, *supra* note 11, at 1184.

¹⁷⁴ Allensworth, *supra* note 9, at 835; Hersch & Bullock, *supra* note 26, at 2373-76.

¹⁷⁵ Allensworth, *supra* note 9, at 835.

¹⁷⁶ Todd & Jewell, *supra* note 40, at 286-87.

¹⁷⁷ Malcolm B. Coate & Jeffrey H. Fischer, Daubert, *Science, and Modern Game Theory: Implications for Merger Analysis*, 20 SUP. CT. ECON. REV. 125, 151 (2012).

¹⁷⁸ Alan O. Sykes, *An Introduction to Regression Analysis* (COASE-SANDOR INST. FOR LAW & ECON., WORKING PAPER No. 20, 1993).

¹⁷⁹ Todd, *supra* note 28, at 243; Todd & Jewell, *supra* note 40, at 286-87 (describing how experts must sort through “voluminous data, such as market information showing prices and sales, or financial records showing revenues and expenses” as well as account for the variable of time).

Statistical techniques such as regression analysis can establish and isolate the causal link between an independent variable—the defendant's alleged wrongful conduct—and a dependent variable, the plaintiff's injury.¹⁸⁰ Experts also perform complex valuation of assets and corporations for cases involving business torts.¹⁸¹ Additionally, they use empirical models to construct a counterfactual past that estimates what a plaintiff's position would have been but-for the defendant's wrongful conduct.¹⁸² These estimations provide a basis for calculating the amount of damages, which is the difference between the plaintiff's current position and their but-for position.¹⁸³

In sum, economics experts use their knowledge and technical expertise to “fill[] that evidentiary void” between complex, raw data and actionable information that the jury can understand and evaluate.¹⁸⁴ Econometric models frequently comprise the only proof of causation and damages, so the outcomes of many cases are contingent on the jury seeing this testimony.¹⁸⁵

B. The Jury's Role in Assessing the Credibility of an Expert's Story

As factfinders, juries are tasked with determining the facts in issue of a case given the available evidence.¹⁸⁶ By assessing witness credibility and weighing competing evidence, juries decide whether the defendant is liable and if so, the amount of

¹⁸⁰ Lopatka & Page, *supra* note 10, at 687 (stating that economic models help determine whether “the alleged harm bears the necessary causal link” in antitrust inquiries).

¹⁸¹ Casey & Simon-Kerr, *supra* note 11, at 1178.

¹⁸² Allensworth, *supra* note 9, at 837.

¹⁸³ Roger D. Blair & William H. Page, “*Speculative*” *Antitrust Damages*, 70 WASH. L. REV. 423, 435-36 (1995); Lopatka & Page, *supra* note 10, at 687 (writing that the “causal link [between injury and harm] forms the basis for any damage model.”).

¹⁸⁴ FED R. EVID. 702(a) (“the expert’s scientific, technical, or other specialized knowledge will help the trier of fact to understand the evidence or to determine a fact in issue”); Casey & Simon Kerr, *supra* note 11, at 1179.

¹⁸⁵ Blair & Herndon, *supra* note 17, at 802.

¹⁸⁶ See Casey & Simon-Kerr, *supra* note 11, at 1185.

damages.¹⁸⁷ However, jurors do not approach evidence with a blank state.¹⁸⁸ Instead, they filter the evidence through the lens of their past experiences.¹⁸⁹ These experiences engender a common sense and intuition about how the world works.¹⁹⁰ With the advantage of numerosity, juries are the entity best equipped to make common-sense judgments regarding “credibility and choice among competing inferences.”¹⁹¹

Furthermore, juries evaluate evidence holistically rather than in isolation, searching for continuity among the various elements presented to them.¹⁹² With these evidentiary fragments, the jury constructs “alternative interpretations, or ‘stories,’ about the events that led to the dispute now on trial.”¹⁹³ Each party also has a story about these events supported by their respective evidence.¹⁹⁴ The parties present these opposing narratives to the jury, and use rhetoric and persuasion to convince this audience to share their respective conceptualizations of reality, essentially, whether or not the defendant caused harm to the plaintiff.¹⁹⁵

This model of jury factfinding is no different for expert testimony. Economics experts present their models to the jury and aim to persuade this audience of their model’s credibility.¹⁹⁶ Juries use their past experiences as “buyers and sellers, parties to contracts, and business owners” to gauge the plausibility of the expert’s testimony.¹⁹⁷

¹⁸⁷ Faigman et al., *supra* note 13, at 884.

¹⁸⁸ Neil Vidmar & Shari Seidman Diamond, *Juries and Expert Evidence*, 66 BROOK. L. REV. 1121, 1137 (2001).

¹⁸⁹ *Id.* at 1138; Mnookin, *supra* note 14, at 1540-41.

¹⁹⁰ See Lisa Kern Griffin, *Narrative, Truth, and Trial*, 101 GEO. L.J. 281, 294 (2013).

¹⁹¹ Allensworth, *supra* note 9, at 848-49; Faigman et al., *supra* note 13, at 884 (specifying the jury’s role as the “assessors of witness credibility”).

¹⁹² Mnookin, *supra* note 14, at 1540; see also Griffin, *supra* note 190, at 286 (discussing how different pieces of evidence “interact in ways that alter their individual significance”).

¹⁹³ Vidmar & Diamond, *supra* note 188, at 1138.

¹⁹⁴ See Lopatka & Page, *supra* note 10, at 622-24.

¹⁹⁵ *Id.* at 622.

¹⁹⁶ Todd, *supra* note 12, at 1018-22.

¹⁹⁷ *Id.* at 1034.

Because the jury is a lay audience, experts rely on qualitative explanations and natural language to communicate the model's results.¹⁹⁸ The role of economists as storytellers becomes especially prominent in the context of litigation.¹⁹⁹ In isolation, models are but "skeletal representations" whose substantive contributions are revealed only when they are accompanied by the modeler's story.²⁰⁰ The expert must explain his idealizations and omissions,²⁰¹ and aims to convince the audience that the model bears sufficient resemblance to relevant aspects of the real world.²⁰² If the expert is successful in his storytelling role the jury will accept the conclusions of his model, such as the causal link between the defendant's conduct and the plaintiff's injury, or a given damages estimate.²⁰³

Rhetoric and persuasion are particularly important when juries are confronted with dueling experts, as parties aim to dissuade the jury from accepting the opposing expert's model and conclusions.²⁰⁴ The jury may or may not agree with these attacks, so each expert must defend his modelling choices in order to maintain his story's credibility in the eyes of the factfinder.²⁰⁵

While expert testimony is a critical piece of evidence in many lawsuits, it is but one element embedded in a greater narrative that each party constructs.²⁰⁶ Econometric

¹⁹⁸ See *supra* text accompanying notes 78-79.

¹⁹⁹ See Todd, *supra* note 12, at 1018-20.

²⁰⁰ Mäki, *supra* note 36, at 330-31.

²⁰¹ *Id.*

²⁰² Gilboa et al., *supra* note 80, at F518.

²⁰³ See *supra* text accompanying notes 180-83.

²⁰⁴ See Hill et al., *supra* note 15, at 342 (referencing the "battle of experts"); see *id.* at 358-64 (describing courts' struggles with expert partisanship).

²⁰⁵ See Todd & Jewell, *supra* note 40, at 313 (writing that the plausibility of assumptions partly rests on the "persuasiveness of the [expert's] reasoning").

²⁰⁶ Hill et al., *supra* note 15, at 334.

models showing causation and damages are thus evaluated in relation to other evidence and lay witness testimony.²⁰⁷

C. The Ill-Defined Gatekeeper Role for Judges Ruling on Admissibility

Before a jury can assess the weight of expert testimony, the judge must first act as a “gatekeeper” and evaluate the evidence for admissibility.²⁰⁸ This division of responsibility aims to prevent scientifically invalid expert testimony from reaching the jury and skewing verdicts.²⁰⁹ Admissibility determinations thus require weighing the relative competency of the jury in evaluating complex scientific evidence.²¹⁰

In the case of model-based testimony, delineating the separate domains of judge and jury is both important and troublesome. If the admissibility threshold is too low, judges may admit “junk science” testimony that misleads or “bamboozles” the jury.²¹¹ Conversely, a high admissibility threshold may cause a court to “substitute its judgment for the jury” in deciding issues of credibility.²¹²

Furthermore, admissibility rulings are increasingly frequent and high-stakes decisions.²¹³ Given the vital role of economic models in showing causation, establishing injury, and estimating damages, the absence of such evidence can be outcome-determinative.²¹⁴ One possible outcome is the case never makes it to a jury. An excluded model may mean the plaintiff is unable to establish causation between alleged

²⁰⁷ Mnookin, *supra* note 14, at 1577; Vidmar & Diamond, *supra* note 188, at 1138.

