Abstract: Chance is a kind of predictive choke point between the present and the future; there is a
great deal of evidence that one might presently have about whether a particular event will occur
in the future, but the event’s present chance of occurring is at least as good grounds for one’s
expectations about whether the event occurs in the future as is (nearly) all of that other evidence.
I offer a novel explanation of this aspect of chance’s predictive role. On my view, chance is a
predictive chokepoint because chance is also an explanatory chokepoint: the present chances
explain future occurrences, while the present conditions, causes, and natural laws help to explain
the present chances.

0. Introduction

The wide acceptance of indeterministic physical theories, such as the standard
interpretation of quantum mechanics, has livened the possibility that our world is not
diachronically deterministic; that is, it may well be that the way the world is at one time does not
fix what the world is like at other times. Instead, our world might be diachronically
indeterministic: the way the world is at one time might be consistent with many different futures
and pasts. For example, the fact that there is some particular atom of radium-226 in the world
right now does not settle when, or even whether, that atom will decay. The atom might decay in
the next ten minutes, the next ten years, the next ten millennia or not at all. There simply are no

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facts about the way the world is right now, according to the standard interpretation of quantum mechanics, that determine which of these (or of many other) futures will occur.

We hope that our best scientific theories will enable us to predict future occurrences that we have yet to witness and to retrodict events in the past for which we have no record. In a deterministic world, if it were possible for empirical investigation to reveal a complete description of the world at a time along with a complete account of the laws of nature, there could be a scientific theory that specified how the world is in every way at every time. However, the possibility that the world is indeterministic threatens to dash any hope for a predictively or retrodictively valuable science. That the future is not determined by the past opens up the possibility that there is no connection whatsoever between the future and the past. If there were no connection between the future and the past—if it were, so to speak, just one damn thing after another—then it seems that knowledge of the nearby past and present could never give us knowledge of the future or of the distant past.

Thankfully, then, our best indeterministic physical theories seem to suggest that, though the world is indeterministic, there is nevertheless a kind of ligature that connects the future to the past: chance. Various ways the future could unfold (given what has previously occurred) have, it seems, various chances of being what actually occurs. In positing chance, we posit an objective and empirically discoverable connection between the past and the future—a loose enough connection to allow for indeterminism but a connection nonetheless—and knowledge of that connection justifies our predictions and retrodictions, despite the fact that our world is indeterministic.

For example, theories of radioactivity underwritten by quantum mechanics (arguably) reveal the chance that an atom will decay in the next 100 years, in the next 1600 years, in the
next ten millennia, and so on. If we were to know the chances of the various ways that the atom might behave, then we would also know what to expect about whether each of these outcomes will occur. Though we will have to make due with more uncertainty about the past and the future in an indeterministic but chancy world than in a deterministic world, the existence of chances secures the possibility of predictive and retrodictive knowledge in indeterministic worlds.

In addition to enabling us to justifiably predict and retrodict, we further hope that our best scientific theories will enable us to understand what occurs in light of what has come before, and such understanding seems attainable in a diachronically deterministic world. If we understand what it is about the world in virtue of which the past and present necessitate the future, we seem to thereby understand later occurrences in light of earlier ones. For example, when we want to understand why there was recently a solar eclipse, it is helpful to be told that the solar eclipse was necessitated by the prior positions of the celestial objects and the laws of planetary motion. However, just as indeterminism threatens to undermine our ability to justifiably predict and retrodict, indeterminism also threatens to undermine our ability to understand the world; a world in which it is just one damn thing after another is not a world whose temporal evolution is intelligible to us. Does the existence of chance secure the possibility of understanding in an indeterministic world, just as the existence of chance secures the possibility of justifiable prediction and retrodiction in an indeterministic world?

Here, the answer is more controversial. Some will doubt that any events that occur by chance can be explained (e.g., Kitcher 1989). Still others will allow that likely occurrences can be explained but will doubt that unlikely occurrences are explicable (e.g., Hempel 1965). But
even assuming that all chance events can be explained, there is little to no consensus about how they are to be explained.

To preview, my answer will be that the existence of chance does indeed allow us to understand the world; my view is that every event that occurs by chance—likely or unlikely—is in principle explicable. I distinguish between an explanation of the occurrence of a chance event, which I call a chance explanation of that event, from an explanation of an event’s chance of occurring, which I call an explanation of chance. For example, an explanation of a given radium-226 atom’s decay, on say, December 24th 1981, is a chance explanation of this event’s occurrence (i.e., of the atom’s decay), while the explanation of this radium-226 atom’s 50% chance of decaying in, say, a 1600-year interval, is an explanation of chance (i.e., of the atom’s chance of decaying).

With the distinction between a chance explanation of an event’s occurrence and an explanation of an event’s chance of occurring in hand, I advocate for a novel conceptualization of what explains the occurrence of chance events (i.e., a novel conceptualization of chance explanation). It is, I claim, the chance. Whereas in a deterministic world the future occurs because it had to, in a chancy world the future happens because it had a certain chance of happening; our scientific theories explain what ultimately happens by revealing the (precise) chances of these happenings. The explanatory role of information about laws of nature, prior conditions, or causes, on my view, is to help us to understand why a particular event had a particular chance of occurring—that is, to help provide us with explanations of chance—rather than in directly explaining the event—that is, rather than in providing us with chance explanations of the event’s occurrence.
On my picture, the existence of chance provides an intelligible connection between the future and the past; the past helps to explain the chances, while the chances explain what will happen in the future. I will argue for this picture of chance’s explanatory role by showing that it helps to account for an aspect of chance’s predictive role; on my view, chance’s explanatory role accounts for why, of all the evidence we might (typically) have about whether some event will occur in the future, none is better grounds for prediction than is the event’s present chance of occurring.

Though my particular picture of chance explanation is novel, the view that chance events are explicable is not; most philosophers of science have come to agree that the occurrence of both likely and unlikely events can be explained. A standard line is that, though there may be some sense in which scientific explanations of events that had to occur are more satisfying than are scientific explanations of events that occurred by chance, we should not conclude from that fact that we do not understand the occurrence of chance events. (See, e.g., Jeffrey 1969, Salmon 1971, Railton 1978, Strevens 2000, Skow 2013.)

Nevertheless, the view that both likely and unlikely occurrences can be explained has some consequences that strike the ear as awkward or unintuitive. Over the course of this essay, I attempt to explain away these intuitions as holdovers from an ideology that assumed determinism. In section 1, I identify two intuitions about explanation that are reasonable in deterministic contexts but that, when transferred without modification into indeterministic contexts, have implausible implications about whether (and which) chance events can be explained. After advocating for my particular picture of chance’s explanatory role in section 2, I return to these two intuitions in section 3. I argue that these two intuitions are motivated by
reasoning that remains plausible given my view of scientific explanation in indeterministic but chancy worlds.

1. Two Intuitions About Explanation in Deterministic Contexts

Let’s start by addressing the intuition that not all events that occur by chance can be explained. And, let’s start that project by thinking about explanation in diachronically deterministic worlds.

At an intuitive level, a diachronically deterministic world is one in which the state of the world at one time and the natural laws fix the exact state of the world at any other time.\(^2\)

Suppose, then, that the world is deterministic and that I come down with strep throat. I take penicillin as directed by my doctor and I recover in about a week. What explains my recovery? Perhaps citing a cause of my recovery—such as, in this case, that I took penicillin—helps to explain my recovery. However, suppose we further learn that only 95% of patients who have strep recover after taking penicillin. In that case, one might have the intuition that a full understanding of my recovery requires more than knowing that I took penicillin; because the world is deterministic, there are some facts about my case in virtue of which I had to recover, and if having taken penicillin is consistent with both recovery and a failure to recover then it seems like there is more to understand about why I recovered than that I took penicillin. And so, it seems that any putative explanation of my recovery that cites factors of my case that do not guarantee my recovery leaves something about my recovery unexplained.

\(^2\) There are several different ways one might try to make this intuitive statement of determinism more precise. See, for example, Earman 1986.
Notice that the world’s being deterministic implies only that the entire state of the world at a time and the natural laws fix how the world is at any other time, and so is consistent with its being true that any incomplete description of the world at a time leaves out some fact that is necessary to fix the state of the world at some other time. For example, it might be that some of the features of the world that go into determining whether or not I will recover from strep throat fall outside the domain of medical science. Indeed, it might be that my recovery is only guaranteed relative to how things were with each subatomic particle in the world at a time prior to my recovery; it might be that the type of strep I have, the type of penicillin I take, my general health, my genetics, etc., all fail to fix (in conjunction with the laws) whether or not I will recover from strep. If nothing that we would recognize as medical science describes features of my case in virtue of which I had to recover, should we then say that the full scientific explanation of my recovery—the whole story about why I recovered—lies outside the domain of medical science? To answer in the affirmative is to open oneself up to the consequence that nothing is every completely explained by anything less than a complete description of the world at a time (and, perhaps, a complete accounting of all the natural laws). That is a very demanding picture of scientific explanation indeed. But, on any less demanding picture, it seems possible for a scientific explanation to leave out some information that is crucial to understanding why an event occurs by leaving out some aspect of why that event had to occur. In a deterministic world, it seems that a fully explanatory scientific theory will identify which events had to occur as well as the factors in virtue of which those events had to occur, while partial or incomplete explanations—such as an explanation of my recovery that merely cites my having taken penicillin—are explanatory in virtue of revealing some but not all of the features that combine to ensure my recovery.
Suppose once more that I am stricken with strep throat and that I take penicillin, but this time imagine that I am part of the unlucky 5% who do not recover. What explains my failure to recover? This time it seems very bad indeed to say that I failed to recover because I took penicillin. Not only is my having taken penicillin insufficient to guarantee my failure to recover (in virtue of being consistent with my recovery), it does not even begin to explain my failure to recover since, in some intuitive sense, my having taken penicillin favors my having recovered over my failure to recover. Because, in a deterministic world, it is in principle possible for an explanation to cite features of the prior state of the world in virtue of which I could not have recovered, it seems that an explanation of my failure to recover should at least cite factors that favor my non-recovery over my recovery.

