In a probabilistic universe, different possible futures have different chances of occurring. We can think of the chance distribution at $t$ as a probability measure on the class of those metaphysically possible worlds that are compatible with the actual history up to $t$ and with the actual laws of nature. Given this connection between chance and modality, one’s views about modal space can have significant implications for the theory of physical chance, and one’s modal views can be evaluated in part by how plausible these implications are. I apply this methodology to two influential modal theses. The first of these is the view, proposed by Hugh Chandler and Nathan Salmon, that many individuals have their modal features contingently. This thesis can be shown to entail that the present chances of various events are partly determined by the outcomes of future chance processes. As a result, the account yields a cluster of problematic consequences that are usually associated with Humean frequentist accounts of chance and which are known as “the problem of undermining futures.” The second account I consider is the thesis (held by a number of philosophers) that the existence of a possible world $w$ depends on the existence of the contingent individuals that exist at $w$, and that many possible worlds are therefore contingent existents. The problem of undermining arises for this view as well, although in a milder form.

1. **Modality and chance**

The philosophical literature is full of debates about the general features of the space of metaphysically possible worlds: its plenitude, the ways worlds can differ, whether the features of the space are themselves necessary, and so forth. To decide such disputes, it seems natural to compare the modal statements underwritten by the competing views for their plausibility, including possibility and necessity claims and counterfactuals. But often these data are inconclusive. I aim to show that some well-known debates about modality can be made more tractable by considering an additional source of evidence: the implications of the rival positions for the theory of physical chance.
The connection between modality and chance is straightforward: There can be a non-zero chance at \( t \) that \( P \) only if it is metaphysically possible that \( P \). Moreover, we can think of the sample space of the chance distribution at \( t \) as a set of metaphysically possible scenarios. To be more specific, the chance distribution at time \( t \) can be regarded as a probability measure on the set of what we may call the ‘possibilities that are open at \( t \)’, that is, the metaphysically possible worlds that are like actuality through \( t \) and that never violate the actual laws. Under determinism the actual world is the only open possibility and it has a 100\% chance of being actualized, while under indeterminism chances may be spread out more widely over worlds. Ordinary chance claims can be explained in this framework. For example, the present chance that it will rain in New York City tomorrow equals the present chance measure of the set of open possibilities where it rains in New York City tomorrow. More generally:

(MC) Necessarily, for any proposition \( P \) and time \( t \), \( P \)’s chance at \( t \) equals \( x \) iff the chance measure at \( t \) of the set of open possibilities where \( P \) is true is defined and equals \( x \).

I will call this claim the Modality-Chance Principle (MC).

Thanks to these connections between modality and chance, one’s views about the shape of modal space can have significant implications in the philosophy of chance, and it is a desideratum for a good theory of modality that its implications in this area should be plausible. This general requirement imposes a number of more specific constraints on an account of modal space. By considering each of these constraints in turn and determining which views satisfy it and which do not, we can gradually narrow down the range of theories consistent with a satisfactory account of chance. The results will have implications for various ongoing disputes in the philosophy of modality, since the competing positions will be supported or disconfirmed to the extent that they meet the constraints.

One relevant constraint is discussed in Author a: an account of modality should afford a sufficiently rich sample space for physical chance. I argued that this desideratum can be brought to bear on the debate about haecceitism. Haecceitists hold that two possible worlds can be qualitatively alike—in the sense that they feature the same pattern of instantiation of purely qualitative properties and relations—but differ in how things stand
with specific individuals.\textsuperscript{1,2} Anti-haecceitists believe the opposite. On their account, all facts globally supervene on the qualitative facts: no two possible worlds differ in any way at all without differing qualitatively. I tried to show that anti-haecceitism does not yield a rich enough sample space for physical chance. My goal in the present paper is to argue that some haecceitist views have implausible consequences about chance as well. I will attempt to show this by considering a second constraint that some influential haecceitist views fail to meet: a good account of modality should avoid what is known as \textit{the problem of undermining}.

This problem is usually discussed as a difficulty for Humean frequentist accounts of chance.\textsuperscript{3} Frequentists believe that the laws of chance are determined by the frequencies of different patterns of events throughout the history of the universe. On this view, the present chances of different possible futures depend in part on future frequencies. But these may themselves depend on how future chance processes will turn out. It may therefore be presently chancy what the present chances are: event $E$ may have a 50\% chance right now, but there may also be a non-zero present chance that $E$’s present chance is not 50\%. Adopting a term introduced by David Lewis, we can describe such cases by saying that the present chances ‘undermine themselves’. As is well-known, the fact that frequentists are committed to the possibility of undermining forces them to abandon some very compelling principles about chance.

The problem of undermining does not affect frequentism alone. It can arise for any account that entails that the present chances depend on facts that are determined by future chance processes. Now, the present chances depend in part on the modal facts, since (as mentioned above) the present chance that $P$ can be greater than zero only if it is metaphysically possible that $P$. Any theory that entails that the relevant modal facts in

\hspace{1cm}

\textsuperscript{1} I am roughly following David Lewis’s definition of ‘haecceitism’ (Lewis 1986b, Sect. 4.4). The term ‘haecceitism’ is due to David Kaplan (1975, pp. 722–3.). See Adams 1974, 1979, 1981, Lewis 1968, 1986b (Ch. 4), Skow 2008, Fara 2009, Stalnaker 2011, and Author a for some discussions of haecceitism and anti-haecceitism.

\textsuperscript{2} By ‘purely qualitative property’ I mean, roughly speaking, a property whose instantiation by a certain individual $x$ is in no way a matter of which specific individual $x$ is or which specific individuals $x$ is related to. The properties of being Katie’s sister, of being French, and of being a Marxist are not qualitative, while those of being a quark and of having a certain mass arguably are qualitative.

turn depend on the outcomes of future chance processes is at risk of generating undermining cases.

I will try to show that this problem arises for two well-known haecceitist views. The feature that these views share, and which makes them susceptible to the problem of undermining, is that they entail that *de re* modal facts about specific individuals are often contingent, and that under indeterminism such contingent modal facts may be the outcomes of chance processes. However, the two theories motivate these theses in quite different ways. The first view, proposed by Hugh Chandler and Nathan Salmon, starts from examples that seem to show that many individuals have their modal features contingently—they could have had different modal profiles from the ones they actually have. I will call this theory *modal-profile contingentism* (MPC) and will discuss it in section 2. As will be shown below, MPC has many of the same implausible implications as frequentism. The second view argues for the contingency of *de re* modal facts from the observation that many individuals are contingent existents. This account, which I will call *modal existence contingentism* (MEC), will be the topic of section 3. MEC comes in different forms and not every version of it entails that undermining cases are possible. However, we will see that one well-known variant (proposed by Robert Adams among others) does have this consequence, though the resulting difficulties for the view are less severe than those for MPC.

2. Modal-profile contingentism

2.1 The case for contingent modal profiles
Consider the following familiar line of reasoning, due to Hugh Chandler (1976) and Nathan Salmon (1979; 1982, pp. 238–40). Suppose that your living-room is graced with a wooden table by the name of ‘Woody’ that was made from three parts, A, B, and C. It seems very plausible that Woody could not have been made from completely different parts. To fix ideas, let us assume that

(1) It is necessary that Woody, if he exists, is made from at least \( \frac{2}{3} \) of ABC.

On the other hand, Woody could surely have been made from *slightly* different parts. For example, there is a possible world where a few atoms get removed from ABC just before
a table is made from this hunk, but where that table is still Woody. Again, to fix ideas, let us assume that

(2) It is not necessary that Woody, if he exists, is made from more than $\frac{2}{3}$ of $ABC$.

It seems plausible that these modal facts about Woody are instances of some more general principles about the modal profiles of tables:

*Necessity.* Where $x$ is any table and the $y$s are $x$’s parts, it is necessary that if $x$ exists, then $x$ is made from at least two thirds of the $y$s.

*Tolerance.* Where $x$ is any table and the $y$s are $x$’s parts, it is not necessary that if $x$ exists, then $x$ is made from more than two thirds of the $y$s.\(^4\)

It also seems plausible that Necessity and Tolerance do not just happen to hold at the actual world—by metaphysical coincidence, as it were—but are true at all possible worlds.

