Structural Indeterminacy

STRUCTURAL INDETERMINACY

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Abstract

The threat of ontological deflationism (the view that disagreement about what there is can be non-substantive) is averted by appealing to realism about fundamental structure—or so tells us Ted Sider. In this paper, the notion of structural indeterminacy is introduced as a particular case of metaphysical indeterminacy; then it is argued that structural indeterminacy is not only compatible with a metaphysics of fundamental structure, but it can even safeguard it from a crucial objection; finally, it is shown that, if there are instances of structural indeterminacy, a hitherto unacknowledged variety of ontological deflationism will arise. Unless structure is shown to be determinate, ontological deflationism remains a live option. Furthermore, I will consider whether structural indeterminacy could be challenged by adopting a naturalistic epistemology of structure; the question is answered in the negative on the basis of a formal result concerning theory choice. Finally, I submit a new way of articulating the epistemology of structure, which hinges on the very possibility of structural indeterminacy.

The conviction that ontology is a worthy enterprise is threatened by a number of contemporary deflationary views according to which disagreement about what there is can be, and in many cases is non-substantive. Such a deflationary attitude has found in Eli Hirsch's quantifier variance a sophisticated and influential embodiment. A most acute critic of quantifier variance is Ted Sider, who in *Writing the Book of the World* has argued that

a suitable metaphysics of fundamental structure is capable of defusing the threat of ontological deflationism. The aim of this paper is twofold. Firstly, the notion of structural indeterminacy is introduced and articulated; then it is shown that, if structure is indeed indeterminate, a deflationary view will arise, which is not ruled out by Sider's metaphysics of structure. Secondly, I will offer two reasons for believing that structure is indeterminate—one flowing from the very nature of realism about fundamental structure; another one motivated by the epistemology of structure. The moral to be drawn is that more needs to be done in order to vindicate the worthiness of ontology.

The paper's roadmap is as follows. Section 1 lays the groundwork by introducing the contemporary metaontological debate, with its two opposing camps: ontological deflationism vs. realism—exemplified by Hirsch's quantifier variance and Sider's realism about joint-carving, respectively. Sider's main argument for ontological realism is then sketched. Section 2 is where most of the action takes place. Firstly, the notion of structural indeterminacy is defined, as a particular case of metaphysical indeterminacy; then it is argued that structural indeterminacy is not only compatible with a metaphysics of structure, but it can even safeguard it from a crucial objection; finally, it is shown that, if there are instances of structural indeterminacy, a hitherto unacknowledged variety of ontological deflationism will arise, which is not ruled out by Sider's realism. Section 3 addresses the question whether structural indeterminacy can be ruled out by a naturalistic epistemology of structure. The question is answered in the negative on the basis of a formal result concerning theory choice. Finally, I argue that structural indeterminacy makes room for a novel way of articulating the epistemology of structure, which is superior to the extant ones.

1 Metaontology

Whereas ontology aims to answer existence questions (Are there numbers? Mereological sums? Possible worlds?), metaontology addresses the seman-

tic, logical, epistemological and methodological presuppositions of ontological practice. Metaontology has come to the fore of the contemporary debate mainly due to a cluster of broadly neo-Carnapian positions that deny the substantivity of many ontological questions, and that fall under the umbrella term of *ontological deflationism* (hereafter *deflationism*). The most influential variety of deflationism is arguably the one associated with the doctrine of *quantifier variance*, which countenances a plurality of existence meanings, or language-relative unrestricted quantifiers (Hirsch [14] [15]). By way of example, let's consider the debate on the ontology of time. According to presentism, only present things exist (Bigelow [4], Markosian [23], Keller [17]).[1] On that view, I exist, my iPhone exists, but neither dinosaurs nor the 73th President of the United States exist. According to eternalism, on the other hand, what there is includes past, present and future things alike (Rietdijk [30], Putnam [29], Sider [32]).

The diagnosis of the quantifier variantist is that the debate is non-substantive, and the *prima facie* disagreement rests on the two parties employing different existence meanings: in the presentist's language, 'being' is equivalent with 'being present', whereas in the eternalist's language it is equivalent with 'being past, present or future'. Accordingly, when eternalists assert 'there are Fs', presentists can charitably paraphrase that statement into their own language as 'it was, is, or will be the case that there are Fs'; and when presentists assert 'there are Fs', eternalists can charitably paraphrase that statement into their own language as 'there are present Fs' (cf. Dorato [10], Lombard [21], Miller [26]). By means of that two-way paraphrase, eternalists and presentists can agree on all coarse-grained facts. The substantivity of the first-order ontological question is therefore threatened by the outcome of metaontological considerations.

Generally speaking, suppose that speaker A asserts 'there are Fs', whereas

[1] It has been argued that 'only present things exist' cannot be an adequate characterization of presentism, insofar as it is is either trivially true or trivially false, depending on the reading of 'exist'; see Crisp [7] [8], Ludlow [22]. I will set this issue aside.

speaker B asserts 'there are no Fs'; and let $\mathcal{L}_A$ and $\mathcal{L}_B$ be regimentations of the languages spoken by A and B, respectively. According to the doctrine of quantifier variance, A and B are having a *non-substantive ontological disagreement* just in case:

D1. $\mathcal{L}_A$ and $\mathcal{L}_B$ are equally expressive;[2]

D2. 'F' is a common predicate of $\mathcal{L}_A$ and $\mathcal{L}_B$;[3]

D3. there are quantifiers '$\exists_A$' of $\mathcal{L}_A$ and '$\exists_B$' of $\mathcal{L}_B$ such that (i) '$\exists_A$' ('$\exists_B$') is $\mathcal{L}_A$-unrestricted ($\mathcal{L}_B$-unrestricted);[4] and (ii) '$\exists_A xFx$' is true, whereas '$\exists_B xFx$' is false.

In *Writing the Book of the World*, Sider has argued that the above three conditions are necessary, although not jointly sufficient to characterize the non-substantivity of ontological disagreement. Sider's defense of *ontological realism* (the denial of deflationism) hinges on realism about joint-carving, the thesis that the world is endowed with a fundamental structure. The official primitive of Sider's theory is the notion of a *structural*, or *joint-carving* term (or concept, or meaning)—informally, one that adequately captures some aspect of the world's fundamental structure. Since terms of any syntactic category are apt to be structural, realism about joint-carving is a generalization of Lewisian naturalness (Lewis [19], Sider [34, p. vii]). According to Sider, we can then define a binary comparative structure relation ('is more structural than'), which orders the terms from the (perfectly)

[2]Hirsch [14, p. 235], Sider [34, pp. 177–80]; cf. Liebesman [20, p. 303].

[3]Therefore, A and B agree on the interpretation of 'F' in the sense that they assign the same truth-value to 'that is F' in their respective languages, provided that the two utterances of 'that' are coreferential.