So far, we have teased apart two intuitions about explanation in a deterministic world. The first is that the full explanation of some event (such as my recovering from strep throat) must cite features of the past state of the world in virtue of which the thing being explained had to occur (given the past state of the world and the laws). The second intuition is that an explanation of some event (such as my recovering from strep throat) must, at a minimum, cite some factors that favor the occurrence of the event being explained over its non-occurrence; we cannot, for example, explain why I failed to recover from strep throat by pointing out that I took penicillin and that most people who take penicillin recover from strep throat. My point in collecting these intuitions is not to insist that either withstands careful philosophical scrutiny when evaluated at deterministic worlds, but rather is to note that each seems reasonable.

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3 Perhaps the explanation consists in a list of some (or all) of the causes of the event being explained (as in, e.g., Lewis 1986, Humphreys 1994, Woodward 2003) or perhaps the explanation contains law statements as well (as in, e.g., Railton 1978, 1981).
Transferred without modification to worlds in which events occur by chance, however, both intuitions mislead us about the nature of explanation.

Before evaluating our two intuitions at indeterministic but chancy worlds, let me say a little bit about what I will mean when I say that an event occurs “by chance”. Nothing in what follows is meant to hang on any controversial assumptions about the nature of chance, but there is frustratingly little that can be said about chance that is not controversial. First, I assume that chances are objective (i.e., mind-independent) features of the world that are modeled by functions that satisfy the standard probability axioms and that sometimes take values between 0 and 1. Second, I’ll assume that the chances that various events occur can vary as time passes, and when this assumption makes a difference, I will mark it by talking about the chance at a time that an event occurs; sometimes, however, I leave the indexing to a time as implicit. Third, I will assume that it makes sense to talk about the chance of an individual event occurring, as opposed to talking only about the chance of some type of occurrence among a collection of relevantly similar events (though see, e.g., von Mises 1957, Howson and Urbach 1993, Gillies 2000 for skepticism about that assumption). Fourth, I presume that if our best current theories of fundamental physics were true and if there were any individual events that occur by chance, then radioactive decay events would be among them. That said, in what follows I do not mean to be committed to any controversial claims about whether any events occur by chance in our world or about which scientific theories are true. I’ll use toy cases of chance events involving radioactive decay, but I will also help myself to coin flips and rain and so on for the sake of having

\[\text{\@\textsuperscript{4}}\] I make this assumption mostly for the sake of familiarity. Perhaps chances are better modeled by a non-standard probability theory, as in e.g., Lewis 1980.

\[\text{\@\textsuperscript{5}}\] In indexing chances to times, I do not mean to thereby take a stand on whether chance is essentially relativized to a time or on whether chance is fundamentally conditional as in, e.g., Hájek 2003 and Hoefer 2007.
additional simple and familiar examples with which to work. Finally, I assume that, in an
indeterministic but chancy world, the laws of nature and a complete description of the world at a
time determines the chances that obtain at that time.

Caveats out of the way, let us consider what implications our two intuitions have when
applied to indeterministic but chancy worlds. The first intuition, recall, is that a full explanation
of some event must cite features of the past state of the world in virtue of which the thing being
explained had to occur (given the past state of the world and the laws). In contrast, explanations
that fail this demanding standard (such as an explanation of my recovery from strep that cites my
having taken penicillin) might nevertheless be partially explanatory because they cite some of
the factors in virtue of which the thing being explained had to occur. When an event occurs by
chance, however, there are no features of the past state of the world in virtue of which the event
had to occur (given the past state of the world and the laws) and so the first intuition implies that
events that occur by chance are never fully explained. Furthermore, to the extent that a partial
or incomplete explanation is one that reveals at least some of the factors in virtue of which the
thing being explained had to occur, events that occur by chance are not even partially explained.
So, the first intuition suggests that events that occur by chance cannot be explained at all.

That conclusion, however, is implausible on reflection. After all, it is a serious
(epistemic) possibility that our own world is one in which nearly every event happens by chance;
if the correct interpretation of quantum physics is that microphysical events occur by chance and

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6 Here I make the increasingly controversial assumption that determinism and chance are
incompatible, which I retain throughout this essay. In fact, however, the view of chance
explanation that I develop below can be extended to accommodate the possibility that
determinism and chance are compatible. For details, see my manuscript, “Where are the
Chances?”
7 Though see Kitcher 1989 for an argument that attempts to mitigate the apparent implausibility
of this conclusion.
if macrophysical events depend on the occurrence of microphysical events, then it seems that the chanciness of the microphysical world might “percolate up” into the macrophysical world. However, few of us are prepared to infer that it is thereby a serious (epistemic) possibility that our world is one in which nearly everything that happens defies explanation. The discovery of quantum physics did not reveal that our world is full of inexplicable occurrences, but rather helped us to better understand why the events of our world occur.

The second intuition is that, at a minimum, an explanation of some event (such as my recovering from strep throat) must cite some factors that (in some intuitive sense) favor the occurrence of the event being explained over its non-occurrence. This second intuition seems compatible with there being explanations of some events that occur by chance. When a likely event occurs, even if we cannot cite factors about the state of the world prior to the event’s occurrence in virtue of which the event had to occur, it seems that we can at least cite factors about the state of the world prior to the event’s occurrence that favor the event’s occurrence. If an atom presently has a very high chance of decaying within some time interval, for example, then it seems that there are presently factors that favor the atom’s decaying within that time interval, such as the atom’s being a particular isotope that has a very short half-life.

However, when an unlikely event occurs, there are no factors that favor its occurrence over its non-occurrence. Suppose, for example, that some atom’s chance of decaying in the next hour is presently only 5%, but that the atom nevertheless decays within the hour. In that case, there simply are no features of the world prior to the atom’s decay that favor that atom’s decaying within the hour over the atom’s failure to decay within the hour. Our second intuition, then, seems to imply that we cannot explain the occurrence of unlikely events.
The idea that unlikely events cannot be explained is perhaps more attractive than is the idea that no event that occurs by chance can be explained, but I think it is also implausible on reflection. The explanatory role of positing chance is to account for both likely and unlikely occurrences. After all, if the only events that ever occurred were deemed likely by a particular scientific theory, we would doubt the explanatory power of that theory rather than affirm it. For example, a theory according to which an atom of some particular isotope has a 90% chance of decaying within an hour (probably) leaves something important unexplained if all the many observed samples of that isotope completely decay within an hour.

Or, for another example, suppose that some events that occur by chance can be explained but that there is some threshold $n$ beneath which an event is too unlikely to be explained. (It makes no difference to the intuitive force of the example whether that threshold is 49%, or is 5%, or is even lower still.$^8$) An atom created in a laboratory has decayed during some time interval, and you have been tasked with finding out why. In an attempt to explain why the atom decayed, you set out to discover the one true theory of everything, which you then use to calculate that the atom’s chance of decay was above $n$. However, just as you are about to go celebrate the fact that you have completed your task of explaining why the atom decayed, you get some news. Though you have indeed discovered the one true theory of everything, you made an error when calculating the atom’s chance of decay; actually, the atom’s chance of decay is lower than $n$. Is the correct response to cry out in anguish at the realization that not only have you failed to explain the atom’s decay, you will never explain the atom’s decay because the decay is inexplicable? No; the correct response is to celebrate the fact that, having fixed your calculation,

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$^8$ If we adopt the standard analysis, then events with chance 0 of occurring can nevertheless occur. My view is that even these chance 0 occurrences are no more inexplicable than are their more likely counterparts.
you have now completed your task and provided an explanation of the atom’s decay. The intended moral is that discovering the correct chance of an event’s occurrence is important to providing a chance explanation of that occurrence, but that whether an event is explicable seems not to depend on whether its chance of occurring is high or low.

So, our two intuitions about scientific explanation in deterministic worlds have implausible consequences when applied to indeterministic worlds.9 However, it is not very satisfying to be told that, though it is strange and counterintuitive to accept that unlikely events can be explained, it is even stranger and more counterintuitive to deny it. Why do our very sensible intuitions about how explanation works in deterministic worlds get explanation in indeterministic worlds so badly wrong? My answer will be that we have mistakenly transferred these two intuitions from deterministic to indeterministic worlds instead of transferring the underlying reasoning by which each is motivated. My view of chance’s role in explanation vindicates what I take to be the reasoning that supports these two intuitions in deterministic contexts, but first things first; I turn now to my view of chance explanation.

2. A Theory of Chance Explanation

2.1 Chance’s Predictive Role

When an event occurs by chance, what explains its occurrence? I think there is a lot to learn about chance explanation from chance’s predictive role, so that is where we will start.