²⁰⁸ Faigman et al, *supra* note 13, at 861.

²⁰⁹ *Id.* at 862.

²¹⁰ *Id.* at 884.

²¹¹ Lloyd, *supra* note 31, at 423.

²¹² Mnookin, *supra* note 14, at 1570.

²¹³ *Id.* at 1569.

²¹⁴ Blair & Herndon, *supra* note 17, at 802 (describing how a plaintiff’s case may “evaporate” without expert testimony that shows injury from anticompetitive behavior or provides damages estimates); Mnookin, *supra* note 14, at 1569 (noting that admissibility determinations are often case dispositive).

misconduct and personal or financial harm.²¹⁵ Without sufficient proof of causation, the judge may grant summary judgment to the defendant.²¹⁶ Even when a suit does make it to the jury, excluded expert testimony constitutes a significant missing “thread” in the party’s case.²¹⁷ Admissibility rulings allow a judge to control the “evidentiary landscape” that a jury may use in constructing a coherent narrative of what happened.²¹⁸ Even partial exclusion can mean that the relative weight between opposing expert testimony becomes lopsided, which can result in a party losing its case.²¹⁹

Admissibility versus weight is clearly a critical distinction, but the boundary between the two remains fuzzy for model-based testimony.²²⁰ An overview of the existing rules and precedents will illuminate how current standards are lacking.

1. Shortcomings of Current Evidence Law and Case Law on Admissibility

The first element a judge considers when evaluating evidence is relevance, that is, whether it “has any tendency to make a fact more or less probable than it would be without the evidence.”²²¹ If relevant, FRE 402 follows a principle of “general admissibility”²²² where evidence should only be excluded if it is “unfairly prejudicial, misleading, a waste of time, deceptive, redundant, or unreliable.”²²³ Expert testimony in

²¹⁵ Mnookin, *supra* note 14, at 1569.

²¹⁶ *Id.*

²¹⁷ Hill et al., *supra* note 15, at 334.

²¹⁸ Lopatka & Page, *supra* note 10, at 619 (explaining that “a jury’s evaluation of conflicting economic opinions rarely decides cases because federal judges’ choices limit the scope and force of expert testimony.”); Mnookin, *supra* note 14, at 1542.

²¹⁹ Todd, *supra* note 12, at 997.

²²⁰ Faigman et al., *supra* note 13, at 884.

²²¹ FED. R. EVID. 401.

²²² FED. R. EVID. 402.

²²³ Faigman et al., *supra* note 13, at 875.

particular has its own set of parameters in evidence law.²²⁴ FRE 702 states that expert testimony may be admitted if:

- (a) the expert’s scientific, technical, or other specialized knowledge will help the trier of fact to understand the evidence or to determine a fact in issue;
- (b) the testimony is based on sufficient facts or data;
- (c) the testimony is the product of reliable principles and methods; and
- (d) the expert has reliably applied the principles and methods to the facts of the case.²²⁵

This rule was amended in 2000 to incorporate a trilogy of Supreme Court cases that has culminated in the *Daubert* standard.²²⁶ *Daubert v. Merrell Dow Pharmaceuticals, Inc.* was the first of these cases, and involved a mother’s allegations that a prescription drug had caused her child to have birth defects.²²⁷ The plaintiff’s expert offered testimony that suggested causation, but the evidence was declined because it was based on methods that were not accepted by the general scientific community.²²⁸ The *Daubert* ruling thus established that expert testimony must adhere to the principles, methods, and procedures of the scientific method.²²⁹ The Court also issued a series of flexible and non-exhaustive “Daubert factors” that a judge may consider in evaluating expert testimony.²³⁰ Importantly, this ruling restricted the judge’s gatekeeping function to an expert’s principles and methodology, reserving the conclusions for the jury to evaluate.²³¹

²²⁴ See FED. R. EVID. 702–705.

²²⁵ FED. R. EVID. 702.

²²⁶ FED. R. EVID. 702 Committee Notes on Rules—2000 Amendment.

²²⁷ 509 U.S. 579 (1993).

²²⁸ *Id.* at 579.

²²⁹ *Id.* at 589-90.

²³⁰ *Id.* at 593-94 (listing these factors: 1. Whether the theory or technique in question can be and has been tested; 2. Whether it has been subjected to peer review and publication; 3. Its known or potential error rate; 4. The existence and maintenance of standards controlling its operation; 5. Whether it has attracted widespread acceptance within a relevant scientific community).

²³¹ *Id.* at 595.

The second case in the *Daubert* trilogy, *General Electric Co. v. Joiner*, involved allegations that chemical exposure at the workplace had accelerated the onset of the plaintiff's lung cancer.²³² While the reliance on animal studies was an accepted methodology, the Court still excluded the testimony because the studies were insufficient grounds for the expert's conclusion.²³³ The *Joiner* ruling consequently expanded the judge's range of discretion by allowing the perceived gap between methodology and conclusions to be a basis for exclusion.²³⁴

The final *Daubert* case reinforced and supplemented this finding. A judge declined to admit expert testimony in *Kumho Tire Co. v. Carmichael*, where an engineer inspected an allegedly defective tire and concluded that the defect had caused the tire to explode.²³⁵ While visual and tactile examination was an acceptable method, there was too great of an analytical gap between the method and the conclusion that the defect caused the blow out.²³⁶ *Kumho* thus reinforced that an expert's methods should not only be reliable in the abstract, but must also be reliable in context and application.²³⁷

While the purpose of the *Daubert* standard was to protect juries from scientifically invalid evidence, some legal commentators fear that it set the admissibility threshold too high.²³⁸ In evaluating the "reliability" of an expert's conclusions, courts may inadvertently encroach upon the jury's domain, which is to make credibility

²³² 522 U.S. 136 (1997).

²³³ *Id.* at 136.

²³⁴ *Id.* at 146 (holding that "conclusions and methodology are not entirely distinct from one another" and that a "court may conclude that there is simply too great an analytical gap between the data and the opinion proffered.").

²³⁵ 526 U.S. 137 (1999).

²³⁶ *Id.* at 139.

²³⁷ Faigman et al., *supra* note 13, at 872-73 (citing FED. R. EVID. 702(d)).

²³⁸ See Mnookin, *supra* note 14, at 1570; Todd, *supra* note 12, at 976, 1024-25.

judgments amid competing testimony.²³⁹ The *Daubert* standard has garnered several other critiques, most notable of which are vagueness²⁴⁰ and lack of consistency in application.²⁴¹

Furthermore, all three cases in the *Daubert* trilogy concerned expert testimony from the “hard” sciences. Consequently, the guidelines derived from these cases are couched in terminology regarding the scientific method and objective scientific validity.²⁴² But economic models are not a hard science,²⁴³ making these guidelines a poor fit for model-based testimony.²⁴⁴

The next section illuminates why model-based testimony should be treated differently from the “hard” sciences in litigation. This discussion will also inform why courts struggle to distinguish between issues of admissibility versus weight with regards to economics experts and their models.

2. Common Challenges to Economic Models in Litigation

The conversation surrounding econometric models suggests a highly rigorous and straightforward scientific inquiry.²⁴⁵ However, though the methods themselves (regression analysis, for example) are mathematically sophisticated, their construction is

²³⁹ Mnookin, *supra* note 14, at 1570-71.

²⁴⁰ Hersch & Bullock, *supra* note 26, at 2377.

²⁴¹ Andrew I. Gavil, *Defining Reliable Forensic Economics in the Post-Daubert/Kumho Tire Era: Case Studies from Antitrust*, 57 WASH. & LEE L. REV. 831, 874 (2000); Todd & Jewell, *supra* note 40, at 311 (observing that “some courts pay only lip service to Rule 702 and the *Daubert* trilogy and focus their analysis on pre-*Daubert* authority rejecting expert testimony that is too speculative”).

²⁴² See *Daubert v. Merrell Dow Pharm., Inc.*, 509 U.S. 579, 590 (1993) (“The adjective ‘scientific’ implies a grounding in the methods and procedures of science. Similarly, the word ‘knowledge’ connotes more than subjective belief or unsupported speculation. . . in order to qualify as ‘scientific knowledge,’ an inference or assertion must be derived by the scientific method.”).

²⁴³ Allensworth, *supra* note 9, at 829 (holding that “models are not scientific in the Popperian sense of being falsifiable; as inventions designed to perform a task, they are purposive rather than positive.”).

