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CONJUNCTION AND AGGREGATION

*Saul Levmore**

INTRODUCTION

This Article begins with the puzzle of why the law avoids the issue of conjunctive probability. Mathematically inclined observers might, for example, employ the "product rule," multiplying the probabilities associated with several events or requirements in order to assess a combined likelihood, but judges and lawyers seem otherwise inclined. Courts and statutes might be explicit about the manner in which multiple requirements should be combined, but they are not. Thus, it is often unclear whether a factfinder should assess if condition A was more likely than not to be present — and then go on to see whether condition B satisfied this standard — or whether the factfinder's task is to ascertain if *both* A and B can together, or at once, satisfy the standard. A mathematically inclined judge or jury that thought a tort defendant .6 likely to have been negligent and .7 likely to have caused plaintiff's harm might conclude that plaintiff had failed to satisfy the preponderance of the evidence standard because the chance of *both* requirements being met is surely less than either alone and, indeed, less than .5. Yet, the law often instructs the jury to find the defendant liable, or is strangely ambiguous in its instructions. Legal practice seems at odds with scientific logic, or at least with probabilistic reasoning. I will refer to this puzzle as the "math-law divide." Although this divide is encountered frequently in law, its puzzling character is unfamiliar to most lawyers and (even) legal scholars, and it is missed entirely by most litigants and judges.

This Article seeks to explain or rationalize law's suppression of the product rule, or indeed any explicit alternative strategy for dealing with the conjunction issue. Part I discusses in greater detail the nature of the math-law divide and a number of traditional reactions to the puzzle. The Article then advances the idea that the process of aggregating multiple jurors' assessments hides valuable information. First, Part II.B. posits that the Condorcet Jury Theorem indicates that

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agreement among multiple jurors might raise our level of confidence in a particular determination beyond what the jurors themselves individually report. Second, Part II.C. urges that a supermajority's mean or median voter is likely to have a different assessment from that gained from the marginal juror. As such, a supermajority (or unanimity) rule may take the place of the product rule where there are multiple requirements for liability or guilt. An attempt to extract this inframarginal information more directly would likely generate strategic behavior problems in juries. Part III extends this analysis to panels of judges, for whom "outcome voting" may (somewhat similarly) substitute for the product rule.

I. THE CONJUNCTION PROBLEM

A. *Law's Suppression of the Conjunction Problem and the Product Rule*

Consider the straightforward problem of combining two judgments concerning two or more elements of a legal claim. If, for example, the law holds *A* liable to *B* when *A* is negligent and when this negligence has (proximately) caused *B*'s injury, a factfinder must evaluate the likelihood of *A*'s negligence and the likelihood of the causal link between this negligent behavior and *B*'s injury. An illustrative jury instruction is as follows:

> In order to prove the essential elements of plaintiff's claim, the burden is on the plaintiff to establish, by a preponderance of the evidence in the case, the following facts: *First*, that the defendant was negligent in one or more of the particulars alleged; and *Second*, that the defendant's negligence was a proximate cause of some injury and consequent damage sustained by the plaintiff.[1]

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1. EDWARD J. DEVITT ET AL., 3 FEDERAL JURY PRACTICE AND INSTRUCTIONS, CIVIL § 80.17 (4th ed. 1987). Nearly identical language is used in actual cases. *See, e.g.*, Folks v. Kirby Forest Ind. Inc., 10 F.3d 1173, 1176 n.4 (5th Cir. 1994) (noting language used by district court below while reversing and remanding on other grounds). There is some variety across states, as the elements of a tort claim might be described as two or three or even one in number. Thus, in Alabama:

> The plaintiff claims the defendant was negligent and that his negligence proximately caused certain injuries suffered by the plaintiff.... This presents for your determination the following. Was the defendant negligent as claimed by the plaintiff? If so, was such negligence of the defendant the proximate cause of any injury sustained by the plaintiff as claimed? If you find both of the above issues in favor of the plaintiff and against the defendant what sum of money will fairly and reasonably compensate him for the injury so sustained?

ALABAMA PATTERN JURY INSTRUCTIONS – CIVIL 21.01 (1974). But in Colorado:

> For the plaintiff to recover from the defendant on his claim of negligence, you must find that all of the following have been proved by a preponderance of the evidence: 1. The plaintiff had injuries; 2. The defendant was negligent; and 3. The defendant's negligence was a cause of the plaintiff's injuries. If you find that any one or more of these [three] statements has not been proved, then your verdict must be for the defendant. On the other hand, if you find

Quite generally, juries are told that the "essential question is whether the evidence taken as a whole, both direct and circumstantial, establishes every element of the plaintiffs' case by a preponderance of the evidence."[2]

Imagine now that the factfinder concludes that there is a .7 chance of negligence and a .6 chance of causation.[3] Doctrinally, the law seems to require that *A* pay if and only if *A* is negligent *and* causes *B*'s harm. The question is whether this "and" is conjunctive. Most people who are experienced in probabilistic thinking hurry to say that *A* should be liable if *A* is both negligent and the causal agent, and that this combined probability is (.7)(.6) = .42. The product of the two probabilities, or likelihood of these two events, is thus less than the .5 hurdle estab-

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that all of these [three] statements have been proved, then your verdict must be for the plaintiff.

COLORADO JURY INSTRUCTIONS – CIVIL 9.1 (4th ed.). Oregon expresses the ideas of negligence and causation almost as if these were a single element: "To recover, the plaintiff must prove by a preponderance of the evidence that the defendant was negligent in at least one respect charged in plaintiff's complaint which was a cause of damage to the plaintiff." OREGON JURY INSTRUCTIONS FOR CIVIL CASES 10.01 (1984).

Some states are more ambiguous in their treatment of the conjunction issue. For example, Florida's standard jury instructions read:

> The issues for your determination on the claim of (claimant) against (defendant) are: whether (defendant) was negligent in (describe negligence); and, if so, whether such negligence was a legal cause of injury sustained by claimant. If the greater weight of the evidence does not support the claim of (claimant), then your verdict should be for (defendant).

FLORIDA STANDARD JURY INSTRUCTIONS IN CIVIL CASES 3.5, at 1c – 2, 3.6, 3.7 (1967). Although this instruction is somewhat ambiguous on whether the weight of the evidence must support the entire claim or individual issues, Florida and other states with similar jury instructions seem to suppress the product rule as well.

Instructions might also be given regarding the meaning of the preponderance standard, of negligence, and so forth. Even where judges are inclined to roll everything they wish to communicate into one (ambiguous) sentence, the jury may return with questions as to how to combine its findings. As will become clear, there are many ways to try and avoid the conjunction problem, but I prefer in this Article to show that the apparent illogic of the law may actually be clever in light of aggregation problems. Other commentators have of course noted and argued about the law's ambiguity and the correct approach to multiple requirements. *See, e.g.*, Ronald J. Allen, *A Reconceptualization of Civil Trials*, 66 B.U. L. REV. 401, 405-08 (1986) (arguing that the conventional but misguided view of trials is what makes the conventional view of probability as applied to law seem erratic and irrational); Dale A. Nance, *A Comment on the Supposed Paradoxes of a Mathematical Interpretation of the Logic of Trials*, 66 B.U. L. REV. 947 (1986) (noting math-law divide and emphasizing ambiguity of jury instructions). As a descriptive matter, there is some dispute as to what courts actually do, and as a normative matter there is no agreement on what they ought to do. I weigh in with my own descriptive and normative views, but the more important point here is to show the possibility of a connection between conjunction and aggregation, and in turn the possibility of seeing prevailing practices, both as to conjunction (or not) and as to supermajority votes, in a new and fairly optimistic light.

2. LEWIS A. GROSSMAN & ROBERT G. VAUGHN, A DOCUMENTARY COMPANION TO *A CIVIL ACTION* 626 (1999) (quoting jury instruction regarding circumstantial proof).

3. There are several ways to interpret these numbers. Our factfinder might reason that if he or she observed evidence of this sort ten times, it would be the case that the defendant was negligent seven times and not negligent three times.

lished by the preponderance of the evidence ("POE") standard normally applied to civil claims.[4]

In contrast, most lawyers who have thought about this subject regard the (representative) jury instructions as calling for holding the defendant liable in this case because plaintiff apparently satisfies the first requirement (inasmuch as .7 exceeds the .5 trigger established by the POE standard), and also satisfies the second requirement (again, inasmuch as .6 exceeds the .5 benchmark). At the risk of oversimplification, the problem is that the mathematics of the matter instructs us to multiply the two probabilities, following what is known as the "product rule" (for combining independent probabilistic assessments).[5] Law, however, appears not to abide by this rule. Hence the math-law divide.

B. *Reactions to the Math-Law Divide*

There are a number of conventional reactions to the math-law divide, including simple denial. In asking whether it is more likely than not that two coin tosses will yield two heads more than one in three times, everyone would agree that the problem solver should multiply .5 times .5 to see that the answer is no, for two heads are expected but one in four times. But when the questions are whether *A* was more likely than not to have been driving negligently and whether such driving caused *B*'s neck injury (where there is some chance that *B* has no real injury or a preexisting condition), reasonable people are comfortable with the idea that if each answer is that it is .6 likely we should stop there and find *A* responsible. We are, perhaps, not looking for the conjoined probability that both things are true at the same time. The question is why intuitions about conjunction vary.

1. *Independence*

One reaction to the law's disinclination to use the product rule focuses on the likelihood that issues like negligence and causation are not likely to be perfectly independent of one another. The product rule applies only where the events or requirements in question are independent. That interdependence changes the way we ought to com-

4. The "product" or multiplication rule applies whenever two events are independent. Thus, there is a .25 chance of seeing two heads in a row when a fair coin is tossed, because for each coin the probability of a head is .5 and (.5)(.5) = .25. Independence, prior probabilities, and other nuances are taken up presently.

5. The product rule is but one strategy for dealing with the conjunction issue, but in order to avoid repetition I will use the terms in a way that approaches interchangeability. Law avoids the conjunction issue; a reasonable and nearly universal approach (outside of law) to this issue is to deploy the product rule; law therefore can be said to suppress the product rule.

bine probabilities is obvious; the chance of flipping three heads in a row with a fair coin is (.5)(.5)(.5) = .125; it is expected to occur once in eight times. But if I know that the coin is weighted so that it will always come out the same, I need only flip it once to see whether it is weighted one way or the other. Now the tosses are completely interdependent and the probability of three consecutive heads (or tails) is .5.