[4]Hirsch [15, p. 64]. Although Hirsch does not provide a precise formulation of language-relative (un)restrictedness, the notion can be characterized as follows. An existential quantifier '$\exists$' of $\mathcal{L}$ is *$\mathcal{L}$-unrestricted* just in case, for every individual term 't' and formula ϕ of $\mathcal{L}$, $\phi(t)$ entails $\exists x\phi(t/x)$. It follows that any existential quantifier of a language $\mathcal{L}$ validating the classical rule of existential generalization is $\mathcal{L}$-unrestricted.

structural down to the less and less structural.[5]

A language whose primitives are all structural is said to be *fundamental* (Sider [34, p. 8]), otherwise it is non-fundamental. A truth is said to be *fundamental* if it is expressed in a fundamental language, otherwise it is non-fundamental. A truth-condition expressed in a fundamental language is said to be a *metaphysical semantics*. The following Completeness Postulate is assumed by Sider [34, ch. 7.1]:

(Comp) Every non-fundamental truth has a metaphysical semantics.

This postulate captures the thesis that every truth either is fundamental, or holds in virtue of some fundamental truth. For a realist about joint-carving who is, say, a mereological nihilist, the metaphysical semantics of 'there is a table' is 'there are simples arranged table-wise*', where 'arranged table-wise*' is the definition of the plural predicate 'arranged table-wise' in structural terms; for an eternalist, the metaphysical semantics of 'there were dinosaurs' is 'there are past dinosaurs*', where 'dinosaur*' is the definition of the predicate 'dinosaur' in structural terms; and so on and so forth.

We can finally see how the hypothesis of realism about joint-carving bears on the metaontological debate. Insofar as ontology is concerned with what there is in the metaphysically fundamental sense of 'there is', the characterization of a non-substantive ontological dispute must factor in some structural condition involving quantification. Sider takes the relevant condition to be as follows:

D4. '$\exists_A$' and '$\exists_B$' are equally structural, and there is no language $\mathcal{L}$ and no $\mathcal{L}$-unrestricted quantifier '$\exists$' such that '$\exists$' is more structural than either '$\exists_A$' or '$\exists_B$'.[6]

[5] How to define comparative structure is far from obvious. One strategy, Lewisean in spirit, has it that 's' is more structural than 't' if the shortest fundamental definition of 's' is shorter than the shortest fundamental definition of 't' (cf. Sider [34, p. 130]). That strategy is criticized in Williams [42]. Which method, if any, is able to provide a definition of comparative structure within Sider's theory is something I am leaving for another day.

[6] Sider [34, p. 46].

Ontological disagreement between speakers A and B is non-substantive, according to Sider, just in case it meets conditions D1-4.

Now that all the pieces are in place, the Completeness Argument for ontological realism of Sider [34, ch. 9.6.2] can be sketched. Suppose, by way of *reductio*, that two parties have a non-substantive ontological disagreement. As a consequence, there are two equally structural existential quantifiers (by D4), none of which is perfectly structural.[7] Since no fundamental language features quantifiers, there must be quantifier-free metaphysical semantics for our best theories (by **Comp**). But the fact that "no serious work on the foundations of physics and mathematics has been done in a quantifier-free setting" (Sider [34, p. 183]) strongly suggests that we cannot provide a metaphysical semantics for our best theories without the help of quantifiers.[8] Consequently, the two parties are not having a non-substantive ontological disagreement, which concludes the *reductio*.

2 Structure and indeterminacy

In the present section I will argue that realism about joint-carving is unable per se to rule out ontological deflationism. My argument hinges on two

[7] In fact, there is a further option, namely that both existential quantifiers are perfectly structural. This option is entertained in Hirsch [16], under the label of *egalitarian quantifier variance*. Sider [35, p. 750] dismisses that option, on the grounds that it would lead to redundancy in the world's fundamental structure. Whether egalitarian quantifier variance can be successfully pursued lies beyond the scope of this paper. It is worth noting that egalitarian quantifier variance should be distinguished from *ontological pluralism*. According to the former, there are multiple structural existential quantifiers, each belonging to a different language, and each unrestricted in its own language. According to the latter, there are multiple structural existential quantifiers, which can all coexist in one and the same language, namely in a fundamental language; as such, at most one of them will be unrestricted in a given language.

[8] Nevertheless, see Donaldson [9] for an argument against the indispensability of quantification, and Torza [38] for a rejoinder to Donaldson and a defense of first-order ideology. Settling this debate is beyond the scope of the present paper.

points. The first point is a methodological observation about the strategy carried out by Sider. The rationale for introducing D4 is that ontological substantivity should be constrained by structure. Indeed, D4 employs the comparative structure relation, which is defined via the primitive structure predicate and induces a total ordering on the class of existential quantifiers. As we will see, however, the comparative structure relation has a close relative, which is also defined via the primitive structure predicate and induces a total ordering on the class of existential quantifiers. If non-substantivity is defined by appealing to this alternative relation instead, the completeness argument for ontological realism will break down under some specific conditions. Those conditions occur if in the world there are instances of structural indeterminacy (a particular case of metaphysical indeterminacy). My second point is that Sider's metaphysics doesn't conclusively rule out structural indeterminacy—in fact, realism about joint-carving even provides reasons to accept that structure is in fact indeterminate.

To sum up, the gist of this section is twofold: (i) if there are instances of structural indeterminacy, and if ontological substantivity is defined not via comparative structure but rather via the alternative relation in its close vicinity, deflationism is the correct metaontological position; moreover, (ii) there are reasons for regarding structure as indeterminate. Therefore, when arguing for ontological substantivity, the realist about joint-carving will have to either rule out structural indeterminacy, or else show that comparative structure is indeed the correct structure-involving notion to appear in the definition of ontological substantivity.

I will proceed as follows. In section 2.1 I introduce structural indeterminacy as a particular case of metaphysical indeterminacy, and argue that Sider's theory doesn't rule out that structure could be indeterminate. On the assumption that structure could be indeterminate, in section 2.2 I first articulate a non-Siderean metaontology based on Sider's notion of structure, and then show that this alternative metaontological picture leads to defla-

tionism. In section 2.3 I will argue that structural indeterminacy offers a way out of a crucial objection to realism about joint-carving. Section 2.4 considers, and ultimately rejects, alternative replies to that objection.

2.1 Metaphysical and structural indeterminacy

Up to now we have been implicitly assuming that statements of the form '$\mathcal{S}(t)$' ('t' is structural) are either true or false. Things become interesting when that constraint is relaxed and indeterminacy at the level of fundamental structure is countenanced.