I take the following to be a central truth about chance’s predictive role: of all the evidence we presently have about whether some outcome will occur in the future, none is better

9 This point is not novel; that our intuitions about explanation in deterministic worlds have implausible consequences when applied to indeterministic worlds is a point I first learned in Salmon 1971, 1989 and in Railton 1978, 1981.
than is the outcome’s present chance of occurring.\textsuperscript{10} Other information we might presently have about the future, such as a complete description of the present state of the world and a complete accounting of the laws of nature, can only ever be as good grounds for our expectations about the occurrence of future events as are the present chances of those events.\textsuperscript{11} For example, suppose you are interested in predicting whether an atom will decay. Facts about, say, the atom’s being some particular isotope or the laws governing radioactive decay are evidence about whether the atom will decay. And, facts about the past times of decay for atoms of the same isotope and the testimony of famous research scientists about when the atom will decay are further examples of evidence you might have about whether the atom will decay. However, none of that evidence is better evidence than is the atom’s present chance of decaying. Once you are certain of the atom’s present chance of decaying, you have no need—as far as making good predictions goes—of any information about the atom’s isotope, about the laws governing decay, about similar atoms, about the opinions of experts, and so on. Of course, evidence about an event’s occurrence that is available \textit{after} the event occurs might be better grounds for one’s expectations about whether the event occurred than is the

\textsuperscript{10} Here I use “evidence” in an objective sense in which whether one thing is evidence for another is not relativized to the background beliefs of any agents. I have no analysis of this notion to offer, or of precisely what it means to say that one piece of evidence is objectively better than another, but instead rely on the reader’s intuitive understanding of the objective reading of these and related notions, such as “best grounds for belief” or “best grounds for our expectations”.

\textsuperscript{11} The laws of nature and the present state of the world at a time fix the chances that obtain at that time and so are just as good evidence about the future as are the present chances. In contrast, the chances that presently obtain underdetermine the natural laws and present conditions. For example, that an atom presently has a 50% chance of decaying in some time interval does not determine the features of the atom or the relevant laws that are responsible for the atom’s 50% chance of decaying (within that time interval). Nevertheless, no additional information about the atom’s features or about the relevant laws is better evidence about whether the atom decays than is the atom’s mere chance of decaying.
event’s past chance of occurring. A record of an atom’s decay, for example, is better grounds for one’s expectations about whether the atom decayed than is its prior chance of decaying.\textsuperscript{12}

Perhaps also, in a more speculative mood, we might allow that there are some strange cases in which information about the past or present state of the world is even better grounds for one’s expectations about the future than is the future’s present chance of occurring. Perhaps, for example, it is possible for a time traveler to witness our atom’s decay and then to travel back in time to tell us that the atom decays. Or, perhaps there could be some kind of magical crystal ball that is somehow able to accurately and non-accidentally predict future occurrences without causing those occurrences (as discussed in Lewis 1980). If an event’s occurring by chance is consistent with its occurrence being foretold long ago by time travelers or magical crystal balls, then there are conceivable cases in which information about the present and past state of the world is even better grounds for one’s expectations about what the future will be like than are the present chances. Later, I will argue that this fantastical kind of evidence is importantly like the mundane kind of evidence we (typically) have only after an event occurs (e.g., a record of the event’s occurrence); I give the same account of why each of these two kinds of information might be better evidence about whether an event occurs than the event’s chance of occurring.

Putting aside such fantastical cases for the time being, when it comes to making predictions about events that have yet to occur, one can do no better than by being certain of the present chances. In this sense, the present chances are a kind of predictive choke point, with the present and past on one side and the future on the other.

\textsuperscript{12} Perhaps, even in this case, it is technically correct to say that the atom’s present chance of having decayed in the past is as good grounds as one can have for one’s expectations about whether the atom decayed in the past, but only in the trivial sense in which the present maximal chance of an event’s past occurrence merely marks that the event occurred.
But why? Why should the chances be at least as good evidence about the future as is the rest of our evidence about the future? That some particular matter of fact about the present—namely, the present chances—is guaranteed to be at least as good of evidence about the future as is anything else that one might come to learn about the present and the past calls for explanation. While it is easy enough to have the intuitive feeling that there is something special about the chances that makes them as good grounds for our expectations about the future as are all other past and present features of the world, it is not so easy to identify that special something. The chances must be importantly different from other features of the past and the present in some way that accounts for their unique predictive role. In what way are the chances different?

My answer will be that chance plays a special predictive role because chance plays a special explanatory role; the difference between chances and other features of the past and the present is that the chances play a unique role in explaining what happens in the future. Before explaining that answer, however, I want to briefly survey strategies for explaining chance’s predictive role that differ from my own, and to point out the difficulties these other strategies tend to face.

2.2 Explaining Chance’s Predictive Role: Alternative Strategies

Typically, philosophers wonder not only why chance is our best grounds for forming expectations about the occurrence of future events but also why, when we are certain of an event’s chance, we should, on pain of irrationality, match our expectations in the occurrence to the event’s chance of occurring. In other words, not only is it true that we have no better evidence about the future than the present chances, it is also true that we must (on pain of irrationality) act as if we have no better evidence about the future than the present chances by
conforming our degree of expectation in various events to what we take to be the chance value of those events. Others have attempted to explain why rationality would require this.

My project is somewhat different; I am interested in explaining why, as a matter of fact, we have no better grounds for our expectations in the future than the present chances (rather than in explaining anything about what rationality requires of us given our opinions about the chances). These two projects are important to distinguish because it is not in general true (or, at least, not obviously so) that rationality requires us to respond to what, in fact, is good evidence. For example, my high fever is good evidence that I have a flu but not good evidence that I have a cold. If I misremember the symptoms of colds and flus, and so take my fever to be evidence that I have a cold but not that I have a flu, then I am making a mistake but I am not (at least, not obviously) being irrational. In contrast, if I do not take the present chances to be evidence about what the future will be like, I am not simply failing to correctly identify good evidence—I am being irrational.

That said, the more traditional project and my own are closely related. First, an explanation of why rationality compels us to act as if we have no better evidence about the future than what we take to be the present chances might also show why it is in fact true that we have no better evidence about the future than the present chances. In such a case, attempts to answer the question philosophers more typically puzzle over, i.e., the question of why rationality compels us to coordinate our expectations about whether an event occurs with our beliefs about the event’s chance of occurring, also serve as attempts to answer my question, i.e., the question of why chances really are as good evidence about the future as we can get.\(^\text{13}\) Second, I presume

\(^{13}\) In Elliott 2016, I engaged in the more common strategy of attempting to answer both questions in one fell swoop. Now I suspect that a better strategy is first to identify why chances really are
that showing that the chances really are as good evidence about the future as we can get is at least a step toward explaining why rationality compels us to treat them as such.\textsuperscript{14} So, my attempt to answer the question of why chances really are as good evidence about the future as we can get will hopefully help us to make progress on related questions about the requirements of rationality.

Let’s take a look, then, at the more traditional project and the roadblocks one encounters in its pursuit.

Following Michael Strevens (1999), I use the term “principle of probability coordination” to refer to a rule that specifies an agent’s rational degree of confidence in an outcome given her opinions about that outcome’s chance. The most famous candidate principle of probability coordination is David Lewis’s “Principal Principle” (1980), but there is disagreement over what exactly is the correct principle of probability coordination (e.g., Lewis 1994, Hall 1994, Nelson 2009, Meacham 2010). That said, most everyone agrees that if an agent is certain that some outcome has a particular chance of occurring, then (continuing to ignore deviant cases involving, as good evidence about the future as one can get before tackling further questions concerning the requirements of rationality.

\textsuperscript{14} There are really two different questions one might ask about what rationality requires of us regarding chances: why do our beliefs about the chances determine our rational expectations in the future, and why do our beliefs about chances determine our rational expectations in the future \textit{in the particular way that they do}, e.g., why is it that high chance values compel us to have high expectations rather low expectations. (This distinction appears in Elliott 2016) I take the project I am presently engaged in to be a step toward answering the first question; that chances are, in fact, our best grounds for expectations about the future presumably plays a role in explaining why rationality requires that it is our beliefs about chance values, rather than our beliefs about other aspects of the present and past, that determines our rational expectations in the future. However, I do not think my present project helps to answer the second question; I do not address the question of why, e.g., high chance values are evidence that an outcome will occur and low chance values are evidence that the outcome will not occur.
e.g., time travelers and magical crystal balls) her degree of confidence in that outcome should equal the chance of that outcome (on pain of irrationality).

A natural first thought is that the Principal Principle, or some suitable variant, holds because of the metaphysical nature of chance. However, it has proved (perhaps surprisingly) difficult to give non-circular justifications of principles of probability coordination from more fundamental claims about chance’s metaphysical nature.

Consider, for example, the view that the chance of a given type of outcome is simply the frequency of that type of outcome among the total number of actual outcomes. On this view, for example, a coin has a 50% chance of landing heads exactly on the condition that it lands heads half of the times it is flipped (throughout its entire existence). Let’s call this theory “ARF” for “actual relative frequency”. ARF is not an otherwise plausible theory—it has unacceptable consequences, such as that a fair coin cannot be flipped an odd number of times—but if any theory of chance could explain probability coordination, it seems that ARF could. According to ARF, chance values are grounded by chance outcomes; indeed, if we know the chance of an outcome then we know precisely how frequently that outcome actually occurs. How hard could it be to argue that an agent’s knowledge of chance values rationally constrains her opinions about the outcomes that determine those very chance values?

As it turns out, pretty hard. Suppose an agent is certain that her coin is fair and knows nothing else of relevance about what will happen if the coin is flipped. Then, her degree of confidence that the coin lands heads should be, on pain of irrationality, .5. How might we argue that our agent should do what the principle of probability coordination requires? We could try arguing that she will “do better” if she obeys the principle than if she does not, in the sense that she will score higher according to some strictly proper scoring rule that rewards agents for
having high expectations in outcomes that occur and low expectations in outcomes that do not occur. ¹⁵ That seems like a promising start, especially because ARF rules out deviant series such as the coin landing heads on every toss (since ARF implies that half the flips of a fair coin land heads). Indeed, if we restrict our attention to agents who (a) assign the same credence value to the outcome of each coin flip they consider and (b) form an opinion about the outcome of every flip of the coin that actually occurs, we can show that such agents do best by matching their degrees of confidence to the chance values (on the assumption that ARF is true).¹⁶ The difficulty is that it is not at all clear why the rest of us should follow a policy that works best for agents who satisfy both (a) and (b).

