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RESEARCH ARTICLE

Equivalent Theories and Ontological Commitment

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Abstract

The literature on theoretical equivalence in philosophy of physics is replete with physical theories that look quite different but are purportedly equivalent. Plausibly, there might exist a pair of equivalent theories that look different insofar as they existentially quantify over different entities. However, given the preeminence of the quantificational theory of ontological commitment, which tells us to look to quantified entities to inform ontology, such a pair of theories seems to be a problem. In this paper, I argue that there is no good way out of the problem, and I reject the quantificational theory of ontological commitment.

1. Introduction

Philosophers of physics have recently identified pairs of theories that look quite different, but we have good reasons for thinking that they are equivalent in the sense of saying the same thing about the world (Halvorson, 2012; Barrett and Halvorson, 2016*a*; Weatherall, 2019). In cases where we have two equivalent formulations of a single theory, a scientific realist might ask what ontological commitments are incurred by accepting one formulation as true. The standard view of ontological commitment tells us to look to a theory's formulation to determine its ontological commitments. We are told that one is ontologically committed to all the entities that are existentially quantified over in the formulation of the theory one accepts to be true, and one's total ontological commitments are given by the existentially quantified entities in all the theories they accept to be true. In some cases of equivalent formulations, though, the two formulations existentially quantify over different things. However, determining the ontological commitments of a theory with multiple equivalent formulations in this way leads to contradiction.

More precisely: there are three plausible claims about equivalence and ontological commitment that are jointly inconsistent:

Same Ontology. Equivalent theories have the same ontological commitments.

Quantificational Theory. A theory's ontological commitments are all and only the entities it existentially quantifies over.

Different Quantification. It is possible for there to be equivalent theories that existentially quantify over different entities.

The first claim is a principle that is so intuitive that it does not get explicitly discussed. If ontological commitments are the demands a theory makes on what exists, then equivalent theories—which say the same thing about the world—must say the same thing about what exists. We should conclude that one of the features of a theory that is preserved between equivalent formulations is its ontological commitments.

The second claim is the quantificational theory of ontological commitment. It is ubiquitous in analytic metaphysics, and metaphysicians of science tend to adopt it wholesale. The intuition behind the view is something like this: When one accepts a theory that entails that Xs exist, that is just to say that they are ontologically committed to Xs in virtue of accepting the theory. There is nothing more to ontological commitment than what your theories say exists. (A more precise statement shortly.)

There are two reasons to accept the third claim. First, there are cases where we have good reason to think that there *are* two formulations of the same theory that appeal to different entities. Rosenstock et al. (2015) present one such case. I give an example in §3 of two ways of formulating electrostatics that quantify over different entities. The second reason to accept this claim is that there is no reason to think that the correct standard of equivalence among physical theories would rule out the possibility of equivalent formulations of a theory that existentially quantify over different entities. Accordingly, it seems exceedingly plausible that there *could* be such formulations of a theory.

These three claims are jointly inconsistent. If a theory's ontological commitments are determined by what it existentially quantifies over, and if two equivalent theories existentially quantify over different entities, then those theories must have different ontological commitments. But this is inconsistent with equivalence entailing equivalent ontology. And so on.

The existence of apparently quite different formulations of the same physical theory presents a problem for any metaphysician of science. My goal in the present paper is to show that the most plausible claim to reject is the quantificational theory of ontological commitment. There is no good way to maintain it in the face of equivalent theories that look quite different. I consider two other ways out of the inconsistent triad and argue that they are not acceptable for a proponent of the quantificational theory. Finally, in §6, I very briefly consider what implications my argument has for other theories of ontological commitment—in particular, neo-Carnapian theories.

In the course of this argument, I will make two assumptions. The first is a broad strokes methodological naturalism that entails some form of scientific realism. The question of what our ontological commitments are in cases of equivalent theories is only tractable if one thinks that we should base ontology on our best scientific theories. This assumption plays an important role in my argument (in §5). The second is that in the course of my argument, I am relying on a controversial standard for physical equivalence between theories. I take this to be inessential to the argument, and I will say more about this shortly (in §3).

2. Preliminaries

2.1. The Quantificational Theory of Ontological Commitment

The quantificational theory of ontological commitment claims that a theory's ontological commitments are determined by what is existentially quantified over in the theory. This theory has roots in Tarski (1936, 1944) and in Quine (1948, 1951a,b). Here I'll lay out the theory as it is used today, since its influence is extraordinarily widespread.

Conceptually, the ontological commitments of a theory are what must exist in order for the theory to be true (Rayo, 2007, 428). In the bulk of this paper, I will interpret 'what must exist' as applying to which kinds an agent is ontologically committed to (as opposed to which particular entities). We can understand 'kind' in whatever deflationary or nominalistic way one might want, or in a robust way.

A *theory* of ontological commitment tells us how to determine what kinds of things a given theory is committed to. Perhaps the most straightforward way is to say that a theory's ontological commitments are those kinds that the theory explicitly references or quantifies over. This is the guiding intuition behind the quantificational theory. Following Rayo (2007, 432), the quantificational theory of ontological commitment is as follows:

Quantification. An agent S is ontologically committed to kind Ks if and only if S accepts as true some theory T that existentially quantifies over Ps, where P is a predicate term that expresses membership to kind K.

The idea is that, when properly formulated, our theories entail consequences of the form $\exists x Px$, where P is a predicate term that expresses membership to some kind K. In virtue of accepting such a theory, according to the quantificational view, we are ontologically committed to Ks. The quantificational theory provides a straightforward route for "reading off" a theory's ontological commitments from its formulation by looking to which things are existentially quantified over.[1] According to the quantificational theory, moreover, one's ontology—the things one thinks exist—is determined entirely by one's ontological commitments.