By Tolerance, there is a possible world that meets the following description:

\[ w_1: \text{Woody is made from } XBC. \]

Since Tolerance also holds at $w_1$, it is true at $w_1$ that there exists a possible world that satisfies the following description:

\[ w_2: \text{Woody is made from } XYC. \]

But by Necessity, there does not actually exist such a possible world. ($w_2$ may *exist* at the actual world, but only as an *impossible* world.) So, it is possibly possible that Woody is made from $XYC$, but it is not possible. The following schema is consequently invalid:

\[ (S4\diamond_M) \quad \diamond_M \diamond_M P \to \diamond_M P, \]

where ‘$\diamond_M$’ is the metaphysical possibility operator. Similarly, we obtain a counterexample to the following schema (which is equivalent to $(S4\diamond_M)$ if the metaphysical necessity operator ‘$\square_M$’ is inter-definable with ‘$\diamond_M$’ in the usual way):

\[ (S4\square_M) \quad \square_M P \to \square_M \square_M P \]

\(^4\) The name ‘Tolerance’ that I am using for this principle is borrowed from Forbes 1985.
While it is necessary that Woody (if he exists) is made from at least $\frac{2}{3}$ of $ABC$, it is not necessarily necessary (since it is not necessary at possible world $w_1$).

Let us use the term ‘modal-profile contingentism’ (or ‘MPC’) for the view that some principles like Necessity and Tolerance are necessarily true and that the S4-schemata are to be rejected for the reasons described. Examples like the one considered provide good prima facie motivation for this view. What is more, it is not clear at first blush what to say against MPC. It is true that the S4-schemata are valid in S5, which is sometimes called the ‘standard modal logic’ for metaphysical modality, and that some authors write as if it was a substantial cost of an account if it forces us to reject S5. But I think that it is far from obvious that that is true. Offhand, I find it very hard to know what to think about the likes of $(S4\diamond_M)$ and $(S4\Box_M)$, and it is difficult for me to imagine that anyone has strong views about these principles that are not fueled by theory, the result of philosophical upbringing, or merely suggested by the imagery evoked by talk about possible worlds. There may be theoretical reasons for adopting S4 or S5 for metaphysical modality, but in my judgement there are at least equally weighty reasons against this choice.\(^5\)

However, I will argue in the next couple of sections that MPC has implausible implications about chance that make it considerably less attractive overall. In preparation for this argument, it will be necessary to distinguish two versions of MPC that require slightly different treatment (section 2.2). The first version will be discussed in sections 2.3–2.4. I will try to show that this view gives rise to undermining cases and that, as a result of this fact, it violates a number of very compelling principles about chance. In section 2.5 I will argue that many of these arguments also apply (in slightly different form) to the second version of MPC. If we reject MPC for the reasons I will discuss, then we face the question of how we should accommodate the data that motivated MPC. Section 2.6 will briefly discuss some of the options.

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\(^5\) For mutually opposing views on this issue, see Adams 1981 and Author b on the one hand and Williamson 2013 on the other.
2.2 Two versions of modal-profile contingentism

Proponents of MPC believe that if Woody is actually made from \(ABC\), then some tables in other possible worlds that are made from \(BCD\) are identical with Woody. But they are not committed to saying that every such table is Woody. In other words: for all MPC says, being made from \(BCD\) may not be a sufficient condition for a table in another possible world to be Woody, and it may not even be part of any non-trivial sufficient condition. So, MPC theorists are free either to assert or to deny the following principle:

\[\text{Sufficiency.} \text{ Necessarily, if Woody could have been made from the ys, then there is some condition (not necessarily a purely qualitative one) that can be conjoined with the property of being made from the ys to obtain a non-trivial sufficient condition for a table in another possible world to be Woody.}\]

That means that we can distinguish two versions of MPC that differ in their attitude towards Sufficiency. The arguments I will give below need to be formulated in slightly different ways depending on which variant of MPC is under discussion. I will focus at first on a version of MPC that endorses Sufficiency (sections 2.3–2.4), before considering a version that does not (section 2.5).

Anyone who denies Sufficiency must say that there could have been two possible worlds \(w_1\) and \(w_2\) where a table is made from the same parts and which are indistinguishable from each other—not just qualitatively, but also in their distribution of qualitative roles over specific individuals—except that at the one world the table is Woody, while at the other it is not. It is worth pausing briefly to appreciate the strength of this commitment. It is much stronger than the thesis (which some haecceitists may accept) that there could have been qualitatively indistinguishable worlds one of which contains Woody while the other does not. The tables in \(w_1\) and \(w_2\) are not just qualitatively alike. They are made from numerically identical particles and by the same person, who is herself composed of numerically identical particles at the two worlds. More generally, the tables stand in the same relations to all other individuals, and yet the

\[\text{It is obviously possible to obtain a sufficient condition for being Woody by conjoining the property of being made from the ys with, say, the property of being Woody, or with the property of being self-distinct. Sufficient conditions of these kinds are clearly of no interest to our discussion. The qualification ‘non-trivial’ in my formulation of Sufficiency is meant to rule them out.}\]
one table is Woody while the other is not. To me it sounds implausible that there could have been such a pair of worlds. But I will not dwell on this point, since my arguments will not rest on it. As we will see, the problem of undermining arises for MPC theorists regardless of whether they endorse Sufficiency.

2.3 Undermining and the Basic Chance Principle

Let us say that the chances at \( t \) ‘undermine themselves’ iff it is chancy at \( t \) what the chances at \( t \) are, or in other words, iff there is a non-zero chance at \( t \) that the chances at \( t \) are different from what they actually are. To state this definition more formally, and to conduct the discussion in the rest of this paper more efficiently, it will be useful to use some symbols. Where \( P \) is a singular term for a proposition or a variable ranging over propositions, let \( \lceil \text{ch}_t(P) \rceil \) abbreviate \( \lceil \text{the chance of } P \text{ at } t \rceil \). Similarly, where \( S \) is a sentence or open formula, let \( \lceil \text{ch}_t(S) \rceil \) abbreviate \( \lceil \text{the chance of the proposition that } S \text{ at } t \rceil \). And where \( C \) is a singular term for a set of worlds or a variable ranging over such sets, let \( \lceil \text{ch}_t(C) \rceil \) abbreviate \( \lceil \text{the chance measure of } C \text{ at } t \rceil \). Undermining can then be defined as follows:

The chances at \( t \) undermine themselves \( \text{iff} \) for some proposition \( P \) and number \( x \),

\[
\begin{align*}
\text{ch}_t(P) &= x, \\
\text{ch}_t(\text{ch}_t(P) \neq x) &> 0
\end{align*}
\]

As mentioned in the introduction, frequentists about chance are committed to the claim that undermining is possible. But even those who endorse this claim tend to concede its implausibility. (David Lewis, for example, whose frequentist account of chance forced him to accept the possibility of undermining cases, called such cases ‘peculiar’ (Lewis 1986a, postscript C).) It is natural to think of the present chance that \( P \) as something like the strength of the universe’s present tendency to evolve into a state where \( P \). And it is strange to think that the strength of that present tendency depends on how the universe will in fact evolve. Undermining cases are particularly bizarre if they run counter to what Bigelow, Collins and Pargetter (1993) call the ‘Basic Chance Principle’. A slightly strengthened version of this principle runs as follows:
Basic Chance Principle*. If $\text{ch}_t(P) > 0$ at possible world $w$, then there is some possible world that is like $w$ up to $t$, where the chances at $t$ are the same as at $w$, and where $P$ holds.\(^7\)

This principle seems extremely plausible, but it is violated by the undermining scenarios generated by frequentism.

As mentioned in the introduction, the problem of undermining can arise for any theory according to which the present chances are partly determined by the outcomes of future chance processes. MPC is one such position. Remember that if $P$ is metaphysically impossible, then $P$’s chance must be zero at all times. That means that $P$’s present chance may depend on whether $P$ is metaphysically possible. MPC in turn entails that $P$ may be metaphysically possible at one possible world but not at another. Moreover, which of these worlds is actualized may itself depend on the outcomes of future chance processes.

Let us consider an illustration of this problem, focusing for now on a version of MPC that endorses Sufficiency.

Example 1. You are planning to make a table but cannot make up your mind about whether to use $ABC$, $BCD$, or $CDE$. At time $t$, you decide that you will settle the matter by spinning a wheel of fortune with three equiprobable possible outcomes. You spin the wheel at $t+1$ and, abiding by the outcome of the spin, you end up making a table from $BCD$. You call the table ‘Woody’.