First, agents who violate (a) by varying their credences across coin flips may well do better than agents who have credence .5 in heads for every coin flip. The highest score possible, for example, goes to any agent who ignores the coin’s chances and is instead certain that the coin lands heads every time that it does. Of course, we might have the feeling that such an agent is irrational for changing her opinions across various tosses for no “good” reason, but we must admit that violating (a) might nevertheless pay off.

It is tempting to argue that the vice of agents who violate (a) is that they violate some further principle of rationality (e.g., the principle of indifference) by treating like cases differently.¹⁷ No two coin tosses are alike in every respect, so now the trouble is to say what it is for cases to be relevantly alike. As Strevens (p. 262-263, 1999) points out, however, it is very hard to see how to correctly identify, e.g., coin flips that are relevantly alike as anything other

¹⁵ Never mind wondering what justifies this sort of scoring rule over any another—the argument fails even if we grant the scoring rule. See Winkler (1996) for a discussion of scoring rules.
¹⁶ This result is straightforward for strictly proper scoring rules.
¹⁷ Strevens (1999) attributes this strategy to Howson and Urbach (1993). Hoefer (2007, fn. 32) maintains that Strevens has misunderstood Horson and Urbach but does not expound.
than exactly those coin flips that have the same chance of landing heads. However, the principle that one should assign the same credence to any two outcomes that have the same chance of occurring is, as Strevens says, “just a special case” of the principle of probability coordination and thus can provide no independent grounds for adhering to that principle.

Second, agents who satisfy (a) but not (b) by having credences about the outcomes of only a (proper) subset of the total number of coin flips might also do better by having a credence in heads equal to some value other than .5. To take an extreme example, that the actual relative frequency of heads is .5 is consistent with the first half of the total number of flips all turning up heads. In that case, an agent who is only around to experience that first half of flips does best to be certain that the coin lands heads on each of them. Note too, that even if there is, contra the previous paragraph, some non-circular argument to be found that violating (a) is irrational, falling short of (b) is not only permissible but is the lot of all actual agents. The problem is a familiar one: why should we, who live in the short run, follow policies that are sure to be best only in the long run? As Keynes famously wrote, in the long run we are all dead.18 (Keynes, 1923)

That said, while it is possible for an agent to do best in the short run by setting her credence in heads to something other than .5, she very likely will not (so long as the “short run” contains a sufficiently large number of tosses). We can show that an agent’s best chance at a high score when forming expectations about a (sufficiently large) subset of the total number of coin flips is to have credence .5 that the coin lands heads on any particular flip. But why should

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18 The principle of probability coordination applies just as much to one’s opinions about the outcome of a single trial as it does to one’s opinions about a series of trials, but a strategy that is best if followed over the long run is not guaranteed to be best when applied in the short run. If you have one day to live you need not brush your teeth or contribute to your 401k, but you are still obliged to follow the principle of probability coordination.
an agent expect to succeed when following a strategy that gives her the best chance of success? 

This question is simply a higher-order version of the question with which we began. We set out to justify an inference from chance to expectation but we have justified only an inference from one chance to another, and so we are no closer to having justified any principle of probability coordination.

Things only get worse when we acknowledge that chance values need not match actual relative frequencies. Of course, there are other strategies for justifying principles of probability coordination and there are more sophisticated theories of chance. But similar problems seem to face many different attempts. When it comes to explaining chance’s predictive role, then, we should welcome all the help we can get.

2.3 Explanation-Expectation Connection

I do not know how to justify the Principal Principle or any similar requirement of rationality. I do think I know, however, how to account for the fact that, among all the sources of evidence we typically have about how the future will go, chances are our best grounds for forming expectations about the future. Chances are a predictive chokepoint between the (past and) present and the future because chances are an explanatory chokepoint between the (past and) present and the future.

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19 Intuitively, the fact that a particular coin is fair is consistent with its frequency of landing heads being any value whatsoever; indeed, a coin’s being fair is consistent with the coin being destroyed after only one toss or with the coin having never been flipped. Even those who deny that chance values are consistent with any actual frequency, such as the Lewisian about chance (Lewis 1994), nevertheless accepts that there is sometimes wide divergence between chance values and actual relative frequencies.

20 Notable attempts to explain some principle of probability coordination can be found in, e.g., Loewer 2004, Hoefer 2007, Schwarz 2014.

21 For a more thorough discussion, see Strevens 1999.
To understand what I have in mind, start by noticing that we often take the appearance of structure among evidential relations to be indicative of some further structure among various kinds of underlying relations. For example, barometer readings and low atmospheric pressure are both evidence about whether or not it will rain; however, low atmospheric pressure is always at least as good evidence about whether it will rain as is a barometer’s reading, while a barometer’s reading is not always at least as good evidence about whether it will rain as is low atmospheric pressure. This structure in the evidential relations that hold between low atmospheric pressure, barometer readings, and rain might be used to uncover the underlying causal relations that hold between low atmospheric pressure, barometer readings, and rain.

Such a strategy might proceed by first identifying ways in which the structure of causal relations among events can give rise to evidential relations between those events. Particularly relevant to the case of the barometer is the fact that a common cause of two events is at least as good evidence about the occurrence of each event as either event is about the other (provided that no further causal relations between the three events obtain). So, the hypothesis that barometer readings and rain share the common cause of low atmospheric pressure would, if true, account for the fact that low atmospheric pressure is at least as good evidence of whether it rains as is a barometer’s reading, and that is some reason to think that barometer readings and rain really do share the common cause of low atmospheric pressure. In this way, the evidential relations that obtain between various events can help us to discover the kinds of causal relations that obtain between those events.

I suggest we employ the similar strategy of taking chance’s distinctive role as a predictive chokepoint to be indicative of some further underlying relations in which chances stand. Unlike barometer readings and atmospheric pressure, however, chances themselves do not stand in any
causal relations. Chances, like laws of nature, might be importantly related to causation but are
not the kinds of things that can themselves be causes. However, again like laws of nature,
chances are the kinds of things that might stand in explanatory relationships. My strategy is to
argue that chance’s role as a predictive chokepoint is indicative of the underlying explanatory relations in which chances stand.22

The first step in such a strategy is to identify ways in which the structure of explanation relations can give rise to structure among evidential relations. Admittedly, the philosophical project of locating connections between the scientific goals of explaining and predicting has not always been fruitful. For example, in the hope of finding a philosophical treatment of scientific explanation that avoids commitment to any metaphysical posits that might alarm Empiricists (such as causation), philosophers such as Hempel (1965) and Salmon (1971) attempted to analyze scientific explanation in terms of evidential relations (nomic expectability, in Hempel’s case, and statistical relevance in Salmon’s). These attempts (famously) failed, and the moral many philosophers drew from that failure (including Salmon himself, in Salmon 1984) is that explaining and predicting are distinct theoretical goals, neither of which can be analyzed exclusively in terms of the other.

While I agree with the contemporary consensus that explanation is not analyzable in terms of evidential relations, I nevertheless think that there is a (much more modest) connection between explanation and good grounds for expectations. First, notice that information that is, in some vague but intuitive sense, explanatorily relevant to an event’s occurrence is also (at least typically) evidentially relevant to the event’s occurrence (though the converse is not true). The

22 Whether this explanatory structure is itself accounted for by some further underlying structure is not a question I take up here.
past positions of the celestial objects, for example, seem to be both explanatorily relevant and
evidentially relevant to the present solar eclipse. Second, notice that, among the items that are
explanatorily relevant to an event’s occurrence, not all need be equally good evidence about
whether the event occurs. Both my present life circumstances and my genetic makeup are
explanatorily relevant to my being content, for example, but my present life circumstances might
be better evidence that I am content than is my genetic makeup or vice versa.

Now, consider all the information that is—again, in some vague but intuitive sense—
explanatorily relevant to an event’s occurrence. As we have already noted, some of that
explanatorily relevant information is evidence about whether the event occurs, and some of that
explanatorily relevant information is better or worse evidence than is other pieces of
explanatorily relevant information. Of the explanatorily relevant evidence, which is the best
evidence about whether the event will occur?

It seems to me that the ideal explanation of an event’s occurrence—the complete
explanatory story of why an event occurs—must be at least as good evidence about whether the
event occurs as is any information that is merely explanatorily relevant to the event’s occurrence.
That is, it seems to me that there is a connection between being the ideal explanation of an
event’s occurrence and being the best evidence about whether the event occurs; among
information that is explanatorily relevant to an event’s occurrence, there is no better evidence
about whether the event occurs than is the ideal explanation of an event’s occurrence.

This (alleged) connection requires clarification. First, though I will not attempt to define
“ideal scientific explanation”, I have in mind that an ideal scientific explanation of an event’s
occurrence leaves out no truths about the world that would improve our scientific understanding
of why the event occurs. The qualification that an explanation is scientific is meant to separate
the kinds of explanations I have in mind from other kinds of explanations, such as metaphysical or mathematical explanations. Further, I assume that irrelevancies are features of only non-ideal scientific explanations, and so stipulate that nothing in the ideal scientific explanation of an event’s occurrence is eliminable.23 Finally, in describing an explanation as ideal, I mean only that it is ideal given the way the world actually is.24

Second, I will also not attempt to give a general treatment of the intuitive notion of “explanatory relevance”, but will instead focus on describing one particular kind of explanatorily relevant information. I distinguish between an ideal explanation of an event’s occurrence and further factors that are explanatorily relevant to this event’s occurrence only in the sense that they, so to speak, help to put the ideal explanation of the event’s occurrence in place.

