At a Glance conference: 11 October 2023

Keynote address

Some Questions of Proof and Probability

Lord Leggatt[1]

Before the start of this address, the members of the audience were polled electronically and asked to answer the following question. "*Please assume the following facts. The claimant is negligently run down by a blue bus. The only issue is whether the bus was operated by the defendant. At trial the claimant adduces evidence showing that the defendant operates 80% of all the blue buses in town. If this is the only evidence adduced at the trial, is it sufficient to prove the claimant's case to the civil standard of proof?*"

(*In answering this question, you are asked to ignore issues that would in practice arise about whether any adverse inference could be drawn from either party's failure to adduce any further evidence and to focus simply on the content of the evidence assumed to be before the court.*)

Approximately two thirds of those who responded answered "yes" and one third answered "no".

Thank you for having me back. Those of you who were here last year may recall that I spoke then about whether you can tell from the demeanour of a witness whether the witness is lying. My original plan was to say more this year about witness testimony. But a year is a long time in law and, when I started to think about what to say to you, my interest fastened on another subject. The civil standard of proof may not immediately strike you as a stimulating topic. But I hope to convince you that it is and that it gives rise to some intriguing questions about probability and proof.

One person who I know will not need convincing is your former chair, Sir Nicholas Mostyn. You may not all be familiar with his paper (co-written with a statistician) published in *The International Journal of Evidence and Proof* called

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"Probability Reasoning in Judicial Fact-Finding".[2] But you will not be surprised to learn that it contains a characteristically robust defence of the reasoning in one of his own judgments against criticisms made by the Court of Appeal. I will come back to this shortly. But let me begin with a little legal history.

A lot has been written about the history of the criminal standard of proof – traditionally defined as proof beyond reasonable doubt. The civil standard has not received the same attention. In fact, there appears to be only one study of its history: an article published in the Florida Law Review in 2015.[3] This study locates the earliest recorded statement of the civil standard of proof in a work published in 1768. The author, Edward Wynne, was (according to the Oxford Dictionary of National Biography) a "gentleman scholar" who qualified as a barrister but "thanks to his large fortune did not need to pursue an active career in the law".[4] His *Dialogues Concerning the Law and Constitution of England* sought to explain principles of English law to non-lawyers. Wynne wrote that:

> "where evidence is produced on both sides, the verdict is given for the Plaintiff or Defendant, according to the superior weight of evidence."[5]

Similar language of superior weight or preponderance of evidence was used in several treatises on the law of evidence published in the early nineteenth century to describe the civil standard of proof. These treatises usually contrasted this standard with the standard in criminal cases where proof beyond reasonable doubt was required.

What explains this difference? Blackstone in his *Commentaries* explained the justification for the criminal standard by saying that "it is better that ten guilty

[2] See Ian Hunt and Nicholas Mostyn, "Probability Reasoning in Judicial Fact-Finding" (2020) 24 International Journal of Evidence and Proof 75, 81.

[3] John Leubsdorf, "The surprising history of the preponderance standard of civil proof" (2015) 67 Florida Law Review 1569.

[4] See Oxford DNB (2023), URL = <https://doi.org/10.1093/ref:odnb/30157>.

[5] Edward Wynne, *Eunomus or Dialogues Concerning the Law and Constitution of England* (1768) pp 153-4.

persons escape than that one innocent suffer."[6] In other words, to convict and punish an innocent person for a crime which that person did not commit is a grave injustice, and no comparable injustice occurs where a guilty person is acquitted. Accordingly, the law should err on the side of acquittal by requiring a high standard of proof to warrant a conviction. Civil proceedings are different. Generally, at least, in a civil case there is no reason to tilt the scales in favour of either party. Indeed, it would be unjust to do so. Take a money claim which turns on an issue of fact. If the claimant's factual case is true, the claimant has a legal right to be paid the money; if not, the defendant has a legal right to keep it. The parties' rights are symmetrical. Hence the principle of equal justice requires that the risk of error in the fact-finding process should be evenly distributed and not biased in favour of one or other party.

The language of "preponderance" or "greater weight" of evidence is still commonly used to describe the civil standard of proof in the United States. It is still occasionally used in England and Wales. But over the course of the nineteenth century another formulation of the civil standard - the "balance of probabilities" – emerged and gradually gained currency. No one ever seems to have discussed which formula is preferable or why. But by the 1920s this had become the dominant test.