There are three key features of the quantificational theory of commitment. First, the quantificational theory says that if we accept as true some theory that existentially quantifies over kind K, then we are ontologically committed to Ks. But the other direction is important to the theory as well. If we are ontologically committed to Ks, then it is in virtue of accepting as true some theory that existentially quantifies over Ks.[2] Truth and ontological commitment go hand in hand.

Second, a defining feature of the quantificational theory is that it permits someone to use the tools of paraphrase.[3] The idea is this. Suppose we accept some theory T that existentially quantifies over some kind that we do not wish to ontologically commit to.

[1] I leave "extrinsic" kinds, like how the kind *parent* entails the kind *child*, aside for this paper. Cf. Rayo (2007, §2.1).

[2] Cf. Rayo (2007, §2.1) and Bricker (2016, §1).

[3] The variety of paraphrase I am considering is often called *revisionary* paraphrase, as opposed to a reconciling paraphrase. Different philosophers use different names for these paraphrases. Metaphysicians use the compatibilist-incompatibilist phrasing (O'Leary-Hawthorne and Michael, 1996; Korman, 2009; Bagwell, 2021). Philosophers of math call these same strategies *hermeneutic* and *revolutionary* paraphrases (Burgess and Rosen, 1997; Leng, 2005). And some call them *reconciling* and *revisionary* (Keller, 2015, 2017).

Suppose T entailed "There is a hole in a piece of cheese " (Lewis and Lewis, 1970). According to the quantificational theory, accepting T ontologically commits to holes. But we might have metaphysical reasons to think that there are no holes. The quantificational theory permits us to *paraphrase away* the unwanted kinds. We can provide a translation that replaces every consequence of T that existentially quantifies over holes with one that does not existentially quantify over holes but otherwise does not change the content of the original consequence. In this way, paraphrases allow one to recapture all the same "facts" as the original.[4] We might replace "There is a hole in a piece of cheese" with "There is a perforation in a piece of cheese." And we can do the same with every consequence of T that existentially quantifies over holes. Our new theory T' no longer existentially quantifies over holes, but is otherwise unchanged from the original.

I take it that the standard version of the quantificational theory entails that paradigm paraphrases change a theory's ontological commitments. Lewis and Lewis (1970) is a paradigm paraphrase. The fan of perforation says,

> You[, hole evangelist], given a perforated piece of cheese and believing as you do that it is perforated because it contains immaterial entities called holes, employ an idiom of existential quantification to say falsely 'There are holes in it'. Agreeable fellow that I am, I wish to have a sentence that sounds like yours and that is true exactly when you falsely suppose your existential quantification over immaterial things to be true. (Lewis and Lewis, 1970, 206 - 207)

Other paradigm cases include paraphrasing away talk of composite objects in favor of talk of mereological simples arranged object-wise (van Inwagen, 1990; Merricks, 2001); talk of fictional characters for talk of according-to-the-fiction (Walton, 1990); and talk of numbers for talk of as-if-there-were-numbers (Yablo, 1998; Dorr, 2010). I am not claiming that these paraphrases are successful in the sense that they *do* recapture all the relevant facts from the original theories. The success of each of these projects has been disputed. Rather, I am claiming that according to the standard way of thinking about the quantificational theory, these paraphrases *would* succeed in changing one's ontological commitments if they are shown to successfully recapture all the relevant facts. As Quine says, "Paraphrases can enable us to talk very considerably and conveniently about putative objects without footing the ontological bill. It is a strictly legitimate way of making theories in which there is less than meets the eye" (Quine, 1969, 101).

The third important feature of the quantificational theory as I discuss it here is it does not make any distinction between *fundamental* entities or kinds and *non-fundamental* entities or kinds. This is a flat theory of ontological commitment. Drawing distinctions between the fundamental and non-fundamental provides a straightforward route out of the inconsistent triad. If one prefers the variety of the quantificational theory that says one is ontologically committed to the *fundamental* entities and kinds in their accepted theories, then they are not a quantificational theorist in my flattened sense, and so not a target of my present argument.

[4] It is difficult to precisely specify the sense in which a paraphrase captures the same content as the original. Some philosophers, e.g., van Inwagen (1990, 113), say that the two "describe the same fact".

2.2. Two geometries of spacetime

The third claim of my inconsistent triad is that it is possible for there to be equivalent theories that existentially quantify over different entities. We need to be a little careful when considering cases that are frequently discussed in the equivalence literature. Consider: Rosenstock et al. (2015) argue that there are formulations of the general theory of relativity where (i) one appeals to spacetime points and the other (apparently) does not and (ii) the theories are plausibly equivalent. They are categorically equivalent to one another, which is a standard of equivalence that is a live option in the literature. The danger with this example is that these theories are not formulated in a first-order language and thus do not strictly existentially quantify over anything. Instead, all we can say is that the mathematical representations of these theories invoke different kinds. We might be able to infer that if we took these two mathematical formalisms and regimented them into first-order theories, we would then have a pair of theories that are plausibly equivalent but existentially quantify over different kinds. (After all, supposing the quantificational theorist accepts the general theory of relativity, they will need to regiment it into a first-order language in order to determine its ontological consequences anyways.) It will behoove us to have a simpler pair of theories.