First of all, we need to be specific about the kind of indeterminacy involved. A statement of the form '$\mathcal{S}(t)$' may be indeterminate in virtue of either '$\mathcal{S}$' or 't'. If the source of indeterminacy is 't', the case is irrelevant. For example, if 't' is a semantically indeterminate quantifier with two precisifications—a perfectly joint-carving quantifier and a disjunctive quantifier—then it will be indeterminate whether $\mathcal{S}(t)$, albeit in a rather unexciting way.[9] For we are now exploring the possibility of indeterminacy about structure, whereas the aforementioned scenario is perfectly compatible with structure being determinate. If the source of indeterminacy is '$\mathcal{S}$', the indeterminacy could be either semantic (originating in language) or metaphysical (originating in the non-representational world). In the former case, there would have to be multiple candidate meanings for '$\mathcal{S}$'. This scenario, however, is ruled out by Sider. On his view, there is a unique structural structure meaning (Sider [34, ch. 7.13]) which is a reference magnet (Sider [34, ch. 3.2]); therefore, the structure predicate cannot be semantically indeterminate.[10]

We are left with a scenario wherein it is metaphysically indeterminate whether $\mathcal{S}(t)$, for some 't', and the source of indeterminacy is not 't'. In other

[9] I am assuming some precisificational theory of semantic indeterminacy, such as the supervaluationism of Fine [11].

[10] Incidentally, this argument is isomorphic to the second argument against vague existence of Sider [33].

words, *structural indeterminacy* occurs just when the following conditions are met, for some term 't':

M1. It is metaphysically indeterminate whether $\mathcal{S}(t)$.

M2. Let $\mathcal{L}$ be such that it is not metaphysically indeterminate whether ϕ, for any sentence 'ϕ' of $\mathcal{L}$. If $\mathcal{L}^+ = \mathcal{L} \cup \{t\}$, then it is not metaphysically indeterminate whether ϕ, for any sentence 'ϕ' of $\mathcal{L}^+$.

Whereas the nature of semantic indeterminacy is relatively well understood, the very possibility of metaphysical indeterminacy used to be cast into doubt until recently. The characterization of metaphysical indeterminacy which has drawn most attention is arguably the one put forward in a number of papers by Elizabeth Barnes and Robert Williams.[11] Their theory is based on the idea that it is metaphysically indeterminate whether p just in case the world can be made completely precise in multiple ways, one according to which p and one according to which $\neg p$.[12] The Barnes-Williams view, however, is unable to account for indeterminacy at the microphysical level, since quantum mechanics tells us that there are pairs of properties (such as position and momentum) which cannot have precise values for the same particle at the same time and, therefore, that the world cannot be made completely precise.[13] The issue is addressed in Torza [39], where I put forward an alternative, non-precisificational view according to which it is metaphysically indeterminate whether p just in case 'p' is neither true nor false, and no terms in 'p' are semantically defective (i.e., either vacuous or semantically indeterminate).[14] This proposal has the virtue of being able to account for quantum metaphysical indeterminacy. Because of its

[11] Williams [40] [41], Barnes [2], Barnes and Williams [3].

[12] That a world can be made precise in a way according to which p is to be understood as the existence of an ersatz world that does not determinately misrepresent reality according to which p.

[13] Skow [36].

[14] Thus, metaphysical indeterminacy is tantamount to the existence of an incomplete ersatz world that adequately represents reality.

greater generality and empirical adequacy, I am adopting the characterization of metaphysical indeterminacy from Torza [39]. Accordingly, structural indeterminacy occurs just when, for some term 't', (**M1**) '$\mathcal{S}(t)$' is neither true nor false, and neither '$\mathcal{S}$' nor 't' is semantically defective; and (**M2**) the result of adding 't' to a semantically nondefective language in which every sentence has a determinate truth value is a semantically nondefective language in which every sentence has a determinate truth value. In what follows I will be concerned with structural indeterminacy in this sense.

Before delving into the main topic of the present section—how the possibility of structural indeterminacy affects the metaontological debate—one important issue needs to be addressed. Sider [34, p. 137] postulates that "the fundamental is determinate", which is captured by the conjunction of the following conditions:

F1. No (in)determinacy operator is structural.

F2. The logic of a fundamental language is classical.

According to **F1**, no such expressions as 'it is (in)determinate that', 'it is supertrue that' etc. are structural. Condition **F2** is going to need some fleshing out: Does it only require the validity of all classical truths? Or does it also require the validity of every classical inference schema? Does it require that the logic be bivalent? Or compositional? **F2** admits of different interpretations, some stronger than others.[15]

The question I wish to address now is whether structural Indeterminacy is compatible with **F1-2**.

[15]It is instructive to compare this case to the case of the supervaluationary analysis of semantic indeterminacy. Supervaluationary logic for extensional languages is regarded as classical, insofar as it preserves classical logical consequence. Nevertheless, when a determinacy operator is added to the object language, classical tautologousness is retained, but a number of classical inference schemas fail in the supervaluationary case (*reductio ad absurdum* and contraposition, among others)—at least, as long as the underlying relation of logical consequence is global.

Beginning with **F2**, we are presented with two subcases, depending on whether 'structural' is itself structural. In Torza [38], I have entertained the denial of $\mathcal{S}(\mathcal{S})$, on the grounds that '$\mathcal{S}$' is intensional. For, on the one hand, disjunction '$\vee$' is structural (Sider [34, ch. 10.2]). On the other hand, consider McGee's [24] wombat disjunction '$\vee^*$', which behaves like disjunction if there are wombats, and like conjunction otherwise. Due to its inherently disjunctive nature, wombat disjunction has to be non-structural, if anything is. So, even though '$\vee$' and '$\vee^*$' are co-extensional, '$\mathcal{S}(\vee)$' is true and '$\mathcal{S}(\vee^*)$' false. Insofar as '$\mathcal{S}$' does not allow substitution *salva veritate* of co-extensional terms in argument position, '$\mathcal{S}$' is therefore intensional. But since no intensional terms are structural (Sider [34, p. 216]), it is not the case that $\mathcal{S}(\mathcal{S})$. We can conclude that, since no truth of the form '$\mathcal{S}(t)$' is fundamental, its being indeterminate whether $\mathcal{S}(t)$, for some 't', won't affect the logic of a fundamental language. So, if it is not the case that $\mathcal{S}(\mathcal{S})$, structural indeterminacy is compatible with **F2**.

Sider [34, ch. 7.13] on the other hand, thinks that $\mathcal{S}(\mathcal{S})$, on the grounds that qualitative similarity is tantamount to the sharing of a structural feature; so, if what joint-carving terms have in common—namely, being joint-carving—were not joint-carving, the subject matter of metaphysics would constitute a messy, qualitatively gerrymandered bunch. If Sider is right, whether **F2** is in conflict with structural indeterminacy comes down to the logic of metaphysical indeterminacy. Barnes and Williams [3] have developed a bivalent logic of metaphysical indeterminacy validating all classical truths and inference schemas. According to that logic, **F2**—even on more demanding construals—will not be violated by instances of structural indeterminacy. If some other logic of metaphysical indeterminacy is adopted instead, the outcome may differ, depending on how more or less strongly **F2** is precisified. As discussed above, I am adopting the characterization of metaphysical indeterminacy from Torza [39], whereby the logic for a language with indeterminate subject matter is neither bivalent nor compositional.