Given MPC and Sufficiency, and given that Woody is actually made from $BCD$, there must be some condition $X$ that can be conjoined with the property of being made from $ABC$ to yield a non-trivial sufficient condition for a table in another possible world to be Woody. Let us assume that it is part of your plan that, if you make a table from $ABC$, you will make sure that that table meets condition $X$. So, in all possibilities that are open at $t$ and where a table is made from $ABC$, that table is Woody. Likewise, let us assume that

\(^7\) The original version of the principle runs as follows:

Suppose $x > 0$ and $\text{ch}_m(A) = x$. Then $A$ is true in at least one of those worlds $w'$ that matches $w$ up to time $t$ and for which $\text{ch}_t(A) = x$. (Bigelow, Collins, and Pargetter 1993, p. 459)

While the cases of undermining that arise on a Humean view violate this weaker principle, those that result from MPC only violate the strengthened version. The two versions seem to me to be roughly equally compelling.
things are set up so that in any open possibility where a table is made either from $BCD$ (as in the actual world) or from $CDE$, that table is Woody. Then in all possibilities that are open at $t$, the table you make is Woody.

I will use ‘$ABC_W$’ both as an abbreviation of ‘Woody is made from $ABC$’ and as a name for the proposition expressed by this sentence (a convenient ambiguity that is harmless in the present context). ‘$BCD_W$’ and ‘$CDE_W$’ are to be understood analogously. Moreover, ‘$CDE$’ will be used as an abbreviation for ‘A table is made from $CDE$’ and as a name for the proposition expressed by this sentence. Figure 1 represents the situation at the actual world (which I will call ‘$@$’):

![Figure 1](image1.png)

**Figure 1.** The open possibilities at $@$ and their chances in Example 1

The black path represents the course that events are in fact taking, while the unrealized possibilities that are open at $t$ (i.e. at the time just before you are spinning the wheel) are represented in grey. Note that the following is actually true:

$$(3) \begin{align*}
\text{(i)} & \quad \text{ch}_t(ABC_W) = \text{ch}_t(\{w_1\}) = \frac{1}{3} \\
\text{(ii)} & \quad \text{ch}_t(CDE_W) = \text{ch}_t(\{w_2\}) = \frac{1}{3}
\end{align*}$$

The situation at $w_1$ is represented in Figure 2. (‘$CDE$’ in Figure 2 stands for ‘Some table is made from $CDE$’.) At $w_1$, where Woody is made from $ABC$, there are two unrealized possibilities that are open at $t$: one where you make a table from $BCD$, and another, $w_3$, where you make a table from $CDE$. Since Necessity is true at $w_1$, the table made from $CDE$ in $w_3$ cannot be Woody. (That is what distinguishes $w_3$ from world $w_2$ represented in Figure 1.) Since at $w_1$ it is metaphysically impossible that Woody is made from $CDE$, it follows that

$$(4) \quad \text{At } w_1, \text{ch}_t(CDE_W) = 0$$
By (3)(i), \( \{w_1\} \) actually has a chance measure of \( \frac{1}{3} \) at \( t \). By (4), \( \{w_1\} \) is a subset of the set of possible worlds where \( \text{ch}_t(CDE_w) = 0 \). It follows that the set of possible worlds where \( \text{ch}_t(CDE_w) = 0 \) must actually have a chance measure of at least \( \frac{1}{3} \) at \( t \). By the modality-chance principle (MC) stated in the introduction, that entails that \( \text{ch}_t(\text{ch}_t(CDE_w) = 0) \geq \frac{1}{3} \). And yet, (3)(ii) tells us that at the actual world, \( \text{ch}_t(CDE_w) = \frac{1}{3} \).

That is a case of undermining: the present chance of \( CDE_w \) is \( \frac{1}{3} \), but there is a non-zero present chance that the present chance of \( CDE_w \) is not \( \frac{1}{3} \) but 0. It is also a violation of the Basic Chance Principle*: even though \( \text{ch}_t(ABC_w) > 0 \) at the actual world, there is no possible world that is like actuality up to \( t \), where the chances at \( t \) are the same as in actuality, and where \( ABC_w \) is true. For the assumption that Necessity is a necessary truth entails that at any possible world where \( ABC_w \) is true, \( CDE_w \) is metaphysically impossible and \( \text{ch}_t(CDE_w) \) therefore equals 0. Hence, at every \( ABC_w \)-world, (3)(ii) is false and the chances at \( t \) are therefore different from what they actually are.\(^8\)

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\(^8\) It is well-known that the possibility of undermining can conflict with the original version of the Principal Principle (OPP), which was proposed by David Lewis in his 1986a. According to OPP, your credence in \( P \) conditional on the assumption that \( \text{ch}_t(\text{P}) = x \) ought to equal \( x \) as long as you have no ‘inadmissible’ evidence relative to \( P \) and \( t \), i.e. as long as your evidence bears on whether \( P \) holds only by bearing on what \( P \)’s chance was at \( t \). (This condition is typically satisfied if you have no evidence about the outcomes of post-\( t \) chance processes that is relevant to \( P \).) Some MPC-generated undermining cases give rise to violations of OPP. Consider a version of Example 1 in which you (the carpenter) explain to me the procedure by which you will decide from which parts the table will be made. Suppose that I am certain that Necessity and Tolerance are true, and that no matter which parts the table will be made from, at open possibilities where a table is made from two of these parts and a different third part it is the same table. I leave the carpenter’s workshop at \( t^* \), just before the wheel of fortune is spun. The next day I return and am introduced to the finished table, Woody, but am not told from which parts he was made. I have no inadmissible evidence relative to \( ABC_w \) and \( t^* \). Moreover, I am certain that either \( ABC_w \) or \( BCD_w \) or \( CDE_w \) is true and I divide my credence equally between these three possibilities. Then my credence function is bound to violate OPP. For, I am certain that \( ABC_w \) is metaphysically impossible if \( CDE_w \) is true, and hence that \( \text{ch}_t(ABC_w) = 0 \) if \( CDE_w \) is true. Therefore, conditional on the assumption that \( \text{ch}_t(ABC_w) = \frac{1}{3} \), my credence in \( CDE_w \) equals zero and my credence in Either \( ABC_w \) or \( BCD_w \) equals one. Moreover, since neither \( ABC_w \) nor \( BCD_w \) is more likely than the other on the assumption that \( \text{ch}_t(ABC_w) = \frac{1}{3} \), it is permissible for me to have a credence of \( \frac{1}{3} \) both in \( ABC_w \) and in \( BCD_w \) conditional on the assumption that \( \text{ch}_t(ABC_w) = \frac{1}{3} \). That is contrary to OPP, which tells us that my credence in \( ABC_w \) conditional on the assumption that \( \text{ch}_t(ABC_w) = \frac{1}{3} \) ought to be \( \frac{1}{3} \).

It is unclear how much proponents of MPC should be worried by the fact that their view generates such counterexamples to OPP. These counterexamples concern an agent’s credence in singular propositions, and there are independent reasons for thinking that OPP yields false predictions when applied to such singular beliefs. (Cf. Hawthorne and Lasonen-Aarnio 2009, p. 97. Also see Chalmers 2011 for relevant discussion.) It seems that OPP needs to be revised in response to these counterexamples in any case, and it is possible that once the revisions have been made, the resulting principle will be consistent with MPC. It is also worth mentioning that that the (admittedly less compelling) undermining-resistant ‘New Principal Principle’ (NPP) proposed by Lewis (1994) and Hall (1994) can be shown to be consistent with MPC.
2.4 Expected future chances and the logic of open possibility

Sitting in front of two buttons, you are about to throw a fair six-sided die. If it lands 6, you will push the left button, an action that has an 80% chance of causing an explosion. If any other number comes up, you will push the button on the right instead, giving the explosion a 20% chance of occurring. What is the current chance of an explosion? Obviously, it is $\frac{1}{6} \times 80\% + \frac{5}{6} \times 20\% = 30\%$. The current chance equals the average of the different possible future chances, weighted by the present chances of these future chances. This exemplifies the following very plausible general rule (‘$t < u$’ abbreviates ‘$t$ is earlier than $u$’):

*Expected-Chance Principle (ECP)*. For any times $t$ and $u$ such that $t < u$, $\text{ch}_t(P)$ equals the expected value, relative to the chance distribution at $t$, of $P$’s chance at $u$ (provided that this expected value and $\text{ch}_t(P)$ are defined).