A quick word about standards of equivalence. The literature on theoretical equivalence, for much of the past ten years, has been concerned with determining the conditions under which two theories say the same thing about the physical world. Surely empirical equivalence is necessary—the two theories cannot make different predictions, even in principle. On top of that, though, there is much disagreement. Many claim that beyond empirical equivalence, the mathematical structures of the theories must bear some particular formal relationship to one another.[5] All parties agree that our guide to equivalence ought to be physics: when physicists claim that two theories are equivalent, we should take this seriously (though not uncritically) and examine the formal relationship that the mathematical structures of the theories bear to one another. By extrapolating from pairs of theories, philosophers of physics have proposed standards of equivalence that range from more conservative to more liberal. Conservative standards deem relatively fewer pairs of theories equivalent, liberal standards deem relatively more pairs equivalent. The standard trajectory from liberal to conservative goes from categorical equivalence (having their categories of models be equivalent in a precise sense[6]) to Morita equivalence[7] (defining all the sorts and predicates) to definitional equivalence (defining all the predicates) to model isomorphism (having the same internal structure within models) to logical equivalence (having the same consequences).[8]

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[5] For some pushback against the formal criteria, see, e.g., Wilhelm (2021).

[6] See Mac Lane (1998, 93).

[7] Placed at roughly the same liberality as Morita equivalence is bi-interpretability. It is an open question whether these two standards are functionally equivalent, whether they deliver the same verdict on physical theories. See Button and Walsh (2018, 113 - 114) and Halvorson (2025).

[8] In order, see first Rosenstock et al. (2015), second Barrett and Halvorson (2016*a*), third Glymour (1971, 1977, 1980), fourth North (2009); Curiel (2014) (though the terminology comes from Halvorson (2012, 187)), and there are no philosophers that explicitly endorse logical equivalence as the only condition under which theories can be equivalent, but some remarks by Sider (2009) and van Inwagen (2009) indicate affinity for something like a logical equivalence criterion. North (2021, Ch. 6) later rejects the model isomorphism criterion.

Here, I am not neutral in the debate over equivalence. One of my claims relies on equivalent theories that quantify over different things. Plausibly, if we adopt one of the conservative standards of equivalence (model isomorphism or logical equivalence), there are no such theories. Accordingly, I am assuming that the proper standard of equivalence lies on the liberal side of definitional equivalence. But whichever of those liberal standards one endorses, there are instances where two theories are deemed equivalent but apparently existentially quantify over different entities.

Let's provide our toy theories. These are taken from Barrett and Halvorson (2017) (and before them Hilbert (1930)), but here we interpret them as physical theories—not merely mathematical theories—at the brief suggestion by Barrett and Halvorson (2017, 1055). Let T_p be a theory of the geometry of spacetime that only existentially quantifies with the predicate 'is a spacetime point'. I'll sometimes drop the term 'spacetime', though keep in mind that we are considering physical theories of the geometry of spacetime, not pure mathematical theories. Interestingly, T_p can intuitively capture any result about the geometry of spacetime that appeals to lines. The idea is that when one is tempted to speak of a line, they can instead speak of two distinct points. To do this, T_p avails itself of a primitive three-place colinearity predicate. Three spacetime points are colinear when, intuitively, they lie on the same line—though, of course, T_p does not have the conceptual resources to talk of points lying on a line. Consider, for example, Playfair's axiom, which in common parlance says the following: Given a point p and a line x that p does not lie on, there is a line y that p lies on which is parallel to x, in the sense that no point lies on both lines x and y. On T_p, Playfair's axiom can be captured like this: *Given three spacetime points p, q, and r that are not colinear, there is a spacetime point s such that if some other spacetime point is colinear with p and s, then it is not colinear with q and r.* Though slightly more cumbersome, Playfair$_p$ contains the same relevant content as its ordinary counterpart. In this way, all theorems of affine plane geometry of spacetime can be formulated as T_p, which only existentially quantifies over spacetime points.

Let T_l be a theory of the geometry of spacetime whose only existential quantification is with the predicate 'is a spacetime line'. T_l can also capture any result about the geometry of spacetime that appeals to points. Any time one is tempted to speak of a point, they can instead speak of two intersecting lines. Again, to do this, T_l will appeal to a primitive three-place compunctuality predicate, which is intuitively when three lines intersect at the same point. We can state Playfair's axiom using the language of T_l: *Given three lines w, x, and z that are not compunctual, there is a line y that is compunctual with w and z and does not intersect x.* Using similar strategies as above, one can show that T_p can be formulated using only the resources of spacetime lines in T_l.

It is plausible that T_p and T_l are physically equivalent in the sense that they say all the same things about the physical world. This is because the two theories are interdefinable (in a precise sense): everything that can be said in one can be rendered, without loss, in the voice of the other. If we properly formulate T_p and T_l in a language, we would see that each can explicitly define the other's non-logical vocabulary and can be conservatively extended to introduce new sorts that are built from its own. Once these explicit definitions and sort-adding declarations are added on both sides, the resulting theories are definitionally equivalent (Barrett and Halvorson, 2017). More formally, T_p and T_l are Morita equivalent (Barrett and Halvorson, 2016*b*). Morita equivalence is a generalized version of definitional equivalence (often called "generalized definitional equivalence";

see Weatherall (2021, 429)). *Definitional equivalence* obtains when each theory provides explicit definitions of the other's non-logical symbols—like its predicates— and, after adding these, the theories are logically equivalent; intuitively, it is sameness up to choice of notation. Morita equivalence permits the logical reconstruction of sorts and then asks for definitional equivalence after those extensions. On that standard, T_p and T_l are Morita equivalent but not definitionally equivalent.

As some philosophers of physics have argued, it is plausible to think that if two physical theories are Morita equivalent (and empirically equivalent), then they are physically equivalent.[9] So, we have a pair of physically equivalent theories T_p and T_l that seem to existentially quantify over entirely different kinds; the former spacetime points, the latter spacetime lines.