If factfinders are given multiple requirements for liability, and these requirements are highly interdependent, then a blanket instruction to apply the product rule would seriously underdeter defendants and undercompensate plaintiffs compared to the ideal set out by law. To take an extreme case, if a factfinder assesses the likelihood of defendant's negligence in a case by defendant's demeanor as a witness, then it is quite likely that a comparable assessment of causation amounts to drawing the same conclusion twice in a way that makes the estimates highly interdependent. Somewhat similarly, if *B* claims that pharmaceutical company *A*'s nondisclosure caused *B*'s allergic reaction, then it may well be that causation and negligence are virtually the same question. If *A*'s drug has the side-effect that *B* asserts, then the factfinder might well conclude that *A* was negligent not to have warned of it, and the same inquiry is likely to drive the causation assessment. If events are completely interdependent and the factfinder thinks that each is still .6 likely, then .6 rather than .36 is our best assessment of the likelihood that *A* satisfies the two requirements for liability. Where multiple requirements are entirely interrelated, application of the product rule *is unnecessary*. Moreover, there are cases — but only some — in which a greater likelihood of one requirement (such as negligence) does imply a greater likelihood of the other (such as causation) if only because it becomes less likely that the plaintiff would have suffered the injury if defendant had avoided its failure as to the first requirement.[6]

The concern for independence is most convincing if factfinders are incapable of following instructions regarding interdependent and independent events. It may be that where elements are independent, factfinders allow their view of one element to influence their assessment of another.[7] But even so, if there is so much interdependence between two requirements for a decision that we are better off not multiplying a factfinder's estimates, then it often follows that there is little need to have the second requirement in the first place. If the connection between two requirements is nearly perfect, so that whenever

6. In the torts setting the idea is that absent defendant's misstep, the chance that plaintiff would have been injured is very low. "[T]he more serious the breach of duty and the less the amount of unavoidable accident, the less proof that should be required of the plaintiff on the cause in fact issue." MARK F. GRADY, CASES AND MATERIALS ON TORTS 567 (1994).

7. For evidence to this effect, see *infra* Section I.B.5 and accompanying notes.

there is negligence there is also causation, for instance, then the law need only ask whether it is more likely than not that there has been negligence. Generally speaking, if it is worthwhile to ask multiple questions, then logic or math suggests that we do better applying the product rule — though we need to be careful about independence and conditional probabilities.[8] But such generalizations may be beside the point because we can instruct the factfinder(s) not only about multiple requirements and the product rule, but also about the necessary modifications if the same factfinder deems the requirements to be somewhat interdependent.

2. *Misuse of Probabilities*

A second reaction to the math-law divide is that factfinders, (especially lay juries) and attorneys are likely to misuse probabilities.[9] This point is sometimes made in association with the previous argument that multiple requirements are often interdependent.

The misuse point is often associated with a famous case in criminal law in which the prosecutor at trial emphasized certain facts (modified here for expository purposes) and encouraged the jury to make conclusions based on the product rule. The prosecutor stressed that the defendants' appearances matched eyewitness reports of a perpetrator's hair color (blond), hair style (pony tail), companion's race (black), automobile color (yellow), and so forth.[10] If each characteristic were a one in ten possibility, and the defendant presents a match for four such features, the prosecutor or expert witness is tempted to say that there is but a (.1)(.1)(.1)(.1), or only a one in ten-thousand chance that the defendant is not the perpetrator.

But this application of the product rule is normally absurd. In the first place, it suffers from an ex post flaw, amounting to a serious sort of selection bias. The one-in-ten-thousand claim might be appropriate where a witness had described these four traits, and then a perpetrator was arrested somewhere else, perhaps after committing a similar crime, and the question was whether the arrested person might also be responsible for the first crime. But where the police pick up a suspect

8. Thus, if a jury thinks that defendant was negligent, it is sensible for it to ask whether *given defendant's negligence* and given plaintiff's injury, it is more likely than not that defendant's negligence caused plaintiff's injury. This sort of argument is developed in A.P. Dawid, *The Difficulty About Conjunction*, 36 THE STATISTICIAN 91 (1987).

9. *See, e.g.*, Laurence H. Tribe, *Trial by Mathematics: Precision and Ritual in the Legal Process*, 84 HARV. L. REV. 1329 *passim* (1971).

10. *See* People v. Collins, 438 P.2d 33, 36 (Cal. 1968) (concluding that defendant should not have had his guilt determined "by the odds," where prosecutor misapplied the product rule in remarkable fashion). The case is discussed in Maya Bar-Hillel, *Probabilistic Analysis in Legal Factfinding*, 56 ACTA PSYCHOLOGICA 267, 268-70 (1984), and Tribe, *supra* note 9, at 1341-42 & n.40.

because this suspect matches the characteristics reported by a witness, the product rule tells us very little. The police have searched the population for someone who presents the four traits, and it now adds no extra information to find out that these traits are fairly unlikely to be present in any one randomly drawn person. It might be useful to know how likely it was that an individual (not randomly) selected by the police had no alibi for a given time, or how large the local population was (so that the police could not look across hundred of millions of people to find the one-in-ten-thousand combination), but without this sort of information multiplying probabilities leads only to misconceptions. The product rule is also misapplied to the extent blond hair is more likely than other colored hair to be in pony tails, or blond-haired persons are more likely to drive yellow cars. If these links are not random, then the events are not independent (though likely to multiply out to a large denominator anyway).

I set aside this reaction to the puzzle of the math-law divide because it is unlikely that some actual or potential misuse of the product rule explains why it is avoided entirely in every setting. The preferred reaction to misapplication of a tool is normally to educate lawyers and even jurors in order to reduce this misuse. Moreover, in the criminal context we hesitate to convict when there is fear of bias or misused evidence, but it is hard to see why this tilt toward individual liberty would lead law to prefer that *A* pay *B* in a civil case, even though it was more likely than not that *A* was not *both* negligent and the cause of *B*'s injury. Finally, the product rule can be used and abused in favor of both prosecutors and criminal defendants, as it can help civil plaintiffs and (in other cases) civil defendants. Given that a prosecutor might need to establish several elements of a crime in order to prevail, it will sometimes be the prosecution that prefers to suppress the product rule. Perhaps the best conclusion to draw is that the suppression of the product rule in criminal law might be understood to follow from the possibility of misuse of probabilistic evidence and reasoning along with a disinclination to intervene and do more harm than good. But if some role is played by the fear that the product rule will be misused in favor of convictions in criminal law, then we might expect a bias in civil law *against* recovery — which would normally mean an inclination in favor of the product rule, inasmuch as it reduces fractional numbers through multiplication.[11]

11. Of course, the product rule could often be used in favor of plaintiffs, but courts and litigants have not recognized the necessary arguments. Imagine, for example, a plaintiff in a products liability suit who should win if she can show that defendant's product was defectively designed (D), defectively manufactured (M), or sold with an inadequate warning (W). Here, the multiple requirements are not to be conjoined because they are alternative routes to success. If plaintiff can show only that each claim is but .4 likely to be true, the lawyer expects plaintiff to lose — but the product rule suggests that plaintiff should win. There is, after all, a .6 chance that defendant did *not* produce a defective design, D, and similarly a .6 chance of not-M. If D and M are independent, then there is a .36 chance that defendant was

3. *Objections to Numbers and Probabilities*

A closely related reaction is that the puzzle is nothing new but rather another example of law's disinclination to ask factfinders specific questions, especially regarding numbers. We feel comfortable asking whether something meets the preponderance of the evidence standard, or whether proof in a criminal trial is strong enough to eliminate reasonable doubt, but even these standards are rarely reduced to probabilities or to numerical guidelines. Wherever possible, law avoids mathematical tasks.

A problem with this last generalization is the slipperiness of the "wherever possible" concept. We regularly ask juries or judges to engage in difficult damage assessments, and this produces something of a puzzle as to why we do not ask these factfinders for precise probabilistic estimates.[12] I suggest below that, at least in the case of multimember juries or panels, we might lose more than we would gain by asking for numerical assessments because of the danger of strategic behavior. In contrast, we might have little to lose by asking for precision where damages are concerned.

Still, it is fair to wonder how we might instruct juries or judges to follow the product rule if we wished to do so. Indeed, what does it mean to ask any factfinder for a probabilistic assessment of a requirement such as causation or negligence? A leading possibility is to express the problem or task in terms of frequencies[13] — although this can

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well-behaved with respect to both design and manufacture. The possibility of W, a third route for plaintiff, further reduces the likelihood (to .216) that defendant should be absolved; with three such routes, it is quite likely that we err by requiring plaintiff to satisfy the preponderance standard for at least one alternative on its own. In this example, conjunction issues arise where there are not multiple requirements but alternative routes for a decision; the plaintiff's alternatives amount to the presence of multiple requirements (and conjunction) for defendant to succeed.

Unfortunately, the court that has come closest to recognizing this issue of reverse conjunction failed to grasp the full power of the pro-plaintiff argument. *See* Cheshire Med. Ctr. v. W.R. Grace & Co., 49 F.3d 26, 31-32 (1st Cir. 1995) (acknowledging the product rule issue but, by focusing on plaintiff's burden rather than the conjoined likelihood of defendant's avoiding all alternative claims, missing the applicability of the product rule). I will return to this "reverse conjunction" problem below. It presents no special difficulty for the theory advanced here.

12. We ask factfinders to overcome their math anxieties with respect to things other than damages. Thus, some jurisdictions impose market share liability where there are "recurring cases," and some give recovery for "lost chances." *See* Saul Levmore, *Probabilistic Recoveries, Restitution, and Recurring Wrongs*, 19 J. LEGAL STUD. 691 (1990).

13. Following the framing strategy advanced by Gerd Gigerenzer, *The Psychology of Good Judgment: Frequency Formats and Simple Algorithms*, 16 MED. DECISION MAKING 273 (1996) (discussing the use and accuracy of "fast and frugal algorithms" that help people perceive statistical or probabilistic relationships). *See also* Gerd Gigerenzer & Ulrich Hoffrage, *How to Improve Bayesian Reasoning Without Instruction: Frequency Formats*, 102 PSYCHOL. REV. 684 (1995).

be quite difficult to do for most tort cases.[14] Another approach is to translate probabilistic questions into descriptions of wagers or, perhaps more accurately, wager-like tests for risk-neutral persons. If a judge, juror, or legislator were to ask for an explanation of the POE rule with respect, say, to causation, it would be fair to say that the question is whether *A* "caused" *B*'s injury, and that if the evidence leads the decisionmaker to believe that she would be indifferent as to which side of a wager to take — where the winner of the wager is the person who correctly predicts how a large panel of voters would regard the evidence as to causation and would "vote" for or against causation — then this decisionmaker should say that there is a .5 chance of causation. The large panel is appealing because of a theorem, discussed presently, which describes conditions under which the larger the group the more correct it is likely to be. Similarly, an assessment of .8 should reflect the fact that the decisionmaker would give 4-1 odds that a majority of the hypothetical large group would vote that *A* caused *B*'s injury. The wager metaphor could no doubt be a real self-assessment tool, but the point is that the metaphor explains the notion of uncertain and probabilistic assessment.

One weakness of the wager approach is that it requires some baseline or idealized conception of the perfect decisionmaker. We cannot ask a juror or judge to imagine betting on the truth. After all, various legal rules will have excluded some relevant evidence. A problem with appealing to faith or reason in a large group of voters, who have heard the same evidence and instructions observed and admitted at trial,[15] is that our decisionmaker may comprehend flaws in this approach. A large group might exhibit herd behavior or polarization, for example. There is surely something awkward about asking a judge (or even a jury) to try and imitate a mob.