In the last 50 years there has been another development. The balance of probabilities is sometimes now expressed numerically. The first example of this that I have found is in *Davies v Taylor*, in 1974, where Lord Simon of Glaisdale said:

> "Beneath the legal concept of probability lies the mathematical theory of probability. Only occasionally does this break surface - apart from the concept of proof on a balance of probabilities, which can be restated as the burden of showing odds of at least 51 to 49 that such-and-such has taken place or will do so."[7]

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[6] Sir William Blackstone, *Commentaries on the Laws of England*, 9th ed, book 4, ch 27, p 358 (1783).

[7] [1974] AC 207, 219.

In recent years statements of this kind have become increasingly common. Here is a typical example, from a judgment given in the High Court last year:

> "… I reach my conclusion on the basis of simple probability, that is, that it is more likely than not (more than 50% likely) that such and such a thing happened."[8]

Many more examples could be given. The current edition of *Financial Remedies Practice* has gone further. It assigns percentage probabilities to the requirements which need to be satisfied on various types of injunction application: for example, the "real prospect of success" required by the *American Cyanimid*[9] test is given an "approximate numerical probability" of >25%.[10]

What accounts for this trend of expressing the civil standard of proof mathematically? I see it as a reflection of the extent to which the concept of probability, understood mathematically, has pervaded modern thought - not only in the natural, social, and medical sciences but in everyday life. To give just two examples, it is now the norm for weather forecasts to express the prospect that it will rain as a percentage probability; and, as a cricket match progresses, a prediction of the outcome, expressed as a percentage probability, is now regularly displayed on televised broadcasts. Thinking in such terms has become more and more natural. For many people it is now intuitive to express the idea that something is more likely than not by saying that it has a greater than 50% probability.

There are cases where judges have expressed as a percentage not just the standard of proof but their view of the probability that an event occurred. I am not talking about cases where statistical evidence is relied on. My interest is in cases where there is no statistical basis for such statements. For reasons of time, I will take a single example: the judgment of Mostyn J in *Re D (A Child)*.[11]

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[8] *Dunbabin v Dunbabin* [2022] EWHC 241 (Ch), para 36 (HHJ Paul Matthews).
[9] *American Cyanimid Co v Ethicon Ltd* [1975] AC 396, 408.
[10] *Financial Remedies Practice* (2023/24), 12th ed, para 20.130. See also *A Local Authority v LD* [2023] EWHC 1258 (Fam), para 29 (Mostyn J).
[11] *Re D (A Child) (Fact-finding Hearing)* [2014] EWHC 121 (Fam).

The fact in issue in that case was whether the mother of a baby born with multiple ailments and diseases, and dependent on a constant supply of oxygen to survive, had deliberately switched off her child's oxygen supply while staying overnight in the hospital. There were agreed to be three possibilities: (1) the oxygen supply was not in fact turned off and a nurse was mistaken in thinking that it had been;[12] (2) a student nurse had accidentally turned off the oxygen tap when asked to check that the machine was working; or (3) the oxygen supply was deliberately turned off by the mother.

Counsel for the local authority invited the judge first to find as a fact on the balance of probabilities that the tap was indeed turned off, and then to decide on the balance of probabilities whether this was done deliberately by the mother or accidentally by the student nurse. Mostyn J rejected that approach. He found on what he called "the barest balance of probability" that the tap was indeed turned off.[13] But he pointed out that if he were then to treat this as a fact and decide whether the nurse or the mother was responsible, he could reach an illogical and unjust result. To illustrate this point, he put the probability that the tap was indeed turned off at 55%; and, if required then to choose between the two possible explanations for the tap being turned off, he assigned probabilities of 40% to a deliberate act by the mother and 60% to a mistake by the nurse. On the approach suggested, this would have led to a finding that the student nurse turned off the oxygen supply. But Mostyn J pointed out that on his illustrative figures the true probability of that event would be 60% of 55%, ie 33%, and therefore less probable than not. It would therefore be wrong to conclude that this was probable cause of the incident.

There was no appeal in that case. But in two other cases this type of reasoning has been criticised by the Court of Appeal. The first is *Milton Keynes Borough Council v Nulty*,[14] decided in 2013. In that case Toulson LJ rejected a submission that the court should ascribe percentage probabilities to different possible

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[12] It was agreed that the baby's blood oxygen level could have fallen abruptly even though oxygen was being administered.