2.3. The Inconsistent Triad

What I have done is provide a case where there are two candidate theories of the geometry of spacetime that are equivalent and existentially quantify over different entities. The inconsistent triad from above now has an instance:

Same Ontology. Equivalent theories have the same ontological commitments.

Quantificational Theory. A theory's ontological commitments are all and only the entities it existentially quantifies over.

Different Quantification$_T$. T_p and T_l are equivalent and existentially quantify over different entities.

Again, these three claims are jointly inconsistent. Since T_p (apparently) existentially quantifies over points but not lines, it is committed to points (but not lines). And T_l (apparently) quantifies over lines but not points, and so is not committed to points (but is committed to lines). But since T_p and T_l are equivalent, and equivalent theories have the same ontological commitments, T_p is ontologically committed to points but also is not ontologically committed to points. This is a contradiction. Something must go.

I think rejecting Same Ontology is a non-starter. This claim follows from reflecting on the nature of equivalence. Two theories are equivalent when they say the same thing about the world. For any contentful question regarding how the world is, the two theories will say the same thing. The question of ontology is one such contentful question. So equivalent theories necessarily will provide the same answer.

This leaves us with two options: reject the quantificational theory of ontological commitment or the claim that T_p and T_l are equivalent but existentially quantify over different entities.

Some philosophers of physics have shown a way for rejecting the latter. We might say that T_p and T_l do *not* quantify over different things (Barrett and Halvorson, 2017), or we might say that T_p and T_l are not equivalent in the way that determines ontology (North, 2021). I will show that each of these ways out of the inconsistent triad comes with high costs for a proponent of the quantificational theory. (To be clear, Barrett and Halvorson and North do not incur these costs, but a quantificational theorist who uses their strategies would.) It is important to remember that this is a conceptual puzzle for

[9] See Barrett and Halvorson (2016*b*).

the proponent of the quantificational theory. Because of this, simply rejecting Different Quantification$_T$ is not a complete response. A quantificational theorist must also give a story for how we determine the ontological commitments of theories like T_p and T_l—theories for which the quantificational theorist maintains are all but ontologically equivalent.

In the end, I think the most plausible claim to reject is the quantificational theory. My arguments are not likely to sway a quantificational theorist, but it is important to show the costs of accepting such a theory in the face of developments in philosophy of physics.

3. A wrinkle about liberal standards of equivalence

Before we can try to resolve the inconsistent triad, it seems there is a prior problem for the quantificational theorist in accepting the "very liberal" standards of equivalence like categorical equivalence or Morita equivalence (or bi-interpretability). Here's why: when two theories are, e.g., Morita equivalent, their domains of quantification can look radically different from one another. As one example, theories that are equivalent according to these very liberal standards can seemingly disagree about cardinality. In our present case, there is a model of T_p and T_l where T_p says there are five things and T_l says there are six things (Barrett and Halvorson, 2017, 1045). Thus, there are theories deemed equivalent on the liberal standards of equivalence where there is not a *stable domain of quantification*. Does the theory say, of this model, that there are five things or six things? It seems like these theories deeply disagree about ontology, and perhaps that means that Same Ontology is inconsistent with a very liberal standard; equivalent theories might not have the same ontological commitments. So, if a quantificational theorist adopts a liberal standard of equivalence, they must explain how theories can have the same ontological commitments where there is seemingly not a stable domain of quantification.

Let's look at three ways out. First, the liberal quantificational theorist might adjust the statement of the quantificational theory by saying that in such cases as T_p and T_l, the ontological commitments are those entities that are quantified over in the common "Morita extension" of the theories. That is, when we affirm that T_p and T_l are Morita equivalent, we mean that in the larger language that defines all the predicates and sorts of each theory, the two are logically equivalent. The current proposal is that we just look to the quantified entities in this more expansive formulation. In the Morita extension in which T_p and T_l are logically equivalent, both points and lines are quantified over, and thus the ontological commitments are both spacetime points and spacetime lines, and we have recovered a stable domain of quantification. The problem with this proposal is that it is trivial to create more conservative Morita extensions (Barrett and Halvorson, 2016*b*, 563 - 564). For instance, we can construct the sort *parallels* from pairs of non-intersecting lines, or the sort *triangles* from every triple of non-colinear points. Thus, we could prove that there is a common Morita extension of T_p and T_l that quantifies over points, lines, parallels, and triangles. And this process can iterate infinitely. Thus, since further Morita extensions are cheap to produce, the move to common extension does not stabilize the domain. We can easily construct new sorts.

The second proposal swings in the other direction, proposing that the ontological commitments of such theories are the entities that appear in the domains of all equivalent formulations of the theory. That is, the entities that are invariant among the different formulations. While this serves to stabilize the domain, it reduces the ontological commitments of theories to the point of absurdity. If we take this proposal, then T_p has *no* ontological commitments, since it is equivalent to a formulation T_l that shares no primitive unary predicates. T_p doesn't talk about lines, and T_l doesn't talk about points. There are no shared entities, and thus no ontological commitments, and I take this to be an intolerable consequence.