So, if $\mathcal{S}(\mathcal{S})$, and if **F2** is understood in such a way as to require bivalence or compositionality, structural indeterminacy in the present construal will end up conflicting with **F2**.[16]

I now turn to **F1**. Barnes & Williams take metaphysical indeterminacy to be expressible via an object-language joint-carving sentential operator '∇'.[17] Since all structural indeterminacy is metaphysical indeterminacy, any instance of structural indeterminacy *à la* Barnes & Williams is tantamount to the truth of a sentence of the form '$\nabla\mathcal{S}(t)$', such that $\mathcal{S}(\nabla)$, against **F1**. On the other hand, my own characterization of metaphysical indeterminacy does not involve any joint-carving (in)determinacy or supertruth operator. As a consequence, on the view of metaphysical indeterminacy adopted here, statements of structural indeterminacy are compatible with **F1**.

To recap, Sider's postulate that the fundamental is determinate rules out structural indeterminacy only under certain special conditions. Indeed, structural indeterminacy is compatible with **F1** on the present construal of metaphysical indeterminacy; and **F2** is compatible with structural indeterminacy if 'structural' is not structural, or if the logic of metaphysical indeterminacy is classical. In the remainder of this section I will delve into the consequences of acknowledging the possibility of structural indeterminacy.

2.2 Structural indeterminacy and ontological deflationism

Realists about joint-carving routinely assume that terms can be totally ordered by means of a binary comparative structure relation. Thus, it makes sense to ask whether 's' is more or less structural than 't', for any terms 's' and 't'. (Perhaps the order is partial, if it only makes sense to compare terms of the same syntactic category; be that as it may, the issue can be set

[16] Notice that either way, Sider's position appears to be inconsistent. For, since 'structural' is intensional, it cannot be maintained both that intensional terms are not structural and that 'structure' is structural (Torza [38]).

[17] "We argue... for the legitimacy of a primitivist conception of indeterminacy, where indeterminacy itself is metaphysically fundamental", Barnes and Williams [3, p. 104].

aside, since only the case of existential quantifiers is relevant to this debate). Once structural indeterminacy is introduced, and statements of the form 's is structural' are allowed to be true to varying degrees, a different kind of ordering will obtain, depending on whether 's is structural' is more or less true than 't is structural'.[18]

One may be tempted to think that the two orderings are isomorphic, i.e. that 's' is more structural than 't' just in case 's is structural' is truer than 't is structural'. Crucially, that is not the case. When 's is structural' and 't is structural' are both false, it can be the case that 's' is more structural than 't' (recall that 'structural' has the intended meaning of 'perfectly structural'), although it is of course not the case that 's is structural' is truer than 't is structural'. Conversely, if 's is structural' is indeterminate and 't is structural' false, 's is structural' is truer than 't is structural'. But then 's' is not more structural than 't'; for if 's' is more structural than some term, then either it is perfectly structural, and so 's is structural' is true, or it is less than perfectly structural, in which case 's is structural' is false. It can be concluded that 's' being more structural than 't' is neither necessary nor sufficient for 's is structural' to be truer than 't is structural'.[19]

On the basis of the newly introduced ordering, a competing notion of a non-substantive ontological dispute naturally arises, which is the same as Sider's (section 1), except that condition D4 is replaced with

D4*. '$\exists_1$ is structural' is just as true as '$\exists_2$ is structural', and there is no language $\mathcal{L}$ and no $\mathcal{L}$-unrestricted quantifier '$\exists$' such that '$\exists$ is structural' is truer than '$\exists_i$ is structural', for each $i \in \{1, 2\}$.

[18] How many degrees of truth are there? At least three: true, false, indeterminate. Technically, the new kind of ordering can be defined even if every statement of the form 's is structural' is either determinately true or determinately false. As it will soon become clear, however, if 's is structural' is never indeterminate, no cases of non-substantive ontological disagreement will arise, thus making the alternative ordering uninteresting to the present discussion.

[19] In fact, the isomorphism fails even in the less general case in which there is no structural indeterminacy.

Ontological disagreement meeting conditions D1-3 and D4* is said to be *non-substantive**.

There are three possible scenarios of non-substantive* ontological disagreement, according to D4*. The first scenario is such that (i) '$\exists_i$ is structural' is true, for each $i \in \{1, 2\}$. But then multiple unrestricted existential quantifiers will be joint-carving, which amounts to the doctrine of egalitarian quantifier variance, which was discussed and abandoned in section 1 on the grounds that it leads to structural redundancy (fn. 7).

The second and third scenarios of non-substantive* disagreement are, respectively, such that either (ii) '$\exists_i$ is structural' is false, for each $i \in \{1, 2\}$, or (iii) '$\exists_i$ is structural' is indeterminate, for each $i \in \{1, 2\}$. Either way, there is no '$\exists$' such that '$\exists$ is structural' is true, which entails (via **Comp**) that every truth has metaphysical semantics in a quantifier-free language. This takes us back to the discussion of Sider's completeness argument for metaontological realism, where we conceded that no best theory has quantifier-free metaphysical semantics. As long as we stick to the dialectics of section 1, the second and third scenarios are ruled out, too. It appears that ontological disagreement cannot be non-substantive*, either.

On closer inspection, however, a case can be made for the possibility of non-substantive* disagreement. The conclusion that both scenarios (ii) and (iii) should be ruled out on completeness grounds was reached by implicitly understanding **Comp** as equivalent with

(Comp$^+$) Every true sentence containing some term which is not determinately structural has truth-conditions in a language whose primitive terms are determinately structural

that is, by construing a fundamental language as being such that all primitives are determinately structural. **Comp**$^+$ tells us that every truth containing some term 's' such that 's is structural' is not true has a metaphysical semantics in a language wherein every primitive 't' is such that 't is structural' is true.

Crucially, the fates of scenarios (ii) and (iii) come apart if a fundamental language is construed as being such that all primitives are not determinately not structural, and **Comp** is therefore precisified as

(Comp$^-$) Every true sentence containing some term which is determinately not structural has truth-conditions in a language whose primitive terms are not determinately not structural.

According to **Comp**$^-$, every truth containing some term 's' such that 's is structural' is false has a metaphysical semantics in a language wherein every primitive 't' is such that 't is structural' is not false.