[13] *Re D* [2014] EWHC 121 (Fam), para 35.

[14] [2013] EWCA Civ 15; [2013] 1 WLR 1183.

explanations of a fire and then see whether one had a probability greater than 50%. He described such an approach as "intrinsically unsound". He said this:

> "The chances of something happening in the future may be expressed in terms of percentage. Epidemiological evidence may enable doctors to say that on average smokers increase their risk of lung cancer by X%. But you cannot properly say that there is a 25% chance that something has happened ... Either it has, or it has not."[15]

Toulson LJ also said that to express the probability of some event having happened in percentage terms is "illusory".[16]

The second case, *Re A (Children)*, is the one I alluded to at the start of this talk. There the Court of Appeal adopted Toulson LJ's remarks. They referred to a judgment of Mostyn J and expressed "the greatest respect" – always a damning judicial comment – for "the erudition of Mostyn J's arithmetical approach" before saying that it was inappropriate. And they described the use of percentage probabilities as "pseudo-mathematical".[17]

The Court of Appeal in these two cases made a striking claim. They claimed that it is "intrinsically unsound" to ascribe percentage probabilities to past events. This claim is easy to refute.[18] Suppose that I toss two coins, wait for them to land, and then (without letting you see how they landed) ask: "What is the probability that they have both landed heads?" I do not imagine you will have any trouble in answering that it is 25%.

But it would, I think, be too quick to leave the matter there. That is because the distinction drawn by Toulson LJ between the probabilities of future and past events raises some fundamental questions about the nature of probability which are worth exploring.

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[15] *Nulty* [2013] 1 WLR 1183, para 36-37.
[16] *Nulty* [2013] 1 WLR 1183, para 35.
[17] R*e A (Children)(Care Proceedings: Burden of Proof)* [2018] EWCA Civ 1718: [2018] 4 WLR 117, para 59.
[18] See Ian Hunt and Nicholas Mostyn, "Probability Reasoning in Judicial Fact-Finding" (2020) 24 International Journal of Evidence and Proof 75, 81.

Any basic course on mathematics nowadays includes a section on probability. The mathematical rules of probability are well established. They can be expressed as a set of axioms from which conclusions logically follow. In themselves, they present no conceptual difficulty. But, to adapt the words of Lord Simon, beneath the mathematical theory of probability lies the philosophical concept of probability. What kind of phenomena are probabilities? If you read any of the literature discussing this question, you soon realise that there is more than one concept, or conception, of probability. Numerous different interpretations have been put forward. The subject is complicated by the fact that there is no agreement about how to classify the different theories nor how many different theories there are. For simplicity, I will adopt the classification which I have found the clearest and most useful. It is that used by the late Hugh Mellor, a philosopher whose lectures I attended many years ago at Cambridge, in his excellent philosophical introduction to the idea of probability.[19]

Mellor distinguishes three different conceptions or types of probability. The first he calls "physical probabilities" or "chances". Examples are the chance of winning a lottery or of living to be a hundred or of contracting a disease if exposed to it. (Where the outcome is a bad one, like contracting a disease, we often refer to such chances as "risks".) This is the conception of probability that Toulson LJ evidently had in mind. Statements about chances are inherently forward-looking. They are either statements about what will happen in the future or counterfactual statements about what would have happened if something had happened differently in the past. Chances are important in many areas of life. For example, the whole business of insurance is based on estimating chances.

Another way of thinking about probabilities is as degrees of subjective belief. Mellor calls probabilities of this kind "credences". Credences are measures of how strongly we believe propositions, such as that it will rain next week or that England will win the Ashes, or that Lee Harvey Oswald did not act alone when he shot President Kennedy. The beliefs may relate either to the future or to the past. But there is no necessary connection between the strength of my belief

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[19] See DH Mellor, *Probability: A Philosophical Introduction* (2005).

that something will happen or has happened and any facts about the world, and two individuals can assign different subjective probabilities to the same proposition given the same evidence. The first person systematically to develop a subjective theory of probability was the brilliant philosopher, mathematician and economist, Frank Ramsey, who made seminal contributions to all those fields before he died at the age of only 26 in 1930.[20] He developed the idea that degrees of belief can be quantified by seeing what odds someone is prepared to accept in a bet on a particular outcome. If I am prepared to bet £4 in return for winning £6 and getting my stake back (i.e. £10 in all) if Manchester City wins the Premier League this season, this can be interpreted as my ascribing a subjective probability of at least 40% to that occurrence.