The third proposal is to deny that we have reason to believe there is an unstable domain of quantification in the case of T_p and T_l. In particular, the liberal quantificational theorist might say that, in the case of ontologically committing theories, there is no top sort of "things" such that two theories can disagree about how many things there are. Instead, the only questions one can ask are *kind*-specific (or sort-specific): how many *points*, how many *lines*. In this way, T_p might say of a particular model that there are five points, and T_l might say that of that same model that there are six lines. But this is not to say that there is some deep disagreement over ontology. Or, more precisely, we might deny that we have reason to believe that there is some deep disagreement over ontology. Just because the domains of equivalent theories have different cardinalities, we cannot conclude that there is no stable domain of quantification. Instead, it might be that we just have different ways of describing the same domain. We are reminded here of Frege's claim that asking "How many" for a deck of cards is incomplete; we must ask how many *suits* (4), how many *card faces* (13), how many *cards* (52), or how many *decks* (1) (Frege, 1884/1950, §22). And the difference between these numbers is not evidence for there being an unstable domain of quantification.

I think one who is sympathetic to the quantificational theory of ontological commitment and to a very liberal standard of equivalence is likely also drawn to this third strategy (and perhaps forced to it as well). Thus, the tension has been resolved for the quantificational theorist who also accepts a standard of equivalence more liberal than definitional equivalence.

You might think that this is all evidence that we should not adopt standards of equivalence where equivalent formulations can (even seemingly) deeply disagree about the domain of quantification. Instead, perhaps, we should think that there are no pairs of equivalent theories that are, e.g., Morita equivalent but not definitionally equivalent. So, maybe the line is at definitional equivalence, a liberal but not *very* liberal standard. This raises difficult questions about how to determine the correct standard of equivalence, and whether considerations like these should count—or whether it should only be scientific practice that adjudicates standards of equivalence.

If someone does not accept, then, that T_p and T_l are equivalent formulations, then they might think they can simply reject my argument. This is not so. There are not just Morita equivalent theories that quantify over different entities, but also *definitionally* equivalent theories that quantify over different entities. We can see this with relatively simple examples.

Consider two ways of describing an electrical network. One formulation, call it T_ϕ, assigns a potential value to each *node* and states the usual electrostatics laws in that language. A second formulation, call it T_E, assigns an electric field value to each *edge* (wire) and states the corresponding divergence and "zero curl" constraints. These presentations differ in what they treat as basic kinds (nodes vs. edges), and so they apparently quantify over different things. Even so, there is a straightforward translation in both directions: from node-potentials you immediately get edge-values (each wire's value is fixed by its two endpoints); and from edge-values you can reconstruct the node-potentials once you choose a reference node. These facts are standard in textbook treatments of electrodynamics (see, e.g., Griffiths (2017, §§2.2.4–2.3.3), Purcell and Morin (2013, §§2.1–2.2), and Jackson (1998, §1.5).) We can provide these translations as explicit definitions, and once added to the theories, they entail the same sentences. Thus, prior to a formalization and a proof, we have good reason to believe that T_ϕ and T_E are *definitionally equivalent*, even though they quantify over different entities.

What this means is that even if one wishes to reject Morita equivalence (or any more liberal standard of equivalence)[10] and thus reject that T_p and T_l are physically equivalent, they still must contend with theories that are definitionally equivalent and yet apparently quantify over different things.

To finish smoothing out this wrinkle: we have shown that a quantificational theorist can consistently adopt a very liberal standard of equivalence and also accept Same Ontology, so long as they reject kind-less ontological questions. The inconsistent triad remains. We've shown too that adopting a liberal (but not very liberal) standard of equivalence, like definitional equivalence, also begets the inconsistent triad. Thus, the proponent of the quantificational theory must find a way to reject Different Quantification$_T$.

4. Proposal: No Different Quantification

To reject Different Quantification$_T$, we can reject either of its conjuncts. There is a natural way to reject the claim that T_p and T_l existentially quantify over different entities. Consider Barrett and Halvorson:

> The two theories allow one to "quantify over" precisely the same things; they simply use different languages to do so... Indeed, if one is inclined to think that the ontological commitments of a theory can be "read off" from what the theory quantifies over, then [T_p] and [T_l] make precisely the same ontological commitments. (Barrett and Halvorson, 2017, 1059)[11]

Barrett and Halvorson are saying that because T_p and T_l are Morita equivalent, there's a sense in which there's *no real difference* between a theory that quantifies over spacetime points rather than spacetime lines. Spacetime points are "logical constructs" of spacetime lines, and *vice versa*—more precisely, points can be constructed by equivalence classes of pairs of nonparallel lines (Halvorson 2021: 275).

Precisely how does this strategy reject Different Quantification$_T$? The idea is that the predicates of T_p can be fully captured by quantifying over spacetime lines (or equivalence classes of spacetime lines). So, the fact that T_p employs the predicate 'is a spacetime point' is not sufficient to infer that T_p existentially quantifies over the kind *spacetime point*—for it may existentially quantify over spacetime lines. Just because a

[10] We need to be careful how we interpret these claims. Any pair of theories that is definitionally equivalent is also straightforwardly Morita equivalent. Definitional equivalence is a limiting case of Morita equivalence where the two theories have the same sorts. Similarly, logical equivalence entails definitional equivalence. So when I say 'if one wishes to reject Morita equivalence', I mean someone who wishes to say that there are no equivalent formulations of a theory that are Morita equivalent but not definitionally equivalent.

[11] See also Dewar (2019*a*,b, 2023).

theory employs a particular predicate, that's not enough to show that that theory existentially quantifies over that kind. Barrett and Halvorson's strategy entails quantificational *opacity*: the predicates of a language do not transparently point to kinds. Thus, we do not have sufficient reason to believe that T_p and T_l existentially quantify over different entities, and can safely reject Different Quantification$_T$.

The second desideratum on a response is to say what the ontological commitments of such theories are. For Barrett and Halvorson, the ontological commitments of T_p are clearly stated: either spacetime points or spacetime lines, and which kind is underdetermined by the content of the theory. There is not one unique way the world must be in order for T_p (and T_l) to be true.