For example, imagine that the ideal explanation of a hiker’s having survived her recent hike contains the fact that, at a particular stage in her hike, she ducked. Suppose further that, a little while before the hiker ducked, a boulder began rolling down a hill near to our hiker. It seems to some people that the boulder beginning to roll down a hill near to the hiker helps to explain why the hiker ducked but does not help to explain why the hiker survived; the intuition is that the hiker was endangered by a boulder rolling down a hill near to her, and so it is not true that the hiker survived because of the boulder. (I borrow this case from Hall 2004.) Suppose that intuition is correct, i.e., suppose that the boulder beginning to roll down a hill near to our hiker is

23 For an argument that irrelevancies ruin explanations, see Salmon 1971.
24 There is a sense in which, say, the fact that Bruce Wayne and Batman are never in the same room at the same time is better explained by their being the same person than by its just being a coincidence that they’ve yet to run into each other. But if it really is just a coincidence that they’ve yet to run into each other, then the ideal explanation of their never being in the same room at the same time will not say otherwise. Similarly, even if events that occur in deterministic worlds are, in a sense, better explained than are events that occur by chance, there might still be ideal explanations of events that occur by chance, given what I mean by “ideal”.

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explanatorily relevant to our hiker’s survival only in the sense that it helps to explain something which, in turn, explains why our hiker survived her hike. 25

Let’s call information that is explanatorily relevant to some proposition only in the sense that it helps to explain something which, in turn, is the ideal explanation of that proposition “explanatorily antecedent” to the ideal explanation of that proposition. So, in our example, that the boulder began rolling down a hill near to the hiker is explanatorily antecedent to the ideal explanation of why the hiker survived her hike.

Let’s also call “explanatorily antecedent” any information that is explanatorily relevant to a proposition only in the sense that it helps to explain something that helps to explain the ideal explanation of that proposition. For example, suppose that the boulder began rolling down a hill because some nearby dynamite exploded. If we also suppose that the dynamite exploding does not help to explain why our hiker survived, then the dynamite exploding is explanatorily antecedent to the ideal explanation of our hiker’s survival.

More generally, let us call “explanatorily antecedent” to the ideal explanation of some proposition any information that is explanatorily relevant to that proposition only in the sense that it is information that stands somewhere in one of various chains of explanation relations leading to the ideal explanation of the proposition.

The connection that I posit between the structure of explanatory relations and the structure of evidential relations is, then, simply this: the ideal explanation of some event’s occurrence is at least as good grounds for one’s expectations about whether the event occurred as

25 I use the case of the boulder and the hiker merely as an illustration—nothing that follows depends on the intuition that the hiker’s survival is explained by information about the ducking but not by information about the rolling boulder.
is any information that is explanatorily antecedent to the ideal explanation of the event’s occurrence. I call this connection “Explanation-Expectation Connection”:

Explanation-Expectation Connection: Let “P” be the name of the proposition that a particular event occurred and let “X” be the name of an explanation of P. If X is the ideal explanation of P, then X is at least as good grounds for one’s expectations in P as is any information that is explanatorily antecedent to X.

Explanation-Expectation Connection is not meant to be motivated by any particular theory of scientific explanation, but rather by more general intuitions about the connection between ideal scientific explanations (as I use the term “ideal”) and good grounds for expectation. Suppose we have a proposition P, which states that some particular event occurred, and the ideal explanation of P—whatever that explanation might be—called “X”. Since X is the ideal scientific explanation of P, X contains absolutely everything that is necessary to a full scientific understanding of P. And, since X is the ideal scientific explanation of P, there is no other ideal scientific explanation of P that might be better evidence about whether P is true than is X.

Now suppose we have some further information, call it “Y”, that is explanatorily relevant to P only in the sense that Y helps to explain some information already contained in X. Y may or may not be the ideal explanation of X, but I stipulate that Y contains only as much

\[\text{26 If you object that there can be no such Y because explanation is transitive, Explanation-Expectation Connection is trivial by your lights.}\]
information as is needed to (at least partly) explain X, i.e., that no part of Y is eliminable. On my terminology, Y is explanatorily antecedent to X.

If X is the ideal scientific explanation of P and Y is not explanatorily relevant to P except by way of helping to explain the information contained in X, then I do not see how Y could be better grounds for forming one’s expectations in P than is X. While X is the full explanatory story of why P is true, Y merely helps to explain X and does not “directly” explain P at all. So, among the ideal explanation of P (i.e., X) and some further information that merely helps to explain the ideal explanation of P (e.g., Y), it seems to me that there can be no better evidence about whether P is true than the ideal explanation of P.

Finally, it seems to me that if there is some further scientific explanation of Y—call that further explanation “Z”—that is not explanatorily relevant to X or to P except by way of helping to explain Y, then X must be at least as good grounds for one’s expectations in P as is Z. And so on, for all the links in all the chains of scientific explanations leading up to X that there might be. That is, it seems plausible to me that the ideal scientific explanation of an event’s occurrence must be at least as good grounds for one’s expectations about whether an event occurs as is all the information that is explanatorily antecedent to the ideal scientific explanation of the event’s occurrence—just as Explanation-Expectation Connection says.

I hope that Explanation-Expectation Connection sounds plausible to you too; I have no more basic principles to offer from which to argue for it. Though the view that explanation is

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27 For example, while Y and P together might be better grounds for one’s expectations about P than is X, Y and P together are not an explanation of X because P is eliminable.

28 Explanation-Expectation Connection does not rule out that information that is explanatorily antecedent to the ideal explanation of an event’s occurrence is as good evidence about whether the event occurs as is the event’s ideal explanation, i.e., it could be that X and Y are equally good grounds for our expectations in P. For example, Y might entail X in addition to explaining X, in which case Y is as good evidence for P as is X.
analyzable in terms of prediction has been roundly refuted by the existence of cases in which grounds for expectations are not at all explanatory, it is an overreaction to deny that there is any connection between the structure of explanatory relations and the structure of evidential relations. Explanation-Expectation Connection is meant to state a very modest aspect of that connection.

That said, there are no doubt clever counterexamples to the letter of Explanation-Expectation Connection to be found. However, if the letter of Explanation-Expectation Connection has counterexamples, I think it is only because I have failed to capture its spirit. The motivating thought behind Explanation-Expectation Connection is that, in virtue of being links in a chain of explanations leading to an ideal scientific explanation of some proposition, various bits of information stand in evidentiary relations to that proposition; but none of that information can be better evidence about whether that proposition is true than the final link in the chain—the ideal explanation of that proposition. Whatever counterexamples there might be to Explanation-Expectation Connection, I think that they will all be cases that, in some intuitive sense, involve some information being evidence for a proposition in virtue of being explanatorily antecedent to the ideal explanation of that proposition and in virtue of standing in some additional evidentiary relation to that proposition. Finding a precise formulation of Explanation-Expectation

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29 One place to look for such counterexamples is in stories about time travel in which a particular event stands in a chain of explanation relations to itself. Imagine, for example, that I build a time machine and travel back in time to tell myself how to build a time machine, which, in turn, helps to explain why I ultimately build a time machine. Perhaps such cases can be used to generate examples in which X is the ideal explanation of P, P is explanatorily antecedent to X, and yet P is better evidence about P’s truth than is X. My diagnosis of such cases is that they are not a serious threat to the spirit of Explanation-Expectation Connection because they are cases in which P is evidence for P both in virtue of being explanatorily antecedent to X and in virtue of being identical to that which we are attempting to predict—though it will be difficult to precisely characterize what it means to say that one piece of information is evidence for another via both an explanatory route and some other evidentiary route.
Connection that will correctly sort all such cases might be difficult, but I think the intuitive idea behind Explanation-Expectation Connection will nevertheless stand.

2.4. An Explanatory Chokepoint

Let’s take stock. I began section 2 by observing that chance is a kind of predictive chokepoint; the chance of an event is at least as good grounds for one’s expectations about whether the event will occur as is all the other information we (typically) have about the present and the past. My goal is to use this fact about chance’s predictive role to learn more about chance’s explanatory role by showing how this structure in evidential relations could arise from an underlying structure among explanatory relations. To that end, I have posited a connection, Explanation-Expectation Connection, between the structure of explanatory relations and the structure of evidential relations. The final step is to identify a view of scientific explanation in chancy worlds that, given Explanation-Expectation Connection, would give rise to chance’s unique role as a predictive chokepoint.

The view of scientific explanation in chancy worlds that I develop in this section has two components, which correspond to two different questions we might have when an event occurs by chance: (i) why did the event occur? and (ii) why was the event’s chance of occurring equal to $n$? (Let $n$ be a real number along the unit interval.) An answer to question (i) is what I have termed a chance explanation of an event’s occurrence, while an answer to question (ii) is what I have termed an explanation of chance, i.e., an explanation of an event’s chance of occurring. A single scientific theory can provide both chance explanations and explanations of chance. For example, theories of radioactivity help to explain both why an atom decayed during some
particular time interval and why the atom’s chance of decaying in that time interval was, say, 50%.³⁰

The first component of my view that I will discuss is about explanation of chance. Though I have nothing approaching a precise theory of explanation of chance to offer, I do think there are at least two ways that a scientific theory might help to explain why an event has a particular chance of occurring—both of these ways will be important to my account of chance’s predictive role.