²⁴⁴ Todd, *supra* note 28, at 252 (explaining that “the relative clarity of the *Daubert* factors for the hard sciences become muddied when applied to the non-scientific choices of the modeler”).

²⁴⁵ Kaye & Freedman, *supra* note 82, at 272 (noting the general perception of statistical models as “marvel[s] of mathematical rigor”).

not an exact science.²⁴⁶ Models exhibit an “illusion of objectivity” that masks the integral role of the modeler’s subjective judgments,²⁴⁷ as pure theory and data alone cannot create a model.²⁴⁸ The combination of statistical techniques with human discretion thus makes modelling both a science and an art.²⁴⁹

Perhaps the first choice a modeler makes is the methodology he wishes to use to achieve a given purpose, such as asset valuation.²⁵⁰ Multiple regression analysis is particularly popular for showing causation due to the method’s power in isolating the effects of independent variables on a target variable.²⁵¹ However, established methodologies such as these do not guarantee admissibility²⁵² and there are alternative methodologies that can achieve the same purpose.²⁵³

Though they are not explicitly phrased as assumptions, model construction decisions regarding type of methodology, data, and variables are tacit assumptions.²⁵⁴ Choice of methodology implicitly assumes the appropriateness of that method for the task at hand,²⁵⁵ whereas choice of data assumes the similarity between a firm or market in a

²⁴⁶ Allensworth, *supra* note 9, at 841 (describing how “scientifically acceptable choices are neither unique . . . nor objective”).

²⁴⁷ Hill et al., *supra* note 15, at 334.

²⁴⁸ Morrison & Morgan, *supra* note 72, at 15.

²⁴⁹ Allensworth, *supra* note 9, at 829 (holding that the art of modeling exists where experts do not agree); Klock, *supra* note 22, at 198 (stating that “The art of good model-building lies in the ability to assume well”); Morrison & Morgan, *supra* note 72, at 31 (noting that good model-building, like an art or craft, involves “acquired skills in choosing parts and fitting them together”).

²⁵⁰ See Allensworth, *supra* note 9, at 841; Hill et al., *supra* note 15, at 338-39 (enumerating the various and “frequently subjective” choices involved in valuation methodologies).

²⁵¹ Hill et al., *supra* note 15, at 352.

²⁵² Lopatka & Page, *supra* note 10, at 690.

²⁵³ Allensworth, *supra* note 9, at 841 (noting how modeling goals can be achieved through more than one method).

²⁵⁴ See Todd & Jewell, *supra* note 40, at 302, 318.

²⁵⁵ Gavil, *supra* note 241, at 876 (emphasizing the need for “fit” between a methodology and the facts of a case); Todd, *supra* note 12, at 990 (stating that “the type of math to perform and the applicable valuation method are themselves artistic choices.”).

past study and those involved in the present case.²⁵⁶ These types of assumptions often only become apparent in their negation, that is, whenever opponents attack the modeler's choices in methodology, data, or variables. Judges' treatment of these challenges has historically been inconsistent: some courts have required that experts use a certain methodology (such as regression analysis)²⁵⁷ while other courts have held that choice of methodology is an issue of weight.²⁵⁸

Another implicit assumption is a modeler's choice in variables, which presumes the relevance of those included and the irrelevance of those excluded.²⁵⁹ Again, courts do not approach these challenges with consistency.²⁶⁰ In some cases, courts determined that omitted variable were issues of weight; in others, the omission of relevant variables caused the testimony to be excluded.²⁶¹

In addition to choosing appropriate methodology, data, and variables, modelers make a series of explicit simplifying assumptions.²⁶² In litigation, these assumptions often involve similarity judgments between products and markets, as well as constructing alternate pasts where the defendant's misconduct did not occur.²⁶³ Other types of

²⁵⁶ Todd & Jewell, *supra* note 40, at 298 (describing the underlying assumption in yardstick approaches to damages that “but for the anticompetitive behavior, plaintiff’s business would have performed like the comparator”); *id.* at 318 (noting a court’s rejection of growth projections based on tacit comparisons between TV markets).

²⁵⁷ Lopatka & Page, *supra* note 10, at 689.

²⁵⁸ Hill et al., *supra* note 15, at 313 (citing Popham v. Popham, 607 S.E.2d. 575, 576 (Ga. 2005)).

²⁵⁹ Mäki, *supra* note 82, at 248; Todd & Jewell, *supra* note 40, at 302 (describing how unfounded omissions involve a “tacit assumption [] that some important and relevant factor is unimportant and irrelevant.”).

²⁶⁰ Hill et al., *supra* note 15, at 353.

²⁶¹ *Id.* (citing the court’s holding in Bazemore v. Friday, 478 U.S. 385 (1986) that omitted variables go to weight, not admissibility); Lopatka & Page, *supra* note 10, at 691 n.479 (citing, *inter alia*, Blue Dane Simmental Corp. v. Am. Simmental Ass’n, 178 F.3d 1035, 1040–41 (8th Cir. 1999) (finding an expert’s before-and-after model too “simplistic” to be admissible because it failed to account for other independent variables)).

²⁶² See generally, Mäki, *supra* note 36, at 328-29 (describing idealizing assumptions).

²⁶³ Todd & Jewell, *supra* note 40, at 298.

simplifying assumptions are needed to distill patterns or abstract salient features from a “chaotic reality.”²⁶⁴ These assumptions typically involve tradeoffs between accuracy, simplicity, and usefulness.²⁶⁵ These simplifying assumptions are those described by the assumptions typology, where certain factors are idealized or omitted for a second-order purpose that may be negligibility, applicability, or tractability.²⁶⁶

Due to their subjective nature, simplifying assumptions are the elements most likely to be scrutinized in *Daubert* motions.²⁶⁷ Litigants often attack these simplifying assumptions as speculative or unrealistic, which prompts a highly ambiguous determination that appears to be guided primarily by “the predilections of the individual judge.”²⁶⁸

Many simplifying assumptions cannot be falsified,²⁶⁹ such as whether a product or market is similar enough to the ones in the underlying studies and data.²⁷⁰ Speculating on what a plaintiff’s position would have been but-for the defendant’s wrongful conduct is also an exercise in reasoning rather than a verifiable fact.²⁷¹ These types of assumptions regarding the plaintiff’s position in a counterfactual past also see mixed results from

²⁶⁴ Allensworth, *supra* note 9, at 862; Klock, *supra* note 22, at 196 (stating that “the goal is to abstract the salient features of reality without becoming mired in minutiae”).

²⁶⁵ Allensworth, *supra* note 9, at 832-833, 840; Klock, *supra* note 22, at 196 (noting that, like the construction of roadmaps, assumptions involve “aesthetically pleasing trade-off[s] between reality and abstraction”).

²⁶⁶ See *supra* Part II.B. (Musgrave-Mäki-Hindriks typology).

²⁶⁷ Hill et al., *supra* note 15, at 331-32 n.253 (claiming that these assumptions are the most understandable for non-expert counsel).

²⁶⁸ Lloyd, *supra* note 31, at 408.

²⁶⁹ Allensworth, *supra* note 9, at 840.

²⁷⁰ Todd & Jewell, *supra* note 40, at 298-300 (observing that unreasonable comparisons are a major category of assumptions that opponents frequently challenge).

²⁷¹ Blair & Page, *supra* note 183, at 435-36 (emphasizing that due to the “multitude of potential influences on business conditions, a plaintiff cannot prove what would have happened with the same degree of certainty that it can prove what did occur”); Hill et al., *supra* note 15, at 335 (citing *Gross v. Comm’r*, 272 F.3d 333, 356 (6th Cir. 2001)) (calling the damages estimation process a “fiction”).

courts.²⁷² Justifying these assumptions requires subjective judgments regarding “similarity,” “salience” and “credibility,” which, by their nature, cannot be expressed in mathematical or logical terms.²⁷³ The modeler should accordingly be able to articulate these justifications and defend his choice of assumptions.²⁷⁴

Aside from these simplifying assumptions, there are also statistical assumptions that are not subject to a modeler’s “idiosyncrasies.”²⁷⁵ Regression, for example, assumes a linear relationship between the variables, as well as normally distributed and random error terms.²⁷⁶ Todd and Jewell note the importance of this distinction between statistical assumptions and artistic assumptions made by the econometrician in the construction of his model.²⁷⁷ For example, they observe the often overlooked distinction between omitted variable bias as a statistical issue and the omission of relevant variables as a fundamental flaw in model construction.²⁷⁸ The former limits the precision of a model and may skew the coefficient estimates, but can often be resolved with other statistical procedures.²⁷⁹ A violation of a statistical assumption is therefore “not likely to be fatal on its own.”²⁸⁰ The latter, however, is an artistic choice.²⁸¹ An appropriately omitted variable may serve the

²⁷² Todd, *supra* note 28, at 236 (comparing the conflicting rulings about whether the “likelihood and extent” of business expansion (*Polymer Dynamics, Inc. v. Bayer Corp.* 2005 WL 1041197 (E.D.)) or consumer behavior (*Nebraska Plastics, Inc. v. Holland Colors America, Inc.*, 408 F.3d 410, 416 (8th Cir. 2008)) are issues for the judge or jury to decide.).