I think, though, that an adherent of the quantificational theory shouldn't pursue Barrett and Halvorson's strategy. This is because it undercuts paraphrase. A major feature of the quantificational theory is that paradigm cases of paraphrase, if successful, change one's ontological commitments.

To show this, let's take a closer look at our two theories of cheese and their purported holes. We will properly formulate a toy version of these theories. Consider the signature $\Sigma = \{p, q, r\}$, where p is the predicate 'x is a piece of cheese', q is the predicate 'x is a hole', and r is the binary predicate 'x is in y'; and the signature $\Sigma' = \{p, s, r\}$, where p is the predicate 'x is a piece of cheese', s is the predicate 'x is a perforation', and r is the binary predicate 'x is in y'. Let T and T' be the Σ- and Σ'-theories defined by

$$T = \{\exists x \exists y (p(x) \wedge q(y) \wedge r(y, x))\} \qquad T' = \{\exists x \exists y (p(x) \wedge s(y) \wedge r(y, x))\}$$

T and T' are definitionally equivalent (and thus they are also Morita equivalent). It is very simple to construct a shared definitional extension for these theories by adding the following axioms to T and to T' respectively:

$$\delta s : \forall x (q(x) \leftrightarrow s(x))$$
$$\delta r : \forall x (s(x) \leftrightarrow q(x))$$

The definitional extension of T to T^+ that is generated by adding δs to T, and the definitional extension of T' to T'^+ that is generated by adding δr to T', are straightforwardly logically equivalent theories. This entails that T and T' are definitionally equivalent theories.

Now surely the claims we accept about cheese and holes are much more complicated than T suggests, which only tells us that there is a piece of cheese and it has a hole in it. However, the promise of a paraphrase is that we can provide *general* rules for replacing consequences that entail that there are holes. So long as there is a one-to-one correspondence between holes and perforations, each instance of paraphrase will match what is happening with T and T'. Indeed, paraphrases are often given by presenting a "replacement definition" of the bad entity in terms of good entities. As van Inwagen says about his paraphrases of *object* talk into *things arranged object-wise* talk,

> The main logical feature that unites [my] paraphrases and separates them from the original is that, where the original ... contains ordinary predicates like 'x is a table', the paraphrases contain variably polyadic predicates like 'the xs are arranged tablewise'. (van Inwagen, 1990, 111)

Here van Inwagen notes that *the feature* that differentiates his paraphrase from the original theory is the replacement of one predicate with another. Accordingly, many paradigm examples of paraphrase in fact look like T and T', silly as those theories seem.

If one adheres to Barrett and Halvorson's strategy, then there is no difference between theories formulated using the predicate 'is a table' and the predicate 'are simples arranged table-wise'. This means that there is no *ontological* difference between these theories. Accordingly, it is not the case that T' has different ontological commitments than T. One does not remove commitment to holes by accepting T' rather than T.

I think this is too much for most proponents of the quantificational theorist to give up. Paraphrase is a ubiquitous strategy in analytic metaphysics, and this way out of the inconsistent triad wholly nullifies it. There are many cases where one provides a paraphrase by replacing one theory with another that is straightforwardly definitionally equivalent. And according to this strategy, paraphrase does not change one's ontological commitments.

Here's another way to see the problem. Providing an easily-recoverable eliminating definition of some kind of entity is usually seen as a good-making feature of a paraphrase. When one provides a general paraphrase strategy, they propose to replace all instances of quantification over *B*s—the bad entities—in favor of quantification over *G*s—the good entities. To do this, they provide a translation rule of *B*s in terms of *G*s and the properties of *G*s. Often, these translations are easily seen as going both ways—we can not only translate *B*s into *G*s, but we can translate *G*s back into *B*s. For instance, when van Inwagen (1990) tells us to replace all instances of 'table' with 'simples arranged table-wise', we can easily recover the original theory by replacing all instances of 'simples arranged table-wise' with 'table'. It is plausible, then, that these paradigm instances of paraphrase are cases where one has replaced one theory with a definitionally equivalent one. If so, then the proponent of the present strategy is forced to say that paraphrase does not change one's ontological commitments. If one is to be follow Barrett and Halvorson's strategy, where definitionally equivalent theories do not quantify over different entities, then successful paraphrases do not change ontological commitment. (I suspect that this result is welcomed by Barrett and Halvorson.) And this is a high cost for the quantificational theorist.

To be clear, this is not to say that all paradigm instances of paraphrase are ones where one is offering a definitionally equivalent alternative. In particular, if one provides a definition of the *B*s in terms of the *G*s such that the original theory is not recoverable (up to logical equivalence) from the one formulated in terms of the *G*s, then we do not have definitionally equivalent theories.

5. Proposal: No Equivalence

Another way out of the inconsistent triad is to agree that T_p and T_l are intimately related but not fully equivalent. Then we might have reason to *prefer* one over the other, and inform our ontology with the preferred one. I think this *preference strategy*, when conjoined with the quantificational theory of ontological commitment, is in tension with methodological naturalism.

The preference strategy walks a thin line. On the one hand, it must—in line with a broad-strokes naturalism—respect that two theories might be equivalent in some important sense. But on the other, it must identify a metaphysical difference between them. North (2021) advocates for the preference strategy (though she rejects the quantificational theory as written[12]). She says that the two theories can be "informationally equivalent" while still being "metaphysically *in*equivalent". Theories are informationally equivalent when they are deemed equivalent by the "proper" formal standard of equivalence, whatever that turns out to be. Informationally equivalent theories can recover the same scientific facts as each other, but they might still have metaphysically significant differences.