4. *Evaluating Competing Stories*

A fourth reaction shifts the ground of the inquiry a bit and insists that the fundamental task of a trial (at least in adversarial systems) is to pose two competing stories in order for a factfinder to say which story is more likely to be true.[16] *B* tells a story about his injury, and *A* then responds with a claim that *A* could not have been negligent be-

14. We do not want to ask the jury to imagine 100 cases in which there are injuries of the sort experienced here, followed by the question of how often defendant was negligent (and then how often in this subset defendant caused the injury) because this encourages hindsight bias of a sort.

15. This is an important condition because without it jurors will feel encouraged to expand the number of voters on their own through consultation and the like. We might encourage jurors to see themselves as representatives of a large group, but one that is constrained to work with certain information.

16. *See* Allen, *supra* note 1.

cause *A* took a set of precautions, and so forth. Indeed, it is sometimes said that every successful tort claim has the plaintiff describe an untaken precaution that the defendant should have taken.[17] Presumably, the defendant then disputes the claim or, at least, the causal connection between the untaken precaution and the injury at issue. In any event, the more we imagine the factfinder to be comparing two stories, the less it matters whether the factfinder multiplies probabilities.

There is much to be said for this reaction, though perhaps more in some areas of law than others. Empirical evidence about factfinding is necessary to evaluate the claim. Imagine, for example, that plaintiff's "story," *X*, involves two elements, assessed as being .7 and .6 likely to have occurred or to have been satisfied. If defendant tells a story that is .3 likely, this approach suggests that we move our attention away from the fact that the plaintiff's story is .42 likely, so to speak, and look instead at the fact that .42 is greater than .3. So far so good. But what if the defendant says that what happened was not *X*, as the plaintiff claims, but rather *either* Y *or* Z. Is defendant (or plaintiff) really required to choose one possible story? The combined likelihood of either *Y* or *Z* might be more than .42. In short, I have little doubt but that successful litigants weave stories and artfully compare their stories with those produced by adversaries, but this way of thinking resolves the puzzle of the math-law divide only if we somehow think that law insists that each side simplify its argument in this way. And, again, even if we compare the best story on one side with the best mustered on the other (so that arguments in the alternative are deeply discounted), the product rule might be helpful as it operates within a single story. A mathematician might choose a different winner than most uninstructed lay (or legally trained) factfinders, if these factfinders are told only that plaintiff's side overcomes its burden of proof if and only if it shows that each of two requirements is more likely than not to have been met in its winning story.[18]

17. *See* Mark F. Grady, *Untaken Precautions*, 18 J. LEGAL STUD. 139 (1989).

18. Thus, when told a story about "Bill" (an "intelligent, but unimaginative" thirty-four-year-old), subjects in a psychology experiment regularly assessed the likelihood that Bill was an accountant *who also played jazz* as greater than the likelihood that Bill was an accountant or jazz hobbyist. It appears that the compound story of Bill as an accountant who plays jazz for a hobby is more appealing, if that is the right word, than the story of Bill as a mere accountant *or* jazz hobbyist, even though, as a mathematical proposition, the likelihood of the conjunctive event (accountant and jazz hobbyist) is, of course, less likely than the single event (accountant).

In these studies, subjects were not asked to generate numerical assessments but rather to rank the likelihood of various stories or characteristics (including both compound and single ones), so that we do not know whether the conjoining error they made involved underestimates of the likelihood of the single characteristic or overestimates of the compound characteristics. It is difficult, therefore, to take from these studies any easy conclusions about law. It is possible that factfinders seriously overestimate conjoined events, because the entire story is somehow more appealing, and that law does nothing to offset this either because lawmakers suffer from the same psychological bias or because lawmakers think there is no point in fighting human nature. But it is also possible that factfinders generate reasonable

Rational actors aside, the "competing stories" approach is easily linked to the interesting psychology literature which suggests that, quite apart from any problem with numbers or math, people have difficulty thinking logically about conjunctive probabilities.

5. *A Results-Orientated Approach*

Yet another reaction begins with the intuition that not all applications of the product rule are alike. If the factfinder assesses the likelihood of defendant's negligence as .8, and the likelihood of this negligence as having caused plaintiff's injury as .6, some observers (and perhaps jurors and judges) will be comfortable with a decision in favor of liability because of the intuition that making negligent parties pay "too much" is harmless or even healthy. I should rush to add that other observers, and for all we know other factfinders, are likely to focus elsewhere, tilting toward liability, perhaps, when there is a high likelihood of causation even though the negligence requirement is not quite met, or the product rule leaves us below the POE point. This latter view is consistent with a preference for strict liability, and with a bit of imagination it is encouraged by a preference for partial or probabilistic recoveries as well.

One problem with this sort of explanation is that it is quite specific while the suppression of the product rule is nearly universal, except perhaps in criminal law.[19] In other words, the product rule sometimes favors plaintiffs and sometimes favors defendants, but its suppression is not tailored accordingly and is not limited to such areas as the zone between negligence and strict liability.[20]

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assessments of multiple events and simply underestimate single events that are not embedded in complete and appealing stories. *See* Amos Tversky & Daniel Kahneman, *Judgments of and by Representativeness*, *in* JUDGMENT UNDER UNCERTAINTY: HEURISTICS AND BIASES 91-96 (Daniel Kahneman et al. eds., 1982).

19. In criminal law, the defense is given some latitude. It is conventional for the defense to remind the jury of all the small doubts that have been raised and to imply that they combine to leave more than a reasonable doubt. Unfortunately, the law (once again) suppresses the nature of this combinatorial process. It is not surprising that in criminal law we are especially disinclined to attach real numbers to standards. The product rule suggests that the jury engage in some multiplication; lay (statistically unsophisticated) intuitions suggest addition; a third, reasonable view might require that at least one of these doubts on its own needs to be substantial enough to meet the reasonable doubt standard. After all, if reasonable doubt means that one has a reason for the doubt, then perhaps a check on this reason is that it not be trivial. On the other hand, it can be uniquely held. A jury can acquit even when each juror points to a different reasonable doubt, but there are other elements that jurors might need to agree upon. *See* Richardson v. United States, 526 U.S. 813 (1999) (holding that, in a continuing criminal enterprise case under 21 U.S.C. § 848, jurors are required to agree unanimously not only that accused committed continuing series of violations, but also as to which specific violations made up the continuing series). I do not pursue these puzzling rules here.

20. For the claim that suppression can (somehow) offset the lack of a partial liability rule, see Alex Stein, *Of Two Wrongs That Make a Right: Two Paradoxes of the Evidence Law and Their Combined Economic Justification*, 79 TEX. L. REV. ____ (forthcoming 2001).

II. AGGREGATION AND THE PRODUCT RULE IN JURIES

A. *Introduction*

In American law, at least, the sort of factfinding referred to here is frequently carried out by juries, often consisting of twelve members and nearly always instructed to return unanimous or supermajority verdicts.[21] Such factfinding requires the aggregation and assessment of (like but not identical) views. The arguments offered below show that group factfinding is likely to produce probabilistic assessments that underestimate the numbers, or likelihoods, that the product rule would have us multiply. I do not suggest that lawmakers consciously suppress the product rule in order to compensate for these underassessments; indeed, there is little reason to think that the great majority of lawmakers have given any thought whatever to the product rule. But there is an interesting connection between our practices with respect to aggregation and conjunction — if only because one leads to overestimates while the other leads to underestimates — and this connection might serve as a kind of explanation, rationalization, or vehicle for understanding the suppression of the product rule in law. A more ambitious conjecture, explored in Part II.C below, is that the supermajority norm (which as we will see plays an important role in generating underassessments) is a reaction to the frequency with which juries deal with cases involving multiple requirements for liability — where the product rule is most apt.

In Part III, I turn to cases where juries are not deployed. There is the obvious question of what we should expect when factfinding is in the hands of a single judge, so that there are no aggregation issues. There is also the question of how the law treats the product rule when panels of judges (as opposed to lay jurors) are involved.

B. *The Product Rule and the Condorcet Jury Theorem*

The Condorcet Jury Theorem tells us that where each voter has more than an even chance of being right on some matter, then the more voters we have the closer we get to a probability of 1.0 of getting the matter right by abiding by a majority vote. A group, or jury, does better than an individual (where the assumption rules out the case where the individual is an identifiable expert).[22] An obvious implica-

21. As far as I can tell, no state encourages simple majority verdicts. *See infra* note 33.

22. Condorcet's 1785 work is discussed in DENNIS C. MUELLER, CONSTITUTIONAL DEMOCRACY 158-59 (1996). The theorem assumes that there is a "right" answer to the question at hand, that each voter is equally likely to know the right answer, or at least that each is more likely than not to discern the correct answer, and that we have no way of identifying those who are most likely to be right or even likely to benefit from deliberation. On some issues an expert will obviously do better than a large well-meaning group of voters, although adding in enough additional voters, each of whom is more likely to be right than wrong, will

tion is that a jury system that employed a jury of fifty would do much better than one that deployed a jury of six — and dramatically so if (as is common) there is a supermajority rule in place and the larger group is able to satisfy that rule.[23]

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eventually improve the stew. It is where a non-expert is more likely to be wrong than right, or where a non-expert does no better than guess, that we most need experts.

Thus, if only to date this Article, the audience in the television program "Who Wants to be a Millionaire" offers a remarkably reliable "lifeline" for contestants. When this audience agrees on an answer it is rarely wrong. In the program, there is a "right" answer, there is no way of discerning experts except that the contestant knows his own doubts and non-expertise, there is no incentive for the jurors to vote strategically, and the nature of the questions and audience suggests that indeed each member is more likely than not to be right.

23. Many readers will wish to know how quickly groups converge on the Condorcet Jury Theorem's result. How much better are fifty than twelve, or nine judges rather than one, and so forth? The question is harder mathematically than it first appears. If we ask how quickly (as the number of voters grows) a majority of a group is very likely to be correct when each individual voter is but barely likely to be correct, the answer is not quickly at all. Thus, fifteen voters raise the likelihood of correctness from .51 (for each voter) to .5309; jumping ahead to judges (for whom the Jury Theorem may sometimes or arguably be applicable), there may not be much support on this ground for the common idea that supreme courts, which use simple majority rules, should have six (or two or four) more members than intermediate appellate courts. It takes many more voters to do much better, and even if each voter is .6 or .7 likely to be right, a few more voters do not add terribly much with simple majority rule. *See* Nicholas R. Miller, *Information, Electorates and Democracy: Some Extensions and Interpretations of the Condorcet Jury Theorem*, *in* INFORMATION POOLING AND GROUP DECISION MAKING 173, 176 (Bernard Grofman & Guillermo Owen eds., 1986). It goes almost without saying, however, that a few more voters, or judges, might be desirable for political or deliberative or diversity reasons, or it might simply put an expert in the group, at least with respect to most subjects likely to be encountered. These sorts of reasons for expanding the number of judges, committee members, or other voters are excluded from the Condorcet Jury Theorem's domain.