²⁷³ Sugden, *supra* note 61, at 4.

²⁷⁴ Todd, *supra* note 28, at 239-40.

²⁷⁵ Allensworth, *supra* note 9, at 839-40.

²⁷⁶ Sykes, *supra* note 178, at 5-6.

²⁷⁷ Todd & Jewell, *supra* note 40, at 290.

²⁷⁸ *Id.* at 290-93.

²⁷⁹ David L. Rubinfeld, *Reference Guide on Multiple Regression*, in FED. JUDICIAL CTR., REFERENCE MANUAL ON SCIENTIFIC EVIDENCE 303, 314, 322 (3d ed. 2011); Sykes, *supra* note 178, at 23-27.

²⁸⁰ Todd & Jewell, *supra* note 40, at 292.

²⁸¹ Rubinfeld, *supra* note 279, at 281 (describing how omitted variables involve “assumptions made going into the analysis, rather than conclusions that come out of the data.”).

purposes of isolation, since models cannot capture the vast complexity of the world.²⁸²

An inappropriate omission, however, can “easily invalidate any statistical results,” if a factor that the record suggests is relevant is excluded from the model.²⁸³

Todd and Jewell also note that while opponents purport to attack the purely scientific or statistical elements of a model, most arguments invoke the lack of foundation or reasoning an expert has for his modeling choices.²⁸⁴ Essentially, opponents attack the artistic rather than the scientific elements of a model.²⁸⁵ As a result, the application of the *Daubert* standard to these artistic choices is improper.²⁸⁶ The inconsistency arising from this improper application of standards is consequential, as the outcome of a case is frequently contingent on the admission or exclusion of expert testimony.²⁸⁷ Furthermore, large class actions and antitrust suits often involve eight- or nine-figure damages: estimates in *Dover v. British Airways* ranged between \$143 and \$161 million.²⁸⁸

3. Proposed Solutions in Legal Scholarship

Some legal commentators have attempted to illuminate this issue through various paradigms that center around the distinction between the judge’s domain of law, and the jury’s domain of facts. Allensworth states that models do not meet the criteria to be categorized as “facts,” and thus advocates that judges—ideally those with some basic

²⁸² Uskali Mäki, *MISSing the World. Models as Isolations and Credible Surrogate Systems*, 70 ERKENNTNIS 29, 30 (2009).

²⁸³ Todd & Jewell, *supra* note 40, at 292 (describing how poor choices in model construction cannot be fixed by statistical tools); *see id.* at 312 (stating that failure to include a clearly relevant variable can make the entire model irrelevant).

²⁸⁴ *Id.* at 316, 319; *see also* Hill et al., *supra* note 15, at 352-53 (observing that the inclusion or exclusion of variables in regression models is a frequent point of contention).

²⁸⁵ Todd & Jewell, *supra* note 40, at 293.

²⁸⁶ *See* Todd, *supra* note 28, at 252.

²⁸⁷ Mnookin, *supra* note 14, at 1569; Todd & Jewell, *supra* note 40, at 282-83.

²⁸⁸ 321 F.R.D. 49, 57 (E.D.N.Y. 2017).

quantitative training—are best equipped to deal with model-based testimony.²⁸⁹ Casey and Simon-Kerr stand on the opposite end of the spectrum, equating expert testimony with that of lay witnesses, the evaluation of which requires no more than “run-of-the-mill fact-finding.”²⁹⁰ Some legal scholars see model-based testimony as a mixed issue of law and fact. For example, Kaye distinguishes between “legislative” and “adjudicative” considerations.²⁹¹ The former involves facts that are external to the case such as the general acceptability of a certain methodology; these issues should be addressed by the judge.²⁹² “Adjudicative” considerations such as failure to account for outliers, by contrast, are internal to the case and can be resolved by the jury.²⁹³

Other legal scholars, however, reject this law-fact debate entirely. Allen and Pardo assert that the law-fact distinction has no epistemological or ontological grounding, and that in order to protect the domains of judge and jury, pragmatic conventions should take the place of abstract dichotomies.²⁹⁴ In order to be truly useful, these conventions should “import criteria and methods from the relevant scientific community” rather than pigeonhole disparate scientific disciplines into the existing legal framework.²⁹⁵

IV. A POTENTIAL SOLUTION BACKED BY ECONOMICS METHODOLOGY

Recognizing this need for practical conventions, Todd proposes a functional framework that is based in economics methodology.²⁹⁶ This approach is in line with evidence law, since comments to FRE 702 instruct judges to look to the standards of the

²⁸⁹ Allensworth, *supra* note 9, at 852.

²⁹⁰ Casey & Simon-Kerr, *supra* note 11, at 1182.

²⁹¹ Kaye, *supra* note 31, at 1975.

²⁹² *Id.* at 1983-85.

²⁹³ *Id.* at 2012-13.

²⁹⁴ Allen & Pardo, *supra* note 31, at 1806-7.

²⁹⁵ Allensworth, *supra* note 9, at 829.

²⁹⁶ Todd, *supra* note 28, at 239, 282-90.

field in evaluating expert testimony.²⁹⁷ The Musgrave-Mäki-Hindriks typology of assumptions describes how assumptions should be evaluated relative to their second-order purpose, since all models have false first-order assumptions.²⁹⁸ Mäki's types of realism illuminate how assumptions that are unrealistic in one sense (*e.g.*, false) can still be valid if they are realistic in another sense (*e.g.*, plausible).²⁹⁹

Todd synthesizes and adapts these typologies for use in the context of litigation.³⁰⁰ Perhaps most importantly, judges should evaluate assumptions according to their purpose and context, rather than in isolation.³⁰¹ The second-order assumption clarifies this purpose, which may be negligibility, tractability, or applicability.³⁰² It is crucial that modelers be specific about the second-order purpose of their assumptions,³⁰³ as well as be willing to defend these choices in the event they are challenged.³⁰⁴ Judges should focus their admissibility decisions on whether the second-order assumption is appropriately realistic, rather than exclude models with unrealistic first-order assumptions.³⁰⁵ If the second-order assumption is materially disconfirmed by the evidence, the judge can exclude the testimony or require the expert to fix the assumption.³⁰⁶ For example, the judge may exercise his gatekeeping function when an expert excludes a variable for negligibility purposes, but the record shows that the factor

²⁹⁷ *Daubert v. Merrell Dow Pharm., Inc.*, 509 U.S. 579, 593-94 (1993) (listing general acceptance by the relevant field as one factor judges may consider in their admissibility rulings); Todd, *supra* note 28, at 237 (citing FED. R. EVID. 702 Committee Notes on Rules—2000 Amendment).

²⁹⁸ Todd, *supra* note 28, at 282; *see supra* Part II.B.

²⁹⁹ Todd, *supra* note 28, at 284; *see supra* Part II.B.

³⁰⁰ Todd, *supra* note 28, at 282-91.

³⁰¹ *Id.* at 290.

³⁰² *Id.* at 282.

³⁰³ *Id.* at 287.

³⁰⁴ *Id.* at 282.

³⁰⁵ *Id.* at 292.

³⁰⁶ *Id.*

is actually non-negligible.³⁰⁷ Lack of evidence, as opposed to disconfirmation by evidence, is not necessarily fatal to an assumption's validity.³⁰⁸ After all, modelers must grapple with multiple "unknowns and unobservables" in constructing models that simplify a complex reality.³⁰⁹ Assumptions therefore may be justified for tractability purposes, in order to handle this lack of evidence or data.³¹⁰

If a modeler has no explanation for an assumption, the judge may exclude the testimony.³¹¹ In cases where the modeler can both articulate the purpose for his assumptions, and the stated purpose is not disconfirmed by evidence, the judge can admit the model to the jury.³¹² Jurors will then use their collective common sense and experience to assess realisticness as plausibility, as well as the coherence of the model with the rest of the evidence.³¹³

Todd's synthesis between the two typologies arms judges with the vocabulary to approach a model's assumptions with a degree of clarity that has historically been lacking.³¹⁴ The mechanics of the framework also help sketch a reasonable boundary between admissibility and weight with a threshold that does not tend to either extreme.³¹⁵ The requirement that second-order assumptions be meaningfully connected to reality prevents indiscriminate acceptance of invalid models.³¹⁶ Otherwise, judges need not

³⁰⁷ *Id.* at 286-87 (citing *in re Live Concert Antitrust Litig.*, 863 F. Supp. 2d 966, 971-81) (an expert did not account for the effects that the advent of downloadable music might have on concert ticket prices. If the exclusion of this variable was a negligibility assumption, it would be invalid because evidence showed that downloadable music significantly affected ticket prices).