A strategy for identifying metaphysical differences between informationally equivalent theories has to do with the way content is presented. One formulation of a theory might be more *perspicuous* than another, in the sense that it "more directly gets at the true nature of physical reality" (North, 2021, 7). The most sustained defense of perspicuity in adjudicating between informationally equivalent theories comes from North (2021, Ch. 2, Ch. 6).[13] Other ways of identifying metaphysical differences between such theories are intrinsicality (Field, 1980/2016, 29) and fundamentality (Sider, 2020, Ch. 5).

The Preference strategy rejects Different Quantification$_T$ by claiming that informational equivalence (the story I told in §2.2) is not enough for full equivalence. In addition, the theories must be metaphysically equivalent. So, while T_p and T_l are informationally equivalent, they are not metaphysically equivalent. They "present different pictures of the physical world" (North, 2021, 213).

As we noted above, it is not enough that one rejects a claim of the triad. A solution must also say what our ontological commitments are in accepting theories that look quite different but we have good reason for thinking are in some sense equivalent. The Preferer must first find a way to non-arbitrarily prefer one of two informationally equivalent formulations using some metaphysical principle. This is not a simple task, but let's assume it gets accomplished. Then, the Preferer has a simple way to determine one's ontological commitments: commit to the entities that are existentially quantified over in the preferred formulation. If there is reason for thinking that T_p is preferable in some respect, then we may say that the ontological commitments of accepting a spacetime geometry are just spacetime points.

My objection to the Preference strategy is that it is inconsistent with a reasonable principle of methodological naturalism (or 'naturalism'). Naturalism is famously difficult to define, but it means roughly that we should do philosophy in the way of science.[14] Recall that the Preferer already accepts some form of naturalism; the determination that two physical theories are even informationally equivalent comes from embracing physics, not philosophy, as informing what a theory's content is. As I will argue, it is up to the Preferer to tell us how they are consistent with naturalism.

[12] She explicitly argues that a theory can be ontologically committed to something even if it does not quantify over it. (North, 2021, 57 - 58).

[13] Cf. Wallace and Timpson (2010, 702). For discussion, see Le Bihan and Read (2018); Dewar (2019*a*); Martens and Read (2020); Jacobs (2022); Hunt et al. (2023).

[14] See Emery (2023, 10).

The basic idea behind this principle is that we should trust when scientists are evaluating the strength of their evidence in the context of theory choice. As a practice, science will not regularly infer the truth of some theory for which we do not have sufficient evidence. Here I am not only talking about empirical evidence, but also the non-empirical virtues that scientists appeal to like simplicity, elegance, etc. Accordingly, I propose we adopt the following naturalist principle about theory choice:

Deference. We ought to defer to the practices of science regarding the extent to which evidence can adjudicate between physical theories.

Deference is relatively innocuous. It does not tell us to defer to scientists in determining metaphysics nor to only inform our metaphysics using scientific theories (cf. Ladyman et al. (2007)). Instead, it says that science is quite good at determining whether, and to what extent, its evidence supports some theory. If science cannot distinguish between two physical theories, philosophers should not see a difference between those two theories either. Deference does not entail deferring to the pronouncements of actual scientists. Rather, we take it to mean that we should take as authoritative the practices of scientists in adjudicating between theories. For instance, though Heisenberg and Schrödinger asserted their matrix and wave quantum mechanics were inequivalent, in fact they are mathematically equivalent; Deference tells us to look to mathematical practice, not scientific pronouncement, for whether they are distinct.

One corollary of Deference is this:

No adjudication. If two theories are physically equivalent according to some standard that arises out of the practices of science, then scientific evidence cannot adjudicate between those theories.

The idea here is that because science is good at adjudicating its evidence, and because it has not adjudicated between theories that bear some standard of physical equivalence, if some pair of theories is equivalent according to that standard, then our scientific evidence cannot adjudicate between those theories. Once again, 'scientific evidence' does not mean merely empirical evidence, but the sum total of scientific evidence. We can formulate No adjudication as a maxim: Do not see a physical difference between theories where science would not see a difference between those theories.

I argue that the Preference strategy is inconsistent with Deference. Let us first remind ourselves that according to the quantificational theory, ontological commitment covaries with accepting some theory as true. That is, one is ontologically committed to some kind if *and only if* that agent accepts as true some theory that existentially quantifies over that kind. And this is meant to be a conceptual truth. As Rayo says, "for a sentence to carry [ontological] commitment to Fs is for the sentence's *truth* to demand of the world that it contain Fs" (Rayo, 2007, 428).[15] What ontological commitment *is* is a matter of the entities that must exist in order for a theory to be true. Accordingly, it is incoherent to be ontologically committed to some kind without accepting as true some theory that requires of the world that there are entities of that kind.

The Preferer is committed to three things. First, that T_p and T_l are informationally equivalent. They accept, on the basis of their naturalistic commitments, that physicists

[15] See also Bricker (2016).

would (or should) not distinguish between them based on what each can say about the world. Second, that are ontologically committed to only—say—spacetime points in virtue of finding some way to prefer T_p over T_l. And, third, they are not ontologically committed to spacetime lines (since the two theories are not fully equivalent). But the connection between ontological commitment and truth entails that this Preferer accepts T_p as true but does not accept T_l as true. At this point, the Preferer runs afoul of the principle of deference.

The principle of deference tells us that when we are faced with deciding between two physical theories, we should trust scientists when they say they do not have enough evidence to adjudicate between those two theories. In particular, when we are faced with a case where scientists will (or do) take two theories as being physically equivalent, we should not think that *we* are in a better position to determine which is true than the scientists are. And this is the condition that the Preferer violates. They accept as true one of the two equivalent formulations of some theory in virtue of ontologically committing to the kinds of that formulation. In doing this, they supersede the authority of scientists' ability to adjudicate between theories.

