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Hume-Russell Causation in Lieu of Actual Causation: An Economic Turn[1]

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ABSTRACT: HR causation, short for Hume-Russell causation, is a type-causation-based account of causation which, while capturing some salvageable features of commonsensical actual causality, makes sensible causal attributions in complicated cases such as over-determination, pre-emption, joint cause, and mixed cases in such a way that social goals are more efficiently achieved. This novel notion of HR causation is justified by, so far as social evolution is concerned, the fact that a society adopting HR causation typically outperforms its counterpart society that resorts to actual causality in liability ascription.

KEY WORDS: actual causation, but-for test, HR causation, Law and Economics movements, probability exhaustion, type causation

1. Causal Skepticism and the Economic Turn

Russell made the following remark about causation in Russell (1913):[2]

> The law of causality, I believe, like much that passes muster among philosophers, is a relic of a bygone age, surviving, like the monarchy, only because it is erroneously supposed to do no harm. (1)

However, today, a century and a decade after Russell's remark, causation still plays, as it always does, an essential role in law and other areas. Causal eliminativism has apparently fallen out of favor with philosophers. According to Blanchard (2016), "... virtually everybody nowadays rejects Russell's causal eliminativism ..."

To better grasp what one might mean by "causal eliminativism" (CE, for short), we can distinguish two modes of it. CE1 is the thesis that no

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[2] Thanks to an anonymous referee for reminding me that the relevant context of the quote is modern physics, not tort law, so it may not be appropriate to attribute my sceptical position concerning the role actual causation may play in tort law to Russell.

metaphysical reality corresponds to actual causation.[3] CE2 is the thesis that the pragmatic issue of responsibility attribution can be dealt with adequately without resorting to actual causation, a metaphysically substantial relation. According to CE2, causation is reducible to responsibility bearing, which is, allegedly, a social rather than metaphysical reality.

In these terms, Russell was a proponent of CE1, but he had not been successful in convincing others to accept it. In this paper, we will not pursue the task of proving CE1 for Russell. We shall rather point out that CE2 is a more interesting and more relevant thesis to explore for people working in a practical subject such as law.

When it comes to causal eliminativism, Russell certainly is not without alliance. In particular, in law, American Legal Realism and its two intellectual descendants, the Critical Legal Studies movements and the Law and Economics movements, respectively, all adopt a skeptical view toward causation, either being reluctant to reckon the existence of a natural relation in the world called "causation" or being reluctant to admit that actual causation plays an essential role in liability ascription. The attitudes of the three movements are briefly summarized below.

For American Legal Realism, cause-in-fact is more a matter of policy[4] than a matter concerning a relation in the physical world, and to be 'the cause' of some harm is just another way of saying one is responsible for the harm.[5]

The attitude of the Critical Legal Studies is reflected in Mark Kelman's remark:

> My arguments in essence support the more skeptical Realists, who argued that causation judgments could not be factual because no single concept of causation was uniformly satisfactory. I believe the Realists were indeed correct, that one must be a causal skeptic not only as to the possibility of learning facts about the external world but in deciding what the concept of cause might mean. (Kelman 1987a: 591)

What Kelman primarily did was attacking the counterfactual theory of causation—arguably the dominant test of cause-in-fact in law—and concluded that cause-in-fact in law cannot be a matter of fact. However, Kelman cannot be said to have established CE1, because even if one could prove that neither Lewis' counterfactual theory of causation nor any of the six possible modifications of it outlined in Chapter 4 of Moore (2009) is a consistent

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[3] Actual causation, alternatively called 'token-causation' or 'singular causation', is to be distinguished from type-causation (or, general causation), which merely maintains that certain type of events are typically followed by another type of events.

[4] That is, a matter depending on "our free and independent sense of justice and—perhaps—the interest of society" (Edgerton 1924: 347).

[5] See Malone (1956).

account of causation, it is still a long way from establishing that causation-in-fact is not a real relation in the world—it is nearly impossible to exhaust all possible accounts of causation and disprove them all.

Like the Realists and the Crits, proponents of the Law and Economics movements are typically skeptical about 'causation'. However, unlike the Realists and Crits, its ground for favoring one policy over the other is more specific: liability ascription should encourage efficient behavior.[6] For example, Steve Shavell offers a principle-based account of causation in Shavell (1980a) and has the following remark near the end of the paper:

> Questions about causation are to an important extent resolved by resort to intuitions about the justness of applying a rule of liability. In practice it is often asked when, according to common sense notions, liability of an injuring party for harm done ought to be contemplated; and it is not asked how liability would affect incentives or otherwise influence the attainment of certain basic social goals. Thus if the instrumentalist approach yields a successful explanatory theory, it must be that the intuitions about what is just comport with the application of a cost-benefit calculus in relation to the posited social goals. (Shavell 1980: 502)

A hardcore skeptic of actual causation, presumably, would disregard causal talks altogether. However, here, while acknowledging that, in practice, posited social goals and means to maximizing them do not concern us in our causal judgment, Shavell seems to remain hopeful that the two would comport with each other. This inevitably makes someone wonder whether Shavell is really a skeptic of causation.[7] As Moore correctly points out, 'unnoticed by the economists was that this monistic policy focus on efficiency made their causal skepticism unnecessary and beside the point' (Moore 2009: 93). In our terminology, Moore maintains that the economists' position makes CE1 irrelevant insofar as pragmatics is concerned. In other words, the economists are causal skeptics in the CE2 sense. In this regard, whether actual causation turns out to comport with the calculus of the efficiency in achieving social goals or not is beside the point. However, CE2 is interesting only when actual causation does not comport with the calculus, and indeed, in practical fields such as law, particularly tort law, they occasionally make contradictory liability ascriptions. Therefore, if efficiency is the ultimate guiding principle, actual causation will be eliminated in the end, as it is not the *fittest* insofar as efficiency in achieving social goals is concerned.

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[6] See, for example, Calabresi (1975), Shavell (1980), and Landes & Posner (1983).

[7] General remarks on economical analyst's ambiguous attitude towards actual causation requirement in tort law can be found in Wright (1985), in which Wright review Calabresi (1975), Shavell (1980), and Landes & Posner (1983) in turn to refute their respective attempts to incorporate limited actual causation requirements into their supposedly causal skeptic accounts.

Later in this paper, I shall introduce HR causation[8] to capture the spirit of the Law and Economic movements without defending CE1.[9] Whether the legal meaning of the term "cause" differs from the ordinary meaning of the term in non-legal English, or whether any of them can be reduced to, or explained by, the HR cause will not be addressed in this paper. Instead of accounting for past court rulings, we shall merely be concerned with what HR causation would say in general about liability ascription in real world cases.

My approach basically follows that of David Hume in Hume (1748), namely, formulating an HR causation as a spatiotemporal instantiation of a type causation, where a type causation, or a so-called "causal law," is some sort of uniformity in sequence between event-types,[10] in the sense that the obtaining of the cause-type typically increases, in contrast to the non-obtaining of it, the probability of the effect-type. The motivation for HR causation is the same efficiency-in-meeting-social-goals principle that motivated the Law and Economics movements. Our treatment differs from the economists such as Calabresi, Shavell, Landes, and Posner, who tried to incorporate basic actual causation requirements into their scheme, in that, while granting our opponents a notion of causation-in-fact for argument's sake, we shall show that that notion, whatever it is, often steers us away from, rather than towards, the principle of maximizing the social welfare. We shall first sketch how actual causation fails to serve our posited social goals. Then, in Section 2, we formulate the HR causation scheme, which supposedly performs better.

1.1 Some Complications Concerning Causation in Law

It is commonly held in law that causation grounds responsibility.[11] When there is an underlying causal relation between an act and an effect, the agent

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[8] Short for Hume-Russell-causation, which, while bearing the name 'causation,' has nothing to do with any existing versions of "actual causation." The 'R' in the name 'HR causation' is added to pay tribute to Russell for his insightful skepticism about causation.

[9] This attitude resembles that of Hume, which was termed 'skeptical solution' in Kripke (1982: 66–8): "... causation makes no sense when applied to two isolated events, with the rest of the universe removed. Only inasmuch as these events are thought of as instances of event types related by a regularity can they be thought of as causally connected . . .," except that I will not try to *reduce* any notion of "actual causation" adopted by philosophers, judges, or lay people, to this HR causation, because a causal skeptic in the CE2 sense could not care less about the ontological status of actual causation or its pragmatic merits.

[10] The notion of event is widely adopted in the literature on causation. The term 'event types' is used here only as a placeholder. Strictly speaking, the causal relata of type-causation/causal law are not "event-types" at all. We shall spell out our HR account more carefully in subsequent sections, in terms of notions other than "events," "facts," "facta," etc., so as to make our account more concrete and to avoid future complications.

[11] See Moore (2009) and the reference therein.

who performs the act is responsible for the effect. However, there are complications in various cases where the so-called causal relation is hard to determine, giving rise to cases that are termed 'over-determination,' 'joint cause,' 'pre-emption,' 'lack of a proof of causation,' etc., which have received great attention from philosophers.[12] On the other hand, the lack of a proof of causation (for the claimant), or the difficulty of getting one, is an important topic in law also, to the extent that an entire book, Sandy Steel's *Proof of Causation in Tort Law*, is devoted to it, even though it is not an issue that typically concerns philosophers.[13]

In sum, so far as causation in law is concerned, there are three domains of cases:

C_0: straightforward cases on which intuition and nearly all causal theories agree.

C_1: complication-1 cases, where **proof** of the underlying causal relation is difficult to obtain.

C_2: complication-2 cases, where the underlying causal relation itself is difficult to determine.

Now, to illustrate that actual causation deviates, fundamentally, from the principle of maximizing posited social goals, we shall, instead of focusing on the problematic cases in C_1 and C_2, which attract the attention of most causal theorists, tackle the core domain C_0—the domain of cases where nearly everyone perceives a clear causal relation between an act and an effect[14]—and show that the naive notion of actual causation does not ground liability in accordance with the principle of maximizing social welfare.[15]

The account of HR causation comes with two prominent features. One is that difficult cases in C_1 and C_2 that concern causation theorists pose no threat to the account, as, according to the account, there is no need to pin down a specific "cause token," be it an event or a fact, for a specific "effect," be it an event or a fact. The other is that, for limited cases, liabilities can be grounded on the instantiation of a type-causation, without hypothesizing a

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[12] See, for example, Paul and Hall (2013) and Halpern (2016).