The group approach is more attractive when we abide by a supermajority or unanimous decision. When each of three jurors is .51 likely to be correct, and they all agree, there is a .5299 chance that they are all correct rather than all incorrect. (If each were .6 likely to be correct, it would be much more likely, on the order of .77, that if they all agree they are all correct.) It is a Bayesian question of the form "if each voter and potential voter is .51 likely to be correct and we observe three voters agreeing (which is itself only slightly more than a .25 chance), how likely is it that these agreeing voters are all correct rather than all incorrect?" For three jurors, we have $p^3/(p^3 + (1-p)^3)$, where p is the chance that each voter is correct rather than not. *See* Bernard Grofman & Guillermo Owen, *Condorcet Models, Avenues for Future Research*, *in* INFORMATION POOLING AND GROUP DECISION MAKING 93, 98 (Bernard Grofman & Guillermo Owen eds., 1986). As the number of voters increases, and as the likelihood that each is correct increases, the chance that the supermajority is correct increases — but of course the likelihood that they are unanimous or nearly so decreases. Twelve like-minded jurors, each .51 likely to be right, are .6178 likely to be correct, but the probability that they will all agree in the first place is very small, less than .01. If we ask for a supermajority of 9/12, the likelihood of gaining a supermajority is .1469, and the likelihood that this supermajority is right is .5658. And if each juror is .6 likely to be correct, they are .24 likely to form an agreeable supermajority, and will then have a .9365 chance of being correct. If we seek a supermajority of five out of a group of six jurors, each .6 likely to be correct, we have a .2742 chance of agreement and then a .8506 chance of correctness. (We must add the chance of a correct 5/6 agreement with that of a correct unanimous, 6/6, agreement: $(p^6 + 6p^5(1-p))/(p^6 + (1-p)^6 + 6p^5(1-p) + 6(1-p)^5p)$, where p is, once again, the chance that each voter is correct.)

But of course these numbers should appeal only to the purist, as they are misleading. In reality, when supermajority or unanimity rules are in place, and especially when they are symmetrical as between the parties, the voters are encouraged to deliberate and to reach a verdict. It is hardly the case that 99 out of 100 twelve-person juries generate mistrials when

But now what if a very large jury assessed the likelihood that the requirements for liability have been met as .7 and .6, respectively? Is it not possible that if a single factfinder or a small jury did so we ought to be comfortable applying the product rule on our way to finding that .42 was less than what the POE rule required, but that when a large group does so we should somehow think it more likely that they are right on both counts? The easiest version of this argument focuses on a psychological and behavioral question. It is quite plausible that members of a large jury have little inkling of the Condorcet Jury Theorem so that they do not appreciate the added value of their own agreement. If every juror reacts to evidence of defendant's negligence with an individual assessment that this is .6 likely, it seems plausible if not certain that this jury would report a unanimous .6 assessment (if asked for a number). But we would know (by way of the Jury Theorem) that these well-meaning jurors failed to appreciate the combined power of their assessments. Had we asked each whether the assessment of negligence should be .6 or more, all would have responded affirmatively, and it is reasonable to think that every juror is more likely than not to get this question right. If each juror thinks that .6 is a good assessment of the first requirement, and .7 is a good assessment of the second, then the large jury's overall chance of being right, as to the questions of negligence (or not) and causation (or not), may be quite high with respect to each question. The product rule is still correct, to be sure, but the product rule yields a number almost surely closer to 1.0 than to .42.[24]

bound by a unanimity rule. Without some excellent theory and evidence as to how such compromise verdicts (if they are that) are reached, it will be impossible to assess our confidence in the correctness of the results.

Finally, note that the discussion sets aside such things as the possibility that six jurors would pay more attention to the evidence than would the fifty because of a kind of collective action problem. But this sort of claim takes aim at the basic assumptions of the Jury Theorem, because it raises the possibility that each member of a small group is significantly more likely to be right than each member of a large group.

24. I hesitate to say that the probability approaches 1.0 because of the problem, *see* Grofman & Owen, *supra* note 23, that in reality this unanimous group may have compromised or impatiently emerged with a unanimous decision. In any event, the text avoids some nuances that are not central to the argument. Thus, I ignore the possibility that voters know when to abstain; it is possible that an advantage of large-group decisionmaking is that those who know that they are clueless abstain, while the remaining voters do better because they are more expert. I also avoid questions that are not posed in binary form. We can ask as many jurors as we like to add .25 and .6, and the fact that most if not all give answers of .85 does not make the right answer 1.0. The Jury Theorem is best framed as dealing with binary questions, such as guilt (under some standard) or not, liability or not, and so forth. If we ask jurors whether the sum of .25 and .6 is more likely to be .85 or 1.0, and each is more likely than not to get such an addition problem right, then with a likelihood approaching 1.0 the group will vote for .85. Still, framing can turn many questions into binary form. If we want an assessment of negligence, we can ask a jury whether a defendant is more than .5 likely to have behaved negligently. If there is an affirmative answer we can then ask whether it is more than .6 likely, and so forth. But for the most part we avoid confusion if we are careful with the part of the Jury Theorem that requires that each voter be more likely than not to get the question right.

This link between the Condorcet Jury Theorem and the product rule might serve to explain law's disinclination to instruct factfinders according to that basic rule of probability. If juries systematically underassess their ability to find facts, then they might well multiply their average or individual assessments rather than the improved findings of the group. In some sense this argument is like the familiar reaction dismissed above in Section I.B.3., that the product rule is suppressed because of misuse and abuse by factfinders or attorneys. Here the misuse claim is that juries would take the product of two (or more) numbers that are lower than the numbers that they ought to use. They should, in a sense, be good Bayesians, asking, for instance, what the chances are that one factfinder who finds a .6 likelihood of negligence would be wrong about the presence of negligence given that eleven other jurors have found the same thing. But inasmuch as this is difficult to understand and carry out, it is quite plausible that law does better leaving out the product rule rather than including it in its instructions to finders of fact.[25] This is not to say that lawmakers do this consciously; the evolutionary process of law may be mysterious, but this sort of explanation or rationalization follows a long tradition of positive theorizing.

This explanation of the math-law divide is, of course, more powerful the larger the jury. It will not, for example, allow us to say much about panels of three judges who decide cases on appeal — even when we are satisfied that these judges are searching for a correct answer, and not injecting preferences, predictable expertise, and so forth. These panels, discussed in Section III.C. below, raise questions that are comparable to those raised by factfinding because appeals often

Still, framing can make the Theorem's applicability a slippery question. Imagine that the evidence suggests that *A* was negligent in injuring *B*, but that one witness thought that *B* has a preexisting condition such that it was possible, perhaps 10% or 20% likely that *A* did not cause *B*'s injury. If this witness was perfectly credible, all the jurors might simply share the view that *A* was negligent and that *A probably* caused *B*'s harm. Additional jurors or voters will simply confirm the reaction to the defense witness but it will not raise the probability of getting it all right to 1.0. For the purpose of this Article, however, I think it more than sufficient to say that large juries or large supermajorities can often raise our confidence level above what any one juror thinks. I will be careful not to insist that this increase is to the limit — but I do think it is fair to say that without the benefit of the Condorcet Jury Theorem we would underestimate the power of group decisionmaking.

25. It is possible that thinking of this sort is at the root of the argument in Neil Cohen, *Confidence in Probability: Burdens of Persuasion in a World of Imperfect Knowledge*, 60 N.Y.U. L. REV. 385, 399 (1985) — that subjective assessments of probabilities by factfinders are more properly analogized to probabilities from sample data rather than complete information. One claim is that:

> Not only must factfinders determine that their best estimate of the probability in question exceeds the threshold level — 0.5 for the preponderance of the evidence standard — based on the evidence presented, but they also must have a certain level of confidence that the true probability, based on all possible evidence, exceeds that threshold.

Id. But Cohen says nothing about the number of factfinders, and indeed the argument might be about a single assessor.

deal with multiple issues, all of which must be decided one way to support a given disposition or legal remedy. Thus, a panel of judges might be deciding whether a claimant has standing even as it hears arguments about whether substantive law supports the claim. The familiar conjunctive question arises, albeit in slightly different form, when we ask what such a panel — or any single judge on it — should do if it thinks that there is a .6 chance that the (best or constitutional or inherited) law provides for standing and a .7 chance that the claimant should (if standing is found) succeed as a matter of substantive law. For now, it is easy to anticipate a conclusion offered in Part III below with the point that the Condorcet Jury Theorem argument developed here may be extremely attractive for referenda involving thousands of voters[26] and for truly unanimous juries (of even small size), somewhat useful for juries of twelve — but quite useful when these juries reach true supermajority decisions, and of little use for panels of three judges or for other small juries that can decide matters with simple majority votes.

Finally, it may be worthwhile to note that the argument offered here may be offset by the well-known tendency of people to be sticky and even overconfident (if expert) in their initial judgments.[27] If an individual juror is initially offered evidence that suggests likelihoods of .6 and .7, it is possible that the individual will overestimate his confidence in the two results and also discount contradictory evidence; deliberation might polarize or deepen individual convictions, and individuals might discount evidence or arguments that contradict their first impressions, while accepting that which confirms first impressions. The overconfident juror may then report likelihoods greater than .6 and .7. Taken alone, this danger (or bias if it is really that) might intensify the mystery of the math-law divide because overconfidence might be nicely offset by instructions to multiply one's (overconfident) assessments.[28] But taken together with the argument offered here about the Condorcet Jury Theorem, it is possible to say that a group of jurors might individually assess likelihoods as satisfying the preponderance rule, that they might be overconfident in their assessments, but that they might not recognize the power of additional judgments submitted by fellow jurors. Whether one of these effects dominates is difficult to know without careful — and even then only

26. Though it should be noted that statutes or constitutions permitting plebiscites, referenda, or other exercises in direct democracy sometimes limit the problem by imposing a single-subject requirement on these popular votes. *See generally* James D. Gordon III & David B. Magleby, *Pre-Election Judicial Review of Initiatives and Referendums*, 64 NOTRE DAME L. REV. 298, 303 (1989).

27. *See* Matthew Rabin & Joel L. Schrag, *First Impressions Matter: A Model of Confirmatory Bias*, 114 Q.J. ECON. 37 (1999).

28. And it is unlikely that the overconfidence bias would generate a corresponding need in the opposite direction.

suggestive — empirical testing. It should be easy to get an idea of test subjects' abilities to internalize the Condorcet Jury Theorem, but so far as I know there is no work on this question of self-centered biases.[29]

In any event, I can do no more than be suggestive with these occasional remarks about connections between the arguments offered here and the psychology literature on various biases. The Condorcet Jury Theorem works with individual assessments; we know something about what happens when individuals deliberate in groups before rendering their decisions, but there is much that we do not know. My focus is on aggregation issues and how they relate to the product rule. I can only hope that my suggestions will complement insights regarding the psychology of group decisionmaking.