First, an insight familiar from deterministic contexts is that many scientific explanations proceed by deriving the proposition to be explained from premises about the relevant laws of nature and antecedent conditions. Events that occur by chance cannot be so explained since chance events do not have to occur, even given all the laws and antecedent conditions. So, chance explanations of events do not consist in derivations from laws and antecedent conditions. However, this insight can nevertheless be extended to indeterministic contexts in the form of a claim about explanation of chance; one way to explain an event’s chance of occurring is by reference to the laws of nature and antecedent conditions that determine this event’s chance of occurring. So, for example, we might explain our atom’s chance of decay by deriving the atom’s chance of decay from premises about what the atom is like and about the relevant laws of nature.

Second, yet another insight familiar from deterministic contexts is that one way to explain something is to answer what James Woodward (2003) has descriptively named “what-if-things-had-been-different questions” about whatever it is that is being explained. In deterministic contexts, causal information seems to answer “what-if-things-had-been-different-

³⁰ See my manuscript “Two Explanatory Questions” for a more thorough discussion of why tracking the difference between chance explanation and explanation of chance is crucial to developing a satisfactory account of scientific explanation.
questions” about the occurrence of particular events. For example, the information that overeating causes weight gain in certain individuals helps to explain why those individuals gain weight by conveying the further information that, had those individuals not overeaten (and had other factors, such as exercise level, been held fixed) they would not have gained weight.

In contrast, causal information does not answer “what-if-things-had-been-different” questions about the occurrence of chance events because chance events need not counterfactually depend on their causes. Suppose, for example, that whether or not one gets cancer is always a matter of chance, that it is possible to develop cancer without having smoked, and that smoking causes cancer in virtue of increasing one’s chance of getting cancer. In that case, it is neither true that, for any individual, she would have gotten cancer had she smoked (because, since getting cancer is a matter of chance, each individual might not have gotten cancer) nor is it true that, for any individual, she would not have gotten cancer had she not smoked (since each individual might have gotten unlucky and developed cancer anyway). So, I doubt that causal information provides chance explanations by answering “what-if-things-had-been-different questions” about the occurrence of chance events. (For a more thorough discussion see my manuscript “Two Explanatory Questions.”)

However, I do not at all doubt that one way to explain is by answering “what-if-things-had-been-different questions”. In indeterministic contexts, causal information does not (at least typically) tell us how things would have been different with respect to which chance events would have occurred, but causal information does tell us how things would have been different with respect to the chances of various events. For example, the information that being near radioactive material causes Geiger counters to click might convey the further information that a Geiger counter’s chance of clicking counterfactually depends on whether the Geiger counter is
near to radioactive material. On my view, a second way to explain an event’s chance of occurring is by providing information about the causes of that event. The fact that this Geiger counter is near radioactive material, for example, helps to explain why the Geiger counter’s chance of clicking is high because the Geiger counter’s chance of clicking counterfactually depends on whether it is near to radioactive material.

So, my view of explanation of chance is that there are (at least) two kinds of information that (at least help to) explain an event’s chance of occurring: information about laws and antecedent conditions, and information about an event’s causes.

The second component of my view is about chance explanations of events. On my view, the ideal scientific explanation of any event that occurs by chance is simply a description of the event’s chance at a particular time (though which time is a more complex matter that we will confront after we are a bit further along). When an event occurs by chance, it is chance—and chance alone—that explains the event’s occurrence. As a result, my view denies that explanation is transitive. The ingredients of explanations of chance are not themselves chance explanations; while an explanation of chance might entail a chance explanation of an event’s occurrence, it does not thereby explain the event’s occurrence.

My picture of chance’s role in explanation, then, is that chance is a kind of explanatory chokepoint, with the future on one side and the present and past on the other. Roughly, the present chances explain various future occurrences, and other information about the past and the present that is intuitively explanatorily relevant to the future serves not to explain what happens in the future “directly”, but is instead explanatorily antecedent to the chances, i.e., explains the chances, or explains something that explains the chances, or explains something that explains something that explains the chances, and so on.
2.5. From an Explanatory Chokepoint to a Predictive Chokepoint

We are finally in a position to see how chance’s role as a kind of explanatory chokepoint can give rise to chance’s role as a kind of predictive chokepoint.

Imagine that whether it rains is a matter of chance. Presently it is morning, and the present chance of rain this evening is 70%. The present chance of rain this evening is at least as good grounds for one’s expectations about whether it will rain this evening as are the following instances of three types of evidence we might presently have about whether it will rain this evening:

1. It is a law that whenever condition C obtains, there is a 70% chance it will rain (within roughly 12 hours), and condition C presently obtains.
2. There are presently storm clouds overhead and storm clouds cause rain.
3. The barometer needle presently points to “rainy”.

1, 2, and 3 are all evidence about whether it will rain this evening, but none is better than is the present chance of rain this evening. Why?

Suppose that it does rain this evening and that the present, i.e., morning, chance of evening rain is the ideal explanation of the fact that it rains this evening. (As we will see shortly, this supposition cannot be quite right—but for now I put off any further complexity.) My view is that 1 and 2 help to explain the present 70% chance of rain this evening, but do not otherwise explain why it rained this evening. That is, using my terminology, 1 and 2 are explanatorily antecedent to the present chance of rain this evening. By Explanation-Expectation Connection,
the ideal explanation of this evening’s rain—which, we are supposing, is the present 70% chance of rain this evening—is at least as good grounds for one’s expectations in this evening’s rain as is any other information that is explanatorily antecedent to the ideal explanation of this evening’s rain. So, the present 70% chance of rain this evening is at least as good grounds for our expectation that it rains this evening as is either 1 or 2.

What about 3? 3 is slightly trickier because 3 is not explanatorily antecedent to the ideal explanation of this evening’s rain; 3 neither explains the present chance of rain this evening nor any other link in any chain of explanation relations leading to the present 70% chance of rain this evening. Why is it that 3, which is intuitively explanatorily irrelevant to whether it rains this evening, is nevertheless evidence about whether it does? The answer, I think, is that 3 is only evidence about whether it will rain this evening in virtue of being evidence for something that does help to explain the present 70% chance of rain this evening—namely, the presently low barometric pressure. The presently low barometric pressure, then, must be at least as good evidence about whether it rains this evening as is 3. In turn, the presently low barometric pressure is a cause of rain this evening and so, on my view, helps to explain the present chance of rain this evening but otherwise does not explain the occurrence of rain. That is, using my terminology, the low barometric pressure is explanatorily antecedent to the present chance of rain this evening. The present chance of rain this evening is at least as good grounds for our expectations about whether it rains this evening as is the low barometric pressure (given Explanation-Expectation Connection and our supposition that the present chance of rain this evening is the ideal explanation of the fact that it rained this evening), and the low barometric pressure is, in turn, at least as good grounds for our expectations about whether it rains this evening as is the barometer’s reading (since the barometer’s reading is evidence about whether it
will rain only in virtue of being evidence about the low barometric pressure). So, the present chance of rain this evening is just as good grounds for our expectations about whether it rains this evening as is 3.

So far, so good. My picture of chance’s explanatory role combines with Explanation-Expectation Connection to entail that the present chance of rain this evening is as good grounds for our expectations about this evening’s rain as is 1, 2, and 3.

Next, recall that the present chance of rain this evening is not guaranteed to be as good grounds for our expectations about whether it rains this evening as is all other information. Information that is (typically) available only after an event occurs, such as a record of the event’s occurrence, and fantastical kinds of information that might (in principle) be available prior to an event’s occurrence, such as a magical crystal ball’s prognostication, might both be better evidence about whether an event occurs than is the event’s chance of occurring. For example, the present chance of rain this evening is not guaranteed to be better evidence about whether it rains this evening than is the following:

4. It is evening and I can see rain.
5. Long ago, a magical crystal ball foretold that it rains this evening.

On my account, 4 and 5 receive the same treatment. Unlike 1 and 2, 4 and 5 are not explanatorily antecedent to the present chance of rain this evening; that I see it rain this evening explains nothing at all that is related to why it rains this evening, and—assuming that our magical crystal ball merely foretells the future but does not cause the future—the crystal ball’s prediction is similarly explanatorily irrelevant to whether it rains this evening. Unlike 3, 4 and 5
are not evidence of whether it rains this evening only in virtue of being evidence for something that is explanatorily antecedent to the present chance of rain this evening; though 4 and 5 might both be evidence that, say, the present chance of rain this evening is high, that 4 and 5 are evidence of the present chance of rain this evening is simply a byproduct of their being non-explanatory evidence that it rains this evening. So, there is no reason, on my picture, that 4 and 5 must be better evidence about whether it rains this evening than is the present chance of evening rain.