[13] As long as there is an underlying cause-in-fact, the case is "closed" for philosophers, even if the claimant is still struggling to find a proof.

[14] Of course, Hume, Russell and the author are excluded.

[15] By challenging the common sensical causal judgement, we *seem* to disagree with Lewis's position concerning our common sense about causation, namely that "[w]hen common sense delivers a firm and uncontroversial answer about a not-too-far-fetched case, theory had better agree. If an analysis of causation does not deliver the common-sense answer, that is bad trouble." (Lewis 1986: 194, which is quoted in Paul and Hall (2013), though Paul and Hall disagreed with Lewis on this issue.) However, as a CE2 skeptic, we need not refute common sensical causal judgement at all, we merely need to show that such causal ascription does not help us realizing posited social goals.

connection between a specific act token and a specific effect token.[16] Moreover, the resulting liability ascription in some way reflects the insight of the economists.

As a corollary, the three exceptional cases where a proof of causation is unavailable, and their associated principles, namely, *Reliance upon wrongful conduct principle*, *Prevented claim principle*, and *Proven causation principle*,[17] that concern Steel are no longer "exceptional." Rather, they pave the way to the true nature of liability ascription—there is no need to find proof of causation at the token level, and the liability of a defendant need not be linked to the loss of the claimant at the token level.

1.2 A Scenario

The following scenario helps us see that cause-in-fact does not always produce a responsibility attribution that minimizes the risk of the recurrence of an undesired act. It is a seemingly non-problematic case of actual causation. A rich man, Jack, lived in a house beside a tall apartment building, and he placed a valuable vase in the front yard of his house. One day, a boy living in the tall building went up to the top of the building and threw a baseball down, intending to hit a bird in Jack's front yard. The baseball hit the vase, and it was broken into pieces. According to actual causation theorists, the boy's act is the sole cause of the breakage of the vase. Thus, based on a causation-based account of liability, he or his parents should be held responsible for the loss of Jack. I guess most people would agree with the verdict. However, let me reveal more story details, and you can decide whether you would stick to the original judgment.

Actually, Jack owned 5 vases of the same make, each of them with a market value of $10,000. Jack had a strong desire to display a vase in his front yard. As a result, three of the vases had been broken previously in each of the following ways: swept by a gale onto the wall, knocked over when a wild cat was chasing another, and crashed into pieces by a penny-less homeless child who threw a rock into his front yard, respectively. As Jack could not claim any compensation from any party for the loss of the three vases, he decided to move into a new house in a serene and wealthy neighborhood where no gale, wild cat, or poor neighbor could harm his vases.

Even so, with only two vases left, Jack was very cautious in placing one of them in his garden, especially when he was planning a 10-day vacation, during which period he had no way to catch any person who broke his vase,

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[16] This is precisely why we term our account "Hume-Russell"—like Hume and Russell, we are not committed to the existence of such a connection.

[17] Readers unfamiliar with Steel's work can see Appendix 1 to get a rough idea.

and he could not ban children from going up to the top of the nearby tall building in that period also. According to his estimate, a child's throwing an object down into his garden has 30 percent chance of hitting his vase. So if 10 children throw something down for a 10-day period, the chance that he comes back to find his vase broken after the vacation is more than 97 percent, more precisely, $1 - (7/10)$.[10] Jack placed his fourth vase in his garden and took a 10-day vacation, and set up CCTVs to record everything that happened on top of the neighboring building and in his garden, confident that in the very likely event that his vase got struck by something during the 10-day span, he could sue someone for compensation.

As the odds had it, Jack came back with a broken vase awaiting him. The CCTV on top of the tall building did give him clear images of 10 children that went up to the top, one on each day. They all carried a baseball of the same make, and the garden were left with 10 baseballs and a broken vase.[18] The situation was complicated by the fact that the CCTV overseeing his garden was hit by a baseball too, so that all images about his garden were destroyed. As a consequence, no one knew on which day the vase was broken. This resembles a version of the Two Hunters cases considered by Sandy Steel in his book. So, without Steel's principles concerning exceptions,[19] Jack failed to obtain any compensation once again, this time for the lack of a proof of causation in a defendant indeterminate situation.

Now, to reveal the truth, the child whose baseball struck Jack's vase was actually the boy that we mentioned in the very beginning of the story. For most actual causation theorists, this piece of information in effect turns the fourth vase case from a C_1 or C_2 case to a C_0 case, and allows Jack to seek full compensation from this boy (or his parents). But is this the right move to make from the economist's point of view? The fact that, only a moment ago, Jack still could neither prove whose baseball broke the vase nor prove whose baseball broke the camera—thus was deprived of a chance of obtaining a proof of the former nature—might prompt us to have a second thought

[18] Note that in Hitchcock (2004: 410), a similar scenario (Scenario 6)—two gunmen are shooting at a Ming vase, each with a certain chance of hitting the vase, yet the first gunman's shot hits the vase while the second gunman misses it—is sketched to show that the raising of the probability of the vase's shattering alone does not entail that the second gunman's shot is a cause of the shattering of the vase. Our story here in effect increases the number of gunmen and the numbers of vases and incorporates social factors into it to illustrate the situation even better. Furthermore, the HR account that shall be introduced in Section 2, for which probability-raising is one but *not* the only one criterion for being a cause, can adequately deal with Hitchcock's Scenario 6 in a systematic way.

[19] Steel's *Prevented claim principle* is unapplicable here, because a possible proof of causation had been destroyed by someone who we could not identify.

about whether to have an alternative conviction.[20] After all, there were nine other kids who did the same thing as he did. Why should we hold this boy solely responsible for the breakage of the vase? If obtaining this so-called "proof of causation" would cost Jack another $10,000, on what ground do we require a claimant to obtain such a proof? Does pinning down the kid who broke the vase serve any retributive or corrective purpose? Even if it does, can we not achieve the same without spending that extra amount of money?[21]

With only one vase remaining and an unquenchable desire to exhibit a vase in his garden, what should Jack do?

1.3 The Economic Turn and Two More Scenarios

Civilization is often driven by realistic needs—instead of avoiding the forbidden fruit, we try to optimize our fruit production by all means. We learn to pay more attention to various possible relations between event types than to the association of event tokens. For instance, there is no point giving a special award to the police officer who, in a group action with 100 officers each guarding one exit of a large building, happens to guard the exit that the criminal tries to escape through, just as there is no point trying to figure out which grid of a net blocks the escape route of a bee. It is possible that commonsensical actual-causality liability attribution, which tries by all means to locate the kid who broke a vase, does not always align with the economic turn.

In an economic turn movement, type causation plays an essential role. However, it is easy for proponents of actual-causation-based liability to mistake some instantiation of an event type for an event token and mistake some instantiation of a type causation—which is defined by a relation between two types of events[22]—for a relation between two event-tokens, and, as a consequence, do not always make a decision that contributes to the achievement of posited social goals. Pragmatically, we should be more sympathetic to risk theory, in which possible consequences following an act play

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[20] This is essentially the two-hunters case: there are only two baseballs thrown, and we know that one destroys the camera and the other destroys the vase, but we don't know which one does which. Do we have to let both kids go, or we should introduce exceptional rules for such cases as Steel does in his book?

[21] Consider 1) fining one kid with $10,000, while letting go of nine others who did the same, and 2) fining 10 kids each with $1,000. Both can serve the purpose of deterring the kids from doing it again. However, for option 2), we need not strive to find out whose baseball hit the vase.

[22] Here I borrow layman's usage of "events." According to it, smoking is a type of events while getting cancer is another. However, this by no means implies that there are *event tokens* such as "John's smoking a cigarette at *t*." Regarding the latter as an *instance* of smoking, without worrying about whether "John's smoking a cigarette at *t*" and "John's smoking a cheap cigarette at *t*" are the same event-token, would have been a better option.

an essential role in deciding the liability of the actor(s). The scenario mentioned in the last subsection seems to suggest that we can consider developing a type-causation-based account[23] for which no association between an action token and a consequence token is ever needed.

Now, an important clarification is at hand. One might feel that the scenario is a bit *ad hoc* for the HR scheme. Are we really prepared to stick to the scheme for other possible variations of the story also? For example, a month after he left for the vacation, Jack came back and found that the vase was unharmed. He then continued his vacation and came back 11 months later to find his vase broken. Should the kids who threw baseballs down in the first month be held responsible for the breakage also? Or, a month before the end of his vacation, Jack came back to find that his vase was already broken. Can the kids who threw baseballs down in the last month be waived of their responsibility? Or, in the unlikely event that after his vacation, Jack came back and found that his vase completely unharmed. Are the kids who threw a baseball down still to be fined? Finally, how about the kids who threw baseballs down the garden in the month before Jack ever placed his vase in the garden?

According to any folk theory of causation, none of these kids "caused" the breakage of Jack's vase, so according to any actual-causation-based responsibility ascription, they are not to be held responsible for the damage. However, here we can only bite the bullet and insist that in all these variations, none can be waived of their responsibility; otherwise, a simple slippery slope argument would lead us to the unwanted conclusion which we have strived to avoid in the story, namely, all kids, except the one whose baseball struck the vase, are clear of any duty. In sum, we have to bite the bullet and let efficiency in achieving posited social goals be our sole guide, even if its liability ascription deviates from that of common sense. For HR causation, risk amounts to real harm that involves causation,[24] and there is an intrinsic opacity between individual risky acts and the actual value loss that the former seems to bear relation to. Acts that may contribute to the instantiation of a type causation for which the effect type is protected by a law can be weighted according to their respective risks of contributing to a harm, but the true extent of the resulting harm, if any, remains opaque for them.

The spirit of the HR causation can be further illustrated with the following two examples.

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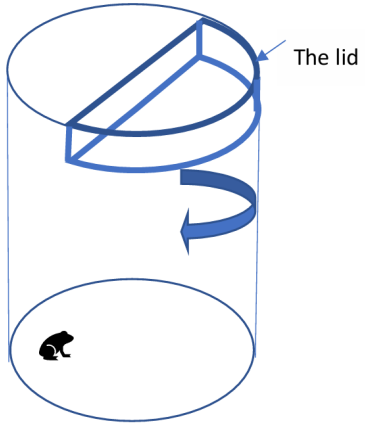
[23] The HR-causation account to be spelt out in the next section.