Is **Comp**$^-$ an admissible interpretation of the Completeness Postulate? The rationale for completeness is that every non-fundamental truth holds in virtue of some fundamental truth, the latter being a truth which is not formulated in non-structural terms. But as we grant the possibility of structural indeterminacy, that can mean different things: a truth could be said to be fundamental insofar as it is not formulated in terms that are not determinately structural, or insofar as it is not formulated in terms that are determinately not structural. The former construal of a fundamental truth leads us straight to **Comp**$^+$, whereas the latter construal yields **Comp**$^-$. Since either construal is *prima facie* equally admissible, **Comp**$^-$ should be regarded as a serious contender, if its stronger sibling is. For the time being I am going to assume that **Comp**$^-$ is indeed the correct precisification of the Completeness Postulate; the assumption will be discharged in section 2.3.

Once we adopt **Comp**$^-$, something interesting happens: whereas scenario (ii) remains precluded, (iii) becomes a live option. Indeed, when '$\exists_i$ is structural' is false, for each $i \in \{1, 2\}$, all quantifiers are determinately non-structural and, by **Comp**$^-$, every first-order best theory has metaphysical truth-conditions in a quantifier-free language, which is ruled out by the Completeness Argument (sec. 1). On the other hand, if '$\exists_i$ is structural' is indeterminate, for each $i \in \{1, 2\}$, each '$\exists_i$' is not determinately

not structural, and can appear as a primitive in a fundamental language. Since metaphysical semantics can be formulated in a first-order language (by **Comp**$^-$), scenario (iii) is compatible with Sider's thesis that our best theories do not have quantifier-free truth-conditions. It can be concluded that non-substantive* ontological disagreement is possibile, when completeness is construed as **Comp**$^-$.

We just saw that Sider's realism about joint-carving rules out non-substantive ontological disagreement, but it does not conclusively rule out non-substantive* ontological disagreement. Indeed, let's suppose that there are instances of structural indeterminacy, in particular indeterminacy about quantifier structure; and that the Completeness Postulate is precisified as **Comp**$^-$; then a disagreement between two speakers can meet conditions D1-3 and D4*. The methodological moral is that the realist about joint-carving who wishes to stave off the threat of ontological deflationism must do more than ruling out non-substantive ontological disagreement; she must also show that non-substantive* ontological disagreement does not constitute a relevant deflationary position. And that requires showing that condition D4*, unlike its close relative D4, is not an admissible structure-involving constraint in the characterization of ontological substantivity.

2.3 A dilemma

My critique of ontological deflationism from section 2.2 hinges on interpreting the Completeness Postulate as **Comp**$^-$. One might object, however, that charity considerations weigh against such an interpretation. For if two equally admissible options are on the table, namely **Comp**$^+$ and **Comp**$^-$, and the former, unlike the latter, is what Sider's defense of ontological realism requires, we should regard **Comp**$^+$ as the intended interpretation.

Although I agree that *ceteris paribus* we should go for the most charitable interpretation, the *ceteris paribus* clause is not satisfied in the present case, as there are countervailing considerations which weigh in favor of **Comp**$^-$.

One unresolved issue of Sider's realism about joint-carving is that, when it comes to selecting the ideology of a fundamental language, we are forced into choosing between arbitrariness and redundancy. For if a fundamental language has to be first-order, either '$\forall$' or '$\exists$' must be structural. The realist is therefore bound to choose exactly one of the following options:

1) both '$\mathcal{S}(\forall)$' and '$\mathcal{S}(\exists)$' are true

2) '$\mathcal{S}(\forall)$' is true and '$\mathcal{S}(\exists)$' false

3) '$\mathcal{S}(\forall)$' is false and '$\mathcal{S}(\exists)$' true.

We are then faced with a dilemma: either fundamental structure is redundant, as per (1), or it is arbitrarily asymmetric, as per (2) and (3).

As it turns out, the possibility of structural indeterminacy offers a way out of the dilemma, namely by allowing the property of being structural to be, as it were, smeared over '$\forall$' and '$\exists$', as per the conjunction of the following conditions:

4.1) 'either $\mathcal{S}(\forall)$ or $\mathcal{S}(\exists)$' is true

4.2) neither '$\mathcal{S}(\forall)$' nor '$\mathcal{S}(\exists)$' is true.

Condition (4.1) captures the thesis that quantification is joint-carving, insofar as some quantifier or other is. Condition (4.2), encoding the idea that no quantifier alone bears the brunt of carving nature at the joints, is incompatible with each of (1), (2) and (3), thus entailing that quantifier structure is neither redundant nor arbitrary.[20]

We are now ready to see how the above considerations bear on the issue of precisifying the Completeness Postulate. From the conjunction of (4.1) and (4.2) it can be inferred that neither '$\mathcal{S}(\forall)$' nor '$\mathcal{S}(\exists)$' is false, and so that '$\forall$' and '$\exists$' are not determinately not structural. By adopting $\mathbf{Comp}^{-}$, we are

[20]It is noteworthy that if (4.1) and (4.2) are both true, the underlying logic is not compositional—as predicted by the characterization of metaphysical indeterminacy of Torza [39].

then allowed to formulate first-order metaphysical semantics. On the other hand, (4.2) entails that neither '$\forall$' nor '$\exists$' is determinately structural and so, if we adopted $\mathbf{Comp}^+$, that quantifiers could not occur in a fundamental language, which is ruled out by the observation that our best theories cannot be given quantifier-free truth-conditions (section 1).

The moral is that $\mathbf{Comp}^-$ should be preferred to $\mathbf{Comp}^+$ for reasons inherent to the kind of metaphysics of structure advocated by Sider. For if structural indeterminacy is indeed possible, we have a way out of the dilemma of choosing between redundant or arbitrary fundamental ideology, namely by endorsing (4.1-2). This strategy is available only when the Completeness Postulate is precisified as $\mathbf{Comp}^-$.

2.4 Dead ends

It is worth discussing how the structural indeterminacy thesis, as codified by (4.1-2) stacks up against alternative strategies aimed at avoiding the dilemma of section 2.3. Two such routes are articulated in McSweeney [25]:

5) either '$\mathcal{S}(\forall)$' is true or '$\mathcal{S}(\exists)$' is true, but we cannot know which

6) both '$\mathcal{S}(\forall)$' and $\mathcal{S}(\exists)$' are false.

Condition (5), which McSweeney dubs *Privileged*, attempts to defuse the dilemma by appealing to a form of radical agnosticism about structure: "the sense in which the question is misguided is that it is unanswerable. The proponent of Privileged thinks that one or the other [quantifier] is indeed joint-carving, but that we could never know which" (McSweeney [25, p. 119]).

Unfortunately, (5) does not provide a way out of the dilemma. For the disjunction in (5) is either inclusive or exclusive: if it's inclusive, (5) entails either (1), (2) or (3); if it's exclusive, it entails either (2) or (3). One way or another, we are still stuck with the dilemma.