Applications of (ECP) are arguably ubiquitous in ordinary reasoning about chances. Your team tends to win games that take place after rain showers, but does poorly otherwise. To calculate your team’s present chance of winning the game tonight, you estimate the present chance that it will rain in the afternoon, and then estimate the chances of winning that your team will have tonight in open possibilities where it rains in the afternoon and in open possibilities where it does not. That allows you to estimate the expectation, relative to the present chances, of the chance of winning that your team will have tonight. And that, in turn, is your best estimate of the present chance of victory.

Another principle that is closely related to (but less powerful than) ECP seems even more compelling:

*Some Chance Principle*. For any times $t$ and $u$ such that $t < u$, if there is a non-zero chance at $t$ that there will be a non-zero chance at $u$ that it will be the case that $P$, then there is a non-zero chance at $t$ that it will be the case that $P$ (provided that the chance at $t$ that it will be the case that $P$ is defined).

For example, if there is some chance now that there will some chance tomorrow that we will win next week, then there is some chance now that we will win.

This second principle is closely related to a third one that deserves our attention as well. However, before considering this third principle, we need to broaden the way we
think about chance. As mentioned before, $P$’s chance is naturally taken to measure the strength of the universe’s tendency to evolve so as to make $P$ true. But a scale from 0 to 1 does not seem sufficient to capture all facts about the strength of that tendency. It misses important distinctions among propositions with chance zero and among those whose chance is one. Imagine a world that is indeterministic, but not pervasively so. Some future occurrences are determined to happen by the past and the laws, while others are matters of chance. You are about to throw a dart with a point-sized (infinitely small) tip at a dartboard. The history up to now and the laws necessitate that you will hit some point on the board, but do not necessitate any stronger claims about where the dart will land. Which point you hit is a matter of chance, and the chance density function is constant over all locations on the dartboard (i.e. any two measurable regions of the same size have the same chance of being hit). Then any point $p$ on the board has a zero chance of being hit, and any point $p^*$ that is not on the board also has a zero chance. But there is an important difference: given the past and the laws, it is still an open question whether or not the dart will hit $p$, but it is already settled that it will not hit $p^*$. There is a sense in which the dart has an even lower tendency to hit $p^*$ than it does to hit $p$—its hitting $p^*$ is precluded in a way in which its hitting $p$ is not. Similarly, the chance is one that the dart will hit some point on the board, and the chance is also one that the dart will hit some point on the board other than $p$. But its tendency to hit some point on the board is stronger than its tendency to hit some point on the board other than $p$, since the former event is pre-determined to happen while the latter is not.

Let us say that it is an open possibility at $t$ that $P$ just in case the proposition that $P$ is compossible with the history through $t$ and the laws, and that it is settled at $t$ that $P$ just in case the history through $t$ and the laws together necessitate that $P$. Then on a natural extension of the ordinary concept of chance, there are different ways of having chance zero. Or rather, as I prefer to put it, the expression ‘chance zero’ covers different chances that a proposition can have (the chances of two propositions can differ without differing numerically). The assumption that the proposition that $P$ has a chance of zero at $t$ is consistent with its being settled at $t$ that $\neg P$ but also with its being an open possibility at $t$ that $P$. In the first case the proposition that $P$ has the lowest of all possible chances, in the second case it has a higher chance than that. In other words: Given a chance measure
over the space of open possibilities, $P$ has the lowest possible chance iff $P$ is not true at any world in the space. $P$ has chance zero but not the lowest possible chance iff the $P$-worlds among the open possibilities form a non-empty set whose chance measure is zero. The expression ‘chance one’ covers different chances as well. If the proposition that $P$ has a chance of one, then it might be that it is settled that it will be the case that $P$, or it might be that it is still an open possibility that it will be the case that $\neg P$. The proposition that $P$ has a higher chance in the first case than in the second.

With the notion of an open possibility clearly in focus, we can formulate another principle, which I will call

*Open Possibility Principle.* For any times $t$ and $u$ such that $t < u$, if it is an open possibility at $t$ that it will be an open possibility at $u$ that it will be the case that $P$, then it is an open possibility at $t$ that it will be the case that $P$.

This principle says about open possibility what the Some Chance Principle says about the slightly stronger property of having a non-zero chance. And it seems equally compelling. If it is still an open possibility now that it will be an open possibility tomorrow that $P$, then it cannot already be settled now that $\neg P$.

MPC yields counterexamples to all three principles stated in this section. Consider

*Example 2.* At time $t$, you resolve to toss a fair coin to decide whether to make a table from $ABC$, $BCD$, or $CDE$. If the coin lands heads, you will make the table from $ABC$. If it comes up tails, you will toss it again. If the second toss lands heads, you will make a table from $BCD$, if it comes up tails, you will instead make a table from $CDE$. In fact, the first toss comes up heads and you make a table from $ABC$. You call the table ‘Woody’.

For the time being, I will again focus on a version of MPC that endorses Sufficiency. As in the discussion of Example 1 in section 2.3, I will assume that things are set up so that in any open possibility where a table is made from $ABC$ (as in the actual world) or from $BCD$, that table is Woody. I will further assume that things are arranged in such a way that in any open possibility where Woody is made from $BCD$, it is true that in any open possibility where a table is made from $CDE$, that table is Woody.
Figure 3 depicts the situation at the actual world. As before, the black path represents the course that events are in fact taking. Unrealized possibilities that are open at \( t \) are greyed out.

**Figure 3.** The open possibilities at @ and their chances in Example 2

Since Woody is actually made from \( ABC \), it follows by Necessity that it is impossible for Woody to be made from \( CDE \). Hence, at the actual world,

\[
(5) \quad \text{ch}_t(CDE_w) = 0
\]

Moreover, it is true at the actual world that

\[
(6) \quad \text{ch}_t(\{w_1\}) = \frac{1}{4}
\]

The situation at \( w_1 \) is depicted in Figure 4.

**Figure 4.** The open possibilities at \( w_1 \) and their chances in Example 2

At \( w_1 \), \( BCD_w \) is true and \( CDE_w \) is therefore metaphysically possible. Moreover,

\[
(7) \quad \text{ch}_{t+1}(CDE_w) = \frac{1}{2}
\]

By (6), \( \{w_1\} \) actually has a chance measure of \( \frac{1}{4} \) at \( t \), and by (7), \( \{w_1\} \) is a subset of the set of possible worlds where \( \text{ch}_{t+1}(CDE_w) = \frac{1}{2} \). It follows that the set of possible worlds where \( \text{ch}_{t+1}(CDE_w) = \frac{1}{2} \) must actually have a chance measure of at least \( \frac{1}{4} \) at \( t \). By the modality-chance principle (MC) stated in the introduction, that entails that
(8) \( \text{ch}_t(\text{ch}_{t+1}(CDE_W) = \frac{1}{2}) \geq \frac{1}{4} \)

(8) entails that the expected value of \( CDE_W \)’s chance at \( t+1 \), relative to the chance distribution at \( t \), equals at least \( \frac{1}{8} \). And yet, (5) tells us that \( \text{ch}_t(CDE_W) = 0 \). That is a violation of ECP. Moreover, (8) entails there is a non-zero chance at \( t \) that there will be a non-zero chance at \( t+1 \) that \( CDE_W \), and yet (5) tells us that the chance at \( t \) that \( CDE_W \) is 0. That violates the Some Chance Principle. The Open Possibility Principle is violated as well. At the actual world, it is compossible with the history through \( t \) and the laws that \( w_1 \) will be actualized. Moreover, at \( w_1 \) it is compossible with the history through \( t+1 \) and the laws that \( CDE_W \). So, at the actual world it is an open possibility at \( t \) that it will be an open possibility at \( t+1 \) that \( CDE_W \). And yet, it is not actually an open possibility at \( t \) that \( CDE_W \), for \( CDE_W \) is metaphysically impossible at the actual world.