Now it is time to reconsider the supposition that the present, i.e., morning, chance of rain this evening explains why it rains this evening. That supposition cannot be quite right. Consider the following evidence that it rains this evening:

6. The chance this afternoon that it rains this evening is 30%.

Though the present chance of rain is 70%, 6 says that, by this afternoon, the chance of rain this evening will drop to 30%. Intuitively, 6 might be better evidence about whether it will rain this evening than is the morning 70% chance of rain; to put the matter (loosely but) intuitively, the afternoon chance of rain takes into account how the world has changed between this morning and this afternoon, and information that factors in such changes might well be better evidence about whether it rains this evening than is information that does not. Furthermore, the later 30% chance of rain this evening surely has at least as good a claim to being the ideal scientific explanation of rain as does the earlier 70% chance of rain this evening. So, either Explanation-Expectation Connection is false or the 70% chance of rain this evening is not the ideal scientific explanation of rain this evening.
The latter option is correct. Elliott 2016 draws a distinction between explaining an event and explaining why one or another chain of events culminated in that event’s occurrence:

[An explanation] of the occurrence of some causal chain ending in an outcome is not guaranteed to be [an explanation] of that outcome. For example, my dog and I head toward the park at three o’clock every afternoon. Sometimes I change my mind on the way and we go for a hike instead. Other times we make it to the park and we play fetch. Occasionally, traffic is bad and we come home after sitting in the car for an hour. But no matter what we do after we head toward the park, my dog ends up exhausted. Today, we played fetch at the park. Why did some causal chain, starting at three o’clock and ending now with my dog being exhausted, occur? Because my dog and I headed toward the park at three o’clock. Why is my dog now exhausted? If all you know about my afternoon is that my dog and I headed toward the park at three o’clock, then you do not know why my dog is exhausted. My dog is exhausted because we played fetch. (pg. 495)

A similar distinction should be drawn between an explanation of this evening’s rain and an explanation of there being some causal chain of events culminating in this evening’s rain. This morning’s 70% chance of rain this evening explains why some causal chain of events, starting this morning and ending in rain this evening, occurred; but, this morning’s 70% chance of evening rain does not explain why it rained this evening or why the actual chain of events

\[\text{\footnotesize 31 In maintaining that there are both explanations of a particular event’s occurrence and explanations of its being true that some causal chain occurred that ended with a particular event’s occurrence, I do not deny that the latter explanandum is more gerrymandered or less natural than is the former. There may well be a sense in which explanations of less gerrymandered or more natural occurrences are better or more illuminating than are explanations of more gerrymandered or less natural occurrences, but this sense in which an explanation might be “better” or “more illuminating” is orthogonal to what I mean by “ideal” explanation.}\]
leading to rain this evening occurred. Similarly, the 30% chance of rain this evening (which obtained this afternoon) explains why some causal chain of events, starting from this afternoon and ending in rain this evening, occurred. This morning’s 70% chance of rain this evening and this afternoon’s 30% chance of rain this evening are both ideal explanations, but of different things—neither of which is the fact that it rained this evening.

Furthermore, this morning’s 70% chance of rain this evening and this afternoon’s 30% chance of rain this evening are themselves explained—in the form of explanations of chance—by different features of the world. For example, this afternoon’s 30% chance of rain this evening is (at least partly) explained by events that occurred after this morning (perhaps, for example, there was an unlikely change in atmospheric pressure between this morning and this afternoon), while this morning’s 70% chance of rain this evening is not at all explained by any events that occur after this morning. So, information that is explanatorily antecedent to this afternoon’s 30% chance of evening rain is not guaranteed to be explanatorily antecedent to this morning’s 70% chance of evening rain.

Return to the question of why the earlier 70% chance of rain this evening is not better evidence about whether it rains this evening than is the later 30% chance of rain this evening. The earlier 70% chance of rain this evening is the ideal explanation of the fact that some causal chain of events, starting this morning and ending in rain this evening, occurred. The later 30% chance of rain this evening is evidence about whether some causal chain, starting this morning and ending in rain this evening occurred, but it is not explanatorily antecedent to the ideal explanation of the fact that some causal chain, starting this morning and ending in rain this evening, occurred. The later 30% chance of rain is instead the ideal explanation of the fact that some causal chain of events, starting this afternoon and ending in rain this evening, occurred.
The later 30% chance of rain this evening, then, is like 4 and 5; all three might well be better evidence than the earlier 70% chance of rain this evening about whether some causal chain of events, starting this morning and ending in evening rain, occurred, because none of the three are explanatorily antecedent to the ideal explanation of the fact that some causal chain of events, starting this morning and ending in rain this evening, occurred—namely, this morning’s 70% chance of rain this evening.

What, then, explains why it rains this evening? As we get closer and closer to this evening’s rain, the causal chain of events leading to rain gets shorter and shorter, until we arrive at a time at which the conditions that obtain are direct causes of rain this evening. At that time, the chance value of rain this evening “takes into account” everything that is intuitively explanatorily relevant to this evening’s rain—all that is left is for it to rain or to not rain. The chance of rain this evening at the time at which rain’s direct causes obtain, then, is the ideal explanation of the fact that it rains this evening.

Generalizing from the case of this evening’s rain, my theory of chance explanation distinguishes between (a) an explanation of a particular event and (b) an explanation of some causal chain occurring which ends in a particular event:

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32 C is a “direct cause” of E exactly if there is no further condition that causes E and is caused by C. Admittedly, the supposition that there is a clean and unproblematic distinction between the time at which an event’s direct causes obtain and the time at which event’s indirect causes obtain is a simplification of a number of complexities. For example, there is no a priori guarantee that any events have direct causes. And, as another example, it is far from obvious how to distinguish a direct cause that stretches out across time from a series of indirect causes that take place at ordered moments in times. Such further complexities are, no doubt, important to a full account of chance explanation, but I ignore them in this essay for the sake of better conveying my general approach.
**Chance explanation:** (a) If event $E$ is caused directly by conditions that obtain at time $t$, the ideal explanation of $E$’s occurrence (at or during some further period of time) is a specification of the chance at $t$ that $E$ occurs (at or during some further period of time). (b) If there is a causal chain between conditions that obtain at $t$ and the occurrence of event $E$ (at or during some further period of time), then a specification of the chance at $t$ of $E$’s occurring (at or during some further period of time) is the ideal explanation of the fact that one or another chain of events, beginning at $t$ and culminating in $E$ (at or during some further period of time), occurred (but is not an explanation of why any particular event or any particular chain of events occurred.)

Let’s look at two more examples for illustration.

First, an example of clause (a). Suppose that there is an atom sitting in a laboratory. Its present chance of decaying in the next second, say, is 50%, and the atom does indeed decay in that second. Plausibly, the direct causes of the atom’s decaying in that second presently obtain—such as, for example, the atom’s isotope presently being oxygen-22. On my view, then, the atom’s present 50% chance of decaying in the next second is the ideal explanation of the atom decaying in that second. Furthermore, some aspects of the present help to explain the atom’s present 50% chance of decaying in the next second, such as the laws of nature governing decay and the fact that the atom’s isotope is oxygen-22. In turn, some of these aspects of the present are themselves explained by earlier chances. Perhaps, for example, it was at some point a matter of chance whether the atom’s isotope would be oxygen-22. If so, the fact that the atom’s isotope is oxygen-22 is explained by the (earlier) chance of the atom’s isotope being oxygen-22. No information about these aspects of the present and past, however, are better
evidence about whether the atom decays in the next second than the present chance that the atom will decay in the next second, because all of that information is explanatorily antecedent to the atom’s present chance of decaying in the next second.

Second, an example of clause (b). Suppose that, presently, my Geiger counter is broken and stored in my closet. I might fix it up and use it to test some samples of material for radiation, but I might just leave it sitting in my closet. If I fix it up and use it to test some samples, there are a wide variety of possible scenarios in which the Geiger counter clicks, e.g., it might click in response to radiation, it might click because it malfunctions, etc. If I leave it in my closet, there are also a wide variety of scenarios in which the Geiger counter clicks, e.g., it might end up clicking because someone else comes along, fixes it up, and uses it to detect radiation. The present, then, does not seem to contain the direct causes of my Geiger counter ultimately clicking. In this case, the present chance of my Geiger counter clicking explains why some such chain of events, beginning in the present and culminating in my Geiger counter clicking, occurred. However, the present chance of my Geiger counter clicking neither explains why my Geiger counter ultimately clicks nor why, as it happens, I fix up my Geiger counter and use it to test samples of material for radiation, after which it clicks in response to radiation. The future chance that my Geiger counter clicks, which obtains right before my Geiger counter clicks, is better evidence about whether a chain of events, beginning in the present and ending with my Geiger counter clicking, occurred than is the present chance that my Geiger counter clicks because the future chance is not explanatorily antecedent to the present chance that my Geiger counter clicks. The present chance that my Geiger counter clicks, however, is better evidence about whether a chain of events, beginning in the present and ending with my Geiger counter clicking, will come to pass than is, say, the fact that I bought a Geiger counter last
Christmas. That is because the fact that I bought a Geiger counter last Christmas helps to explain chances that obtained earlier, and those earlier chances explain various aspects of the present, and various aspects of the present explain the present chance that my Geiger counter clicks; no such explanatorily antecedent information is better evidence about whether a chain of events, beginning in the present and ending with my Geiger counter clicking, occurred than the present chance that my Geiger counter clicks.

On my picture, then, the chances that obtain at a particular time $t$ are ideal explanations of “nearby” future events or are ideal explanations of the fact that some causal chain, starting at $t$ and ending in the occurrence of an event, occurred. In turn, the chances at a particular time are explained by further features of the world, such as the laws and present conditions, or causes, that determine those chances. And, those present conditions and causes are themselves explained by earlier chances, which are themselves explained by further laws and conditions and causes, and so on, so that there are chains of explanation relations that stretch far back into the past. All such evidence about the future is explanatorily antecedent to the present chances, and so none is better evidence about the future than are the present chances.

Furthermore, some evidence about the future is like the barometer pointing to “rainy”; such evidence is not explanatorily antecedent to the present chances but is evidence about the future only in virtue of being evidence about explanatorily antecedent aspects of the past and present. No such information is better evidence about the future than are the present chances. So, a great deal of information about the past and the present is, so to speak, caught up in the explanatory chokepoint that chance creates and is thereby caught up in the predictive chokepoint that chance creates.
Some evidence about what the future is like is not caught up in the explanatory chokepoint that chance creates, and so is also not caught up in the predictive chokepoint that chance creates. Information that is typically available only after an event’s occurrence, such as a record of the event’s occurrence, might well be better evidence about what the future will be like than are the present chances because such information is explanatorily irrelevant to the event’s occurrence. Similarly, if there are, say, magical crystal balls that (non-accidentally) predict but do not explain the future, then the predictions of such crystal balls might well be better evidence about what the future will be like than are the chances—but that is as it should be.