The reason (5) falls short of its goal is that it introduces a red herring: knowability. Indeed, the clause '... but we cannot know which' specifies that certain structure-involving facts are epistemically inaccessible, and so that an agent will never have to face the uncomfortable choice of picking either horn in the dilemma. But the dilemma was never about knowledge to begin with. Rather, it is a dilemma concerning what reality is like: either the world's fundamental structure is redundant, or it displays a repugnant asymmetry. Whether such structural facts are knowable is a further question. (5) is merely an attempt at sweeping the problem under the epistemic rug.[21]

According to condition (6), which McSweeney refers to as *Unfamiliar*, neither quantifier is joint-carving. This strategy is more promising, since at least it doesn't entail either (1), (2) or (3). Now, the Completeness Postulate **(Comp)** tells us that if (6) is the case, every quantified truth must have quantifier-free truth-conditions. In fact, the observation carries over to the propositional fragment: since propositional logic can be completely specified in terms of alternative and disjoint sets of truth-functional constants, (6) tells us that none of those sets of constants are joint-carving, and so any propositional compound must also have truth-conditions in a language which does not employ any truth-functional constants. Putting all that together, we are lead to a radical consequence: no fundamental language contains either truth-functional constants or quantifiers.

How are we to write the 'book of the world', then? The advocate of (6) owes us a story. One account of logic that takes neither truth-functional constants nor quantifiers as primitive is the *logical structuralism* of Koslow [18]. On this approach, the only primitive is a binary consequence relation $\Rightarrow$, plural to both sides, which is implicitly defined by a few Gentzen-style inference rules.[22] As Koslow shows, truth-functional constants, first-order

[21] I will offer my own reasons in favor of agnosticism about structure in the following section, albeit on quite different grounds.

[22] $p_1, p_2, \ldots \Rightarrow q_1, q_2, \ldots$ has the intended meaning: p_1 and p_2 and... therefore q_1 or q_2

quantifiers, as well as most modal operators are definable via $\Rightarrow$ as the only logical primitive.

However, the structuralist project is unable to meet the challenge raised by (6). For **(Comp)** tells us that, if none of the usual logical constants are joint-carving, we must be able to provide truth-conditions for each of them in a fundamental language. Let's take a closer look at how the structuralist defines those constants by considering the case of conjunction. In a structuralist setting, the meaning of '$\wedge$' is defined by the following conditions:

$\wedge\mathbf{E}_1$**.** $p \wedge q \Rightarrow p$

$\wedge\mathbf{E}_2$**.** $p \wedge q \Rightarrow q$

$\wedge$**I.** '$\wedge$' picks out the weakest operation satisfying $\wedge\mathbf{E}_{1-2}$**.**

But of course, since the above implicit definition mentions conjunction, which is by hypothesis not joint-carving, we are not being given a metaphysical semantics for conjunctive statements.

A further issue with pairing logical structuralism with realism about joint-carving is that any consequence relation $\Rightarrow$ possesses a *dual* $\Rightarrow^*$ such that

$$p_1, p_2, \ldots \Rightarrow^* q_1, q_2, \ldots \text{ just in case } q_1, q_2, \ldots \Rightarrow p_1, p_2, \ldots$$

The original problem then raises its head. Which is structural: $\Rightarrow$? $\Rightarrow^*$? Both? Once again, realism about joint-carving will entail that fundamental structure is either redundant or arbitrarily asymmetric.

Perhaps there are other logical approaches which, unlike Koslow's, are able to meet the challenge. If so, the burden is on the advocate of (6) to offer a suitable framework by spelling out the details of the proposal, compatibly with the requirements of **(Comp)**.

Besides (5) and (6), there is one further route that one may attempt for resolving the dilemma: *realism about higher-order joint-carving*. According

---

or...

to this strategy, being structural, or joint-carving is predicated not of individual bits of ideology, such as '$\exists$' or '$\wedge$', but of *ideological kinds*, such as the quantifier kind, the truth-functional kind, the modal operator kind, the mereological relation kind, etc. Being structural, on this view, is a higher-order property. It might seem that, by adopting realism about higher-order joint-carving, the dilemma will quickly dissolve, for neither '$\exists$' nor '$\forall$' are structural, nor any other bit of logical ideology, for that matter—it would be a category mistake to think otherwise. What is structural is the quantifier kind.

But realism about higher-order joint-carving leads to a whole new variety of uncomfortable questions, as there are all sorts of ways of carving out ideological space into kinds. In the case of '$\exists$' and '$\forall$', which is the relevant joint-carving kind: Quantifier? First-order quantifier? Variable-binding operator? Propositional operator? We are faced with a new dilemma: if all of those kinds are joint-carving, the world's fundamental structure is redundant, and horribly so; if exactly one of them is joint-carving, we are going to need criteria for picking the right one, which we don't seem to have.

Or do we? Perhaps the criteria are as follows: whenever the realist about joint-carving is faced with a choice among bits of ideology $t, t'', \ldots$, such that any choice would lead to either redundancy or arbitrariness, the realist about higher-order joint-carving should regard as structural the ideological kind which subsumes $t, t'', \ldots$, and nothing else.

But let's consider then the case in which $t, t'', \ldots$ are just '$\exists$' and '$\forall$'. Which is the relevant kind? Not the first-order quantifier kind, since 'there are 17' and 'there are none' are also first-order quantifiers. As far as I can see, the only ideological kind subsuming '$\exists$', '$\forall$' and nothing else is the existential-or-universal-first-order-quantifier kind. But such a kind is eminently disjunctive, and therefore hardly a candidate for being structural.[23]

[23] An analogous dialectics can be found in the debate about quantitative vs. qualitative ideological parsimony (Torza [38]; cf. Cowling [6], Finocchiaro [12]).

3 The epistemology of structure

In the previous section a case was made for a hitherto unexplored variety of ontological deflationism, which happens to be compatible with realism about joint-carving. In particular it was argued that, if quantifier structure is indeterminate, ontological disagreement can be non-substantive*; and that realism about joint-carving gives us reasons to believe that structure is indeed indeterminate, as structural indeterminacy offers a way out of a worrisome dilemma. I am now going to consider, and ultimately reject, one reason for doubting the possibility of structural indeterminacy (and, consequently, of non-substantive* disagreement).

How do we get to know facts about reality's fundamental structure? Sider [34, p. 12] has put forward the following *criterion of ideological commitment* as an epistemic constraint governing the notion of structure:

(C) We are justified in regarding a term as structural just in case it (or a synonym) is a primitive in the language of the best total theory.

where the best total theory is the axiomatic system of the actual goings-on that strikes the best balance of strength and simplicity.

Now, if the best total theory is defined in a regimented language featuring a primitive term 't', we should regard 't is structural' as true; otherwise, we should regard 't is structural' as false. Either way, **(C)** appears to give us good reasons for ruling out the possibility of structural indeterminacy.