[24] By "causation" here we mean type-causation

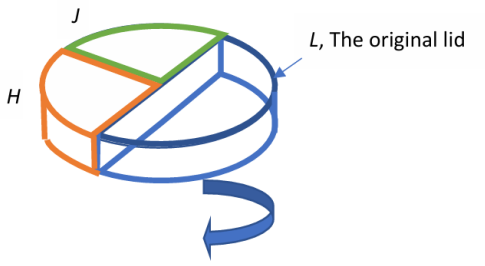
Example 1. The death of the superfrog

Jill owns a precious superfrog which has granted her prosperity for years. She keeps the superfrog in a secret well which is very deep and the opening of the well is half covered by a half circular lid. The half circular lid has shrunk throughout the years so that its radius is now nearly the same as the inner radius of the circular wall of the well. It is likely that the lid would slide down the well and crush the frog. Moreover, the wall of the circular, cylindrical well resembles a rifling barrel, so that when the lid slides down the well it will spin rapidly, and the frog cannot avoid being crushed by the lid simply by living in the unshaded region at the bottom of the well. See the figure below.



Now, if the lid slides down the well with spin, there is a 50% chance that the frog will be killed, and as that is an act of nature, Jill will receive no compensation for that. Jill's rival, Jekyll, knows that his opponent has a 50% chance of losing her superfrog, but, to increase the chance that she loses her superfrog to 75%, he adds a quarter of a cylinder to the lid.

As a matter of fact, Jekyll is not always himself, he is sometimes abducted by a Hyde personality of which he has no control. As far as he can remember, he only adds a quarter of a cylinder to the lid, and leaves the frog with a 25% chance of survival. It is the Hyde personality that adds the last piece to ensure that the frog will be dead so long as the full, spinning pie slides down the well. See the figure on the next page.



According to the folk theory of causation and liability, we should try to find out which portion, i.e. L, J, or H, of the completed lid crushes the frog. If it is L, then Jill gets no compensation as that is an act of nature. If it is H, then Jill still receives no compensation from Jekyll, because that is the act of a psychopath. It is only when the frog was crushed by the J-portion of the lid that Jill can sue Jekyll for tort damages. So, Jill is expecting an all-or-nothing compensation for her loss, and before she can expect any compensation, Jill has to get a proof of causation—finding a way to get physical evidence of which portion of the lid touches the frog in the end. As the well is so deep and the lid is spinning so fast all the way down, the latter task can be formidable.

Now, the moral: why should we place such a heavy burden on Jill? Isn't the resulting state governed, in effect,[25] by a probability distribution? According to the HR scheme, proportional liability is a more realistic option.

Example 2. Social evolution as the ultimate test

Civilization can be seen as an evolutionary process in which (natural) selection favors societies that adopt more advantageous strategies. We can subject the actual-causation-based liability ascription and the risk-based liability ascription, to the test of social evolution to see what happens in the long run. To compare two systems of liability ascription, we compute the fitness associated with people of each system, respectively and compare their long-term performances.

Let systems *A* and *H* each consist of 10 kids and a house owner. In each system, the 10 kids play a baseball game near the owner's house every day, and the game always ends with one kid's breaking one window of the owner. The joy of playing a baseball game is captured by the setting that each kid can earn $14 dollars each day by playing the game. The cost for repairing a

[25] When the money one has to spend in order to obtain a proof of causation exceeds the amount of compensation he or she is expected to get, the underlying fact amounts to "unavailable." In that case, we can resort to facts about the probability distribution.

broken window is $100, and the house has more than 10 windows that are at risk of being broken.

Now in system *A*, a folk theory of actual-causation-based liability is at work, and CCTV would help the house owner locate the child who is hitting or throwing a baseball that breaks his window, allowing him to ask for compensation of $100 from that child to have his window repaired. If the child does not have enough balance to pay for the damage, the owner can only settle for collecting the balance that the child currently has, but that kid will be banned from playing near the house again.[26]

The expected fitness $S_A(n)$ of the ten kids[27] in system *A* at the end of day n will be[28]

$$S_A(n) = 10 * 14 * \sum_{i=1}^{n} \left(\frac{9}{10}\right)^{i-1} \frac{10-i}{10} \text{ when } n \leq 7$$

$$S_A(n) = S_A(7) + 40 * (n-7)\left(\frac{9}{10}\right)^{7} \text{ when } n > 7$$

In contrast, system *H* adopts a risk-based liability. On each day, each kid has 1/10 chance of being the one whose hitting, throwing, or touching of a baseball is spatial-temporally closest to the breakage of a window.[29] So each kid should deposit $100/10=$10 for the compensation each day. So the expected fitness $S_H(n)$ of the ten kids in system *H* at the end of day n will be

$$S_H(n) = 10 * (14 - 10) * n = 40n$$

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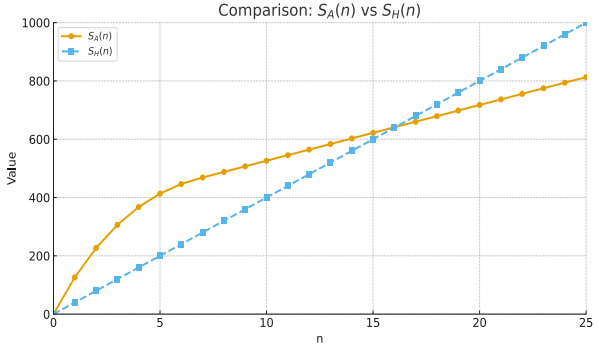
[26] Note that this model "completely ignores the disincentive effects of tort law, which is normally a central part of the economic approach" (many thanks to an anonymous referee for an earlier version of this paper for bringing this to my attention). Indeed, on witnessing the doom of the first couple of kids, it is likely that the remaining kids would be deterred and come to the sensible decision not to play near the house anymore. However, this in effect deprives possible future fun from the kids even earlier than what is portrayed here.

[27] When a kid is banned from coming to play again, we can imagine that an outsider will come to fill his position, so that the chance of breaking a window the next day remain 1/10 for each of the remaining kids. Nonetheless, in calculating the expected fitness of the group—so as to compare it with that of the *H* system in the end—we should only count the fitness of the ten children from the original group, ignoring the gains and losses of the outsiders.

[28] At day $i \leq 7$, a kid remaining in the game has 1/10 chance of being the one who breaks the window and being deprived of all the 14*(i-1) dollars that he has earned from previous rounds, and 9/10 chance of receiving another 14 dollars. As each of the ten kids has 0.9^{i-1} chance of remaining in the game on day i, for all of them, we have $\Delta S_A(i) = S_A(i) - S_A(i-1) = \left(\frac{9}{10}\right)^{i-1}\left(\frac{-1}{10}*(i-1)*14+\frac{9}{10}*14\right)*10 = 10 * 14 * \left(\frac{9}{10}\right)^{i-1}\frac{10-i}{10}$. When i reaches 8, all the kids remaining have enough money to pay for the broken window at the end of the day, so collectively, the expected increment of the day would be $10*0.9^7*(0.1*(14-100)+0.9*14) = 0.9^7*40$.

[29] Note again that I refrain from using the phrase "*causes* the breakage of the window."



So, while the expected fitness of system *A* is greater than that of *H* at the very beginning—simply because the owner could not get full compensation from the kid who "broke" his window, in other words, the kid is not duly punished—in the long term, the expected fitness of system *H* exceeds that of system *A*. So, insofar as social evolution is concerned, (natural) selection favours system *H*.

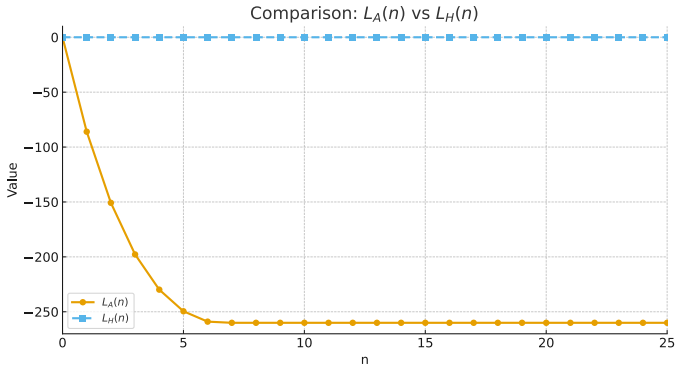
The advantage of System *H* over *A* becomes even more overwhelming when considering the property loss to the owner as well. For system *H*, the owner has no property loss because he always gets the money from the kids to repair the window. However, for system *A*, the expected property loss $L_A(n)$ after day *n* is[30]

$$L_A(n) = \sum_{i=1}^{n} \left(\tfrac{9}{10}\right)^{i-1}(100 - 14 * i) \text{ when } n \leq 7$$

$$L_A(n) = L_A(7) \qquad \text{when } n > 7$$

A simple calculation yields that $L_A(n) \approx 261$ when $n \geq 7$. That means the owner will have three unrepaired broken windows after day 7. More specifically, we have the following (a minus sign is introduced):

[30] Here, to consider only the property loss of the owner associated with the original ten kids, we assume that all the outsiders have enough balance to pay for broken windows.



After 10 days, each kid of System *H* has accumulated 40 dollars, and no one has ever been deprived of the opportunity to play near the house. Furthermore, the owner has no broken windows unrepaired. So the kids have had their fun, and the owner has all his windows in good condition at the end of every day.[31]

This demonstrates that the fitness associated with people in the *H* system is higher than that associated with people in the *A* system. So, in the long run, selection favors a society that adopts the *H* system rather than one that adopts the *A* system, in which, a *morally-unlucky* kid is punished each day and more and more individuals who are capable of contributing to society are deprived of all their future chances of making a contribution, furthermore, property owners run the risk of not having their losses compensated.

2. Towards a Hume-Russell Causation

In Section 1, we reckon that in law, particularly in tort law, people resort to a notion of actual/token/singular causation to make liability ascription, but such ascription may not be fruitful so far as prevention of future harm and assurance of compensation are concerned. In this section, we develop an HR causation that salvages causal talks through reinterpretation.

2.1 The Account

An HR causation can be seen as the instantiation of a type causation that meets certain probability exhaustion conditions. Note that we will not subscribe to a particular notion of type causation. Any notion of type causation can serve as our underlying type causation here, so long as it is well-formulated. However, we do prefer a notion of type causation that *does not require*

[31] With the unrealistic assumption that the repairer comes to fix the window on a daily basis.

that every instance of a cause type is followed by an instance of the associated effect type. This will prove to be an essential tool in the setting up of the account.