A third way of understanding probability is as a measure of the extent to which a given body of evidence supports a proposition. Probabilities of this type are often referred to as "epistemic" probabilities (after the Greek word for knowledge) because that they are always relative to a given state of knowledge. Going back to my two coins, given your knowledge, which includes knowledge of the general properties of coins but not sight of how these coins landed, the probability that they both landed heads is 25%. But if I you saw that one had landed heads but could not see the other, then, given that knowledge, the probability that both landed heads would be 50%. One way of thinking of epistemic probabilities is as degrees of justified belief. In principle, the more strongly our evidence supports a particular hypothesis, the greater the degree of belief in that hypothesis which the evidence justifies. A pioneer of this epistemic conception of probability was one of Ramsey's teachers at Cambridge, John Maynard Keynes, who before the work in economics for which he is most famous wrote an important treatise on probability.[21]

The distinction between these three different conceptions of probability sheds light on the role of probability in English law. Courts have no difficulty in principle in estimating chances, even when there is no scientific or statistical

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[20] His seminal essay on "Truth and Probability", written in 1926, was published in RB Braithwaite (ed), *The Foundations of Mathematics and Other Logical Essays* (1931) pp 156-198.
[21] JM Keynes, *A Treatise on Probability* (1921).

basis for doing so. In particular, courts regularly discount awards of compensation by ascribing a percentage to the chance that something will occur or would have occurred but for the defendant's conduct. An example is discounting a financial award in divorce proceedings by an estimate of the chance that a person will remarry.

When it comes to deciding what happened in the past, the law takes a different approach. Whether or not a past event happened is not a matter of probability in the sense of chance. Once an event has or has not happened, chance no longer comes into it. But we can and do properly say that it is more probable than not that an event happened. The conception of probability which best explains such statements is the epistemic conception. Chances are not apposite. Nor are credences. We expect courts to reach conclusions which are not just statements of the judge's degree of subjective belief but are justified by evidence. The epistemic conception of probability fulfils this role. It provides a method of reasoning from given evidence to a finding of fact by measuring the extent to which that evidence supports or justifies belief in such a finding.

Toulson LJ was therefore right to distinguish between chances and matters of past fact and to say that whether a past event happened is not a matter of chance. But he was wrong to suggest that it is "intrinsically unsound" to speak about the probability of a past event. It makes perfectly good sense to do so, provided we are clear that we are talking about epistemic probabilities and not about chances.

This is not to say that there is generally any rational basis for ascribing a number to the probability, on given evidence, that a particular event happened. Situations in which such quantification is possible are rare. Our ordinary judgments are much more broad brush. We may have reasonable grounds for believing that a certain event is extremely unlikely to have happened, or fairly unlikely to have happened, and so on. We can also often rationally compare or rank the probability of competing claims so as to conclude that, on given evidence, one claim about what happened is more probable, or much more probable, than another. But in most circumstances Toulson LJ was surely right when he said that to express the probability of

some event having happened in percentage terms is "illusory" - by which I take him to have meant that it gives a misleading appearance of precision to an assessment that is necessarily imprecise. A statement such as "the probability that the oxygen tap was turned off is 55%" appears scientific; but, if probed, it will inevitably turn out to be in large part an expression of a purely subjective degree of belief, since there is no system of measurement by which a numerical value can be given to the degree to which the evidence supports such a belief.

I do not suppose for a moment that Mostyn J in *Re D (A Child)* thought otherwise. When he ascribed percentages to the three possible scenarios in that case, he said that he was giving figures only "for the sake of example".[22] There is nothing intrinsically unsound about that. Furthermore, the point that he was using numbers to illustrate was a good one. But assigning numbers to probabilities which are incapable of being represented numerically is liable to give a wrong impression of the nature of the fact-finding process. For that reason, it seems to me better to avoid it.

I turn from the standard of proof to the burden of proof in civil cases.