As it turns out, the above argument against structural indeterminacy clashes with a formal result about theory choice which, paired with Sider's criterion of ideological commitment, leads to radical agnosticism about structure. The result entails that there is no fact of the matter as to which theory is best, and so, by **(C)**, that there is no fact of the matter as to whether we are justified in regarding a particular term as joint-carving.

As shown in Okasha [28], there is no algorithm for ranking theories from best to worst, as long as a few reasonable conditions are met. The result is in

fact a straightforward application of the much-celebrated impossibility theorem of Arrow [1]. Let's suppose that there is a set of particular preference criteria, such as strength, simplicity, etc. by which theories can be ranked, and that preference is a weak ordering (reflexive, transitive and complete). Accordingly, there will be a weak ordering of theories for each particular preference criterion. The problem of theory choice boils down to the issue of aggregating the particular rankings into one overall ranking. The goal, in other words, is to find an algorithm that outputs an overall weak ordering of theories given a set of particular weak orderings. The Arrow-Okasha result can be stated thus: if there are at least three alternative theories, there exists no algorithm for aggregating the particular rankings into an overall ranking which meets the following conditions:

Unrestricted domain: the algorithm must be able to output an overall ranking for every possible set of particular rankings, on the basis of the given preference criteria.

Weak Pareto: if a theory is better than another in all particular respects, then it is better overall.

No dictatorship: there is no preference criterion which alone determines the overall ranking. That is, there is no particular preference criterion such that, if a theory is better than another in that respect, then it is better overall.

Independence of irrelevant alternatives: the overall preference between two theories is only a function of the particular rankings of those two theories, and of no other theories.

The moral is that, provided that the above four conditions are satisfied, there is no fact of the matter as to which theory is best. Now, suppose that 't' is a primitive term in the language of some but not all candidate total theories (and that there are at least thee candidate total theories).

The Arrow-Okasha theorem entails that there is no fact of the matter as to which theory is best and, therefore, as to whether 't' occurs in the best theory. By **(C)**, there is no fact of the matter as to whether we are justified in regarding 't' as joint-carving, which suffices to block the above argument against structural indeterminacy. It can be concluded, in the light of the Arrow-Okasha theorem, that the possibility of non-substantive* ontological disagreement cannot be ruled out on the basis of Sider's epistemology of structure.

The result may not be inescapable, as Okasha [28] considers a number of potential ways out, some more promising than others. Whether the Arrow-Okasha impossibility theorem about theory choice ultimately holds, and to what extent, is currently a matter of controversy (Rizza [31], Stegenga [37], Morreau [27], Gaertner and Wüthrich [13]). A full assessment of the result lies outside the scope of this work. What we know for sure is that, if the result can be vindicated, Sider's criterion leads to radical agnosticism about structure.

Suppose however that a workaround exists, and that the candidate total theories can be ordered from best to worst. Should we then conclude, by **(C)**, that the primitive ideology of the best theory is joint-carving, and so that structural indeterminacy can be ruled out, after all? Not so fast. As noted in Donaldson [9, p. 1054], Sider's formulation of the criterion of ideological commitment carries an unwarranted uniqueness presupposition, insofar as we should speak of 'best total theories', plural. Indeed, although we may be lucky and happen to live in a world where exactly one theory strikes the best balance of strength and simplicity, we have no evidence favoring such presupposition, and therefore a suitable criterion of ideological commitment should not prejudge the issue. Here is a better formulation of the criterion:

(C′) We are justified in regarding a term as structural just in case it (or a synonym) is a primitive in the language of every best total theory.

Out of the frying pan into the fire. For suppose that some best theory T_1 is regimented in a first-order predicate language whose primitive quantifier is '$\exists$'. Then there is an equally good theory T_2, equivalent with T_1, which only differs from T_1 by being formulated in a language whose primitive quantifier is '$\forall$'. By **(C′)**, we must conclude that neither quantifier is joint-carving. The same line of reasoning applies *mutatis mutandis* to disjoint sets of truth-functionally complete sentential operators, such as $\{\vee, \neg\}$ and $\{\uparrow\}$[24]; or dual topological operators, such as the ones for closure and interior; and so on and so forth. Since very little ideology ends up being joint-carving, if any, there is no guarantee that we can come up with a language capable of providing a metaphysical semantics for all nonfundamental truths.

The above observations seem to favor a further revision of the criterion of ideological commitment, namely:

(C″) We are justified in regarding a term as structural just in case it (or a synonym) is a primitive in the language of some best total theory.

This criterion indeed allows us to conclude that all of the aforementioned bits of ideology are structural, provided that they appear in some theory or other. On the downside, we are back to the old problem of redundant structure, one horn of the dilemma from section 2.3, since we would be committed to both '$\forall$' and '$\exists$' being joint-carving—likewise for the other bits of ideology.[25]

But all is not lost. An alternative, and arguably superior route to the epistemology of structure opens up once we (i) allow for structural indeterminacy, and (ii) formulate the criterion of ideological commitment in such a way as to specify the structuralness of multiple terms at once, rather than one at a time. Informally, the criterion I propose says that, given a sequence of terms, we are justified in regarding some term or other in the sequence as structural just in case every best theory features a term in the sequence

[24] '$\uparrow$' is the Sheffer Stroke, also known as 'nand'.

[25] Donaldson [9, p. 1074] offers further reasons against **(C″)**.

(or a synonym) as a primitive bit of ideology. More perspicuously:

(C*) Let $t_1, \ldots, t_n$ be a sequence of terms. We are justified in regarding '$\mathcal{S}(t_1) \vee \ldots \vee \mathcal{S}(t_n)$' as true just in case, for every best theory T, some $t_{i \leqslant n}$ (or a synonym) is a primitive of T's language.

Accordingly, if the language of every best theory contains either '$\forall$' or '$\exists$' as a primitive, we are justified in inferring the truth of '$\mathcal{S}(\forall) \vee \mathcal{S}(\exists)$'.

A crucial observation is due here. Since a language expressing facts of metaphysical indeterminacy is non-compositional (section 2.1), we are not allowed to infer from the truth of '$\mathcal{S}(t_1) \vee \ldots \vee \mathcal{S}(t_n)$' that either '$\mathcal{S}(t_1)$' is true or ...or '$\mathcal{S}(t_n)$' is true—and that's how it should be, if we wish to avoid falling back into the dilemma of choosing between arbitrariness and redundancy in matters of fundamental structure (section 2.3).

It is also noteworthy that in the (unlikely) scenario that there is a unique best theory, **(C*)** will collapse into Sider's criterion **(C)** by considering a 1-term sequence t.

To conclude, one more reason has been found for taking seriously the possibility of structural indeterminacy. For Sider's criterion of ideological commitment prevents a whole class of theoretically indispensable notions (logical, topological etc) from being joint-carving, if it is possible to come up with an overall preference ordering of the total theories, and yet multiple ones are tied for best. If structure is indeed indeterminate, the impasse can be skirted by adopting criterion **(C*)**.