I said in section 2.1 that I have very few untutored opinions about the formal properties of the metaphysical modalities and therefore find it hard to know offhand what to think of \( (S4\Box_M) \) and \( (S4\Diamond_M) \). The situation is quite different when it comes to the formal features of two other pairs of modal operators that relate to chance (in the extended sense of ‘chance’ introduced above). Firstly, consider the following operators:

\( \diamondsuit^\text{OP}_t P \): it is an open possibility at \( t \) that it will be the case that \( P \) (i.e. it is metaphysically compossible with the history up to \( t \) and the laws that it will be the case that \( P \))

\( \Box^\text{OP}_t P \): it is settled at \( t \) that it will be the case that \( P \) (i.e. the history up to \( t \) and the laws metaphysically necessitate that it will be the case that \( P \))

We can formulate the following pair of principles for these operators:

\[ (S4\Diamond^\text{OP}_t) \quad \diamondsuit^\text{OP}_t \diamondsuit^\text{OP}_u P \rightarrow \diamondsuit^\text{OP}_t P \quad \text{for any times } t \text{ and } u \text{ such that } t < u \]

\[ (S4\Box^\text{OP}_t) \quad \Box^\text{OP}_t P \rightarrow \Box^\text{OP}_t \Box^\text{OP}_u P \quad \text{for any times } t \text{ and } u \text{ such that } t < u \]

Secondly, consider the operators

\( \Diamond^\text{SOP}_t P \): the chance at \( t \) is greater than zero that it will be the case that \( P \)

\( \Box^\text{SOP}_t P \): the chance at \( t \) is one that it will be the case that \( P \)

We can think of the claim that \( \Diamond^\text{SOP}_t P \) as telling us that it is an open possibility that it will be the case that \( P \) in a stronger sense than is given by the claim that \( \diamondsuit^\text{OP}_t P \). That is why I
use the subscript ‘SOP’, for ‘strong open possibility’. We can formulate the following pair of principles:

\[(S4\diamond^SOP_t) \quad \diamond^SOP_t P \rightarrow \diamond^SOP_t P \quad \text{for any times } t \text{ and } u \text{ such that } t < u\]

\[(S4\square^SOP_t) \quad \square^SOP_t P \rightarrow \square^SOP_t \square^SOP_u P \quad \text{for any times } t \text{ and } u \text{ such that } t < u\]

Unlike the metaphysical modal operators, the open possibility and strong open possibility operators are relativized to times. Moreover, the consecutive possibility operators in \((S4\diamond^OP_t)\) and \((S4\diamond^SOP_t)\) and the consecutive necessity operators in \((S4\square^OP_t)\) and \((S4\square^SOP_t)\) are indexed to different times. Therefore, unlike the S4-principles for metaphysical modality, \((S4\diamond^OP_t)\), \((S4\diamond^SOP_t)\), \((S4\square^OP_t)\) and \((S4\square^SOP_t)\) do not contain an occurrence of a modal operator scoping over another occurrence of the very same operator. Nevertheless, the four new S4-principles are evidently close analogues of those for metaphysical modality. But unlike the S4-principles for metaphysical modality, those for open and strong open possibility seem extremely compelling. \(S4\diamond^OP_t\) is just what I have so far called the ‘Open Possibility Principle’, and as mentioned previously, that is a very plausible principle. The alternative formulation \(S4\square^OP_t\) sounds equally forceful: if it is settled now that \(P\), then it is settled now that it will be settled tomorrow that \(P\)—or in other words, it cannot already be settled now that \(P\) but still be an open possibility that it will not be settled tomorrow whether \(P\). \(S4\diamond^SOP_t\) is simply the Some Chance Principle, which also seems very plausible. \(S4\square^SOP_t\) seems equally compelling: if the present chance that \(P\) is one, then the present chance is one that the chance that \(P\) at any future time will be one.

It is perhaps not surprising that we have much stronger views about the formal properties of open possibility and strong open possibility than about those of metaphysical possibility. Unlike the notions of metaphysical modality, the concept of chance and its associated modal operators figure prominently in ordinary (non-philosophical) thinking. In particular, it seems likely that outside the philosophy room we are almost never concerned with entailment relations between claims that contain iterated metaphysical modal operators and claims containing a single such operator. By contrast, the above examples of applications of ECP suggest that we do sometimes draw
inferences from iterated chance ascriptions (claims about present chances of future chances) to non-iterated ones (to claims about present chances).

The foregoing line of reasoning shows that the modal-profile contingentists’ rejection of the S4-principles for metaphysical modality requires them to reject the S4-principles for open possibility and strongly open possibility as well, and that is a significant cost. This argument brings out one of the reasons why it can be useful in evaluating a theory about metaphysical modality to consider its implications about chance: it allows us to draw on powerful pre-philosophical opinions about chance in cases where we have no similarly strong views about metaphysical modality.

2.5 MPC without sufficiency

The argument I gave in section 2.3 for the conclusion that Example 1 is a case of undermining relied crucially on the assumption of Sufficiency. Given that Woody could have been made from $ABC$, Sufficiency guarantees that there is some condition $X$ that can be conjoined with that of being a table made from $ABC$ to obtain a non-trivial sufficient condition for a table at another possible world to be Woody. That allowed me to stipulate as part of Example 1 that things have been arranged so as to ensure that in any open possibility where a table is made from $ABC$, that table meets condition $X$ and is therefore Woody. Given that Woody could have been made from $CDE$, a similar appeal to Sufficiency allowed me to stipulate that in any open possibility where a table is made from $CDE$, that table is Woody. From the assumption that there is a non-zero chance at $t$ that an $ABC$-table will be made and a non-zero chance that a $CDE$-table will be made, we can consequently infer the following:

(9) (i) $\text{ch}_t(ABC_W) > 0$, and

(ii) $\text{ch}_t(CDE_W) > 0$

Given (9), it is straightforward to argue that Example 1 is a case of undermining: $\text{ch}_t(CDE_W) = 0$ at all possible $ABC_W$-worlds. Given (9)(i) and MC, we can infer that $\text{ch}_t(\text{ch}_t(CDE_W) = 0) > 0$. And yet, (9)(ii) tells us that $\text{ch}_t(CDE_W) > 0$. So, there is a non-zero chance at $t$ that the chance of $CDE_W$ at $t$ is different from what it actually is.

If MPC-ists are willing to give up Sufficiency, they can deny that there is a condition that can be combined with that of being made from $ABC$ to obtain a non-trivial sufficient
condition for an otherworldly table to be Woody. For every possible world \( w \) where Woody is made from \( ABC \), there is another possible world that is otherwise just like \( w \) but where a table different from Woody is made from \( ABC \). That in turn allows them to deny that in Example 1 things can be set up so as to guarantee that in any open possibility where a table is made from \( ABC \), that table is Woody. So, contrary to what I assumed in my discussion in section 2.3, the possibilities that are open at \( t \) include not only worlds where Woody is made from \( ABC \), but also worlds where a table other than Woody is made from \( ABC \). The assumption that there is a \( \frac{1}{3} \) chance at \( t \) that an \( ABC \)-table will be made therefore does not entail that \( \text{ch}_t(ABC_W) > 0 \). For it could be that there is a \( \frac{1}{3} \) chance that a table other than Woody will be made from \( ABC \), and that the set of open possibilities where \( Woody \) is made from \( ABC \) (while non-empty) has a chance measure of zero. It could even be that the chance measure of this set is undefined. By analogous reasoning, it may be that \( \text{ch}_t(CDE_W) \) is either zero or undefined as well. MPC theorists who deny Sufficiency can therefore reject (9) and deny that Example 1 presents a case of undermining in the sense of ‘undermining’ defined in section 2.3. As the reader can easily verify, denying that \( \text{ch}_t(ABC_W) > 0 \) and \( \text{ch}_t(CDE_W) > 0 \) also allows MPC-ists to avoid violations of the Basic Chance Principle*. Moreover, similar maneuvers allow them to deny both that it is true in Example 2 that \( \text{ch}_t(BCD_W) > 0 \) at the actual world, and that it is true in Example 2 that \( \text{ch}_{t+1}(CDE_W) > 0 \) at the open possibilities where \( BCD_W \) holds. Example 2 then no longer violates the Expected-Chance or the Some-Chance Principle.