³⁰⁸ Todd, *supra* note 28, at 257 (arguing that scenarios projecting a counterfactual past (and thus lacking explicit evidentiary support) are issues of plausibility that the jury can evaluate).

³⁰⁹ *Id.* at 287.

³¹⁰ *Id.* at 297.

³¹¹ *Id.* at 282.

³¹² *Id.*

³¹³ *Id.* at 284.

³¹⁴ *Id.* at 292.

³¹⁵ *Id.* at 284.

³¹⁶ *Id.*

exclude model-based testimony where the only realisticness issue is the question of plausibility, which can be decided by a jury.³¹⁷

Although the framework theoretically provides clarity to admissibility rulings, it is unclear whether the framework holds in practice. Todd samples contentious assumptions from several different cases but does not go into depth on any one case.³¹⁸ *Dover v. British Airways* presents an appropriate opportunity to test the framework's utility on an entire case. First, the case involves dueling experts, a dynamic that has not previously been explored by Todd in his application of the framework. The presence of two experts who reached opposite conclusions regarding the correlation between fuel prices and YQ charges places increased pressure on the judge to confront alternate choices of methodology.³¹⁹ A “battle of the experts” also raises unique questions about the interaction between objective scientific requirements on which experts agree versus artistic choices that may be up for debate.³²⁰ Moreover, Judge Dearie's Expert Ruling provides ample detail about the individual challenges to each expert's testimony;³²¹ this detail yields a more in-depth analysis than would otherwise be permitted. Finally, a high-profile defendant—and the concomitant massive damages estimates—helps illustrate the relevance and importance of these admissibility determinations. Judge Dearie's Expert Ruling details the challenges to expert testimony and explains the rationale behind his admissibility decisions; this document provides the basis for this analysis.

A. *Dover v. British Airways*: Background

³¹⁷ *Id.* at 292.

³¹⁸ Todd, *supra* note 28, at 282-91.

³¹⁹ See *infra* Part IV.B., C.

³²⁰ See *infra* Part V.

³²¹ *Dover v. British Airways*, 254 F. Supp. 3d 455 (E.D.N.Y. 2017).

British Airways had a frequent flyer program called the Executive Club, in which members could accumulate points (“Avios”) by flying with British Airways, renting cars, and staying in certain hotels.³²² These points could then be redeemed for reward flights with British Airways.³²³ The Executive Club contract explicitly granted the airline the right to impose fuel surcharges; in exercising this right, the airline’s fuel surcharge committee used its cost of fuel in 2003-2004 as the baseline for these charges (internally referred to as “YQ charges”). Frequent flyer members alleged that this baseline was arbitrary and yielded YQ charges that were not “substantively or temporally relevant to the actual cost or price of fuel.”³²⁴ As a result, frequent fliers claimed that British Airways breached the Executive Club contract, and moved for class certification of all members who paid the YQ charges for Avios-redeemed flights between November 9, 2006 and April 17, 2013.³²⁵ Among this class were four representative plaintiffs: Russell Dover, Suzette Perry, Cody Rank, and Henry Horsey.³²⁶ Each party enlisted testimony from economics experts to testify regarding the correlation between YQ charges and the cost of fuel.³²⁷ Plaintiff’s expert Jonathan Arnold was an economist from the Chicago Economics Corporation, and Andrew Hildreth was an econometrician retained by the defendant, British Airways.³²⁸ Plaintiffs also provided testimony from Robert Kokonis, an expert in the airline industry who provided relevant input to the challenges against Arnold’s damages models.³²⁹

³²² Dover. v. British Airways, 321 F.R.D. 49, 52 (E.D.N.Y. 2017).

³²³ *Id.*

³²⁴ *Id.* at 52-53.

³²⁵ *Id.* at 53.

³²⁶ *Id.*

³²⁷ Dover v. British Airways, 254 F. Supp. 3d 455, 458 (E.D.N.Y. 2017).

³²⁸ *Id.* at 460, 463.

³²⁹ *Id.* at 459, 462.

B. Plaintiff's Expert Testimony

Plaintiff's expert Jonathan Arnold asserted in his reports that the level of YQ charges bore "no close relationship" with the price of fuel over time.³³⁰ British Airways attacked this opinion as unreliable because it was not based on a regression "or some other peer-review or published studies."³³¹ Instead, his methodology involved a quarter-by-quarter comparison of YQ charges and fuel prices, as well as a comparison of the relative growth of the two figures across time.³³² Judge Dearie accepted Arnold's methodology as "reasonable and sufficiently reliable," and references three cases in succession as self-evident support for this decision:

Zeraga Ave. Realty Corp. v. Hornbeck Offshore Transp., LLC, 571 F.3d 206, 213–14 (2d Cir. 2009) ("[A] trial judge should exclude expert testimony if it is speculative or conjectural or based on assumptions that are 'so unrealistic and contradictory as to suggest bad faith' or to be in essence 'an apples and oranges comparison.'" (quoting Boucher v. U.S. Suzuki Motor Corp., 73 F.3d 18, 21 (2d Cir. 1996)). Any arguable weakness in this methodology, or the possibility that relevant factors were omitted, goes to weight, not admissibility. See id. at 214 ("[C]ontentions that the assumptions [of an expert witness] are unfounded go to the weight, not the admissibility, of the testimony." (alteration omitted) (quoting Boucher, 73 F.3d at 21)).³³³

The inherent contradiction of current admissibility precedent becomes clear here. Judges may pull in quotes ad hoc to support whichever conclusion they decide, since support for either outcome can be found in previous rulings. Referencing *Boucher*, Judge Dearie notes that any arguable weakness and any contention that assumptions are unfounded are issues of weight, not admissibility.³³⁴ Such statements seem to advocate for a threshold

³³⁰ *Id.* at 460.

³³¹ *Id.* at 461.

³³² *Id.*

³³³ *Id.*

³³⁴ *Boucher v. U.S. Suzuki Motor Corp.*, 73 F.3d 18, 21 (2d Cir. 1996).

that is so small as to be effectively non-existent. On the other hand, *Zeraga* describes a situation in which a judge may exercise his gatekeeping function, which involves instances where testimony is “speculative or conjectural.”³³⁵

Ambiguity is also pervasive: it is unclear at what point “unfounded” assumptions become too “unrealistic” to be admissible. Furthermore, essentially synonymous terms are used to justify opposite conclusions: assumptions that are “unfounded” are issues of weight, but those that are “conjectural” raise admissibility concerns. A critical look at Judge Dearie’s rationale thus demonstrates just how nebulous the basis for admissibility rulings can be.

While the framework does not explicitly provide guidelines on challenges to choice of methodology, the methodological literature would likely support admission of the testimony. So long as Arnold can justify the appropriateness of his method, Arnold’s testimony should be admitted so that his story may reach its intended audience, the jury.³³⁶

British Airways raised similar challenges in regards to Arnold’s damages model. Party experts agreed that, assuming breach of contract, “the amount of damages to the class would equal the difference between the amount class members paid in YQ charges and the amount they would have paid had British Airways adopted an alternative, commercially reasonable course of conduct in compliance with the Contract.”³³⁷

Arnold proposed two alternatives for how British Airways could have behaved in this fictional past: either the airline could have adjusted its fuel surcharge on a quarterly basis

³³⁵ *Zeraga Ave. Realty Corp. v. Hornbeck Offshore Transp., LLC*, 571 F.3d 206, 213–14 (2d Cir. 2009).

³³⁶ See Todd, *supra* note 28, at 1039-40 (concluding that if an economist’s story adequately explains their artistic choices, the “gatekeeper should [] step aside so that the factfinder can hear the story.”).