4 Conclusions

Realism about joint-carving is arguably the best-developed framework aimed at defusing the threat of ontological deflationism. Indeed, Sider's theory is designed to rule out the possibility of non-substantive ontological disagreement, as long as the latter is understood in terms of fundamental structure. I have argued that, if there are instances of structural indeterminacy, realism

about joint-carving is unable to rule out the possibility of non-substantive* ontological disagreement—a close relative of non-substantive ontological disagreement. The moral is that, unless it is shown that non-substantive* ontological disagreement cannot arise, or that it has no metaphysical merit, ontological deflationism remains a live option, threatening the outcome of many first-order ontological debates.

Furthermore, I have provided independent reasons in favor of the plausibility of structural indeterminacy; I have rebutted an epistemic argument designed to rule out structural indeterminacy; and I have proposed a novel account of the epistemology of structure that hinges on the very possibility of structural indeterminacy.

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References

[1] Arrow, K. 1951. Social Choice and Individual Values. New York: John Wiley.

[2] Barnes, E. 2010. Ontic Vagueness: A Guide for the Perplexed. Noûs, 44(4): 601–27.

[3] Barnes, E. and Williams, J. R. G. 2011. A Theory of Metaphysical Indeterminacy. In Zimmerman, D. and Bennett, K. (eds) Oxford Studies in Metaphysics, vol. 6: 103–48. Oxford: Oxford University Press.

[4] Bigelow, J. 1996. Presentism and Properties. Philosophical Perspectives, 10: 35–52.

[5] Chalmers, D., Manley, D., and Wasserman, R. (eds.) 2009. Metametaphysics. Oxford University Press.

[6] Cowling, S. 2012. Ideological parsimony. Synthese, 190(17): 3889–908.

[7] Crisp, T. 2004. On Presentism and Triviality. In Zimmerman, D. (ed.) Oxford Studies in Metaphysics, vol. 1, Oxford University Press.

[8] Crisp, T. 2004. Reply to Ludlow. In: Zimmerman, D. (ed.) Oxford Studies in Metaphysics, vol. 1, Oxford University Press.

[9] Donaldson, T. 2014. Reading the Book of the World. Philosophical Studies, 172(4): 1051–77.

[10] Dorato, M. 2006. The Irrelevance of the Presentist/Eternalist Debate for the Ontology of Minkowski Spacetime. In: Dieks, D. (ed.) Philosophy and foundations of physics. The ontology of spacetime. Amsterdam: Elsevier.

[11] Fine, K. 1975. Vagueness, truth and logic. Synthese, 54: 235–59.

[12] Finocchiaro, P. 2019. Ideology and its role in metaphysics. Synthese, 10: 1–27.

[13] Gaertner, W., and Wüthrich, N. (2016). Evaluating competing theories via a common language of qualitative verdicts. Synthese, 193(10): 3293–3309.

[14] Hirsch, E. 2009. Ontology and Alternative Languages. In: Chalmers, Manley, and Wasserman [5].

[15] Hirsch, E. 2011. Quantifier Variance and Realism: Essays in Metaontology. Oxford University Press, USA.

[16] Hirsch, E. 2013. The Metaphysically Best Language. Philosophy and Phenomenological Research, 87(3): 709–16.

[17] Keller, S. 2004. Presentism and Truthmaking. In: Zimmerman, D. (ed.) Oxford Studies in Metaphysics, vol. 1, Oxford University Press.

[18] Koslow, A. 1992. A Structuralist Theory of Logic. Cambridge University Press.

[19] Lewis, D. 1983. New work for a theory of universals. Australasian Journal of Philosophy, 61(4): 343–77.

[20] Liebesman, D. 2015. Quantifier Variance, Intensionality, and Metaphysical Merit. In Torza, A. (ed.) Quantifiers, Quantifiers, and Quantifiers: Themes in Logic, Metaphysics, and Language. Springer: 301–19.

[21] Lombard, L. B. 1999. On the alleged incompatibility of presentism and temporal parts. Philosophia, 27(1–2): 253–60.

[22] Ludlow, P. 2004. Presentism, Triviality, and the Varieties of Tensism. In Zimmerman, D. (ed.) Oxford Studies in Metaphysics, vol. 1, Oxford University Press.

[23] Markosian, N. 2004. A Defense of Presentism. In: Zimmerman, D. (ed.) Oxford Studies in Metaphysics, vol. 1, Oxford University Press.

[24] McGee, V. 1996. Logical Operations. Journal of Philosophical Logic, 25: 567–80.

[25] McSweeney, M. 2017. Following logical realism where it leads. Philosophical Studies, 176(1), 117–39.

[26] Miller, K. 2005. The metaphysical equivalence of three and four dimensionalism. Erkenntnis, 62: 91–117.

[27] Morreau, M. 2015. Theory Choice and Social Choice: Kuhn Vindicated. Mind, 124(493): 239–62.

[28] Okasha, S. 2011. Theory Choice and Social Choice: Kuhn versus Arrow. Mind, 120(477): 83–115.

[29] Putnam, H. 1967. Time and physical geometry. The Journal of Philosophy, 64(8): 240–47.

[30] Rietdijk, C. W. 1966. A rigorous proof of determinism derived from the special theory of relativity. Philosophy of Science: 341–44.

[31] Rizza, D. 2013. Arrow's theorem and theory choice. Synthese, 191(8): 1847–56.

[32] Sider, T. 2001. Four-Dimensionalism. An Ontology of Persistence and Time. New York: Oxford University Press.

[33] Sider, T. 2003. Against Vague Existence. Philosophical Studies, 114: 135–46.

[34] Sider, T. 2012. Writing the Book of the World. Oxford University Press.

[35] Sider, T. 2013. Replies to Dorr, Fine, and Hirsch. Philosophy and Phenomenological Research, 87(3): 733–54.

[36] Skow, B. 2010. Deep metaphysical indeterminacy. The Philosophical Quarterly, 60(241): 851–58.

[37] Stegenga, J. 2015. Theory choice and social choice: Okasha versus Sen. Mind, 124(493): 263–77.

[38] Torza, A. 2017. Ideology in a Desert Landscape. Philosophical Issues, 27(1): 383–406.

[39] Torza, A. 2017. Quantum Metaphysical Indeterminacy and Worldly Incompleteness. Synthese, 50(4): 1–14.

[40] Williams, J. R. G. 2008. Ontic vagueness and metaphysical indeterminacy. Philosophy Compass, 3(4): 763–88.

[41] Williams, J. R. G. 2008. Multiple actualities and ontically vague identity. The Philosophical Quarterly. 58(230): 134–54.

[42] Williams, J. R. G. 2013. Lewis on reference and eligibility. In: Loewer, B. and Schaffer, J. (eds.) A Companion to David Lewis, Wiley Blackwell.