C. *Aggregation and Juries*

This Section offers an additional theory to explain (or perhaps to understand or simply to rationalize) where it is that we suppress the product rule.[30] This theory may complement the Jury Theorem dis-

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29. More generally, it would be useful to know more about the relative strength of the confirmatory and self-confidence biases. It would be interesting to see how juries reacted to hearing first from one side or the other (because the confirmatory bias suggests that there is an advantage in going first) and to hearing warnings about the bias itself. But these topics are beyond the scope of this Article. I aim to make discrete points about the Jury Theorem, the likely views of inframarginal jurors (especially where there are supermajority requirements), and the product rule. I refer to these perception biases in order to remind readers and author alike that there is much more going on than what is discussed in this Article.

30. A different approach would be to work in reverse and to be more interested in the selection of a voting rule than in the suppression of the product rule. The same set of observations can be used to explain the location of supermajority voting rules. We might eliminate uses of supermajoritarianism that appear to take the place of bicameralism, other confederating devices, or "brakes" on faction-supported government intervention, and then ask whether other instances of supermajority requirements can be linked to multiple requirements and hence the (suppression of the) product rule. On the relationship among these tools, see Saul Levmore, *Bicameralism: When are Two Decisions Better than One?*, 12 INT'L REV. L. & ECON. 145 (1992). We might be able to explain the disinclination to assess things more directly (and calculate their product) with our observations about strategic voting.

This is obviously not the place for such an exhaustive exercise, but it may be useful to point out that we virtually never find a supermajority requirement in committees. Closer to home, law faculties often work with supermajority requirements for personnel matters, and often not. These supermajorities can be explained, I think, but not in ways that have much to do with the product rule.

In my own experience in academic settings, simple majority voting has been associated with a wonderful and remarkably low level of strategic voting. Participants seemed to act as if they understood the genius of the Jury Theorem. Some of the most respected faculty members were often, as far as I could tell, perfectly content to "lose" and to abide happily by the majority. My other, shorter experience has been with serious supermajoritarianism. It too functions remarkably well. I might explain the rule as amounting to fairly explicit deference to experts — in keeping with the Jury Theorem after all. Alternatively, every faculty personnel matter can be seen as a difficult question of agenda-setting because one does not know what future appointment is foreclosed by a current appointment. A large and enthusiastic supermajority makes it quite likely that the future candidate will not be preferred to the present one.

cussed above, but may also apply when the conditions necessary for the application of the Jury Theorem do not obtain.

As Sections C.1 and C.2 explain, when the majority of a group agrees that a given threshold (such as POE) has been met, we can normally reason that the standard has been exceeded by a significant amount, especially where a supermajority voting requirement is utilized. Thus, suppression of the product rule following aggregation is often harmless. Section C.3 examines the rationale behind suppressing the product rule even in cases involving two (or more) theories of liability, and Section C.4 discusses the suppression of the rule in cases at the other extreme, involving a single theory with a single requirement. Finally, Section C.5 addresses the lingering question of why the product rule may not be used openly. Namely, it may be very difficult to employ the product rule directly, especially if jurors are inclined toward strategic voting. Accordingly, where law uses sizeable and supermajority juries it is perhaps explicable (and even desirable) that law suppresses the fundamental intuition of the product rule.

1. *Aggregation of Non-Identical Views (and the Product Rule)*

If we ask a jury for a numerical response, it is obvious that this group of respondents may have difficulty agreeing on a single answer.[31] One possibility is to poll the jurors and aggregate their responses through some method decided by law. Another is to instruct the jurors as to how they should aggregate. And the third likely method is to allow the jury to aggregate as it chooses. Jumping ahead of the argument — partly in the interest of appealing to readers from jurisdictions that do not use juries for this sort of thing — it should be noted that panels of judges can be substituted for jurors in most of this discussion, and the idea of allowing the group to aggregate on its own may amount to a version of "outcome" as opposed to "issue" voting, a choice discussed below.[32]

Perhaps the simplest form of my argument in this Section can be made by beginning with the case where jurors are asked for a final answer, so that in effect they are instructed to aggregate on their own and without much guidance. Consider, in other words, the approximate instruction given to most American juries in tort cases: "Tell the court by a unanimous (or supermajority[33]) verdict whether it is more

31. Strategic behavior problems are discussed *infra* Section II.C.5.

32. Put differently, simultaneous — as opposed to sequential — decisionmaking can lead to interesting anomalies. *See infra* Section III.B.

33. Roughly speaking, more than a third of the states require unanimity in civil cases, *see, e.g.*, CONN. SUPER. CT. R. 16-30; S.C. R. CIV. P. 48. (South Carolina). States sometimes relax the unanimity requirement, however, once juries have deliberated for some hours. *See e.g.*, MINN. STAT. ANN. § 546.17 (1999); IOWA R. CIV. P. 203. Moreover, in many states the parties can opt out of the unanimity rule by agreeing on another decision rule.

likely than not that defendant was negligent and tell us also whether this negligence caused plaintiff's injury. If you answer both questions affirmatively, we will ask for your help with respect to damages."

Imagine that there are twelve jurors and that nine (or more) agree that yes, it is more likely than not that there was negligence and the requisite causation. I refer to this as an agreement that the probability of defendant's negligence exceeds .5, and that the likelihood of the relevant causation also exceeds that important number. In fact, let us imagine the worst-case scenario from the perspective of the math-law divide. The supermajority informs the court that in fact it has just barely reached the decision it reported.[34] Nine jurors are willing to vote that there is at least a .51 chance of negligence and nine are willing to vote that there is at least a .51 chance of causation, and all the jurors believe that the two likelihoods are independent. The product rule encourages us to find that imposing liability here would be lawless because the conjunctive probability may be on the order of only .26.[35]

But it is easy to imagine that each supermajority group of nine[36] incorporated individual assessments ranging from just over .5 all the way to 1.0. Just as a majority vote for candidate *X* in a general election is likely to mean that some voters barely prefer *X* over the alternatives while some very much prefer *X*, a vote for (as opposed to against) the .51 response is likely to mean that some voters are at .6 or .75 or even 1.0 (or indeed at .51 for that matter). In the absence of additional information about the actual distribution, we might even proceed amateurishly and recklessly, and hazard a guess that the average assessment of this group of nine is .75, halfway between the marginal .51

Among the states that do not require unanimity, about half call for an 80% supermajority (by requiring agreement of either ten of twelve or five of six jurors, depending on the jury size), many ask for a three-quarters supermajority, and a few permit two-thirds supermajorities. *See, e.g.*, N.Y. C.P.L.R. § 4113 (2001) (five of six); WIS. STAT. § 805.09 (1999) (five of six); CAL. CIV. P. CODE § 618 (2000) (three-fourths rule); TEX. CONST. art. V, § 13 (three-fourths rule); MONT. CODE ANN. § 25-7-403 (West 2000) (two-thirds rule); MO. CONST. art. 1, § 22(a) (two-thirds rule in courts not of record). There is some variety as to jury size, so that a greater percentage might be required for a smaller jury. *See* KAN. STAT. ANN. § 60-248(g) (West 1999); LA. CODE CIV. P. ANN. art. 1797 (West 2000). The supermajority character of the argument offered here is emphasized in the next Section of the text.

34. For expository purposes, I set aside the question of whether the presiding judge permits the jury to convey this information.

35. The language in the text reflects the fact that apart from rare (and perhaps nonexistent) cases with special verdicts as to the jury's precise judgment, we have not received a .51 response but rather an affirmative answer to the question of whether each requirement is met by the POE standard, which is to say is *more than* .5 likely. More generally, it should be noted that special verdicts of the kind observed do not much affect the analysis here. Juries simply tell us that multiple requirements are met (one at a time); they are not encouraged to take the products of probabilities. Nor, of course, does the discussion here suggest that they ought to be so encouraged.

36. The argument here is largely unaffected by the question of whether the majority on one question is different from that supporting the other. Strategic problems aside (for now), it should matter little.

vote and the ceiling offered by 1.0. If we apply the product rule, then .75 times .75 is about .56, exceeding the .5 marker of the POE rule.[37]

I intend to deal with several problems, or unsubtle steps, in this quick example, but it is worth emphasizing the straightforward point by dropping the artificial device of the jury having reported its precise .51 breakpoint. If the jury merely responds to the most familiar question that is asked of it, agreeing that the necessary majority has voted that each requirement for liability is more likely than not to be present then, as we have just seen, our sloppy estimate of what a majority of this jury thinks might be .75, but there is surely not much of a case for something as low as .51. Indeed, our best estimate is undoubtedly higher than before, now that the jury has not saddled us with precise information about the marginal voter. We know now that the marginal member of the majority must be at .51 or greater. And, again, if nine of the twelve report two independent and successive more-likely-than-not findings, it is more than plausible that a fair application of the product rule would produce a conjunctive probability of greater than, if not significantly greater than, .5.

In short, there is a neat explanation for the math-law divide where multiple decisionmakers are concerned because the aggregation process passes over information that would have suggested higher numerical assessments.[38] The mathematician is not generally asked about an aggregation issue, so that in fact there is no inconsistency between the mathematician's and lawyer's intuitions. When a *group* decides that two things are more likely than not, the members of the group are on average likely to be much more confident than an individual responding with two more-likely-than-not assessments. If we were to apply the product rule, we would need a great deal of information from this group (as emphasized presently). And if our choice is either to apply the product rule to those numbers that a majority of the voters' assessments exceed or to avoid the product rule entirely, we are very likely to do better by avoiding the product rule.

It is of course possible to imagine cases in which suppressing the product rule will be indefensible on the above reasoning. Imagine, for example, that three jurors regard negligence as 0.0 likely and nine re-

37. I do not mean to hazard a guess as to the distribution of assessments. But given that unanimity and 80% supermajority requirements are so common, a calculation of the sort sketched here is quite defensible.

38. Perhaps I should say "more intense assessments" because the jury's report will, in like fashion, suppress information that would have suggested a *lower* numerical assessment when the jury finds that a requirement is less likely than not to be present. The math-law divide, however, is only an issue where multiple requirements are all (individually) assessed as satisfying the standard for liability.

Note that the explanation offered here does not depend on the Jury Theorem and therefore, unlike the argument advanced in Section II.B, it is not open to claims that the assumptions of that theorem are absent.

gard negligence as .51 likely, and that the same is true for causation. Setting aside the possibility of compromise, the jury will report that the POE standard is satisfied for both requirements, and we will wish that we used the product rule to discourage a finding of liability.[39] But this sort of distribution is probably unlikely, and the cases against the product rule surely outnumber those that beg for it. Lawyers are accustomed to overinclusive rules and explanations.