Even if MPC-ists were able to resolve all of their difficulties by giving this response, the strategy would come at a cost—as noted in section 2.2, denying Sufficiency amounts to a strong and (I think) implausible commitment. In fact, however, I think that it is clear on reflection that the response does not really go very far in addressing the MPC theorists’ problems (initial appearances notwithstanding). Note first that it does not allow MPC theorists to avoid violations of the Open Possibility Principle. Irrespective of their attitude towards Sufficiency, MPC-ists have to say that in Example 2, \( w_1 \) is actually compossible with the history up to \( t \) and the laws, and that at \( w_1 \), \( CDE_W \) is compossible with the history up to \( t+1 \) and the laws. Consequently, at the actual world it is an open
possibility at $t$ that it will be an open possibility at $t+1$ that it will be the case that $CDE_w$. And yet, it is not actually an open possibility at $t$ that it will be the case that $CDE_w$.

Moreover, it is not clear that denying Sufficiency allows MPC-ists to avoid the real problem with the view that undermining is possible. According to the definition given in section 2.3, the chances at $t$ undermine themselves iff

(10) For some proposition $X$ and real number $x$, $\text{ch}_t(X) = x$ but there is a non-zero chance at $t$ that $\text{ch}_t(X) \neq x$.

What makes it so implausible to say that undermining is possible is that in undermining cases

(11) It is not settled at $t$ what the chances at $t$ are, or equivalently: at $t$ there are open possibilities where the chances at $t$ are different from what they actually are. But the truth of (11) does not require the truth of (10). For, in order for (11) to hold, the set $S$ of open possibilities where the chances at $t$ are different from what they actually are does not need to have a non-zero chance measure (it is sufficient that $S$ be non-empty). Moreover, while the chances at $t$ at the worlds in $S$ need to differ from the actual chances at $t$, they do not need to differ numerically. (As we saw in section 2.4, not all differences between chances are numerical differences.) For example, (11) is true if (i) the proposition that $P$ has chance zero at $t$ and it is settled at $t$ that $\neg P$, and (ii) there are open possibilities at $t$ where the proposition that $P$ also has chance zero at $t$, but where it is not settled at $t$ that $\neg P$. It does not matter whether the set of these open possibilities has a chance measure greater than zero.

I will say that the chances at $t$ weakly undermine themselves if (11) is true, and that they strongly undermine themselves if (10) is true. (Thus, the notion of undermining defined in Sect. 2.3 is that of strong undermining.) Since any view that allows for weak undermining entails that (11) is possible, such a view is problematic in much the same way as a theory that allows for strong undermining. MPC theorists who reject Sufficiency might be able to deny that strong undermining is possible, but they remain committed to the possibility of weak undermining. Example 2 can be used to illustrate this point. As mentioned before, regardless of whether MPC-ists accept Sufficiency, they have to hold that $w_1$ is actually an open possibility at $t$ in Example 2. They also have to say that in the
same example it is true at $w_1$ that it is an open possibility at $t$ that it will be the case that $CDE_W$. So, there actually exists an open possibility at $t$ where it is an open possibility at $t$ that it will be the case that $CDE_W$. And yet, it is not actually an open possibilities at $t$ that it will be the case that $CDE_W$ (for it is actually metaphysically impossible that $CDE_W$).

So, there actually exists an open possibility at $t$ where the chance of $CDE_W$ at $t$ is different from what it actually is. That is a case of weak undermining.

### 2.6 Alternatives to MPC

The discussion of the last couple of sections does not provide knockdown arguments against MPC. But then, the goal was not to give a definitive refutation of the view, but to point out one of its significant costs that should be taken into consideration in any cost-benefit analysis. The alternatives to MPC that are open to haecceitists have drawbacks as well, and it is a matter of judgement which view is most attractive all things considered. It is of course beyond the scope of this paper to provide an exhaustive list of theoretical options and of their pros and cons. But to get some idea of the lay of the land, let us briefly run through the most prominent candidates.

Anyone who rejects MPC—I will call such a philosopher a *modal-profile necessitarian*—needs to reject at least one of the premisses used in the argument for MPC given in section 2.1. The crucial question is which premiss should be given up. The first option is to deny (1) and the principle of Necessity of which (1) is an instance: Woody could have been made from parts entirely different from those he was actually made from. The main drawback of this view is that (1) seems pretty plausible and has been supported with forceful arguments by Kripke and other philosophers. The second option is to deny (2) and the principle of Tolerance of which (2) is an instance: Woody could not have been made from any parts other than those he was actually made from. If a table had been made from $ABC$ minus one particle, then that table would not have been Woody. This form of mereological essentialism is problematic as well, since it portrays Woody’s existence as much more precarious than we normally take it to be.

Another version of modal-profile necessitarianism agrees with MPC that (1) and (2) are true, thereby avoiding the cost of the two views described in the preceding paragraph. However, unlike MPC, this account takes (1) and (2) to be metaphysically necessary. At
a possible world $w$ where Woody is made from $BCD$ rather than from $ABC$, it is still true that Woody could not have been made from less than $\frac{2}{3}$ of $ABC$. Moreover, even at $w$, it is not possible for Woody to be made from $CDE$, though it is possible for him to be made from $ABX$. While Woody conforms to Necessity and Tolerance at the actual world, he does not conform to these principles at $w$. Therefore, contrary to what MPC tells us, Necessity and Tolerance do not hold at all possible worlds or even at all nearby ones.

At first blush, this position seems to be open to the objection that it makes the metaphysical order of the universe seem implausibly fragile. At the actual world, there are general regularities in the distribution of modal profiles over things, which can be expressed by principles of the form All entities of such-and-such kind possess such-and-such of their features necessarily and such-and-such of their features contingently. Necessity and Tolerance look like examples of such principles. But the view described in the preceding paragraph entails that, if some actual tables had been made from somewhat different parts, then Necessity and Tolerance would not have held and the facts about the modal profiles of things would not have been nearly as regular as they actually are. Some tables—including those made from the same parts as at the actual world—would have conformed to Necessity and Tolerance, while other tables would not have. A couple of scratches in a few blocks of wood would have been enough to upset the metaphysical order that actually governs the facts of $de$ $re$ modality. Metaphysicians intent on stating simple and powerful modal principles can count themselves lucky that these blocks remained unscratched. Of course, given that the actual world is surrounded in modal space by other worlds of a less orderly variety, we may start to wonder how we can be so sure that our world is an orderly one. An account that commits us to such absurdities deserves to be rejected.

However, the modal-profile necessitarian can avoid these problematic consequences by giving a different account of the metaphysical order governing the facts of $de$ $re$ modality. One such account rests on a familiar view that is sometimes called ‘multi-thingism’, and which can be motivated by considerations that are independent of the present topic. Multi-thingism tells us that for any material object $m$, there are other

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9 The term ‘multi-thinker’ is used by Karen Bennett (2004), who says that she picked it up from Stephen Yablo. I do not know who initially introduced it.
objects that have the same non-modal features as $m$—in particular, they occupy the same space-time region—but which differ in their modal properties. As a famous example, the multi-thinger may cite Allan Gibbard’s case of the statue, which is necessarily statue-shaped, and the lump of clay it is made of, which occupies the same region but has its shape contingently (Gibbard 1975). Multi-thingism comes in different versions and not all of them can serve the needs of the modal-profile necessitarian. To fix ideas, let us focus on one specific version that does the job (we could call it ‘maximal multi-thingism’). According to this view, the range of modal profiles exemplified by physical objects is as large as it can coherently be held to be. Very roughly speaking, for any physical object $m$ and any set $S$ of properties that $m$ has, if it is coherent to assume that there is a physical object that has the same non-modal features as $m$ and which has all and only the properties in $S$ necessarily, then there is such an object. (This is merely a theory schema that needs to be fleshed in by specifying the conditions of coherence, among other things, but let us not digress to consider how this should be done.) The maximal multi-thinger can say that at a possible world $w$ where Woody was made from $BCD$ rather than $ABC$, it is still necessary that Woody (if he exists) is made from at least $2/3$ of $ABC$, and not necessary that Woody (if he exists) is made from at least $2/3$ of $BCD$. But that does not show that there is a systematic difference in the patterns of modal profiles between $w$ and the actual world. At both worlds, the realm of $de$ $re$ modal facts is governed by one and the same set of maximal multi-thingist principles. There is nothing fragile about the metaphysical order. (For explorations of the multi-thingist response to the considerations that motivate MPC, see Leslie 2011 and Author b.)