By the instantiation of a type-causation, we *do not* mean the existence of an event pair, such as (cause event token, effect event token), where the former entry is associated in some way with the latter.[32] Rather, it means that the type-causation has a fulfillment instance, that is, the utterance of a type-causation is supported by the truth of the assertion of both the cause type and the effect type, and the fact that the effect bears the *signature* of the cause, the exact meaning of which shall be explained shortly. All attempts to establish a relation between two token events should be resisted.

To begin with, we deal with the allegedly unproblematic cases for which philosophers have no difficulties pinning down *the* cause of an effect—cases without the complication of over-determination, joint cause, pre-emption, etc. They correspond to cases where a unique[33] instantiation of type-causation can be found for the effect in question. More precisely, no other type-causation that can possibly cause the effect type is instantiated at that occasion. For example, Suzy and 9 other people's throwing of a stone can all possibly cause the breakage of a bottle, but in the vicinity of where the causal statement is uttered, only Suzy is within the distance of possible breakage of the bottle as prescribed by that particular bottle breaking law. So, on the face of it, Suzy's throwing a rock constitutes the unique instantiation of the type-causation.

However, two tricky and important questions await us here. First, what is the extent of "Suzy's throwing a rock"? This is the recurring theme that we have been addressing in Section 1—there is no easy way to pin down an event/fact of "Suzy's throwing a rock." If that is the case, how do we proceed

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[32] In a footnote of Paul and Hall (2013: 15), we find, "We are glossing how event-identity works across possible worlds. If this worries you, replace 'in any nomologically possible world in which all the members of S occur, E occurs' with 'in any nomologically possible world in which perfect intrinsic qualitative duplicates of all the members of S occur, a perfect intrinsic qualitative duplicate of E occurs.' Perform the same maneuver elsewhere when we make assumptions about event identity across possibilia unless you are expressly barred from doing so." Indeed, I am worried about trans-world event-identity. But "perfect intrinsic qualitative duplicate of E" does not help either. That is why we prefer a type-causation-based account of causation and maintain that to say that something is of a type, we have to spell out, with words of course, what the type is.

See Moore (2009: Ch 14 and Ch 15), for a nice review of the plausibility of taking events as casual relata—based on very different theories of events, such as that of Davidson, Kim, and others. See Bennett (1987) also for more comments concerning essences of events.

[33] We will see later that uniqueness is not a condition that we should demand, because the phenomenon of Nesting can easily destroy the uniqueness. If a white cat's jumping out of the bush causes Bill's losing control of the wheel, then it is possible that a cat's jumping out of the bush causes Bill's losing control of the wheel as well.

to pin down individual instantiation tokens? The answer is this. We do not need to locate the referent of an instantiation token. In other words, we do not need to decide whether "Suzy's throwing a rock" involves the weight of the rock, the color of it, the initial speed of her throwing etc., or whether it is the same event as "Suzy's throwing a round rock." We only need to ensure that the token sentence 'Suzy is throwing a rock' or, alternatively, a token sentence 'Suzy is throwing a round rock' uttered in the context in question is true.

Another tricky question is this. Is it even possible to hold on to the uniqueness criterion? For if we are only after the truth of a token sentence in the context, then the very context can be seen as instantiating a different causal statement with the cause being replaced by 'Suzy is throwing a round rock' and the effect being held unchanged. In other words, the context exemplifies at least two different type-causations with the same effect, hence the uniqueness of the cause could no longer be held. To solve this problem, one might try resorting to numerical identity: whatever entities "Suzy's throwing a rock" and "Suzy's throwing a round rock" might be, they are the same numerically. Therefore, so long as instantiation is concerned, they amount to the same token instantiation of two different type-causations. However, by the same token, in the context that both Suzy and Billy threw a rock and the bottle broke, "Suzy's throwing" and "Suzy and Billy's throwing" can be counted as the same token, too. But if that is the case, then "Billy's throwing" and "Suzy and Billy's throwing" are numerically the same token, too. Does it not imply that "Suzy's throwing" and "Billy's throwing" are numerically the same? This is absurd. Even if two distinct type-causations are instantiated in a single context, the instantiations of the causes remain distinct.

We shall now introduce, without resorting to the individuality of a token event or the uniqueness of a cause, the notion of probability exhaustion, which bypasses these problems and is the key to our account of HR causation.

Definition 1

A cause type *C* and an effect type *E* are associated with type sentences *C* and *E*, respectively. A cause type *C* is instantiated in context *c* if had a token sentence of the associated type sentence *C* been uttered in context *c*, it would have been true. The instantiation of an effect type *E* is defined likewise.[34]

[34] Hereafter, I shall abuse notation by using *C* (in italics) to denote both the type sentence itself and the cause type associated with it. The case for *E* is similar.

Definition 2
Given a cause type *C* and an effect type *E*, *C* is a type cause of *E* if *C raises the probability of E*, in the sense that the conditional probability $P(E|C)$ of *E* given *C* is higher than $P(E|\sim C)$ of *E* given the negation of *C* and that there is no common cause type *B* such that $P(E|C, B) = P(E|\sim C, B)$.

The probability-raising component of the HR account is the key to the probabilistic theories of causation, and the key problem to this type of account is that, on the one side, (1) some events raise the probability of an effect but are not causes, and on the other hand, (2) some causes do not raise the probabilities of their effects; see, for instance, discussions in Woodward (1990, 1994), Hitchcock (2004), Kvart (2004), and Ramachandran (2004).

However, the current account differs from these theories in at least two important aspects. First, probability-raising is only one component of our account. To be a cause of an effect, another criterion has to be met, namely, the probability-exhaustion component to be introduced later. Hence, (1) can be discarded right away. Second, probabilistic theories often assume that causal relata, i.e. causes and effects, are event tokens, but here we only talk about cause-types and effect-types. Furthermore, they are propositional or even sentential in nature, and contexts must be introduced for us to talk about their instantiations. Moreover, a clear advantage of our account here is that, for *C* to be a proposition, it is easy to talk about its negation ~*C*. In contrast, for the event-causation-theorists, given a token event *C*, it is a bit awkward to resort to its negation ~*C* right away in the definition of probability-raising because we have no idea what the negation of an event could possibly mean

As an illustration of how the current account shall deal with (2), let us consider a worry raised by an anonymous referee for an earlier version of this paper: Drinking wine can be a cause of liver disease even if the conditional probability of liver disease is lower among wine drinkers than non-drinkers (having to do with their respective socioeconomic status and the likelihood of exposure to other causes of liver disease). However, in claiming that John's drinking wine regularly, as instantiated in context *c*, is an HR cause of his having a liver disease in *c*, the type cause *C* should be spelled out. Presumably, *C* is that *John* drinks wine regularly, and ~*C* is that *John* doesn't drink wine regularly. In other words, we are never invited to compare wine drinkers with non-drinkers concerning their associated chances of having liver disease in general. What matters remains whether $P(E|C) > P(E|\sim C)$ for this specific type cause *C*.

Definition 3
Given an instantiation of cause type *C* in context *c* and an instantiation of effect type *E* in the same context, and given that *C* is a type cause of *E*, to say that it is an instance of *C* type-causing *E*, the context should be one that *C* takes effect in leading to *E*.

Some remarks are at hand here. Recall that for *C* to be a type cause of *E*, we only require that *C raises the probability* of *E*, so even if *C* and *E* both obtain in *c*, *C* may not take effect in that particular instance (as some other cause types may take effect also). More specifically, two cause types, *C* and *C'*, may each have a certain probability of leading to effect type *E*, and while we could not predict at a particular occasion whether any of them would take effect in leading to *E*, after the occurrence of *E*,[35] an omniscient being can, in principle, know whether it is *C*, or *C'*, or both that did contribute to *E* in this context. In some physical phenomena,[36] a trace of *C* can indeed be found in (*E*, *c*) to indicate that *C* type-causing *E* did take effect in this occasion—saying nothing about whether it is also an instance of *C'* type-causing *E*. So, Definition 3 may sound trivial. Nevertheless, as the cases in Steel (2015) suggest, we are far from being omniscient and are often unable to find traces of *C*, even if it exists. Moreover, it remains possible that there are forgetful type causations, for which no trace of (*C*, *c*) can be found in (*E*, *c*) generally.[37] Therefore, to proceed with the setting up of our *HR* causation account, we introduce the following two more realistic notions.

Definition 4
Insofar as *C*'s contributing to *E* in context *c* is concerned, (*E*. *c*) is said to *bear the signature* of *C* if there is a trace of *C* in (*E*, *c*), indicating that it is an instance of *C* type-causing *E*.[38]

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[35] According to Quantum mechanics, before the effect, even God cannot foresee whether the effect type would take place.

[36] For example, let *E* be the effect type that there is a radioactive decay of a particular nucleus, and C_1 and C_2 be both cause types that may stimulate *E*. Given that C_1, C_2, and *E* all obtain, it is indeed possible to know whether a context *c* is an instantiation of C_1 type-causing *E* or C_2 type-causing *E* by finding traces of C_1 or C_2 in *E*. For instance, if C_1 and C_2 are in principle associated with α-decay and β-decay respectively, then by looking at the emitted particle of the decay, we can pin down the type causation that takes effect in *c*.

[37] For example, two independent cause types C_1 and C_2 can increase the probability of *E* by 20% and 30%, respectively. So, with both C_1 and C_2 obtaining, the probability of *E* will be increased by 1−0.8*0.7 = 44%. Now, when C_1, C_2, and *E* all obtain in *c*, we know (assuming the baseline probability of *E* is zero) that it is within the 44%, but there may simply be *no underlying reality* for us to divide the 44% into three sub-regions (only C_1 takes effect; only C_2 takes effect; both C_1 and C_2 take effect).

[38] I do not intend to give a formal definition of "traces" here, as what they actually are won't affect the structure of HR causation to be defined. However, while not necessary, the

Definition 5
Given that *C* is a type cause of *E* and both *C* and *E* are instantiated in context *c*,[39] we say that *C exhausts* the probability that *E* might come about in *c* if it can be *inferred* that the context bears the signature of *C* if *C* did leave a signature.

The distinction between (*E*, *c*)'s bearing the *signature* of *C* and *C*'s *exhausting* the probability that *E* might come about in *c* will play an essential role in this account.[40] As (*E*, *c*)'s bearing the *signature* of *C* is neither a sufficient nor a necessary condition for *C*'s *exhausting* the probability that *E* might come about in *c*, if our HR causation is to be defined in terms of the latter, we need not strive to establish the former any longer. This, in a sense, releases our burden of "Proof of Causation"[41] in tort law.