Why have a burden of proof? If, as I have argued, in civil cases the principle of equal justice generally requires the risk of error to be distributed evenly between the parties, how can it be right to bias the scales, even if only slightly, in favour of either side? An answer sometimes given is: to cater for a situation where the probabilities are equally balanced. It is said that, as a court does not have the option of declining to decide a case, the burden of proof is needed to operate as a tie breaker in this situation.[23]

I would accept that this is a theoretical reason for placing a burden of proof on one party or the other. But it is not a practical reason. I find it hard to imagine reaching a conclusion that the probability that a statement of past fact is true and the probability that it is false are precisely equal. That would require a very finely calibrated assessment of probability. As with expressing probabilities as

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22 *Re D* [2014] EWHC 121 (Fam), paras 34 and 37.
23 See eg *Hovis Ltd v Louton* [2021] 11 WLUK 299, para 15; *Zuckerman on Civil Procedure: Principles of Practice*, 4th Ed (2021), para 22.56.

percentages, it is surely unrealistic to suppose that the strength of evidence is capable of being measured with such precision.

I have come across one case - though only one - where an equal balance of probability was given as a reason for resorting to the burden of proof. *Morris v London Iron and Steel Co Ltd*[24] was an employment claim for unfair dismissal. The issue was whether the claimant employee had been dismissed by his employer or whether - as the employer alleged - he had voluntarily resigned. The burden of proof was on the employee to prove that he had been dismissed and the tribunal held that he had not discharged that burden, so the claim failed. In giving their reasons the tribunal said:

> "After considering all the evidence and observing the demeanour of the witnesses we find that the probabilities are equally balanced."[25]

Taken at face value, this looks like a rare, possibly unique, instance of a fact-finding tribunal deciding that the probability that an alleged event occurred was precisely equal to the probability that the event did not occur. But I doubt that this is what the tribunal really meant. In the next sentence, immediately after the words I have quoted, they said: "We do not feel able to make a finding of fact as to which version of events is to be preferred."

That is a different reason for their decision. A conclusion that the tribunal does not feel able to make a finding as to which version of events is more probable is not the same as making a finding that the probabilities of the two versions are exactly equal. A positive finding of equal probability would, I have suggested, require a degree of precision in the evaluation of evidence which is unrealistic. A conclusion that the evidence does not permit a positive finding one way or the other, on the other hand, is an understandable response in cases where, for one or another reason, the evidence does not provide an adequate basis on which to rest a conclusion either that a fact in issue is true or that it is false.

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[24] [1988] 1 QB 493.
[25] See *Morris* [1988] 1 QB 493, 499.

In *Morris* the Court of Appeal upheld the tribunal's approach. May LJ (who gave the lead judgment) said that "[j]udges should, so far as is practicable and so far, as it is in accordance with their conscientious duty, make findings of fact". But he also said:

> "In the exceptional case, however, a judge conscientiously seeking to decide the matter before him may be forced to say 'I just do not know': indeed to say anything else might be in breach of his judicial duty."[26]

That, in the Court of Appeal's view, was where the employment tribunal had ended up, with the result that the tribunal was entitled to fall back on the burden of proof. There is a line of later decisions of the Court of Appeal following and endorsing this approach.[27]

It is worth looking in more detail at the leading case on this point: the decision of the House of Lords in *Rhesa Shipping Co SA v Edmunds (The "Popi M")*,[28] sometimes referred to as the "yellow submarine" case.[29] The claimant's vessel, "Popi M", suddenly sank in deep water in the Mediterranean in near perfect weather conditions. The immediate cause of the sinking was a flood of water into the vessel's engine room said to have entered through a large opening in her shell plating. A claim was made on the insurance which covered loss caused by perils of the sea. Competing theories were advanced as to the cause of the sinking. The shipowners' case was that the vessel had collided with a submerged object, which they suggested was a submarine. The insurers' theory was a sudden, catastrophic failure of the shell plating resulting from prolonged wear and tear over many years - a risk not covered by the insurance.

The trial judge was Bingham J. He first considered the owners' submarine hypothesis and gave a series of reasons for regarding it as improbable. He then analysed the wear and tear theory advanced by the insurers. After examining

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[26] *Morris* [1988] 1 QB 493, 504.