2. *Supermajority Requirements*

Supermajority requirements obviously play an important role in these arguments about aggregation and conjunction. With a 7-5 vote we might reason that the negative voters' assessments offset the inframarginal affirmative voters, and that our swing voter is likely to be close to the cutoff that the jury instructions inquired into. But with a 9-3 or 12-0 supermajority, we might have confidence that the median juror (or any other information used to derive our best estimate of the facts) is well above the announced cutoff. Put this way, supermajority voting can be seen as an alternative to, or as inconsistent with, the product rule. If a supermajority finds that negligence is more likely than not, and that causation is as well, we might regard our best estimates of each as closer to .75 than .5; with two requirements, the suppression of the product rule may not vitiate the finding of liability by a supermajority.

I have already implied that our best estimate of a likelihood will take dissenters' views into account; it is this intuition that makes a supermajority look quite different from a simple majority decision that something is (or is not) more likely than not. Imagine, for example, that we could poll the jury and find that we have four jurors responding to questions about negligence and causation with likelihoods of .3, four at .6, and four at .9. A majority, and for that matter a two-thirds supermajority, will respond affirmatively to the preponderance of the evidence questions. If we look only at this majority, then we are comfortable suppressing the product rule because it is hard to justify anything far from a .75 estimate, and two such independent probabilistic assessments survive the product rule. But of course we have four jurors weighing in at .3, and the very intuitions advanced thus far suggest that our best estimates should count those views as well, in which case

39. The only saving grace of the law's suppression of the product rule (as I will continue to call it) comes from the Jury Theorem. If nine million jurors thought .51 and three million thought 0.0, then following the Condorcet Jury Theorem we might be quite confident in the .51. Certainly if the supermajority multitude thought .7 and the minority thought 0.0, we would be comfortable with liability (even though (.7)(.7) is less than .5). But I am trying to set aside this argument from the Jury Theorem against the simple application of the product rule in part because we can do better and in part because we do not deploy juries of huge populations.

we find ourselves at .6 for each requirement, and with a product below that required by the POE rule.[40]

In this example, a rule requiring a three-quarters supermajority will prove convenient. In the absence of compromise, the jury will fall one short of the necessary supermajority and there will be no liability. Generally speaking, when a supermajority of a reasonably sized jury responds affirmatively to the POE questions it is asked to consider, we can guess that the median and mean of the entire jury are well above .5 for each question. This gives us reason to be fairly comfortable with a system that suppresses the product rule and asks only whether a supermajority believes the POE standard has been met for each question. Two affirmative answers from such a supermajority will normally mean that had we enjoyed the luxury of actual assessments, and had we applied the product rule, the POE standard would also have been satisfied. Moreover, if the alternative is to ask a different, single, yes or no question, namely whether a majority or supermajority agrees to (at least) a specific probabilistic assessment, we will do worse. I return to this idea presently.

I do not mean to overstate the fit between the rather common unanimity (or high supermajority) requirement, where juries are used, and the absence of a product rule. The connection is a coarse one. Without careful empirical work regarding instructions, jury reversals, and the like, it would be reckless (and surely incorrect) to claim rather wishfully that there is more suppression of the product rule with larger juries. As far as I can tell, the product rule is suppressed with supermajority juries of six and eight just as it is with unanimous groups of twelve.[41] Still, it is not entirely reckless to suggest that it would not be

40. In some situations we might choose to discard outliers, but again we would do so at both ends of the spectrum. Apart from problems associated with asking jurors for specific assessments (rather than yes or no responses to the POE question), *see infra* Section II.C.5, an added problem here is that jurors may be strategic in their attempts not to be dismissed as outliers.

The discussion in this Section sets aside the Jury Theorem's insight that multiple judgments, in sync with one another, are better than one. Put slightly differently, although the Jury Theorem itself might be the reason why we abide by majorities, there is no reason to throw out the information provided by the putative *minority*, so long as the question is neither binary nor one that commands an absolute majority for a single position (but rather is the kind of question considered here, where we really want a point estimate).

41. There seems to be little relationship between the size and decision rule of a state's juries and the degree to which the product rule is suppressed. Thus, New Hampshire requires a unanimous verdict from a twelve-person jury, but its sample jury instructions are rather ambiguous regarding the product rule: "The plaintiff claims: [State essential elements of the claim, making reference to time, place and circumstances] . . . These are the issues which are to be determined by you based on the facts as you find them to be and by applying the law as the court instructs you." N.H. CIV. JURY INSTRUCTIONS § 1.1 (1999). Michigan permits a verdict from five out of six jurors, but the product rule is suppressed in the sample jury instructions: "The plaintiff has the burden of proof on each of the following propositions: a. that the plaintiff [was injured / sustained damage]; b. that the defendant was negligent in one or more of the ways claimed by the plaintiff, as stated to you in these instruc-

easy to incorporate the product rule into jury decisionmaking, that severe supermajority jury rules are surprisingly common, that supermajority responses to POE questions are likely to reflect assessments that are further from .5 than first meets the eye, and, finally, that with such numbers we might worry less about the suppression of the product rule.

3. *Alternative Routes Revisited*

Any rationalization for the suppression of the product rule must also seek to explain the suppression in cases involving alternative theories of liability (and so forth) and cases involving a single requirement. (Single requirement cases are discussed in the next Section.) In the case of alternative theories of liability, the product rule would favor the plaintiff. The issue for the jury becomes not whether any one of the alternative theories has been established, but whether it is more likely than not that not a single one of the alternative conditions has been met. If the plaintiff wins by showing one or more of W, D, and M, for example, and the jury responds that the likelihood of each is .5 or less, we might imagine (sloppily) that they really "agree" on .45 and that our best guess is .4 for each if only because the Jury Theorem gives us some added confidence. In this illustration the likelihood that all three causes of action fall in defendant's favor is (.6)(.6)(.6) = .216, and perhaps plaintiff should win.[42] We might worry that the suppression of the product rule has unfairly denied plaintiff's recovery because the chances are that defendant is liable because of W or D or M, even though the jury does not think that any one alone is more likely than not.[43]

Once again, however, we have not yet taken into account the spread of the jury's assessments and the question of how to aggregate diverse reactions to the evidence. If the jurors assessments are spread or concentrated far below the .5 divide (about which they were polled), and these likelihoods are independent, then it is possible that plaintiff should still lose and that once again the supermajority rule can be seen as a substitute for the product rule. Thus, if our best guesses are not .45 but rather, say, .3 for W, .2 for D, and .1 for M, then the likelihood that D succeeds in defending against all three grounds argued by plaintiff at once is (.7)(.8)(.9) = .504. Plainly, when a large supermajority says that each of two or more alternative requirements is less likely than not to be met, our best guesses might be

tions; c. that the negligence of the defendant was a proximate cause of the [injuries / damages] to the plaintiff." MICH. STD. CIV. JURY INSTRUCTIONS 16.02 (1998).

42. Similarly, if we had imagined agreement on .25, then (.75)(.75)(.75)=.422.

43. See *supra* note 11, where D, M, and W are given concrete form.

well below the .5 cutoff so that again the product rule's suppression may do no harm.

4. *Single Requirement Cases*

If aggregation and conjunction are indeed somehow or even sensibly connected through the idea of thinking about inframarginal jurors and what they say about our best assessments of likelihoods, then we need to revisit familiar cases where there is no issue of conjunction. If a jury is asked but one question, and most or all voters agree that the answer satisfies some standard such as POE or even reasonable doubt, then it is likely, as we have seen, that our best assessment is much more confident than is first apparent.

And yet the supermajority rule is not relaxed when a jury is asked but one question. If we observed a legal system that asked for unanimous jury verdicts only where multiple (independent) questions were posed or only in areas of law, such as torts, where multiple questions are common, it would be much more obvious that there was a connection between conjunction and aggregation.

Imagine, for example, that a judge asks a jury whether defendant has more likely than not given an inadequate warning. Imagine further that there is no other jury question; perhaps all else is stipulated, or perhaps there is a fine or liability rule associated with an inadequate warning. If all jurors respond affirmatively, we know (compromise and Condorcet aside) that the marginal juror is somewhere above .5 but that the average juror is likely to be at some point significantly higher than .5. But if so, perhaps our rule is too restrictive. After all, if we have some faith in the Jury Theorem and we like the POE rule in civil cases, as I think we should[44], and seven of twelve jurors are above .5, and the mean response is above .5, then why not prefer liability where that result is supported by a majority but not a required supermajority?

The preceding question can be reformulated in a number of ways. One is to ask why we like supermajority decisions in the first place. Another, more formidable construction, asks how we justify supermajority or even unanimous decisions for juries while abiding by simple majorities in the very same cases when issues are reviewed by panels of appellate judges. The larger question, about why and where we require supermajorities, is a topic saved for another day.[45]

For present purposes, one fairly safe argument should suffice. It is that we might require supermajorities in order to encourage some care on the parts of jurors. If juries knew that simple majority decisions

44. *See* Levmore, *supra* 12.

45. *See* Saul Levmore, *More Than Mere Majorities*, 2000 UTAH L. REV. 759 (forthcoming 2001) (manuscript at 13-16, on file with author).

were acceptable, they might retire to the jury room and impatiently poll the group and (absent a tie vote) decide that their job was done. If there is some value to considering evidence that one missed the first time, to hearing others' observations, and to concentrating on the matter at hand, then a supermajority requirement may be an elegant means of forcing such steps. One can barely imagine a legal system that encouraged a judge to tell the jury that it needs a supermajority verdict where there are multiple (or, as we will see, alternative) requirements, but that it might reach a simple majority verdict after due deliberation where there is but one requirement or factual question.[46]

But there are reasons to suggest that we not eliminate the supermajority requirement for single requirement cases. Most important is the possibility that the category of concern, consisting of single requirement (jury) cases, is exceedingly small. Most tort cases will have the jury deciding negligence and causation and more. Most contract cases will also require the jury to consider a number of requirements because of the various available defenses. The plaintiff might win a case if the defendant failed to deliver goods as promised *and* such delivery would not have been impossible (or otherwise excused) *and* the plaintiff mitigated in a reasonable manner, and so forth. In most areas of law, when we rely on juries, we give them multiple questions and we await a series of (somewhat) independent assessments before imposing liability or finding guilt. As such, the number of cases where we might be tempted to tell our judges to instruct juries to abide by a simple majority rule simply because the jury is asked but a single question may well be quite small.[47] It is easy to imagine that judges who were empowered to instruct juries to switch to simple majority decision rules would so overuse this tool as to make things worse rather than better.

Another way to rationalize the use of supermajorities — and especially unanimity requirements — even where single requirements are issue, is to make some reasonable assumptions about the process of jury compromise. If ten jurors think that plaintiff has satisfied the sin-

46. Deliberation might also explain a supermajority rule quite generally, but then aggregation considerations are needed to understand the math-law divide.