In Woodward's review of Humphreys (1989), we find:

> Scenario 1: Suppose we know ... that each of ... C_1 and C_2 ... can cause ... *E* ...It follows on Humphreys' account that since both C_1 and C_2 increase the possibility of cancer, both *cause* or have causally contributed to cancer. But why should we believe this? How do we know that the cancer was not instead *caused* by C_1 alone or C_2 alone? (Woodward (1994: 366), with minor change of notation following Hitchcock (2004), italics mine.)

Clearly, Woodward was short of words for the distinction between the two different usages of "cause" in italics. In our notation, the last sentence could be rephrased as "How do we know that the cancer did not bear the signature of C_1 alone or the signature of C_2 alone?" And the quest for causes is quite another matter.

An essential trick in checking whether some *C* exhausts the probability that *E* comes about at context *c* is that we never assign a 1 to $P(E|C)$, so that insofar as there are two non-nested cause types *C* and *C*′ that can possibly cause *E*, and they are both instantiated, then we could not *infer*, by the instantiation of *E* alone, that the context bears the signature of *C*. Finally, we arrive at the definition of HR causation.

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reader may think of them as features in the context that allow someone to trace the instantiation of *E* back to an instantiation of *C* through a process like that in Salmon's process theory of causation, cf. Salmon (1984).

An additional complication may arise when we reckon that the baseline probability $P(E|{\sim}C)$ can be non-zero in general. For signature bearing in such cases, see Appendix 2.

[39] For simplicity, we assume that the cause and the effect are instantiated in the same context. For the possibility that the antecedent and the consequent of a conditional are evaluated in different contexts, see Tsai (2011).

[40] Note, for example, finding a trace of *C* is an empirical matter, yet proving that the context would have a trace of *C* if it did leave one is a task of inference.

[41] Of course, the term 'causation' here refers to some version of actual causation, rather than our HR causation to be introduced later.

Definition 6
An instantiation of a type cause *C* in a context *c*, (*C*, *c*) in short, is said to be an *HR cause* of an instantiation of a type effect *E* in the same context, (*E*, *c*) in short, if
C is a type cause of *E*, and
C exhausts the probability that *E* might come about in *c*.

Three non-entailments are worth stressing here.

1. That context *c* is an instantiation of *C* type-causing *E* does not entail that *C* leaves a signature at (*E*, *c*).
2. That *C* leaves a signature at (*E*, *c*) does not entail that we can *infer* that (*E*, *c*) bears the signature of *C*.
3. That we can infer that (*E*, *c*) bears the signature *C* does not imply that (*C*, *c*) is the unique *HR* cause of (*E*, *c*).[42]

Nevertheless, the following statements are basically synonymous:

i. It can be *inferred* from (*E*, *c*) that it bears the signature of *C*.
ii. *C* exhausts the probability that *E* comes about at *c*.
iii. (*C*, *c*) is an HR cause of (*E*, *c*).

We can now tackle cases that concern the majority of causation theorists, such as pre-emption, joint cause, over-determinations, etc. Since HR causation is type-causation based—without presupposing a causal relation between cause tokens and effect tokens in the real world—most of these "problems" evaporate.

Take the problem of pre-emption, for example. If Suzy's throwing "pre-empts" Billy's throwing in breaking the bottle, whose throwing is the cause of the breakage? The answer is that, insofar as the instantiation of type-causation is concerned, by the mere fact that both Suzy and Billy threw rocks and the breakage of the bottle obtained, we cannot be sure, that is, without examining how the bottle was broken, which of the two is instantiated. So, *neither* Suzy's throwing *nor* Billy's throwing is an HR cause of the said effect.[43] And this is precisely the theme of HR causation: it is a fundamental mistake

[42] This is to acknowledge the possibility of nested-effects. For example, the jumping out of a cat from the road-side bush and the jumping out of a black cat from the road-side bush can both be causes for John's sudden steering to the left

[43] In Hitchcock and Knobe (2009), to assert that Assassin's actions actually caused Victim to die, while Backup's actions did not, the authors resorted to a "normalized" version of the actual situation: "while Victim's death does not counterfactually depend upon Assassin's action in the actual situation described, it would depend upon Assassin's action *in the normalized version of the situation where Backup is not present*" (589, italics mine). Here, we can also say that *a normalized version of the situation where it could be Billy's rock that hit the bottle* suggests that Suzy's throwing should not be held solely responsible for the breakage of the bottle.

to strive to specify a cause-token for an effect-token, whatever that might mean.

Nevertheless, in interpreting lay people's talk of token causation, the HR causation can do better than that. First, by formulating a type-causation that says *someone*'s throwing a rock typically causes the bottle to break, we do have an instantiation of it here because Suzy's throwing and Billy's throwing are the only bottle-threatening activities around and, taken together, they exhaust the probability that the effect type comes about in the context in question—we can infer, without examining the broken bottle and the two rocks, that the context bears the signature of someone's throwing a rock if some act does leave a signature. This nicely explains our intuition that if Suzy and Billy make up their minds to break the bottle through their joint effort of throwing rocks then they are jointly responsible for the damage regardless of whether it is Suzy's rock or Billy's rock which actually hit the bottle. However, HR causation would *not* render Suzy's throwing alone—the alleged "pre-empting cause"—is the cause of the breakage.

Second, to grasp the intuition of most causation theorists that it is Suzy's throwing a rock that causes the breakage of the bottle, one can go one step further. Recall that the effect type has a descriptive component in nature. Therefore, when we are pinning down the effect in question, we can specify it through descriptions as we wish. For instance, instead of saying 'the breakage of the bottle', we can say 'the breakage of the bottle in this bloody way' and demand that the type-causation we resort to must fit the effect-type as described. Imagine, for example, Suzy threw the rock with a bloody hand, and as it was her rock that hit the bottle, the broken bottle actually had her blood stain on it. In that case, although Billy threw a rock as well, his throwing did not contribute to the type-causation with the effect as described by "the breakage of the bottle in this bloody way." In other words, by refining the type effect in question, it is indeed possible for us to render Suzy's throwing, rather than Billy's throwing, the sole cause of the said effect in the context.

Note, however, as we have repeatedly stressed earlier, we should try our best to avoid describing an effect type with the general qualification "in this particular way," because it would eventually reduce our HR causation to the pragmatically unfruitful account of actual causation. In our type-causation-based HR causation, the effect type should be specifically described (for

example, "bottle is broken with a blood stain on it") rather than through an indexical ("this way").[44]

The above two observations suggest that HR causation can be a promising account that deserves more of our attention.

2.2 The Applications

In this subsection, we consider some key cases that help illustrate how HR causation works and how it, at times, ascribes causation differently from common-sense causation, solving the exceptional cases that concern Steel and others from the first principle.

Over-determination/Pre-emption

Suppose both Suzy and Billy threw a rock toward a bottle and each of their throwing alone is sufficient for the breakage of the bottle as long as the rock hits the bottle. Suppose further that S (Suzy's throwing) and B (Billy's throwing) are the only two atomic cause-types for D (the breakage) that obtained in the context, and that the bottle was indeed broken, can we derive from these very facts that the underlying world state is that of over-determination (that both rocks hit the bottle) or that of pre-emption (Suzy's rock hit the bottle first, preventing Billy's rock from breaking the bottle)? According to the set-up of HR causation, regardless of what happened actually, neither (S, c) nor (B, c) can be said to be a cause of (D, c), because, as shown in Figure 1, neither of them exhausts the probability that D comes about in that context.

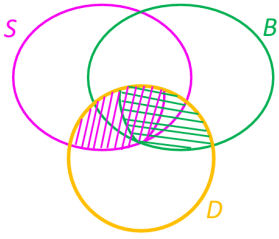


Figure 1

Here, D_S and D_B—represented by pink and green shaded regions respectively—are the sets of contexts such that the effect D bears the signature of S and B, respectively, and it is clear that the intersection of the extensions of S, B, and D neither lies in D_S nor lies in D_B.

[44] One might hear the exclamation "What is the cause of this?" in daily life. However, according to HR causation, that question is meaningless and it can be responded only with the following question "What is 'this', exactly?"

That being said, we can consider whether we can claim that $S \vee B$ accounts for D in context c or that $S \wedge B$ accounts for D in context c.[45] And this is what we get.

$(S \vee B, c)$ is an HR cause of (D, c).

Refer back to Figure 1. Clearly, the shaded region $D_{S \vee B}$, which is simply $D_S \cup D_B$, exhausts all possibility that D comes about in that context.

$(S \wedge B, c)$ is an HR cause of (D, c) also.

The shaded region in Figure 2 is $D_{S \wedge B} = (S \cap B) \cap (D_S \cup D_B)$,[46] while the pink and green shaded regions are $(S \cap B) \cap D_S$ and $(S \cap B) \cap D_B$ respectively and, again, given that both S and B obtain, it exhausts all the probability that D comes about in that context.

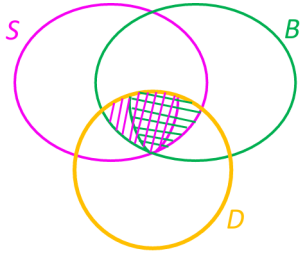


Figure 2

From a) and b), we know that both $(S \vee B, c)$ and $(S \wedge B, c)$ can be said to be causing (D, c),[47] as we can derive, from (S, c), (B, c), (D, c) and the fact that S and B are the sole possible atomic cause types in the context c, that c lies in $D_{S \vee B}$ and $D_{S \wedge B}$. On the other hand, (S, c) and (B, c) aren't causes because neither S nor B exhausts the probability that D comes about in context c. In other words, we can neither be sure that c lies in D_S nor be sure that c lies in D_B.

In sum, given S, B, and D obtain at c, and S and B are the sole possible atomic type causes in the context c, we have

[45] Here, logical connectives $\vee$ and $\wedge$ are to serve as connectives for sentences and propositions alike.

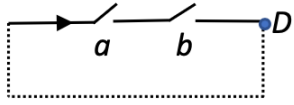
[46] For simplicity, we shall abuse notation, using S to denote the extension of S too.

[47] This nicely justifies my belief, and possibly some readers' intuition, that Steel's *Two hunters* scenario, cf. Appendix 1, should not be dealt with as an exception to the proof of causation requirement, but leads us to a new conception of liability ascription: regardless of whose bullet actually hit the victim or whether one can indeed find proof of it, the two hunters are jointly responsible for the harm.