A common refrain at this point is to say "So much the worse for science! This is exactly why we need to appeal to distinctively metaphysical considerations, since science by itself *cannot* distinguish between physically equivalent theories." Fair enough. I am fully convinced of the need of a *metaphysics* of science, and not merely an accounting of what science says there is. Our best scientific theories are not metaphysically neutral, but nor is it entirely transparent what they commit us to. In the context of the principle of Deference, the point is not to delineate science from non-science, but rather to hold ourselves to the standards we agree to: our guide to metaphysics of science ought to be science. Deference seems faithful to scientific practice, and the Preferer needs to show precisely how they are not running afoul of methodological naturalism.

6. Expanding the scope

So far, this argument has been targeted at the quantificational theorist who thinks that the kinds that we are committed to are transparently appealed to within formulations of a theory. But there are other, more deflationary views of ontological commitment that are also in the scope of my argument. Suppose someone was not excited by any talk of kinds, even of a deflationary variety where kinds are sets of possible and impossible worlds (Nolan, 2013). For example, suppose they were a neo-Carnapian (like Hirsch (2010) or Thomasson (2007)) who thinks that ontological questions follow more-or-less trivially once we have picked a linguistic framework. Ontological commitments, then, are not mysterious answers to substantive questions.

If one accepts a neo-Carnapian metaontology *and* a liberal standard of equivalence, we are forced back to a version of the argument. What a theory's ontological commitments are is a consequence of what linguistic framework we decide upon—which linguistic tools we "appeal" to. But T_p and T_l tell us that theories within different linguistic frameworks can be equivalent and appeal to different things, and thus have apparently different ontological commitments. Additionally, neo-Carnapians think that changing the linguistic framework within which we describe something doesn't make some genuine change in ontological commitments. If two formulations are genuinely equivalent as theories, then differences that arise from redescription do not lead to differences in ontology. This means there are analogues of the three claims of the inconsistent triad for deflationary theories of ontological commitment, and we are forced to reject one.

Examining all the ways that one might push back against the revised version of the triad would take us far afield. I think the best path forward is to attempt to reject the deflationary analogue to Different Quantification$_T$. One might claim that these theories are not both (i) equivalent and (ii) appeal to different entities (in the neo-Carnapian sense of appeal). And there are some difficulties here that might force one to uncomfortable consequences even if they find a way out of the triad.[16]

The broader point is this: once we accept that we can have equivalent formulations of a theory that look quite different, any theory of ontological commitment that tells us to look just to the formulation of a theory will have to contend with this conceptual puzzle.

7. Conclusion

There is not a good way to be a quantificational theorist in light of the possibility of equivalent theories that existentially quantify over different entities. Accordingly, I think we ought to reject the quantificational theory of ontological commitment.

One might want to salvage something like the quantificational theory. In particular, one might abandon paraphrase as a practice that can change one's ontological commitments. This would entail that many of the debates among metaphysicians over the past century have been merely conventional—over which language to express a theory in. This revising of historical debates has precedent in philosophy (like Ladyman et al. (2007), Hirsch (2010), and the logical positivists). But I think it is a route that the fan of the quantificational theory should avoid.

I think the solution is to abandon the quantificational theory whole cloth. It seems to me that the underlying problem with the quantificational theory is threefold. First, that ontology can be "read off" the formulation of a theory. If there is a lesson to be learned, it is that determining what must exist in order for a theory to be true is a complicated question, not answered simply by looking. Second, that a theory's ontology is equivalent to its ontological commitments—in the sense that ontological commitments are what *must* exist in order for a theory to be true. It seems that, in line with the Preferer, we ought to distinguish between the ontological picture that is presented by some formulation of a theory and the ontological requirements it makes of the world. Once we abandon this part of the quantificational theory, we might think that T_p presents an ontological picture of spacetime points, and that T_l presents an ontological picture of spacetime lines, but think that the ontology *required* for the theories are the same. Third, and relatedly, we

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[16] Briefly, it is likely that a neo-Carnapian would accept my arguments in §5, that it runs afoul of naturalism to reject that T_p and T_l are equivalent. This is because those of a deflationary disposition usually arrive at such a position from a deference to naturalism. But what about my argument in §4? Suppose a neo-Carnapian accepts Morita equivalence as the proper standard of equivalence for physical theories. If so, they are committed to equivalent theories having different cardinalities, which is prima facie evidence that those theories genuinely have different ontological commitments. Like in §3, then, the neo-Carnapian is forced to say that only sorted existence questions are intelligible, and thus say we do not have evidence that these theories differ in ontological commitments. If this is their strategy, then it is harder to see how one can reject the claim that these theories appeal to different entities, since *all there is* to ontological questions is the sort we're asking about, and what existence claims follow from the linguistic framework and basic truths. And it seems like we have different answers in the case of T_p and T_l. So it seems that the analogue to Different Quantification$_T$ has not been adequately rejected.

might sever the tie between truth and ontology. We might think that two formulations of a theory, say T_p and T_l, might both be true but have different ontologies. In such a case, one's ontology might be informed by which formulation of a theory they prefer without having to run afoul of the principle of deference. These are difficult and deep questions about our theories of ontological commitment. And it may be that some extant alternatives to the quantificational theory already answer them (e.g., Cameron (2008, 2010)). But, as I hope to have shown, we should not think that a theory's ontological commitments are all and only the entities it existentially quantifies over.

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