Finally, any information about the present and the past that is not evidence of any kind about what the future will be like might also not be caught up in chance’s explanatory chokepoint, but we have no need of an explanation of why information that is not evidence about some future event is not better evidence about whether that event occurs than the event’s chance.

That said, hard cases still remain. What if there is more than one ideal explanation of an event? What if explanatorily antecedent information is also evidence about the future via some other kind of relationship to the future? What if explanatory chains can loop back on themselves, like they must in the closed causal loops of time travel stories? There will be loose ends to tie up and more work to do. But, surely the fact that one objective feature of the world, i.e., chance, is at least as good evidence about the future as is nearly all other present and past objective features of the worlds is indicative of there being some further difference between that objective feature and nearly all other present and past objective features. I think that my view of explanation of chance and chance explanation would, if true, put us well on our way to understanding the difference between chance and other objective features of the world in virtue of which chance is a predictive chokepoint. Until the discovery of some better account, then, I
take chance’s role as a predictive chokepoint to indicate that chance is the explanatory
chokepoint I have described.

3. Reevaluating Our Two Intuitions About Scientific Explanation

Earlier I noted two intuitions one might have about scientific explanation: the intuition
that a full explanation of an event’s occurrence must cite features of the world in virtue of which
that event had to occur (given the past state of the world and the laws) and the intuition that, at a
minimum, an explanation of an event’s occurrence must cite factors that favor the event’s
occurrence over its failure to occur.

On the view of explanation in indeterministic but chancy contexts that I have developed
here, neither intuition is correct. On my view, the full explanation of an event’s occurrence
simply specifies the event’s chance of occurring and so neither shows that the event had to occur
(given the past state of the world and the laws) nor, in the case of unlikely events, cites factors
that favor the event’s occurrence over its failure to occur. In that sense, then, my view is at odds
with these two intuitions about explanation. However, I think that each of these two intuitions is
supported by reasoning that remains plausible on the view I developed above.

Why is the first intuition reasonable when applied to deterministic worlds? If the world
is deterministic and if a complete description of the world at a time and the laws of nature are
knowable via empirical investigation, then it is in principle possible for a scientific theory to
show that the future had to be as it is in light of what has occurred in the past. Against such a
possibility, it is natural enough to think that a scientific theory that fails to show that the future
had to occur also leaves out some information that would (if perhaps only slightly) improve our
understanding of why the future goes as it does. If the world is indeterministic but chancy,
however, the future does not have to turn out as it does (given the past state of the world and the laws) but instead has a certain chance of turning out as it does (given the past state of the world and the laws). In such a world, it is in principle possible for a scientific theory to show that a given future has, at present, this or that chance of occurring. Against such a possibility, the analogous intuition is not that explanations are in some way inadequate unless they show that the future had to occur, but is rather that a scientific theory that fails to show why the future had this or that chance of occurring leaves out some information that would, if perhaps only slightly, improve our understanding of why the future goes as it does. And, this analogous intuition is plausible on my view of explanation in indeterministic but chancy worlds; the ideal scientific explanation of a particular event specifies that event’s precise chance of occurring and the ideal scientific explanation of an event’s chance of occurring cites whatever factors suffice to determine the event’s chance of occurring (such as the relevant laws, antecedent conditions, or causes).

Why is the second intuition reasonable when applied to deterministic worlds? If every event had to occur, it is reasonable to require that, at a minimum, explanations cite factors that favor an event’s having to occur over its having to not occur as a way of getting us closer to having an explanation that cites the factors in virtue of which an event had to occur. The analogous intuition in indeterministic but chancy worlds, however, is not that unlikely events cannot be explained but that, at a minimum, explanations should cite factors that make a difference to the event’s chance of occurring as a way of getting us closer to having specified the future’s chance of occurring. Once again, this analogous intuition remains plausible on my view of explanation in indeterministic but chancy worlds. The fact that, say, an atom’s isotope is radium-226 helps to explain the atom’s chance of decay and so, in that sense, the atom’s isotope
is explanatorily relevant to the atom’s decay. In contrast, the fact that, say, an atom is in Kansas (presumably) does not help to explain the atom’s chance of decay and so, in that sense, is not explanatorily relevant to the atom’s decay.\(^{33}\)

Once we distinguish our surface level intuitions about scientific explanation in deterministic worlds from the reasoning that supports those intuitions, I think we find that our deeper intuitions about scientific explanation are perfectly at home within my picture of explanation in both deterministic and chancy worlds. On my picture, the temporal evolution of deterministic worlds and of indeterministic but chancy worlds are made intelligible by knowledge of the ligaments that connect the future to the present and past in these worlds. In a deterministic world, natural necessity connects the future to the past and present; the future turns out as it does because that is how things had to go, and that is how things had to go because of nomological and causal features of the past and present. In an indeterministic but chancy world, chance connects the future to the past and present; the future turns out as it does because that future had a particular chance of occurring, and the future had a particular chance of occurring because of the nomological and causal features of the past and the present. The discovery of probabilistic scientific theories, such as those underwritten by the standard interpretation of quantum mechanics, does not spoil our hope of ever fully understanding our world by revealing

\(^{33}\) On my diagnosis of the second intuition, if it seems in a deterministic world that my having taken penicillin is not explanatorily relevant to my failure to recover from strep then it should also seem that my having taken penicillin is not explanatorily relevant to the fact that I could not have recovered from strep. And, if it seems that my having taken penicillin does help to explain why I could not have recovered, then it should also seem that my having taken penicillin does help to explain why I could not recover from strep. Similarly, in an indeterministic world, my having taken penicillin is explanatorily relevant to my failure to recover if it helps to explain my chance of recovery—even if that chance is very low. For example, it might be that I failed to recover from strep because recovery is a genuinely indeterministic process and my chance of recovery was 95%, and, in turn, my chance of recovery was 95% (in part) because I took penicillin.
that some events occur by chance and are thus inexplicable; rather, the discovery of probabilistic scientific theories takes us closer to understanding our world by revealing the chances of various occurrences and by showing why those chances obtain.

Of course, I readily admit that my picture of scientific explanation has an unquestionably counterintuitive consequence; it is counterintuitive that ingredients of scientific theorizing such as laws, antecedent conditions, or causes do not—strictly speaking—explain events. I say “strictly speaking” because I have no objection to there being uses of the word “explains” according to which anything that stands in a chain of explanations leading up to some proposition counts as “explaining” that proposition, so long as we keep in mind that such usage elides further explanatory structure that is sometimes of import (i.e., the difference between explanation of chance and chance explanation). Furthermore, I do not anticipate that my view requires much (if anything) by way of revision to our understanding of scientific practice. It remains true on my view that scientific theories contain a great deal of explanatory information apart from chance values, and the practical tasks of discovering chance explanations and explanations of chance are so closely related that we should not be surprised if scientific practice has no need of distinguishing between them. So, though I appreciate how strange it sounds that, say, taking penicillin helps to explain one’s chance of recovery rather than one’s recovery, I think that living with such strange talk in philosophical contexts is a price worth paying for a picture of explanation of chance and of chance explanation that both fits with other intuitions we have about scientific explanation and that accounts for chance’s role as a predictive chokepoint.

4. Conclusion
In this paper, I have put forward the view that every event that occurs by chance (including even the most unlikely events) is explained by some chance ascription, while elements of scientific theorizing more traditionally taken to explain the occurrence of chance events—such as laws of nature, antecedent conditions, or causes—instead explain an event’s chance of occurring.

I have defended this view in two ways. First, I have argued that some intuitions about scientific explanation in deterministic worlds, which are at odds with there being explanations of events that occur by chance in indeterministic worlds, are nevertheless supported by reasoning that my view can accommodate. Second, I have argued that my view can account for a unique feature of chance’s predictive role; I have shown that if my account of chance’s explanatory role is correct (and if explanation and grounds for expectation are related in the way described by Explanation-Expectation Connection), we can understand why the present chances are at least as good grounds for our expectations about the future as is any other information about the past and the present that we typically have.

Along the way, I have made various simplifying assumptions and put aside otherwise interesting issues; the full story of chance’s explanatory role and of its relation to chance’s predictive role will be more complicated than the account I have here provided. However, I hope that by developing an attractive (if surprising) general picture of scientific explanation in indeterministic worlds that can plausibly account for an aspect of chance’s predictive role (that has otherwise proved difficult to explain), I have helped to illuminate both chance’s predictive role and chance’s explanatory role—even though some details in this picture have yet to be filled in.
One fruitful question for further inquiry might be put like this: what are chances like such that they manage to provide explanations? I anticipate that this question will be difficult to satisfactorily answer. However, that it is hard to see how various aspects of reality come by their explanatory power is not problem unique to my view that chances are explainers. For example, there is a long and unresolved debate in the literature on laws of nature over what laws could be like such that they contribute to explanations. And there is a similar debate over what causes could be like such that they contribute to explanations. Though it is more familiar that laws and causes have explanatory power than that chances do, I do not think we have a much better understanding of what makes laws and causes explanatory than we do of what might make chances explanatory. Happily, we do not need to wait until we understand how metaphysical posits such as laws, causes, or chances have explanatory power to be confident that they do; though I have yet to account for how the chances manage to explain, I nevertheless take chance’s unique predictive role to be evidence that they do.

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