There has been much philosophical discussion about the virtues and vices of multi-thingism and about whether and how it can make sense of the utterances we make and the beliefs we hold outside the philosophy room. This is not the place to review this debate. For present purposes, the important point is to observe that multi-thingism provides one alternative to MPC that merits further exploration.\textsuperscript{10}

\textsuperscript{10} For overviews of central issues in this debate, see Varzi 2012, Wasserman 2013.
3. Modal-existence contingentism

A number of haecceitists—including Kit Fine, Robert Adams, and Robert Stalnaker—hold that the existence of many worlds and many propositions is metaphysically contingent (Fine 1977, 1985; Adams 1981; Stalnaker 2011; Author b).\textsuperscript{11} This thesis is typically motivated by two assumptions. Firstly, many individuals exist contingently, for example material objects. Secondly, singular propositions about an individual, and worlds at which that individual exists, existentially depend on that individual, in the sense that they do not exist at possible worlds at which the individual does not exist. For example, if \( w \) is a possible world at which Woody does not exist, then the proposition that Woody is a table and the proposition that Woody exists do not exist at \( w \). Moreover, where \( w^* \) is any possible world at which Woody exists, \( w^* \) does not exist at \( w \) either. I will call this position ‘modal existence contingentism’ or ‘MEC’.\textsuperscript{12}

MEC theorists typically differentiate between two relations of truth with respect to a world (Fine 1977, 1985; Adams 1981; Stalnaker 2011, Sect. 2.6; Author b), called ‘inner truth’ and ‘outer truth’ by Kit Fine, and ‘truth in a world’ and ‘truth at a world’ by Robert Adams. (I will follow Adams’s terminology.) For present purposes, we can think of these relations as follows. The proposition that \( P \) is true in a world \( w \) just in case the following holds: if \( w \) had been actualized, then the proposition that \( P \) would have had the property of truth. The proposition that \( P \) is true at \( w \) just in case it is actually true that the proposition that \( P \) gives a correct partial description of what reality would have been like if \( w \) had been actualized (i.e. just in case if \( w \) had been actualized, then it would have been that \( P \)). As an illustration, let \( Q \) be the proposition that Woody does not exist and let \( w \) be a world where Woody does not exist. If \( w \) had been actualized, then \( Q \) would not have existed and therefore would not have had the property of truth. So, \( Q \) is not true in any possible world where Woody fails to exist. (And of course \( Q \) is not true in a world where Woody exists either. There is simply no possible world in which \( Q \) is true.)

\textsuperscript{11} Also see McMichael 1983 for an argument that actualists should accept a version of this view.
\textsuperscript{12} It is of course possible for haecceitists to resist this argument by denying one of the premisses. For example, Plantinga (1976, 1983) develops a haecceitist position according to which worlds do not existentially depend on the contingent individuals that exist at them. (See Fine 1985 for critical discussion of Plantinga’s position, see Plantinga 1985 for a reply.) And Linsky and Zalta (1994, 1996) and Williamson (1998, 1999, 2013) argue that it is impossible for anything to exist contingently.
However, it is true at the actual world that $Q$ gives a correct partial description of what would have been the case if $w$ had been actualized: if $w$ had been actualized, then Woody would not have existed. $Q$ is therefore true at $w$. Whether a proposition is metaphysically possible (necessary) depends on whether the proposition is true at some (every) possible world, not on whether it is true in some (every) possible world. For example, $Q$ is not true in any possible world. And yet, $Q$ is metaphysical possible, since $Q$ is true at some possible worlds. The modality-chance principle equates the chance of a proposition $P$ with the chance measure of the set of open possibilities at which $P$ is not true, not with the chance measure of the set of open possibilities in which $P$ is true. Suppose that at some time $t$ before Woody was made, there was a $\frac{1}{2}$ chance that Woody would never come into existence. Then the set of open possibilities at which the proposition that Woody fails to exist is true has a chance measure of $\frac{1}{2}$. But the set of open possibilities in which the proposition is true is empty (as we saw above) and must therefore have a chance measure of 0.

I will argue that the problem of undermining afflicts some but not all versions of MEC. Whether an MEC theorist faces this problem depends on whether she takes de re modal claims like (12) to be necessary:

(12) It is possible that Woody exists.

It is clear that by MEC theoretic lights (12) is not true in all possible worlds. For (12) is a singular proposition about Woody that would not exist, and therefore would not have the property of truth, if Wood did not exist. But to determine the modal status of (12), the crucial question to ask is whether (12) is true at all possible worlds, and in particular whether it is true at possible worlds at which Woody does not exist. MEC theorists disagree with each other on that question. Some believe that (12) is necessarily equivalent to the following claim:

(13) There is a possible world at which Woody exists.

In other words, they believe that (12) is true at just those possible worlds at which (13) is true. Since (13) is not true at possible worlds where Woody fails to exist, it follows that
(12) is not true at such worlds either and is therefore contingent.\(^{13}\) I will call the version of MEC that takes modal claims like (12) to be contingent ‘MEC\(_1\)’. (See Adams 1981 and Author b for detailed defenses of this position.) On another version of MEC, (12) holds even at possible worlds where Woody does not exist. Proponents of this view need to deny that (12) is true at just those possible worlds at which (13) is true. They may say instead that a claim of the form *It is possible that P* is true at all possible worlds just in case it is actually true. This view was discussed and rejected in Adams 1981 (pp. 31–3), but has recently been endorsed and developed by Robert Stalnaker (2011). I will call it ‘MEC\(_2\)’.

The question which version of MEC is preferable raises many complex issues in metaphysics and the philosophy of language. But there is no need to address these here, since my goal is not to decide which variant of MEC is better, but to determine which of them confront the problem of undermining. I will argue that a mild form of the problem arises for MEC\(_1\). That is to say, the version of MEC according to which (12) fails to hold at Woody-less worlds entails the possibility of undermining cases. MEC\(_2\), the version of MEC according to which (12) holds at Woody-less worlds, does not have that consequence. In the rest of this section, I will focus on MEC\(_1\).

The problem of undermining for MEC\(_1\) can be illustrated with a variant of the examples we considered in section 2.4. Suppose that the carpenter who made Woody from \(ABC\) tossed a fair coin before going to work, being resolved to make a table from \(ABC\) if the coin lands heads, and to use \(ABC\) as firewood otherwise. Assume also that Woody does not exist at those open possibilities where \(ABC\) end up in the fireplace. Where \(t\) is some time shortly before the coin toss,

\[
\begin{align*}
(14) & \quad (i) \quad \text{ch}_t(\text{Woody will exist}) = \frac{1}{2} \\
 & \quad (ii) \quad \text{ch}_t(\text{Woody will not exist}) = \frac{1}{2}
\end{align*}
\]

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\(^{13}\) For discussions of arguments along these lines, see Adams 1981 (pp. 28–32), Armstrong 1989 (pp. 56–63), Fitch 1996 (pp. 63–5), Bennett 2005 (Sect. 7), Author b.

\(^{14}\) Stalnaker distinguishes (12) from the claim that

\[
(19) \quad \text{The proposition that Woody exists has the property of possibility.}
\]

While he denies that (13) is necessarily equivalent to (12), he accepts that (13) is necessarily equivalent to (19). On this view, (12) is true at a possible world where Woody does not exist, but (19) is not.
Now, (14)(i) surely necessitates the claim that it is possible that Woody will exist—there cannot be a non-zero chance that \( P \) unless it is metaphysically possible that \( P \). Moreover, MEC\(_1\) tells us that at a possible world where Woody does not exist, it is \textit{not} possible that Woody exists. So, by the MEC\(_1\) theorist’s lights, (14)(i) cannot be true at a possible world where Woody does not exist. In other words, MEC\(_1\) entails that

(15) At a possible world where Woody does not exist, \( \text{ch}_t(\text{Woody will exist}) \neq \frac{1}{2} \).

Given the modality-chance principle (MC), (14)(ii) entails that the set of possible worlds where Woody does not exist has a chance measure of \( \frac{1}{2} \) at \( t \). By (15), this set is a subset of the set of possible worlds where \( \text{ch}_t(\text{Woody exists}) \neq \frac{1}{2} \). So, the set of possible worlds where \( \text{ch}_t(\text{Woody exists}) \neq \frac{1}{2} \) must actually have a chance measure of at least \( \frac{1}{2} \) at \( t \). It follows by MC that at the actual world, \( \text{ch}_t(\text{ch}_t(\text{Woody will exist}) \neq \frac{1}{2}) \geq \frac{1}{2} \). So, while \( \text{ch}_t(\text{Woody will exist}) = \frac{1}{2} \) (by (14)(i)), there is also a non-zero chance at \( t \) that \( \text{ch}_t(\text{Woody will exist}) \neq \frac{1}{2} \). That is a case of undermining.