³³⁷ *Dover v. British Airways*, 254 F. Supp. 3d 455, 462 (E.D.N.Y. 2017) (italics added).

or it could have operated without a fuel surcharge at all.³³⁸ British Airways criticized the models as presenting an “unrealistic ex post view” with assumptions that are “speculative.”³³⁹ Judge Dearie offered a brief response to these challenges, referencing the same quote as before:

This objection alone is not grounds for excluding his testimony. See Zeraga, 571 F.3d at 214 (explaining that exclusion is warranted “where an expert’s opinion is speculative or conjectural or based on assumptions that are ‘so unrealistic and contradictory as to suggest bad faith’ ” (quoting Boucher, 73 F.3d at 21))³⁴⁰

Both the defendant and the court see an overly unrealistic assumption as grounds for exclusion. However, the judge’s dismissal of the airline’s challenges indicates that the two disagree regarding what is unrealistic, if it is binary, or, if it is a continuum, when an assumption passes the threshold into being too unrealistic. An exploration of Mäki’s different types of realisticness may illuminate this issue.

If by “unrealistic ex post view” defendants mean unrealistic in the sense of implausible, then the testimony should be admitted because the jury can make credibility judgements based on their common sense and collective experiences.³⁴¹

British Airways also argues that these proposals are inadmissible because they lack foundation . . . Kokonis, however offers a basis for Arnold’s view . . . (stating, based on his experience in the airline industry, that “it is not commercially unreasonable to manage fuel costs without a YQ charge.”)³⁴²

One may presume the defendants mean lacking evidentiary foundation, and thus view realisticness in the sense of empirical confirmation.³⁴³ A lack of evidence, however,

³³⁸ *Id.*

³³⁹ *Id.*

³⁴⁰ *Id.*

³⁴¹ See *supra* text accompanying notes 187-91, 312-17 (issues of plausibility can and should be weighed by the jury).

³⁴² *Dover*, 254 F. Supp. 3d at 462 (citing Kokonis’ May report).

³⁴³ See *supra* text accompanying notes 156-63 (describing Mäki’s types of realisticness).

is not equivalent to disconfirmation by evidence.³⁴⁴ Because it is not disconfirmed, one may not say that Arnold's assumption is unrealistic in this sense.³⁴⁵ To the contrary, evidence does exist to corroborate the statement in the form of Kokonis' expert testimony.³⁴⁶

Absent this supporting testimony, the lack of evidence would still be unproblematic because it is the very reason why the assumptions were imposed in the first place.³⁴⁷ In this case, Arnold's assumptions were imposed for the purposes of empirical tractability. One can infer this second-order purpose because the data needed to calculate damages are unobservable;³⁴⁸ they exist only in a counterfactual past where British Airways complied with the contract.³⁴⁹ To make the analysis tractable, therefore, Arnold must incorporate a hypothetical but-for condition in order to have a basis for comparison with the plaintiff's current position.³⁵⁰ He accomplishes this through the idealization (quarterly adjustment) and omission of YQ charges.³⁵¹ Thus, the formulation becomes:

First-order assumption: Commercially reasonable alternatives include British Airways adjusting its fuel surcharges on a quarterly basis, or operating without fuel surcharges entirely.

Second-order assumption: These assumptions were imposed for empirical tractability purposes because the data needed to calculate damages are unobservable.

³⁴⁴ See *supra* text accompanying notes 308-10.

³⁴⁵ *Id.*

³⁴⁶ Dover, 254 F. Supp. 3d at 462.

³⁴⁷ See *supra* text accompanying notes 308-10 (modelers frequently need to incorporate factors for which they lack evidence).

³⁴⁸ See *supra* text accompanying notes 132-36 (listing the data conditions that may justify empirical tractability assumptions).

³⁴⁹ Blair & Page, *supra* note 183, at 435-36 (describing how plaintiffs must "construct and support a scenario of events in the but-for world.").

³⁵⁰ See *supra* notes 182-83, 271 (experts necessarily craft hypothetical scenarios in damages estimations).

³⁵¹ Dover v. British Airways, 254 F. Supp. 3d 455, 462 (E.D.N.Y. 2017).

The framework dictates that judges evaluate assumptions relative to their second-order purpose, rather than assess their realism at face-value.³⁵² The proper question for Judge Dearie to consider, therefore, is not whether the proposed alternatives are commercially reasonable, but whether the model was actually intractable without these first-order assumptions.³⁵³ The answer is relatively clear in this case because, by definition, damages estimates hypothesize about what the plaintiff's position would have been but-for the defendant's wrongful conduct.³⁵⁴

Since there is no evidence that controverts the second-order tractability assumption, Arnold's model is admissible.³⁵⁵ The jury can then assess realisticness as plausibility of the first-order assumptions, that is, decide whether quarterly adjustment or operating without fuel surcharges are reasonable alternatives given the expert's need for tractability.³⁵⁶ This decision will be informed by their experiences as business-owners and consumers, as well as their common sense and knowledge of how the world works.³⁵⁷

Judge Dearie ultimately made the proper decision in admitting the damages model, but his rationale conflated admissibility with weight. By citing Kokonis' testimony as support for Arnold's assumptions, Judge Dearie muddles the basis for the model's admissibility: the model is acceptable not because evidence supports the assumption, but because the question of the reasonability of a first-order assumption is for the jury to answer, not the judge.³⁵⁸ Supporting evidence in the form of Kokonis'

³⁵² See *supra* text accompanying notes 301-8 (the judge should limit his analysis to whether the second-order assumption is disconfirmed by evidence).

³⁵³ *Id.*

³⁵⁴ See *supra* text accompanying notes 182-83, 271.

³⁵⁵ See *supra* text accompanying notes 312-13.

³⁵⁶ *Id.*

³⁵⁷ See *supra* text accompanying notes 189-91, 197.

³⁵⁸ See *supra* text accompanying notes 301-10 (judges should focus their analyses on the realisticness of second-order assumptions, not first-order assumptions).

testimony may strengthen the plausibility of the model in the juror's eyes, but evidentiary support for first-order assumptions is not a precondition to admissibility.³⁵⁹

Fortunately, the recognition of this distinction becomes clearer as Judge Dearie continues. Judge Dearie cites the *Daubert* case in recognizing that the “presentation of contrary evidence” in conjunction with “vigorous cross-examination” are generally sufficient means for the jury to evaluate models critically.³⁶⁰ British Airways will likely raise the same arguments to the jury during cross-examination and Arnold will be forced to defend his choice of assumptions.³⁶¹

C. Defendant's Expert Testimony

Defendant British Airways enlisted the testimony of econometrician Andrew Hildreth. The expert proffered several regression analyses that supposedly showed a “high degree of correlation (over 70 percent)” between the airline's YQ charges and the price of fuel over time.³⁶² The results of his model would suggest that British Airways had in fact complied with the contract, since their surcharges were reasonably related to fuel prices. However, plaintiffs challenged the reliability of Hildreth's testimony, alleging that his failure to account for the non-stationarity of the underlying data rendered the model's results “spurious.”³⁶³ Non-stationarity is a property of some time-series data, in which statistical parameters such as mean and variance change over time.³⁶⁴

“Colloquially, non-stationary data is said to exhibit a ‘random walk,’ such that knowing

³⁵⁹ See *supra* text accompanying notes 132-36, 308-10 (one purpose of tractability assumptions is to account for variables that lack data).

³⁶⁰ *Dover v. British Airways*, 254 F. Supp. 3d 455, 462 (E.D.N.Y. 2017) (citing *Daubert*, 509 U.S. at 596, 113 S.Ct. 2786).

³⁶¹ See *supra* text accompanying notes 204-5.

³⁶² *Dover*, 254 F. Supp. 3d at 462.

³⁶³ *Id.* at 463.

³⁶⁴ *Id.* (citing reports from both Arnold and Hildreth).

its value today tells us little or nothing about its value tomorrow.”³⁶⁵ Experts from both sides agreed that performing regression analysis on non-stationary data can yield spurious results, such as showing false correlation between unrelated variables.³⁶⁶

In response to these critiques, Hildreth claimed that non-stationary data may still be valid for use in a regression if the data are cointegrated.³⁶⁷ Cointegration refers to two variables in a time-series (YQ charges and fuel prices, for example) that exhibit a long-run equilibrium.³⁶⁸ Hildreth claimed to have tested the data for cointegration using the Engle-Granger method.³⁶⁹ However, plaintiffs presented evidence of the contrary: Engle himself rejected the expert’s finding that the variables were cointegrated, even stating that Hildreth used another method entirely.³⁷⁰ As a result, Engle concurred with Arnold that the results of Hildreth’s regression are “statistically meaningless.”³⁷¹

While these challenges concern alleged statistical errors rather than competing notions of realisticness, the framework may still be useful for analysis. The element of Hildreth’s model under scrutiny may be phrased as an applicability assumption:

First order assumption: Regression analysis is a valid method for demonstrating the correlation between fuel prices and YQ charges.
Second order assumption: If the data are cointegrated, then regression analysis of non-stationary data (such as fuel prices and YQ charges) yields valid results.