47. Unfortunately, it is difficult to quantify this conjecture. In a large fraction of jury-verdict cases, reasonable people might disagree as to whether the jury had been asked one or multiple independent questions. There is difficulty in assessing whether a jury deliberated and voted on multiple requirements (or a single one) and there is also difficulty in assessing whether these multiple questions would (or should) have been regarded as independent. A random sample of jury verdicts reported in *Jury Verdicts Weekly* (Jan.-Mar. 1996), for example, suggests that, in about 30% of cases, jurors must decide on two or more independent, contested elements. In another 20% of the cases, it is clear that jurors are only asked to decide one issue, either because one or more issues are stipulated or not seriously contested or because the case involved but one issue. But in the remaining 50% of the sample cases, it is not clear whether the jury is deciding one issue or more. These cases ostensibly involve multiple elements, but often they are interdependent, as when multiple issues depend on the credibility of a single witness.

gle POE requirement, but two jurors insist on assessments of .4, for example, then it is possible that the two will give in to the ten — in the interest of consensus or in the face of a unanimity rule — but expect to influence the group to award lower damages than might otherwise seem to have been caused by the defendant. Put differently, supermajority requirements may be relaxed by potential dissenters who are influenced by the cultural and democratic norm in favor of simple majority rule, or even who intuit the Jury Theorem. Of course, the more this is so, the less confident we can be that a supermajority reaction to a POE question reflects an assessment that is much above or below .5.[48]

In any event, the most ambitious form of the positive argument advanced here is that the supermajority voting rule in juries takes the place of the product rule where multiple requirements are concerned. We might begin with the danger of simple majority rules and juries rushing to judgment, in which case we prefer supermajorities and then suppress the product rule "because" we would otherwise dramatically overassess likelihoods. Alternatively, we might begin the description with the suppression of the product rule on grounds of math anxiety or strategic behavior,[49] and then conceive of the supermajority requirement as a substitute for the product rule. Either way, the argument is most powerful if most cases do involve questions for conjunction.

5. *The Problem of Strategic Behavior*

I have repeatedly deferred or even avoided the question of why we do not simply ask all the jurors for their best, precise assessments. Note that we have no reason to ask unless there are multiple (and somewhat independent) requirements for liability so that we might wish to use the product rule. In any event, if jurors could and would answer this sort of question sincerely, which is to say without an eye on the aggregate result, we might do much better than we can hope to do by asking multiple POE, yes or no, questions while suppressing the product rule. And it goes almost without saying that, at least following the argument developed here, we should overcome the math-law di-

48. The blending of views into a single number is a useful reminder of the sort of process explored here. If a supermajority agrees on liability but the jurors then discovered, for example, that their damage assessments differ and range from one hundred thousand dollars to one million dollars, I think we would be startled to hear that they could not come to agree on a "unanimous" verdict if required to do so. And it would seem unlikely that our best guess as to their compromise or unanimous verdict would be one hundred thousand dollars. We expect verdicts to reflect the mean or median voter, more or less — and for strategic behavior reasons we are unlikely to wish it were otherwise — and that is why supermajority verdicts (especially) might not require much in the way of application of the product rule.

49. *See supra* Section I.B.5; *infra* Section II.C.5.

vide and apply the product rule when appropriate to these precise responses.

One reason we do not ask for precise probabilistic assessments, but prefer instead the "does it satisfy the POE standard (or not)" question, followed by the same question with regard to the next requirement for liability, is no doubt that we appreciate the level of math anxiety present in the population of jurors (not to mention judges). For obvious reasons, I do not dwell on this easy explanation, though I must admit it as a serious explanation. Cutting against it is the fact that we do ask identical panels to decide damages where they have found liability, and these damage calculations require much more than yes or no (or greater or lesser) responses. They call for estimates, extrapolations, present values, and so forth.

The second and more trying reason is, I think, that we correctly hesitate to enable strategic behavior by jurors (or judges) because if such behavior is unevenly distributed, group decisionmaking quickly loses its appeal.[50] The problem is especially acute if jurors think that we are interested in the mean response. If six jurors bear assessments of .6, and six of .9, then following deliberation[51] the mean response is of course .75 and, if the same is true with regard to the next question, liability is found even after the product rule is applied. But if even one member whose own assessments are, say, .6 and .6 sees that the product rule as applied to his assessments alone suggests that the defendant be free of liability, and acts upon this by responding strategically with 0.0 to each question, then the mean responses (of .7) will be insufficient to survive the product rule. There is much more that could be said about successful and unsuccessful strategic behavior here, but I suspect that most readers will be satisfied with this account (and impatient with more).[52] Legal systems prefer to ask voters, and certainly

50. Note that I am *not* claiming that this strategic behavior leads to perverse results, by which I mean results that are contrary to what the majority itself prefers. For some development of this theory, see Saul Levmore, *Voting with Intensity*, 53 STAN. L. REV. 111, 149-58 (2000), where there is a claim that most legal and political systems prefer schemes that do not lend themselves to strategic behavior that can lead to perverse results — which is to say ex post "dissatisfied majorities." For example, if we allowed people to buy and sell votes, we might easily find ourselves with a winning candidate that a majority did not wish for (even in a two candidate election) and that even most intense voters did not prefer. This winner may have emerged because voters misestimated the likely vote or the likely price of votes. In contrast, if half a jury assesses negligence (and causation, to make the example quicker) at .6 and half at .9, we know that the wisdom of the group favors liability, even with the product rule applied. But some of the .6 assessors may see that when they apply the product rule to their own assessments, the defendant is free of liability. Fearful that other voters will come up with higher numbers, they might respond with 0 or .1 when polled. But at least *they* will be pleased if there is no liability.

51. I do not discuss deliberation here, but it is hard to see why we should prefer to take these votes without or prior to deliberation. Among other things, deliberation can serve to bring out "expert" knowledge and assessments which (even) the Jury Theorem bows to.

52. In an important sense, this argument is a close relative of one considered in the matter of "issue" versus "outcome" voting on judicial panels. *See* Lewis A. Kornhauser &

voters on juries, simple, manageable questions that do not immediately generate strategic responses. Strategic responses can ruin the majoritarian exercise. Even limited awareness of the presence of strategic behavior can demoralize the citizenry.

Nor will it do much good to ask the jury to aggregate on its own and to provide a numerical group assessment. The problem is not in the court's ability to aggregate without enabling strategic voting, but rather in the incentive to dissemble under (at least) some aggregation strategies. If the jury reports its mean assessment, the analysis is much the same as above.

The trick, then, is to aggregate in a way that is resistant to strategic voting. One possibility is not to aggregate. Thus, each member might enter a slip of paper, and the group's assessment will be the assessment on the one slip that is pulled from the pile in lottery style. The advantage of such a scheme is that one may as well be honest.[53] But one disadvantage is that we throw away all that might be gained from numerous voters.[54]

A better plan might be to focus on the jury's median response. In the case of a supermajority requirement this translates into the marginal (as it were) response. If we ask a supermajority whether its level of confidence exceeds .7,[55] the idea being that two such affirmative responses might lead us to think that even with the product rule we are on safe ground, then there is little if any room for destructive strategic behavior. A power-hungry juror may be confident in her own assessment of .4, but she gains nothing by feigning an assessment greater than .7. Similarly, a juror who senses from deliberation that her assessment is above the median or relevant margin is not offered the chance to exaggerate, and will hardly gain by giving a dishonest response. We have simply asked whether individual assessments are above or below a number. One can influence a mean but not a median with exaggeration. Eliciting binary responses in this manner eliminates useful information when the voters are not evenly distributed, but at least we gain something from the deployment of many voters and we do not leave the process as open to strategic behavior problems.

I do not wish to abandon these jury issues with the impression that strategic behavior problems must necessarily drive any positive or

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Lawrence G. Sager, *The One and the Many: Adjudication in Collegial Courts*, 81 CAL. L. REV. 1, 55-56 (1993).

53. Unless the problem is that a juror may think that the deterrence or expressive function of law is too far in one direction or the other. In that case, a juror will be extreme and little influenced by the facts of the particular case.

54. The plan gives up on the Condorcet Jury Theorem, in a manner of speaking.

55. If I were not trying to set the Jury Theorem aside, I might say that with numerous jurors (perhaps twelve), we ought to be satisfied with asking whether their assessments exceeded .6 or even some lower assessment.

normative analysis of this relationship between aggregation and conjunction issues. Nonetheless, it is useful though perhaps startling to question the intuition that some jurors might simply like to get their way, and that strategic behavior will be tempting.

To do this, we need to return to the Condorcet Jury Theorem, which tells us that when there is a right answer to a question, as opposed to a matter of preferences or a matter that is pure guesswork (at least for nonexperts), each of us should be pleased to have the assistance of many other voters. If the majority of my group, and especially of a large group, votes for *X* on such a matter, then if I am in the minority and voted for not-*X*, it would normally be foolish for me to want to get my way. In these situations, if my goal is to get the question right or do my civic duty, then I should be pleased to accede to the majority. In turn, if voters behave as I hope I would, the legal system can safely use mean juror responses (and need not resort to medians) because the jurors will have no interest in voting strategically.

This is not the place to dwell on this rather abstract and counterintuitive argument. It asks us to believe that the legal system reliably asks jurors to do those tasks for which the Jury Theorem is applicable. It asks us to believe very little of what is commonly said about jurors and judges on panels, because a familiar kind of intellectual ambition, ego gratification, and power grabbing is assumed away.[56] These are difficult steps and yet it is possible that we cannot know what to make of the product rule or of its suppression without a better understanding of when and why jurors and judges vote strategically.

III. AGGREGATION WITH JUDGES

A. *Single Judges and the Product Rule*

Some of the analysis in Part II leads to the normative conclusion that a judge working alone in a bench trial should employ the product rule. And nearly all of the analysis leads to the positive prediction that we should find single judges using the product rule. We might expect this pattern to be subtle, both because of the disinclination to deal explicitly with mathematical and statistical concepts and because judges might try to parry the inclination of parties to prefer (or avoid) jury trials in order to avoid (or gain) the product rule.[57] Of course, the

56. One reason it is hard to accept the idea that strategic voting may be against self-interest in some settings, is that we do not experience these settings in everyday life. Thus, in law schools, law firms, and congressional committees, voting is often about matters that relate to one's preferences — rather than to something that has a "right" answer (and regarding which we are unlikely to be expert). But if the Jury Theorem is useful in some domain, and if actual jury decisions as deployed by courts are included in this domain, then strategic behavior "should" be less of an issue than is normally thought.

57. Or at least so they might think. In fact, it might be hard to choose between the supermajority requirement and the single judge.

more subtle the pattern, the more difficult it is to demonstrate. For the most part, I leave the subject of bench trials and the product rule for another day, and especially for a comparative effort.[58] This Article continues to focus on aggregation (and conjunction).

B. *Multimember Panels of Factfinding Judges*

A panel of several judges engaged in factfinding is, of course, a kind of jury. The arguments developed in Part II, however, are somewhat dampened with regard to judicial panels. The Jury Theorem effect is less pronounced because judicial panels are normally smaller than lay juries, and the Jury Theorem is based on the arithmetic of getting something right with an increasing number of (even marginally useful) voters. Still, three (judicial) heads are better than one.[59] Of course, judges might make other errors that jurors do not make. If, for example, judges as experts working alone suffer from the well-known overconfidence bias, then the product rule, if applied, may do too little to correct for this bias.[60] If a judge "should" assess two requirements as .7 and .6 likely, but suffering from an overconfidence bias, prepares to deploy .9 and .9, multiplying those overconfident assessments will produce liability where the proper application of the product rule would not.[61]

There is some chance of finding that smaller panels operating with a simple majority rule suppress the product rule less than large ones bound by supermajority requirements. The experiences of agencies, commissions, military courts and, of course, jurisdictions that do not use juries but sometimes use multimember panels of judges can be combed for this inquiry. But again, this is not yet a comparative enterprise.