Causes of (D, c)	$(S \vee B, c)$ $(S \wedge B, c)$
Non-causes of (D, c)	(S, c) (B, c)

According to the present account, even if we discover, after further investigation, that c does bear the signature of S, and, furthermore, that it prevents c from bearing the signature of B — in other words, it is an instance of the so-called "pre-emption" — we should hold on to our original causal ascription still, because that is the way efficiency in achieving our posited social goals is guaranteed.

Joint Cause



Both the switching-on at node a, call it state A, and the switching-on at node b, call it state B, increase the risk of the type effect D. However, only when an electric current runs through both a and b, would D obtain.

In this case, given that A, B, and D obtain in context c, that A and B are the sole possible atomic cause types in context c, and that both A and B have to obtain for D to take place, we can be sure that context c lies in the shaded region in Figure 3.[48]

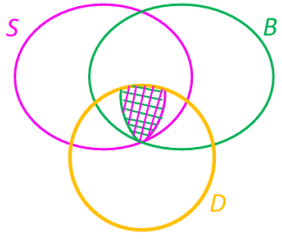


Figure 3

So, every region of which the shaded region is a subset can be said to exhaust all the probability for D to come about in this context and we then have the following causal ascriptions.

[48] Note the unshaded regions of D are empty.

Causes of (D, c)	$(A \vee B, c)$ (A, c) (B, c) $(A \wedge B, c)$
Non-causes of (D, c)	

The Mixed Case

In Johnson (2016), *Burrage v. United States* was discussed as a case of "mixed drug intoxication." This is a nice real-life case to test our account. Suppose any two of A, B, and C are sufficient[49] for D, and at least two of the kinds of A, B, and C are required for D to obtain. Now, given that A, B, C, and D all obtain at c, and A, B, and C are the sole possible atomic cause types in the context c, what can be said to be the cause of (D, c)?

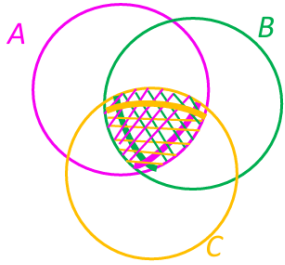


Figure 4

It can be derived that c lies in the doubly-or-above, i.e. doubly-or-triply, shaded region in Figure 4. It is relatively easy to see that $(A \vee B \vee C, c)$ is a cause of (D, c) because the doubly-or-above shaded region of Figure 4 is a subset of the doubly-or-above shaded region of Figure 5.

[49] In the sense of the joint cause case discussed earlier, namely, with the assumption that a current did pass through both nodes. Recall that the switching on at node a does not guarantee that a current can pass through a, accommodating the possibility of mechanical failure, and this is an essential gadget of our analysis, namely, type-causation is never 100%. However, this does not mean that we have to discard all talks of "sufficiency." The "sufficiency" in every day talk can be captured with the assumption that the effects of relevant actions *do obtain*. So Suzy's throwing the stone is sufficient for the breakage of the bottle in the overdetermination case, even though there is a chance that her throwing misses the bottle, and the switching on at both node a and b in the joint cause case is sufficient for D, even though there is a chance that the switching on at either node experiences some mechanical failure so that no current could pass through the node.

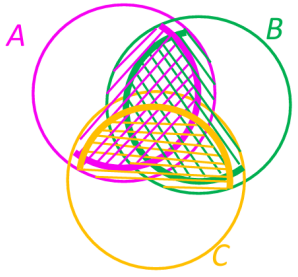


Figure 5

In comparison, (A, c) cannot be said to be a cause of (D, c), because the doubly-or-above shaded region of Figure 4 is *not* a subset of the doubly-or-above shaded region of Figure 6. Analogously, neither (B, c) nor (C, c) is a cause of (D, c).

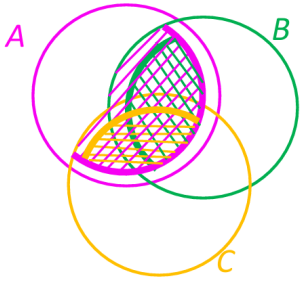


Figure 6

As for $(A \wedge B \wedge C, c)$, given that c lies in $A \cap B \cap C \cap D$ and A, B, and C are the sole possible atomic cause types in the context c, we can derive that c lies in as least two of D_A, D_B, and D_C, but that is enough to ensure that c lies in $D_{A \wedge B \wedge C} = (A \cap B \cap C) \cap ((D_A \cap D_B) \cup (D_B \cap D_C) \cup (D_C \cap D_A))$.

To show that $(A \vee B, c)$ is a cause of (D, c), note that c lies in at least one of D_A and D_B, that is, c bears the signature of A or that of B, and that alone guarantees that c lies in $D_{A \vee B}$, which equals $(D_A \cap D_B) \cup ((D_A \cup D_B) \cap D_C)$ because should c lie in only one of D_A and D_B, it would necessarily lie in D_C as well.

To show that $(A \wedge B, c)$ is a cause of (D, c), note, again, that c lies in at least one of D_A and D_B, and that alone guarantees that c lies in $D_{A \wedge B} = (A \cap B) \cap (D_A \cup D_B)$.

In sum, we have

Causes of (D, c)	$(A\vee B\vee C, c)$ $(A\vee B, c)$, $(B\vee C, c)$, $(C\vee A, c)$ $(A\wedge B, c)$, $(B\wedge C, c)$, $(C\wedge A, c)$ $(A\wedge B\wedge C, c)$
Non-causes of (D, c)	(A, c), (B, c), (C, c)

The Flip-or-Not-flip Case

As a nasty variant of the Joint Cause Case, we consider the following Flip-or-Not-flip Case. For a current to pass through a and b, the switches at a and b have to align with each other. However, as the switches are enclosed in a black box, the inner state of which is known only to God, hence neither agent a nor agent b knows whether the two switches are aligned in the first place. All they can do is to make a decision as to whether to flip the switch or not.

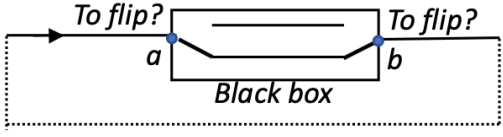


Figure 7

Now, suppose the context c is such that the switches are originally aligned, and both agent a and agent b flip their switches, and, as a consequence, current passes through the circuit after one turns on the power. Which of $(F_a\vee F_b, c)$, (F_a, c), (F_b, c), and $(F_a\wedge F_b, c)$ are HR causes of (D, c), and which of them are not, then?[50] Are the answers the same as that for the Joint Cause case? No. Quite the contrary, none of them is a cause. This is because none of $(F_a\vee F_b, D)$, (F_a, D), (F_b, D), and $(F_a\wedge F_b, D)$ constitutes a type causation in the first place —the obtaining of any of the states *does not increase the risk* of D, compared with the non-obtaining of it. Given that the original state in the black box is randomly assigned, the effect of the flip-or-not-flip decision — regardless of whether each agent acts alone or they make a joint decision — can be easily cancelled by the randomness of the original positions of the two switches, or more specifically, by the randomness of the default alignment. And we come to the following.

[50] Here F_a and F_b stand for the flipping at a and the flipping a b respectively, of course.

Causes of (D, c)	
Non-causes of (D, c)	$(F_a \vee F_b, c)$, (F_a, c), (F_b, c), $(F_a \wedge F_b, c)$

Now, one might wonder, if none of $(F_a \vee F_b, c)$, (F_a, c), (F_b, c), and $(F_a \wedge F_b, c)$ is a cause of (D, c), then who is responsible for it? I guess it is fair to say that the one who sets up the underlying mechanism is responsible for the damage (D, c). When a gunman points a gun at a victim and tells a passerby 'There is a coin in my left hand. Now, heads or tails? His fate is in your hands!' the passerby is not to be blamed for the death of the victim or be praised for the saving of the victim's life, no matter what the outcome is. Rather, the gunman is solely responsible for the setting up of this risky game.

To sum up, HR causation does fare better than the usual actual causation account in the sense that two important principles of Tort Law, namely, Right to Compensation Principle and Reduction of Specific Harm Principle are better met here. First, the three exception rules Sandy Steel stresses in Steel (2017) can all be dealt with directly in the HR framework, and the claimants in various versions of Steel's *Two Hunters* scenario are all entitled to compensation in full from a collection of people based on risk calculus of a harm realized, without their ever need to have the means to prove that a certain defendant is the "actual cause" of his/her loss. Second, the guiding principle of the liability calculus in question is the meta-question "Why asking for a cause?" In other words, a defendant's liability should be proportional to his/her contribution to a *specific harm-type* that has realized, and the sum of liabilities should equal the total sum of harm. The incompatibility between compensation in full and proportional liability that concerns Steel is resolved now by the facts that the essence of type-causation is nothing but the likelihood of somethings followed by some other things, as suggested by Hume, and that compensation and liability actually concern different parties (namely, claimants versus risk-creators). Finally, without the burden to talk about the nonsensical cause-tokens and effect-tokens, we are left with just enough room to create a social ontology that meets the two basic principles.

Miscellaneous "Problems"

Here we look at four scenarios in the literature that allegedly threaten a probabilistic account of causation and indicate what our HR account would say about it.

In Lewis (2004), concerning probabilistic causation, the following scenario is sketched,

> Not all probability-raising counts. One terrorist places an unreliable bomb—a genuinely indeterministic device—on Flight 13; another terrorist places an unreliable bomb on Flight 17. As it happens, the bomb on Flight 13 goes off and the bomb on Flight 17 doesn't. The *Age* runs a headline: "Airline bomb disaster." The headline would have been just the same if it had been the bomb on Flight 17 that went off, or if it had been both. So the bomb on Flight 17 raised the probability of the headline, but certainly didn't cause it. (Lewis 2004: 79)[51]

According to the HR account, so far as the effect of having a headline that reads "Airline bomb disaster" is concerned, while both terrorists' placing of a bomb raise the probability of the headline, neither of them meets the probability-exhaustion criterion, so, contrary to common sense, neither of the acts is a cause. However, the conjunction and the disjunction of the acts are both causes for the effect in this context. This captures our intuition that, by regarding the two terrorists as but two pawns of a terrorist organization, the special action of that organization is a cause of the effect in that context—provided no other agent or organization is conducting other risky action in that context.

In Paul and Hall (2013: 65–66), three problems allegedly threatening an indeterministic account of causation are outlined. And we can see how HR causation can say about them.

First, for *the problem of fizzling*, consider the following figure. While the firing of **C** increases the probability that **E** fires, the signal simply never reaches **E**, and **E** fires by itself.