[27] See *Stephens v Cannon* [2005] EWCA Civ 222, [2005] CP Rep 31, para 46; *Verlander v Devon Waste Management* [2007] EWCA Civ 835, paras 19, 24; *Barnett v Medway NHS Foundation Trust* [2017] EWCA Civ 235, [2017] Med LR 217, paras 34-35, 55; *Constandas v Lysandrou* [2018] EWCA Civ 613, paras 22-26.

[28] [1985] 1 WLR 948.

[29] See eg JR Cunningham, "The Popi M and the Yellow Submarine" (1996) 14 IBL 32.

the expert evidence, he concluded that this theory could effectively be ruled out. That, he considered, left him with a choice between the owners' submarine hypothesis and the possibility that the casualty occurred as a result of wear and tear but by a mechanism which remained in doubt. Faced with those alternatives, Bingham J decided that:

> "... despite its inherent improbability, and despite the disbelief with which I have throughout been inclined to regard it, the owners' submarine hypothesis must be accepted as, on the balance of probabilities, the explanation of this casualty."[30]

This decision was upheld by the Court of Appeal but reversed by the House of Lords.[31] Lord Brandon, who gave the reasons for allowing the insurers' appeal, remarked that "on this occasion even Homer nodded"[32] - a comparison which would certainly lessen the disappointment that a judge feels on being overruled.

The fundamental error identified by the House of Lords was that the judge had regarded himself as compelled to choose between two theories, both of which he regarded as extremely improbable, or one of which he regarded as extremely improbable and the other as virtually impossible, and failed to consider the third possibility which was open to him, of simply finding the claimant's case not proved.[33] Lord Brandon emphasised that a judge is not bound always to make a finding one way or the other with regard to a fact in issue but has open the third alternative of saying that the party on whom the burden of proof lies has failed to discharge that burden.[34] He said:

> "No judge likes to decide cases on [the] burden of proof if he can legitimately avoid having to do so. There are cases, however, in which, owing to the unsatisfactory state of the evidence or otherwise, deciding on the burden of proof is the only just course for him to take."[35]

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[30] *The "Popi M"* [1983] 2 Lloyd's Rep 235, 248.
[31] See *The "Popi M"* [1984] 2 Lloyd's Rep 555 (CA); and [1985] 1 WLR 948 (HL).
[32] *The "Popi M"* [1985] 1 WLR 948, 957G.
[33] *The "Popi M"* [1985] 1 WLR 948, 954E-F, 956E and 957G.
[34] *The "Popi M"* [1985] 1 WLR 948, 951D and 955H.
[35] *The "Popi M"* [1985] 1 WLR 948, 955H-956A.

The "Popi M" and the line of Court of Appeal cases starting with *Morris* show that the function of the burden of proof is not (or at least not primarily) to cater for a theoretical situation where the probabilities on each side are adjudged to be precisely equal. Nor is it to offer an escape route for judges who find it difficult to make up their minds. It is to provide a rule of decision in cases where the evidence is inadequate to permit a fact-finding tribunal reasonably to make a positive finding either way on the balance of probabilities. There are cases in which, whether because the evidence has too many gaps or is too unclear or unreliable or is insufficiently specific, the tribunal does not have reasonable grounds on which to base a conclusion either that a factual allegation in issue is more likely than not to be true or that it is more likely than not to be false. In such cases deciding on the burden of proof is, in Lord Brandon's words, "the only just course" to take.

It is the only just course to take because we do not want judges to make findings of fact which are not rationally supported by evidence. If the evidence is inadequate to justify a decision one way or the other, then rather than make a decision for which there are no reasonable grounds it is better to fall back on a default rule which allocates the risk of such an outcome in advance to one or other party. That is the primary function of the rules which allocate the burden of proof. Those rules are rules of substantive law which identify the essential elements of a claim or defence and hence the party in whose favour a fact in issue must be found for the claim or defence to succeed. It is an efficient principle, and a just one, to place on the party which needs a finding in its favour in order to succeed on an issue the onus of ensuring that there is enough evidence and evidence of sufficient quality placed before the tribunal to enable the tribunal to make a finding. If such evidence is lacking, the issue will be decided automatically by default against the party which bears this burden of proof.