Finally, I should note one normative application of the arguments developed here. A single judge presiding over a bench trial can purchase the advantages of the Jury Theorem, in some fashion, by hearing

58. In American jurisdictions we can look to see whether judges acting alone implicitly apply the product rule where there are multiple requirements. In most non-American jurisdictions judges generally operate without juries — but then sometimes in panels — so that comparisons are likely to be especially interesting. But I should warn the reader that I am not holding back any striking evidence in favor of the broad application of the thesis advanced here. I know of no jurisdiction that explicitly applies the product rule.

59. There would also be opportunity to see a subtle effect when panel decisions were unanimous. Thus, if a three-judge panel is unanimous in finding two elements of liability, we might anticipate more subtle suppression of the product rule than if the panel had been divided.

60. *See supra* text accompanying note 26.

61. Nor is this symmetrical. The judge who "should" assess at .4 thinks that the requirement is less likely than not to be present. The judge will find against liability — and if the judge is overconfident and subsequently revises the estimate to .1, the outcome will be the same.

from scores of witnesses and experts. A judge who thinks she needs only to find that two requirements set out by law are more likely than not to be present might hear from one or two witnesses. But one who wanted to sign off on .7 or .8 assessments (in order to preserve the possibility of liability even after multiplying the probabilities attached to two such assessments) might need to hear from five or ten witnesses on a matter.[62]

C. *Appeals Panels*

Large portions of the arguments offered in Part II can be extended to decisions made by panels of judges considering multiple issues on appeal. There is a small but effective literature on "issue versus outcome voting," but advances in this area are possible, I think, through some exploration of the relevance of the Jury Theorem and the place of the product rule (or its suppression).[63]

Imagine, once again, that there are two requirements for a judgment, or at least for a judgment that favors the original plaintiff. Plaintiff wins if the trial court below was correct in finding not only that this plaintiff had standing to sue but also that substantive law favored the plaintiff's position. A majority of the appellate court might have supported the plaintiff on standing, and a different (but obviously overlapping) majority thinks the lower court was correct in its application of substantive law in plaintiff's favor. A judge who thought there was standing but who thought that plaintiff should have *lost* on the second, substantive question would on her own have decided against plaintiff because plaintiff needs both issues in his favor. Thus, if the judges vote sincerely on issues, one at a time, two distinct majorities produce a victory for plaintiff. But if we ask each judge for a decision as to the outcome of the entire appeal, we will get a different result. Note that if we choose issue voting, as we generally do not in American law, a given judge might strategically "change" her vote regarding the first issue in order to get the overall result she prefers.[64]

One thing missing in the extant literature is the relevance of a judge's level of confidence in her judgment. There is little reason to weigh levels of confidence when a panel is deciding one issue. Deliberation, deference to expertise, and the prevalence of framing norms that call for up or down decisions all figure in this conclusion. But

62. Indeed, if a comparative inquiry suggested that European or Japanese judges, operating without juries, suppressed the product rule in a manner different from their American counterparts, we might connect this observation to the norm of shorter and much less expensive trials.

63. *See* Evan H. Caminker, *Sincere and Strategic Voting Norms on Multimember Courts*, 97 MICH. L. REV. 2297 (1999); Maxwell L. Stearns, *Should Justices Ever Switch Votes?:* Miller v. Albright *in Social Choice Perspective*, 7 SUP. CT. ECON. REV. 87 (1999).

64. *See* articles cited *supra* note 63.

where two or more issues must be decided for a party to prevail, the insight reflected in the product rule suggests some interest in the confidence or precise assessments of the decisionmakers. On the other hand, we may decline to ask for precise assessments by judges for the same reason suggested with respect to lay juries, to avoid strategic voting.[65]

The literature on judicial panels can safely avoid the Jury Theorem not only because these panels are fairly small but also because these panels are competing over arguments and even preferences such that the basic requirements for the Jury Theorem are often absent. Put differently, even where we think the Jury Theorem applicable to what these judges do, the size of the panel and the norm of simple-majority decisionmaking makes us less than comfortable with issue-by-issue decisionmaking.

Given small panels and simple-majority decisionmaking, outcome voting can substitute for the product rule. Imagine, for example, an appeals panel with three members deciding a case with two issues of the sort described earlier. Any one judge who is confident in finding for the plaintiff on both issues is of course pleased with an outcome in plaintiff's favor. But a judge who thinks plaintiff should probably win on the standing issue and just barely win as a matter of substantive law might well internalize the product rule with the intuition that it is more likely than not that at least one of the two issues should be decided against plaintiff, in which case plaintiff should lose. Inasmuch as we do not normally send appeals to a single judge this sort of thinking is hypothetical, except that if we ask three judges for votes as to outcome (only), we might with sincere voting[66] get a different result than we expected after tallying their views as to the two issues. The jury-judge difference is thus fairly straightforward. An optimistic, positive view is that the product rule is reasonably suppressed on fairly large juries with supermajority votes and it is imperfectly supplanted by outcome voting in the case of small, majoritarian judicial panels.[67]

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65. Although we could presumably ask whether the judge's confidence exceeded some level or not. *See supra* Section II.C.5.

66. The same might be true with strategic voting if judges internalize the product rule.

67. Imagine, for example, that we need two issues decided for plaintiff on appeal in order to uphold a finding of liability against the defendant. If we denote a decision on an issue for plaintiff with a "1" and a decision against plaintiff with a "0," then a judge working alone whose assessment is (0,1) or (1,0) should decide against plaintiff, while one who finds on both issues for plaintiff, denoted as (1,1), will find for plaintiff. Imagine now that Panel *A* consists of three judges whose assessments are (0,1), (1,0), and (1,1), and that Panel *B* in a different case has assessments of (1,1), (1,1), and (0,0). Panel *A*'s issue voting yields a win for plaintiff, but two of the three judges would with outcome voting decide against plaintiff. Panel *B* decides for plaintiff by a 2-1 vote either way. With numerous panelists, issue voting seems superior. There are, after all, two affirmative (and, by hypothesis, independent) assessments for each issue on the two panels. But on a small panel the argument for outcome voting is that we may mimic what the product rule would have done with precisely recorded

Finally, it is useful to mention the possibility of vote switching by judges. Judges might attempt to maximize their power through some combination of strategic voting and vote trading.[68] Two judges might trade across cases if they feel strongly about different issues, but they might also trade in order to improve their chances of "victory" on issues regarding which they are highly certain. Jurors rarely have these options and, in any event, the very ideas of preferences and power remind us that we have left the domain of the Jury Theorem.

IV. Conclusion

Law often sets out multiple requirements for liability or other results. These requirements can be questions about facts or about the applicability of legal rules. In turn, judges and juries that find facts and law and apply (or find) law are sometimes uncertain about their judgments and must therefore combine multiple assessments. There is no dispute as to how to combine the chances of arriving at some sequence when flipping a fair coin multiple times, but this method of combination, known as the product rule, is remarkably absent from statutory and judicial vocabularies. Lawmakers either violate or, more often, obfuscate this rule. They do not say what they do and they do not instruct others as to how to combine probabilistic assessments. I have referred to this obfuscation or refusal to follow logic as amounting to a suppression of the product rule and, equivalently, as presenting the puzzle of the math-law divide.

Roughly speaking, I have suggested that we can in fact explain, or at least rationalize, law's suppression of the product rule where multimember panels are used — especially when operating with a supermajority decision rule. First, the larger the panel and the greater the majority, the more confident we can be that the aggregate assessment is correct — and indeed more likely to be correct than any individual non-expert assessment. This is a fairly direct application of the Condorcet Jury Theorem. But this effect on its own is modest both be-

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assessments. Panel *B*'s outcome demonstrates, of course, that outcome voting is not a perfect substitute for precise assessments plus the product rule.

68. If we set aside the aggregation and product rule issues discussed here, a decent argument for outcome voting is that it removes the temptation to vote strategically. The more we ask for outcomes, the less room there is for strategic voting. My concern in this Article is not so much with issue and outcome voting on their own but rather on explanations for the suppression (or recognition) of the product rule. If one kind of voting substitutes for the product rule, and there is reason not to apply the product rule directly, then there is a good argument for that voting procedure.

Vote trading might be defended if we thought judges felt most intensely when they were also most expert or even most confident. On the other hand, judges might recognize subject matter expertise in their fellow judges, and defer accordingly. It seems more likely that trading would elevate judges' preferences, which in turn threatens to diminish the (Jury Theorem style) advantage of using more than one judge — offset, however, by the increased chance of bowing to real judicial expertise.

cause the jury and judicial panels we use are not huge and because it is not always clear when the Jury Theorem's assumptions — including the existence of a right answer as well as voters who are more likely than not to reach this answer — are met.

But there is a second feature of juries and other panels. It is that when a panel — and especially one that is unanimous or otherwise supermajoritarian — finds something to be more likely than not, our best guess following this panel's observation is a likelihood much more than that "more likely than not" decision point. The idea is that the panel's supermajority members are likely to be distributed across a range; they may well have reported the lower end of their group's assessments or even something below that because they were simply asked whether the preponderance of the evidence standard had been met. And our best assessment is made by drawing inferences from the assessments of all the members of the panel. In short, the product rule might be suppressed because the multiple assessments point to greater likelihoods than are reported. Finally, we do not ask the panel directly to carry out just such aggregation assessments with precision (followed by an application of the product rule) because to do so would be to encourage strategic voting.

I have also suggested, though less insistently, that we might turn the direction of the argument around, aiming to explain not the suppression of the product rule but the occasional use of supermajority voting rules. Courts might use such rules to promote jury deliberation and other familiar values, but they might also do so in order to obviate the need for the product rule. One problem with this approach is that it requires the claim that most jury cases present multiple, independent requirements or assessments.

Finally, there is the interesting comparative question. Future work may show that single judges, working without juries, incorporate the product rule in their rulings while their counterparts suppress the product rule in instructing juries. If so, the arguments advanced here will glisten in the comparative light. After all, my claim has been that conjunction strategies change in the face of aggregation advantages and difficulties. Single judges working alone obviously do not face the problem of aggregating non-identical assessments or of assessing the applicability of the Jury Theorem. But what if there is no evidence in American or foreign jurisdictions that lone judges combine likelihoods any differently from sizeable juries? We will have a theory that might work well enough in its limited domain, but have no real reason for so limiting its domain. We might then use the connection between conjunction and aggregation to help decide when to impose (or when to expect) supermajority voting rules.