Figure 8

A probabilistic account might render *C* a cause of *E*, but common sense will have that "*C* is quite obviously not a cause of *E*" (Paul and Hall 2013, p 65). According to the HR account, (*C*, *c*) is not cause of (*E*, *c*) also, because we cannot, in this context infer that *E* bears the signature of *C*.

Second, for *the problem of ambivalence causes*, consider the following figure.

[51] This example is dealt with in Kvart (2004: 370) in other terms as well.

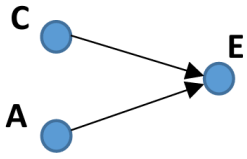


Figure 9

According to Paul and Hall,

> Here, **E** has no chance of firing unless it receives a stimulatory signal from either **A** or **C**. If it receives just one stimulatory signal, then it is certain to fire; but if, as in the events depicted in the figure, it receives two stimulatory signals, then its chance of firing is a mere 0.01. Nevertheless, in this case it does fire. Then we have an odd result: *A* and *C* are clearly symmetrically related to *E*; so if either is a cause of *E*, then surely both are. And, since *E* is clearly not *un*caused, and since *A* and *C* are the only candidate causes, it seems to follow that each is a cause of *E*. But each is also such that it substantially lowers the chance of *E*: if **C** had not fired, then the chance of *E* would have been 1, and likewise for **A**. So we also have an argument that neither is a cause of *E*. (Paul and Hall 2013: 65–6)

We should first point out that their argument for *C*'s being a cause is invalid. According to the HR causation, it is possible that (*E*, *c*) is *caused*, but neither (*C*, *c*) nor (*A*, *c*) is a cause of it.[52] Furthermore, even though the chance of firing of **E**, given $A \wedge C$, is merely 0.01, it is still a raising of probability in comparison with the null result. There are two ways to interpret the HR causation of $A \wedge C$, depending on how we understand the null result (or, default state) in question. If the null result is interpreted as chance of firing of **E** when we have $\sim A \wedge \sim C$, then the raise of probability is simply 0.01. However, if the null result is the chance of firing of **E** when we have $\sim(A \wedge C)$, i.e. $\sim A \vee \sim C$ then the situation is much more complicated.

Let me modify Lewis's Two-Terrorists case to serve as an illustration for the present case. Suppose the bombs are 100 % reliable, and if one, but not both, of the two terrorists, Adam and Carl say, places his bomb on either jet, it would surely destroy the jet and the *Age* would surely run a headline "Airline Bomb Disaster." But if both bombs went off, the chance of the *Age*'s running the said headline will be only 0.01, because most editors would have preferred adding an "s" to it, making it a different headline. As it happened, both terrorists placed their bombs and, against the odds, a careless editor of the *Age* run the headline "Airline Bomb Disaster." Now, does $A \wedge C$ really

[52] Whether *C* raises or lowers the chance of *E*, it is a delicate matter. It depends on the respective frequencies of *C* and *A*, as well as their possible correlation. Such background information is not derivable from causal analysis alone. See the analysis later.

increase the chance of E, in comparison to the null result for $\sim A \vee \sim C$? Note that we normally would not have the background information concerning "how often do terrorists place a bomb on an airplane?" But, the chance is supposedly very low, and that partly explains why such instances always make the headline. Suppose the frequency of A and that of C are both 0.0001, then we have the following tables:

A, C are correlated	$A \wedge C$	$\sim A \wedge C$	$A \wedge \sim C$	$\sim A \wedge \sim C$
$P(\text{--})$	0.0001	0	0	0.9999
$P(E\|\text{--})$	0.01	1	1	0
$P(E\|\sim(A \wedge C))$	0			
$P(E\|A \wedge C)$	0.01			

Table 3. A and C are correlated (a conspiracy)

A, C are independent	$A \wedge C$	$\sim A \wedge C$	$A \wedge \sim C$	$\sim A \wedge \sim C$
$P(\text{--})$	0.00000001	0.00009999	0.00009999	0.99980001
$P(E\|\text{--})$	0.01	1	1	0
$P(E\|\sim(A \wedge C))$	0.00019998			
$P(E\|A \wedge C)$	0.01			

Table 4. A and C are independent

Therefore, in either case, $A \wedge C$ raises and exhausts[53] the probability of E, and $(A \wedge C, c)$ is a cause of (E, c). As to whether C alone raises the probability of E, let q be the frequency of A. If A and C are correlated, then C clearly raises the probability of E. If they are independent, then for $P(E|C)$ to be greater than $P(E|\sim C)$, we should have

$$q \times 0.01 + (1-q) \times 1 > q \times 1 + (1-q) \times 0$$

That is $q < 1/1.99$. Given that the frequency of an action—in contrast to a default state—is generally assumed to be not often, it is fair to say that C raises the probability of E still.[54]

Third, for *the problem of aggregate effects*, consider the example due to Johann Frick in Frick (2009), as introduced in Paul and Hall (2013: 66), represented by the following figure.

[53] See the earlier analysis for the Overdetermination cases.

[54] Note that, given A, C indeed lowers the chance of E, but the point is that, so far as background is concerned, A seldom happens.

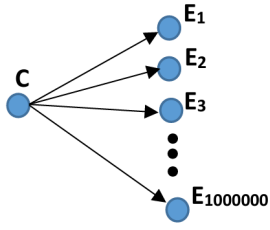


Figure 10

Here, each of the $\mathbf{E_i}$'s has a default probability of firing of 0.9, and when **C** fires, it raises each of the $\mathbf{E_i}$'s probability of firing to 0.901. According to Paul and Hall (2013: 66), "It seems clear, then, that *C* is causally responsible for at least some additional firings, But, curiously, there is no firing such that *C* is causally responsible for *it* — since the probability raising that *C* creates is so slight."[55]

Now, firstly, according to the HR account, no matter how slight the probability raising that *C* creates might be, *C* is still a probability-raising type-cause candidate for some type-effect. Secondly, so long as certain $\mathbf{E_i}$ fires, we can begin the process of cause-ascription, because a harm has indeed been realized. Insofar as the HR account is concerned, the tricky bit of Frick's example lies in the fact that each of the $\mathbf{E_i}$'s has a default probability of firing of 0.9, and it can be difficult in practice to determine whether the firing of a specific $\mathbf{E_i}$ is due to the default firing rate or due to the contribution of *C*—in terms of HR causation, the problem amounts to deciding whether an instantiated (*Ei*, *c*) *bears the signature of* (*C*, *c*).

This is analogous to the Superfrog case we discussed earlier. Here, the total area of the original lid is only 90% of the full pie and *C*, in effect, adds another 0.1% to it. Bearing the signature of (*C*, *c*) amounts to the frog being crushed by the added 0.1% region. Furthermore, the spinning of the lid and the depth of the well guarantee that we have no way to know whether the frog is killed as Nature takes its toll or is killed by the act of some liable agent. Clearly, (*C*, *c*) does not exhaust the probability that (*Ei*, *c*) may come about because we cannot infer that (*Ei*, *c*) bears the signature of (*C*, *c*), so (*C*, *c*) cannot be said to be a cause of (*Ei*, *c*). Nevertheless, we can still ascribe liability to *C* in the following way:

[55] Thanks to an anonymous referee for pointing out that this can be seen as a causal version of the Lottery Paradox.

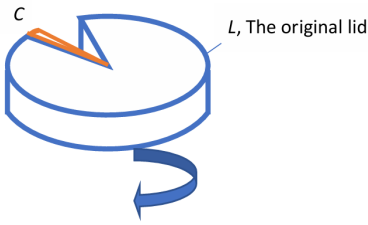


Figure 11

First, had the lid been actually placed by some agent intending to kill the superfrog, and the frog was indeed killed by the slightly-expanded lid *L+C*, then Jill, the owner of the superfrog, should be entitled to sue both agents for tort, and the liability of each agent should, presumably, be proportional to the area associated with him or her. Now, even if the original lid was placed there by an act of Nature, the court can still proceed to ascribe the same percentage of liability, namely 0.1/0.901 %, to *C* as before, except that in this case Jill can sue no one for the remaining 90/0.901 % of her loss.

2.3 A final remark on the But-For test

In Michael Moore's review of Cause-in-fact tests in his entry of "Causation in the Law" in Stanford Encyclopedia of Philosophy, the word 'necessary' or 'necessity' appears not only in the original But-for account but also in every modified account as the italics in following passage illustrate.

A. Cause-in-fact tests
   1. Explicitly defined counterfactual test: the defendant's action must be *necessary* to the occurrence of the harm.
   2. Modified counterfactual tests, where the defendant's act must be:
      a. A *necessary* element of a set of factors that ---
      b. *Necessary* to every detail in ---
      c. *Necessary* to accelerations ---
      d. --- so long as --- is *necessary*
      e. --- where the *necessity* of that act is ---
      f. *Necessary* to an increase in the chance of an effect occurring ---

Apparently, necessity is an essential ingredient in all accounts regardless of their variants. However, in HR causation, there does not seem to be any requirement concerning necessity. Does this suggest that we have gone the wrong way? The answer is "no." As a matter of fact, the but-for ingredient has already been taken care of in our account without the word 'necessary' being employed.

For (S, c) to be a cause of (D, c), S should exhaust all the probability that D may come about in context c. This alone would imply that *no other* possible cause B satisfying $S \cap D_B \not\subset D_S$ can exhaust all the probability that D comes about in context c. To see why, let us assume that there is another possible cause B that exhausts all the probability that D comes about in context c. Then, by assumption, c lies somewhere in D_B, but we already know that c has to lie in D_S also, so $S \cap D_B \subseteq D_S$. In the same token, by symmetry, we can prove that $B \cap D_S \subseteq D_B$. That is, the contingent fact that S, B, and D obtain in context c reduces D_S and D_B into the same set, namely $B \cap D_S = S \cap D_B$. Recall that in Figure 1, D_S and D_B are represented by pink and green shaded regions respectively. In the present case, the requirement that both S and B exhaust all the probability that D comes about in context c amounts to ensuring that c lies in doubly-shaded region, namely $D_S \cap D_B$, which should be equal to $B \cap D_S$ and $S \cap D_B$. In other words, $(B \cap D_S) \setminus D_B = \Phi$ and $(S \cap D_B) \setminus D_S = \Phi$. So Figure 1 becomes Figure 12 as shown below.