The same example also yields a violation of the Basic Chance Principle\(^*\) stated in section 2.3. By (14)(ii), \( \text{ch}_t(\text{Woody will not exist}) = \frac{1}{2} \). Combined with the Basic Chance Principle\(^*\), that entails that

(16) There is some possible world that is like actuality up to \( t \), where \( \text{ch}_t(\text{Woody will not exist}) = \frac{1}{2} \), and where Woody does not exist.

But the MEC\(_1\)-ist has to deny (16). To see this, note first that the claim that \( \text{ch}_t(\text{Woody will not exist}) = \frac{1}{2} \) necessitates that \( \text{ch}_t(\text{Woody will exist}) = \frac{1}{2} \). It follows by contraposition that the claim that \( \text{ch}_t(\text{Woody will exist}) \neq \frac{1}{2} \) necessitates that \( \text{ch}_t(\text{Woody will not exist}) \neq \frac{1}{2} \). Therefore, since MEC\(_1\)-ists hold that \( \text{ch}_t(\text{Woody will exist}) \neq \frac{1}{2} \) at all possible worlds where Woody does not exist, they are committed to saying that \( \text{ch}_t(\text{Woody will not exist}) \neq \frac{1}{2} \) at all such possible worlds. And that immediately entails that (16) is false.

Does MEC\(_1\) yield counterexamples to the Expected-Chance Principle (ECP)? That depends on how the MEC\(_1\) theorists answer another question: what is \( \text{ch}_t(\text{Woody will exist}) \) at a possible world where Woody does not exist? We saw above that by MEC\(_1\)-theoretic lights, \( \text{ch}_t(\text{Woody will exist}) \) cannot be greater than zero at such a possible world. (For the claim that \( \text{ch}_t(\text{Woody will exist}) > 0 \) entails that it is possible that Woody
exists, and MEC$_1$ entails that at a possible world where Woody does not exist, it is not possible that Woody exists.) But that still leaves two possible views. MEC$_1$ theorists might say:

(17) \( \text{ch}_t(\text{Woody will exist}) = 0 \) at possible worlds where Woody does not exist.

Alternatively, they may say that the proposition that Woody exists has no chance, that is, neither a chance of zero nor a chance greater than zero, at Woody-less possible worlds. That is to say:

(18) There is no number \( x \) in \([0; 1]\) such that the proposition that \( \text{ch}_t(\text{Woody will exist}) = x \) is true at possible worlds where Woody does not exist.

There are different ways in which MEC$_1$ theorists could support (18). For instance, some MEC$_1$ theorists may be inclined to say that the claim that \( \text{ch}_t(\text{Woody will exist}) = x \) asserts that a certain relation (viz., the relation of being-the-chance-of) holds between the number \( x \) and the proposition that Woody exists. They could then argue as follows: Since the proposition that Woody exists does not exist at a Woody-less world, the proposition cannot stand in relations to other things at such a world. Consequently, at such a world there cannot be a number \( x \) to which the proposition stands in the relation described by the proposition that \( \text{ch}_t(\text{Woody will exist}) = x \).

When combined with (17), MEC$_1$ violates ECP. To see this, consider:

*Example 3.* There are two sets of possibilities that are open at \( t \) and both of them have a chance measure of \( \frac{1}{2} \) at \( t \). In open possibilities of the first kind, Woody is made from \( ABC \) at time \( t_2 \), while in those of the second kind, \( ABC \) are destroyed at \( t_2 \) and Woody never comes into existence. Until time \( t_2 \), the chance measure of both kinds of open possibility remains constant at \( \frac{1}{2} \). A possibility of the first kind is actualized.

Let \( t_1 \) be some time between \( t \) and \( t_2 \). In open possibilities where Woody comes into existence at \( t_2 \), \( \text{ch}_{t_1}(\text{Woody will exist}) = \frac{1}{2} \). By contrast, if (17) is true, then in open possibilities where Woody does not come into existence, Woody’s chance of existing must be 0 at all times, so that \( \text{ch}_{t_1}(\text{Woody will exist}) = 0 \). So, relative to the actual chance distribution at \( t \), the expected value of the chance at \( t_1 \) that Woody will exist is \((\frac{1}{2} \times \frac{1}{2}) + \)
\( \frac{1}{2} \times 0 = \frac{1}{4} \). And yet, it is true at the actual world that \( \text{ch}_t(\text{Woody will exist}) = \frac{1}{2} \). That is a counterexample to ECP.

While the combination of \( \text{MEC}_1 \) with (17) violates ECP, the view is consistent with the Some Chance and Open Possibility Principles in their original forms. For the sake of brevity, I will only show this for the Open Possibility Principle, but the case of the Some Chance Principle is exactly analogous. In order for there actually to exist an \( \text{MEC}_1 \)-generated counterinstance to the Open Possibility Principle, there would actually have to exist a proposition \( P \) for which \( \text{MEC}_1 \) entails the following: (i) \( P \) actually fails to be metaphysically possible and therefore there are actually no open possibilities at \( t \) where \( P \) holds, but (ii) there actually are open possibilities at \( t \) where \( P \) is metaphysically possible, and at these possibilities there exist open possibilities at \( t+1 \) where \( P \) holds. But \( \text{MEC}_1 \) does not generate such cases. For the only \( \text{MEC}_1 \)-generated examples where an actually existing proposition \( P \) is possible at one possible world and not possible at another possible world are cases where \( P \) fails to exist at the possible world where \( P \) is not possible. Therefore, \( \text{MEC}_1 \) never gives rise to examples in which an actually existing proposition is possible at some unactualized possible world but fails to be possible at the actual world. (\( \text{MEC}_1 \) only generates cases in which an actually existing proposition is possible at the actual world but fails to be possible at some unactualized possible world.)

\( \text{MEC}_1 \) theorists who adopt (18) are in an even better position. Not only is their view consistent with the Some Chance and Open Possibility Principles (as can be shown by an argument analogous to the one given in the previous paragraph), but they can also avoid violations of ECP. Example 3 illustrates this. If (18) is true, then at those open possibilities where Woody does not come into existence, there is no number (not even zero) that is the chance at \( t_1 \) of the proposition that Woody will exist. Consequently, at the actual world the expected value of \( \text{ch}_{t_1}(\text{Woody will exist}) \), relative to the chance distribution at \( t \), is undefined. So, ECP does not apply to the example.

\( \text{MEC}_1 \) in general, and the version of \( \text{MEC}_1 \) that endorses (18) in particular, are less revisionary of our ordinary views about chance than MPC. Again, it is a matter of judgement how to weigh the implausible implications that remain against other relevant desiderata. Those attracted to MEC can avoid undermining cases by endorsing \( \text{MEC}_2 \) rather than \( \text{MEC}_1 \), but only if they are willing to reject the necessary equivalence of (12)
with (13). Alternatively, given that the problem of undermining that confronts MEC\textsubscript{1} is fairly moderate, MEC theorists may decide to endorse MEC\textsubscript{1} and to accept the undermining cases.

4. Summary and conclusion

In order to be compatible with a plausible account of chance, a theory about modal space needs to satisfy a number of requirements. I discussed one of these desiderata in previous work and argued that only haecceitist views satisfy it. But endorsing haecceitism is not enough to avoid implausible consequences about physical chance. The present paper aimed to show this by considering a second constraint: a theory of modality should be consistent with the cluster of very compelling principles about chance stated in sections 2.3–2.4. An account may violate this requirement if it gives rise to undermining cases. This problem besets two widely discussed haecceitist theories, MPC and MEC\textsubscript{1}. The difficulties for MPC are significant enough to provide strong motivation for endorsing one of the alternative views sketched in section 2.6. By contrast, the version of the problem that arises for MEC\textsubscript{1} is comparatively mild, and MEC\textsubscript{1} theorists may simply decide to bite the bullet.

The discussion of the undermining problem in this paper illustrates why it can be helpful in deciding controversies about modality to consider the implications of the competing views for the theory of chance: it allows us to draw on pre-theoretical opinions about chance that are often much firmer than those about metaphysical modality.\textsuperscript{15}

References


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