According to the framework’s specifications, Judge Dearie was proper in evaluating the realism of the second-order assumption rather than that of the first-order

³⁶⁵ *Id.* at 464.

³⁶⁶ *Id.* at 463-64.

³⁶⁷ *Id.* at 464.

³⁶⁸ *Id.*

³⁶⁹ *Id.*

³⁷⁰ *Id.* at 464-65.

³⁷¹ *Id.*

assumption.³⁷² He did not call into question whether the choice of method (regression analysis) was acceptable in a general sense, but instead considered how evidence controverted the *applicability* of that method. Plaintiffs demonstrated that the domain condition was not satisfied, i.e., the data were not cointegrated. Thus, the second-order assumption is disconfirmed by evidence, which is grounds for exclusion because the use of regression analysis outside its applicable domain renders the model invalid.³⁷³

Judge Dearie declined to make an admissibility decision based solely on the parties' submissions and called for an evidentiary hearing to better evaluate the validity of Hildreth's testimony.³⁷⁴ However, the defense withdrew the expert before an evidentiary hearing could be held.³⁷⁵ The case subsequently moved to settlement, with class members collectively receiving up to \$63 million in compensatory damages.³⁷⁶ This result reinforces how the exclusion of expert testimony is outcome determinative: without a model that shows correlation between fuel prices and YQ charges, British Airways lacked a critical thread in their narrative of valid fuel surcharges.³⁷⁷ This, in conjunction with the admission of plaintiff expert testimony, would have led to a loss at trial, which potentially explains why the airline opted for a settlement.³⁷⁸

V. FRAMEWORK ASSESSMENT AND DISCUSSION

The theoretical framework certainly provides greater analytical depth to the evaluation of plaintiff expert Arnold's testimony. By approaching the assumptions of

³⁷² See *supra* text accompanying notes 301-6.

³⁷³ See *supra* text accompanying notes 306-11.

³⁷⁴ *Dover v. British Airways*, 254 F. Supp. 3d 455, 465 (E.D.N.Y. 2017) (citing *Daubert v. Merrell Dow Pharm., Inc.*, 509 U.S. 579 (1993) and *Kumho Tire Co. v. Carmichael*, 526 U.S. 137 (1999)).

³⁷⁵ *Dover v. British Airways*, 2017 WL 4358726, at *2 (E.D.N.Y. Sept. 29, 2017).

³⁷⁶ *Dover v. British Airways*, 323 F.Supp.3d 338, 346 (E.D.N.Y. 2018).

³⁷⁷ See text accompanying notes 14-20.

³⁷⁸ *Id.* (describing how exclusion of one party's expert can increase the relative weight of the opponent's testimony).

quarterly adjustment and zero YQ charges at face-value, Judge Dearie risked making a credibility determination that usurped the jury's role. The framework prevents this outcome by distinguishing between first- and second-order assumptions, as well as describing the various ways these assumptions may be realistic or unrealistic. An understanding of how these two typologies intersect would have allowed Judge Dearie to navigate his admissibility decision with consistency and clarity. Rather than evaluate whether the first-order assumption is realistic as plausible, Judge Dearie could have limited his analysis to whether the second-order purpose was unrealistic as disconfirmed by evidence.

Furthermore, the application of Mäki's typology of realisticness clarifies the previously hazy conceptions of what is "realistic" versus "unrealistic." If defendants had been required to articulate exactly what kind of realisticness Arnold failed to meet, the judge could have made a less ambiguous determination. If British Airways had attacked the assumptions about YQ charges as unrealistic in the sense of implausible, these challenges would clearly be issues for the jury, whose job is to discern credibility. Unrealistic in the sense of confirmation and disconfirmation is a stronger claim, but lack of evidentiary support for a first-order assumption is still not grounds for exclusion because all models involve unrealistic first-order assumptions to simplify the real-world.³⁷⁹ The presentation of contrary evidence regarding the second-order tractability assumption, however, may warrant exclusion.³⁸⁰ If the contract had stipulated a precise method British Airways must use to set fuel surcharges—perhaps automatically

³⁷⁹ See Klock, *supra* note 22, at 196.

³⁸⁰ Hindriks, *supra* note 98, at 410 (describing how the first-order assumptions are often false or unrealistic, but second-order assumptions must be realistic).

calculated and directly related to the cost of fuel—the data concerning plaintiffs’ but-for position might be observable and the empirical tractability assumption would no longer be valid.³⁸¹ Plaintiff’s expert Arnold could have looked at past fuel prices and applied the method mentioned in the contract to calculate what plaintiffs should have paid but-for the breach of contract. The availability of data in this hypothetical scenario would have invalidated the empirical tractability assumptions, since the damages model would actually be tractable without them. In reality, the contract did not specify how fuel surcharges were to be calculated, so Arnold had to impose tractability assumptions regarding how British Airways should have acted in the counterfactual past.

Application to defendant’s expert Hildreth was not as straightforward, but highlights an important distinction. Judge Dearie’s decision to hold an evidentiary hearing for Hildreth’s regression was due to a perceived fundamental difference between the challenges to each expert’s testimony. “Unlike the parties’ arguments respecting the other experts, the possibility that Hildreth’s analysis may be spurious and statistically meaningless goes to the heart of the Supreme Court’s concerns in *Daubert* and *Kumho Tire*.”³⁸² This comment indicates Judge Dearie’s subtle awareness that economic modeling is both science and art.³⁸³ The recognition that Arnold’s simplifying assumptions were subjective and artistic choices was fairly unambiguous. Recall that constructing a “but-for” world is an exercise in reasoning rather than a factual

³⁸¹ See *supra* text accompanying notes 132-36; see also Todd, *supra* note 28, at 297 (citing *Neb. Plastics, Inc. v. Holland Colors Americas, Inc.*, 408 F.3d 410, 416, 416 n.2 (8th Cir. 2005)) (describing a case where an expert imposed an assumption under the guise of tractability, namely that all siding panels would fade and thus be subject to warranty claims. However, historical data for this factor existed that the expert could have used, thus disconfirming the tractability assumption).

³⁸² *Dover v. British Airways*, 254 F. Supp. 3d 455, 465 (E.D.N.Y. 2017).

³⁸³ See *supra* Part III.C.

investigation.³⁸⁴ The science of statistics does not prescribe how Arnold may simplify reality or project a counterfactual past.³⁸⁵ Further, the use of natural language makes the jury capable of assessing the plausibility of the expert’s propositions.³⁸⁶ Aided by their collective common sense and experience, jurors can decide whether Arnold’s model depicts a world that *could be* real.³⁸⁷ The expert, of course, will have to convince his audience of the similarity between his model and reality and persuade them to make the “inductive leap” required to accept his conclusions.³⁸⁸ Though Judge Dearie did not articulate this distinction in these terms, his ultimate decision suggests an understanding that the plausibility of artistic assumptions are issues of weight for the jury.³⁸⁹

By contrast, challenges to Hildreth’s testimony prompted a separate kind of inquiry. Judge Dearie reasoned that the technical nature of these challenges—as opposed to challenges based on logic and reasoning—warranted a more in-depth treatment.³⁹⁰ The question becomes whether this assessment was correct, and consequently, to what extent the theoretical framework can apply.

Recall Todd & Jewell’s distinction between omitted variable bias as a statistical issue versus omitted variables as flaws in model construction.³⁹¹ The former involves a violation of a linear regression assumption that the error term is random.³⁹² This is

³⁸⁴ See *supra* text accompanying notes 269-73.

³⁸⁵ See *supra* text accompanying notes 245-49, 269-74.

³⁸⁶ See *supra* text accompanying notes 196-203 (experts use stories to communicate a model and its assumptions to a lay audience).

³⁸⁷ See *supra* Part III.B.; see also Sugden, *supra* note 59, at 25, 28 (describing models as credible counterfactual worlds that could conceivably be true, given a general understanding of how the world works).

³⁸⁸ See *supra* text accompanying notes 77-81.

³⁸⁹ See *supra* Part IV.A.

³⁹⁰ *Dover v. British Airways*, 254 F. Supp. 3d 455, 465 (E.D.N.Y. 2017) (noting how evidentiary hearings are “highly desirable” and “commonly held in cases like this one that involve expert testimony on complex scientific or economic topics.”).

³⁹¹ Todd & Jewell, *supra* note 40, at 290-93.