If we focus exclusively on probabilities, this point is liable to be overlooked. To explain this feature of proof, another concept is needed. The first person to identify this concept clearly may have been Keynes. In his *Treatise on Probability* he wrote:

> "As the relevant evidence at our disposal increases, the magnitude of the probability of the argument may either decrease or increase, according as the new knowledge strengthens the unfavourable or the favourable evidence; but something seems to have increased in either case – we have a more substantial basis upon which to rest our conclusion."[36]

I will refer to this feature as the "adequacy" of the evidence on which the assessment of probability is based.

Sometimes, where the evidence is inadequate, it may simply not be possible to judge the likelihood that something happened reliably enough to reach a rational conclusion one way or the other on the balance of probabilities.

To illustrate this point, imagine a jar in which I have placed 100 marbles. You are told that all the marbles in the jar are either black or white but not how many there are of each colour. Suppose that 20 marbles are taken at random from the jar; 13 are black and 7 are white; and you are asked to determine whether, on the balance of probabilities, I have placed more black marbles than white marbles in the jar.

If you had to reach a conclusion on this limited information, the only conclusion you could rationally reach would be that the jar probably contains more black marbles than white. Now suppose that a much larger sample is taken: 70 marbles are removed, and you find that 40 are black and 30 are white. Given this information, the probability that I placed more black marbles than white marbles in the jar is lower than the probability based on the first sample, as the percentage of black marbles in the second, larger sample is only around 57% compared with 65% in the first. Yet there is clearly a more substantial basis on which to rest a conclusion, and you would naturally feel much more confident in inferring that the jar contains more black marbles than white.

I believe that this example sheds light on the problem generally known as the "blue bus problem", on which a great deal of ink has been spilt since it was

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[36] JM Keynes, *A Treatise on Probability* (1921) p 78.

raised by in an article in the Harvard Law Review in 1971.[37] This is the problem that I posed to you before the start of this talk.

Scholars have been debating this problem for more than 50 years. Most agree that on the hypothetical facts the claimant has not discharged the burden of proof, but they disagree about why. Many different explanations have been proposed.

My suggested explanation relies on the distinction I have described between the probability of an event on given evidence and the adequacy of that evidence. If the only evidence we have is that the defendant operates 85% of the buses in the town and we are asked whether, given this information, it is more probable than not that the bus which hit the claimant was one of the defendant's buses, then the answer is yes. But it does not follow that this evidence alone is sufficient to discharge the burden of proof. Most people would say that it is not. It is not that there is anything wrong with statistical evidence per se. But the evidence adduced is, by itself, too insubstantial a basis on which to rest a finding that the defendant operated the bus in question. The two main reasons for its inadequacy are, first, that too much relevant information is missing and, second, that the available information is insufficiently specific. To provide an adequate basis for a positive finding, we would need some more and more detailed evidence: for example, evidence about bus routes and timetables from which we could see which company's buses would be expected to have been travelling down the street where the accident occurred at the relevant time. On the unsatisfactory state of the evidence assumed to be before the court, the appropriate conclusion is that the claimant has failed to discharge the burden of proof.

There is a tendency to think of the burden and standard of proof as very closely related concepts and to interpret the standard of proof as specifying the extent or degree to which the burden of proof must be discharged.[38] I suggest that it is more illuminating to view the two concepts as relating to two different dimensions on which evidence must be assessed. The standard of

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[37]   Laurence Tribe, "Trial by Mathematics: Precision and Ritual in the Legal Process" (1971) 84 Harvard Law Review 1329, 1340-1.

[38]   See eg *Murphy on Evidence*, 15th ed (2017), para 4.11.

proof concerns the degree of epistemic probability required to justify a factual finding. The burden of proof, on the other hand, concerns the adequacy of the evidence which forms the basis for this assessment.

I have suggested that the rationale for the civil standard of proof is that fairness requires the risk of error in deciding factual issues to be evenly distributed between the parties. The distribution of the risk of error between the parties is not, however, the only relevant consideration in fashioning the rules that govern proof. Deciding factual issues by spinning a coin would distribute the risk of error equally but it would plainly not be an acceptable basis for a judicial decision. As well as the distribution of the risk of error, the extent of the risk of error is important. We do not expect courts to be infallible, but we expect them to reach factual conclusions which are rationally supported by evidence. Cases where the evidence is so inadequate as to make this task impossible are thankfully rare. But it is in such rare cases that, to maintain the court's legitimacy, it is necessary to fall back on the rules that allocate the burden of proof.