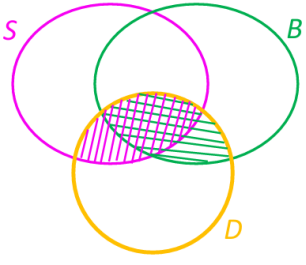


Figure 12

The fact that both 'a skinny cat's jumping out of the bush' and 'a black cat's jumping out of the bush' can be the cause of the car accident[56] nicely illustrates this situation. In this sense, S can be seen as *necessary* for D in context c. In other words, the current account has a sense of but-for inbuilt. When S exhausts the probability of D at context c, we can paraphrase it by saying that but-for S, D would not have obtained in context c.

In the pre-emption case where Suzy's rock broke the bottle ahead of Billy, preventing Billy from breaking the bottle, the but-for test fails to reckon Suzy's throwing the rock as the cause of the breakage because even if Suzy's rock missed the bottle, Billy's rock would have broken it. Many causal theorists consequently modify the but-for ingredient in their account so that their account can still "correctly" predict the common-sense causal ascription. In contrast, the HR causation would not, without specifying the way the bottle broke, regard Suzy's throwing the rock as the cause of "the breakage

[56] Just as both 'a cat's jumping out of the bush' and 'a skinny black cat's jumping out of the bush' can both be the cause of the car accident as well.

of the bottle," the latter being nothing but an instantiation of a token statement 'the bottle broke'. In a sense, the HR causation respects the but-for requirement more truthfully, to the extent that it does not regard Suzy's throwing as a cause in the first place because Suzy's throwing does not pass the but-for test, or more precisely, because it does not meet its counterpart criterion, namely, the probability exhaustion criterion of the HR account.

This completes the introduction of the HR causation which, in limited cases, provides a charitable, type-based interpretation of everyday talk of actual causation, and, in other cases, leads us to a liability ascription that is more efficient in meeting social goals than that suggested by a common sense account of actual causation.

Appendix 1: Steel's three principles concerning exceptions

In Steel (2015), Sandy Steel maintains that, while the common law's version of the general rule that the claimant should prove that the relevant aspect of the defendant's conduct is a cause of its injury on the balance of probability in order to obtain compensation in respect of that injury is generally justified, a set of exceptions to this rule can be justified as well. He proposes the following three principles, 1) *Reliance upon wrongful conduct principle*, 2) *Prevented claim principle*, and 3) *Proven causation principle* as guidelines for dealing with the exceptions. For readers not familiar with Steel's work, the following three examples of Steel may help illustrate what kinds of case Steel is concerned with for each principle.

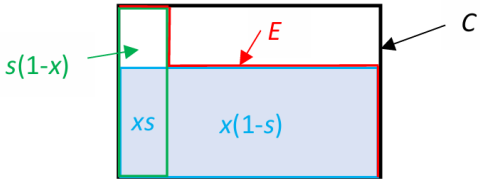
1. Drug. D1 negligently fails to include a warning on the packaging of a drug directing medical professionals not to administer the drug to persons using certain other medication. D2, doctor, administers the drug to C, negligently failing to check for any warnings on the packaging. C suffers injury due to a toxic combination of medications. (Steel 2015: 190)
2. Two Hunters, Evidential Uncertainty. D1 and D2, each on separate hunting trips in the same wood, negligently fire towards C. One bullet strikes C, causing C physical injury. Due to the identical guns and calibre of bullets used, it is not possible to determine which bullet struck C. (Steel 2015: 176)
3. Scarce Antidote. An ambulance negligently fails to turn up to an incident where three people have each been bitten by a snake. Had the ambulance turned up, it would only have had enough antidote to treat one of the three people. The ambulance crew would have decided which person would have received the antidote by lot, giving each person a 1/3 chance of avoiding serious injuries. Each person

> suffers an injury of the same extent due to the absence of an antidote. (Steel 2015: 356)

In these cases, the claimants are unable to produce a proof of causation that meets the standard required by the general rule. However, according to Steel, exceptions to the rule should be introduced. The point of mentioning Steel's principles here is that, in the framework of HR-causation, there is no need for the claimant in each of these cases to prove any "actual causation" in the first place, so no exceptions are needed. Both HR-causation and Steel's principles are, in nature, guided by the ultimate principle of maximizing the social welfare in the long run — the very principle that was embraced by the Law and Economics movements.

Appendix 2: Some remarks on signature bearing

Let us suppose that C is the only cause-type that could raise the chance of E. So, we have $P(E|C) > P(E|{\sim}C)$, knowing that factors other than C and E have no saying on this matter. One should bear in mind that we do not assume that $P(E|C)=1$, in other words, C does not guarantee the E would obtain, nor do we assume that $P(E|{\sim}C)=0$, in other words, there might be a baseline rate that E occurs spontaneously. Now, suppose that, for narrative purposes only, whenever C takes effect in leading to E, it leaves a signature on the effect so that one can judge from the signature that it is indeed an instance of C taking part. Let the chance that C takes effect in leading to E be x, and the baseline rate for E's spontaneous occurring, that is, in the absence of C, be s, then we have the following picture.

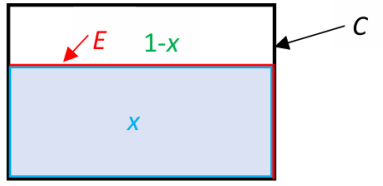


Picture A

Points that lie in the blue shaded-area are contexts that bear the signature of C. In case that both C and E obtain, the conditional probability for E bearing the signature of C is x. Now, the conditional probabilities $P(E|C)$ and $Pr(E|{\sim}C)$ are $x+s-xs$ and s respectively, where $P(E|{\sim}C)$ is the baseline rate of E. And the state C typically raises the chance of E from s to $x+s-xs$, increasing the probability by $x(1-s)$, which is less than x. The most important point to observe here is that, from the fact that C and E obtain in context c, we *cannot* derive that the context is such that (E, c) bears the signature of C because the

effect *E* may turn out to be spontaneous without any contribution from *C*. In other words, *c* might be in the region labeled by *s*(1-*x*) in Picture A.

Only in the simplest case where *E* never occurs spontaneously, i.e. *s*=0, can we derive from the fact that *C* and *E* obtain in context *c* that (*E*, *c*) bears the signature of *C*. And in this case, *P*(*E*|*C*) and *P*(*E*|~*C*) are reduced to *x* and 0 respectively, and picture A is reduced to picture B.



Picture B

References

Bennett, J. 1987. "Event causation: the counterfactual analysis," in J. E. Tomberlin (ed.), *Philosophical Perspectives, 1, Metaphysics*, 367–386.

Blanchard, T. 2016. "Physics and causation," *Philosophy Compass*, 11(5), 256–266.

Calabresi, G. 1975. "Concerning cause and the law of torts: an essay for Harry Kalven, Jr.," *University of Chicago Law Review*, 43, 69–108.

Collins, J., C. N. Hall, and L. A. Paul (eds.). 2004. *Causation and Counterfactuals* (Cambridge, MA: The MIT Press).

Edgerton, H. 1924. "Legal cause," *University of Pennsylvania Law Review*, 72(3), 211–44, 72(4), 343–75.

Frick, J. 2009. "'Causal dependence' and chance: the new problem of false negatives," ms. as quoted in Paul and Hall 2013.

Halpern, J. Y. 2016. *Actual Causality* (Cambridge, MA: The MIT Press).

Hitchcock, C. 2004. "Do all and only causes raise the probabilities of effects?," in Collins et al. 2004, 403–17.

Hitchcock, C. and J. Knobe. 2009. "Cause and norm," *Journal of Philosophy*, 106 (11), 587–612.

Hume, D. 1748. *An Enquiry Concerning Human Understanding*.

Humphreys, P. 1989. *The Chances of Explanation: Causal Explanations in the Social, Medical, and Physical Sciences* (Princeton, N.J.: Princeton University Press).

Johnson, E. A. 2016. "Cause-in-fact *after Burrage v. United States*," *Florida Law Review*, 68(6), 1727–1771.

Kelman, M. A. 1987. *Guide to Critical Legal Studies* (Cambridge, Mass.: Harvard University Press).

Kelman, M. A. 1987a. "The necessary myth of objective causation judgments in liberal political theory," *Chicago-Kent Law Review*, 63, 579–637.

Knowles, D. (ed.). 1990. *Explanation and Its Limits* (Cambridge: Cambridge University Press).

Kripke, S. 1982. *Wittgenstein on Rules and Private Language* (Cambridge, Mass.: Harvard University Press).

Kvart, I. 2004. "Causation: probabilistic and counterfactual analyses," in Collins et al. 2004: 359–86.

Landes, W. and R. Posner. 1983. "Causation in tort law: An economic approach," *Journal of Legal Studies*, 12, 109–34.

Lewis, D. 1986. "Postscripts to 'Causation'," in D. Lewis, *Philosophical Papers*, Vol. II (Oxford: Oxford University Press), 172–213.

Lewis, D. 2000. "Causation as influence," *Journal of Philosophy*, 97, 182–197.

Lewis, D. 2004. "Causation as influence," in Collins et al. 2004: 75–106. This is an expanded version of "Causation as influence," *Journal of Philosophy*, 97, 182-197.

Malone, W. 1956. "Ruminations on cause-in-fact," *Stanford Law Review*, 9, 60–99.

Moore, M. 2009. *Causation and Responsibility: an Essay in Law, Morals, and Metaphysics* (Oxford: Oxford University Press).

Moore, M. 2019. "Causation in the law," in *Stanford Encyclopedia of Philosophy*, accessed 10 March 2025, at https://plato.stanford.edu/entries/causation-law/.

Paul, L. A. and N. Hall. 2013. *Causation: A User's Guide* (Oxford: Oxford University Press).

Ramachandran, M. 2004. "A counterfactual analysis of indeterministic causation," in Collins et al. 2004: 387–402.

Russell, B. 1913. "On the notion of cause," *Proceedings of the Aristotelian Society*, 13, 1–26.

Salmon, W. C. 1984. *Scientific Explanation and the Causal Structure of the World* (Princeton: Princeton University Press).

Shavell, S, 1980. "An analysis of causation and the scope of liability in the law of torts," *Journal of Legal Studies*, 9, 463–503.

Steel, S. 2015. *Proof of Causation in Tort Law* (Cambridge: Cambridge University Press).

Tsai, C-C. 2011. "A token-based semantic analysis of McTaggart's paradox," *Linguistic and Philosophical Investigations*, 10, 107–124.

Woodward, J. 1990. "Supervenience and singular causal statements," in Knowles 1990: 215–216.

Woodward, J. 1994. "Review of Humphreys '*The Chances of Explanation*'," *British Journal for the Philosophy of Science*, 45, 353–374.