³⁹² Sykes, *supra* note 178, at 23-24.

because the influence of an independent variable on a dependent variable becomes reflected in the error term, making these errors systematic rather than random.³⁹³ Similarly, omitted variable bias results in overestimated coefficient estimates.³⁹⁴ Though these problems are “scientific” in nature, they do not necessarily ruin a model’s utility, and may only decrease the model’s goodness of fit.³⁹⁵ The latter conception of omitted variables, by contrast, constitutes an artistic choice that may be a “fatal flaw[] in the model’s construction.”³⁹⁶ Omitting a variable that the record suggests is relevant can make the entire model irrelevant for its purpose.³⁹⁷

It is not immediately clear under which conception Hildreth’s testimony should be placed. One on hand, plaintiff’s challenges may concern purely statistical issues, akin to the former conception of omitted variable bias that often can be fixed and may only weaken precision. Alternatively, Hildreth may have made poor choices in model construction that rendered the entire model invalid.

Plaintiff’s challenges to the expert’s model concerned his choice of methodology in relation to the type of data he used. Those challenges hinged on whether the data exhibited certain properties (stationarity at first, then cointegration) that would allow a regression analysis to yield valid results.³⁹⁸ The technical complexity of these challenges may suggest that Hildreth’s model exhibits statistical and thus purely “scientific” flaws, those which *Daubert* aims to prevent and which are distinct from the framework’s

³⁹³ Sykes, *supra* note 178, at 24-27; *see also* Todd & Jewell, *supra* note 40, at 291.

³⁹⁴ Sykes, *supra* note 178, at 25-27.

³⁹⁵ *Id.*; Todd & Jewell, *supra* note 40, at 290-92.

³⁹⁶ Todd & Jewell, *supra* note 40, at 291.

³⁹⁷ *Id.* at 312.

³⁹⁸ *See supra* Part IV.C.

intended use.³⁹⁹ Since the alleged flaws concerned certain data properties, Hildreth’s assumptions perhaps should be treated more like statistical assumptions, which often concern data properties such as linearity and normally distributed error terms.⁴⁰⁰ Sometimes, the violation of these statistical assumptions may be fairly innocuous. After all, “owing to the nature of economic relationships and the lack of controlled experimentation, these (statistical) assumptions are seldom met.”⁴⁰¹ One can still accept the general conclusions of the model to help answer, although with less confidence than if all statistical assumptions had been met.⁴⁰² Thus, the model may still be useful in helping the trier of fact answer a certain question.

In Hildreth’s case, however, the alleged error was material to the purposes for which the model was designed. Regression analysis applied to non-stationary and non-cointegrated data may yield “spurious” results such as false correlation.⁴⁰³ When the purpose of the model is to establish correlation between fuel surcharges and the price of jet fuel, and false correlation is a potential consequence of the statistical error, the model fails at achieving its purpose. In this case, the judge would be proper in exercising his gatekeeping function, either by requiring that Hildreth fix the issue or excluding his testimony altogether.

Alternatively, Hildreth’s errors may be construed as poor artistic choices to which the framework can be applied. Recall that model construction decisions regarding type of

³⁹⁹ See Todd, *supra* note 28, at 249-52 (noting how statistical assumptions can be tested empirically for validity but artistic assumptions cannot, thus creating confusion among courts).

⁴⁰⁰ Allensworth, *supra* note 9, at 844.

⁴⁰¹ PETER KENNEDY, *A Guide to Econometrics* 25, 1 (6th ed. 2008).

⁴⁰² Rubinfeld, *supra* note 279, at 322.

⁴⁰³ Clive Granger & Peter Newbold, *Spurious Regressions in Econometrics*, 2 J. ECONOMETRICS 111, 112-14 (1974) (explaining the phenomenon of “spurious” regressions in time series data, that is, regressions that show a false correlation between unrelated variables).

methodology, data, and variables are tacit assumptions.⁴⁰⁴ This alternative framing would more clearly fit within the assumptions typology.

Hildreth's use of regression analysis involved an implicit assumption regarding the appropriateness of that method for showing correlation between fuel surcharges and the cost of jet fuel. The second-order assumption restricted the application of that method to instances where the nonstationary data are cointegrated. Plaintiffs alleged that his combination of regression and non-stationary data could yield spurious results that were "meaningless as a matter of statistics."⁴⁰⁵ Lacking the technical knowledge to make a decision based on the parties' submissions alone, Judge Dearie called for an evidentiary hearing. This decision stemmed from a fear about the jury's incapacity to parse the statistical merits of Hildreth's model.⁴⁰⁶

Had the theoretical framework been applied, the evidentiary hearing may not have been necessary. If Hildreth had been unable to defend his choice of methodology, this lack of a "story" would be grounds for exclusion.⁴⁰⁷ While experts have discretion in the construction of their models, their choices must be grounded by a second-order purpose that connects their model to reality in a meaningful way.⁴⁰⁸ Hildreth initially justified his choices through an applicability assumption that would have made regression analysis a valid method.⁴⁰⁹ The presentation of evidence showing that Hildreth violated the domain

⁴⁰⁴ See *supra* text accompanying notes 254-61.

⁴⁰⁵ *Dover v. British Airways*, 254 F.Supp.3d 455, 463 (E.D.N.Y. 2017).

⁴⁰⁶ *Id.* at 465 (considering whether Hildreth's testimony is the very kind of "unsound science" that should trigger the judge's gatekeeping role).

⁴⁰⁷ Todd, *supra* note 28, at 285-86 (stating that an economist's story necessarily involves explanations for their assumptions, therefore "courts need only admit expert testimony if the modeler has a story for the jury.").

⁴⁰⁸ *Id.* at 270; see *supra* Part II.B.

⁴⁰⁹ See *supra* Part IV.C.

of applicability means that the second-order assumption is unrealistic in the sense of disconfirmation, making his model invalid and excludable.⁴¹⁰

Therefore, without having to know whether regression analysis can actually yield valid results with non-stationary and non-cointegrated data, the judge could have looked to how Hildreth's applicability assumption was supported or contradicted by the record and made his decision on this basis. Approaching Hildreth's issues as poor choices in model construction—as opposed to strictly scientific flaws—permits an evaluation of expert testimony that does not require perfect knowledge of statistical requirements and conventions. This type of approach comprises the most frequent basis for exclusion of expert testimony.⁴¹¹ Rather than attack purely statistical problems, opponents and courts have instead seized upon the lack of justification or support for the expert's artistic choices.⁴¹²

The framework thus aligns with how courts have historically approached challenges to expert testimony. Though Todd and Jewell only make claim to a positive rather than normative analysis,⁴¹³ it is a strength of the framework that it would not fundamentally change how courts address contentious issues. After all, the goal is to give judges (a “lay audience” with regards to econometric principles) a set of guidelines that do not require them to be experts in statistics themselves. Though the framework's appropriateness for Hildreth's testimony is initially ambiguous, a closer look reveals that it can help resolve challenges that straddle the scientific and artistic aspects of model-

⁴¹⁰ See *supra* Part IV.C.

⁴¹¹ Todd & Jewell, *supra* note 40, at 318 (noting that “though courts cite to problems arising from the violation of regression assumptions like omitted variable bias, those courts excluded expert testimony not because of statistical problems but because of poor choices in model construction.”).

⁴¹² Todd & Jewell, *supra* note 40, at 314-15.

⁴¹³ *Id.* at 319.

building. Therefore, the framework affords judges the vocabulary needed to address a variety of complex issues from a standpoint that is familiar to litigation: justification for assumptions (specifying second-order purpose), argumentation in defending these choices (both implicit and explicit), and an eye to how the record supports or controverts these arguments.⁴¹⁴

VI. CONCLUDING THOUGHTS

While the framework has wide applicability, it could benefit from additional guidelines that help courts distinguish between attacks to statistical issues versus attacks to choices in model construction. An awareness of the dual-identity of models as both art and science would be the first step to making this distinction. Increased specificity from opponents regarding the precise objects of their attack (*e.g.*, omitted variable bias vs. omission of relevant variables) could also prevent future conflation of the two types of issues. Finally, understanding that models involve many tacit assumptions—such as choice of methodology, data, and variables—can expand the framework’s applicability to more general issues. Application to Arnold’s damages models confirmed the framework’s utility for evaluating internal and explicit assumptions whose realisticness is at issue. Hildreth’s case demonstrated that the framework is also useful when applied to choices that are external to a model’s construction, such as type of methodology and variables. Once these tacit assumptions are phrased explicitly as a pair of first- and second-order assumptions, the judge may evaluate the second-order assumption in light of the available evidence. Therefore, the theoretical framework—in conjunction with a

⁴¹⁴ *See id.* at 283.

firm grasp on modeling as a science and art—can provide more precision and consistency to how courts currently approach admissibility rulings on economic models.

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