Australasian Journal of Philosophy

ISSN: 0004-8402 (Print) 1471-6828 (Online) Journal homepage: http://www.tandfonline.com/loi/rajp20

What Not to Multiply Without Necessity

Jonathan Schaffer

To cite this article: Jonathan Schaffer (2015) What Not to Multiply Without Necessity, Australasian Journal of Philosophy, 93:4, 644-664, DOI: 10.1080/00048402.2014.992447

To link to this article: http://dx.doi.org/10.1080/00048402.2014.992447

Published online: 17 Dec 2014.

Submit your article to this journal

Article views: 543

View related articles

View Crossmark data

Citing articles: 1 View citing articles

Full Terms & Conditions of access and use can be found at
http://www.tandfonline.com/action/journalInformation?journalCode=rajp20

Download by: [Rutgers University] **Date:** 16 December 2015, At: 18:15

Australasian Journal of Philosophy, 2015
Vol. 93, No. 4, 644–664, http://dx.doi.org/10.1080/00048402.2014.992447

Routledge
Taylor & Francis Group

WHAT NOT TO MULTIPLY WITHOUT NECESSITY

Jonathan Schaffer

The Razor commands us not to multiply entities without necessity. I argue for an alternative principle—*The Laser*—which commands us not to multiply *fundamental* entities without necessity.

Keywords: metaphysics, methodology, fundamentality

Downloaded by [Rutgers University] at 18:15 16 December 2015

For the listener, who listens in the snow,
And, nothing himself, beholds
Nothing that is not there and the nothing that is.
(Wallace Stevens, 'The Snow Man')

1. Introduction

The Razor commands: *Do not multiply entities without necessity!* Few principles are as pervasive in contemporary metaphysics. Yet I argue that the Razor is too blunt a measure of ontological economy, failing to distinguish fundamental from derivative entities. Instead I recommend the more precise *Laser*, which is focused specifically on fundamental entities, and commands: *Do not multiply fundamental entities without necessity!*

I argue that the Laser represents an improvement over the Razor, I connect the Laser to an underlying 'bang for the buck' methodology, and I trace the implications of this bang-for-the-buck methodology for certain metaphysical debates. What emerges is general pressure towards a *permissive* and abundant view of what there is, coupled with a *restrictive* and sparse view of what is fundamental. Classical mereology and pure set theory come out as paradigms of methodological virtue, for making so much from so little.

In arguing that the Laser represents an improvement over the Razor, I take for granted that ontological economy is an aspect of rational theory choice. There are deep questions lurking as to how and why ontological economy should matter to rational theory choice [Huemer 2009; Willard 2014], and as to how ontological economy should be integrated with and balanced against other aspects of rational theory choice, which I do not attempt to address. My thesis is that, given that ontological economy is an aspect of rational theory choice, this notion of economy is better scanned through the Laser.

2. The Razor

Occam never said it. As Spade [2011: sec. 4.1] notes: 'Although the sentiment is certainly Ockham's, that particular formulation is nowhere to be found in

© 2014, Australasian Association of Philosophy

his texts.' In Occam's work one instead finds maxims such as: 'Never posit pluralities without necessity' ('*Numquam ponenda est pluralitas sine necessitate*'). Wikipedia has it that it was actually John Punch in 1639 who first said 'Entities are not to be multiplied without necessity' ('*Entia non sunt multiplicanda praeter necessitatem*'), and that it was William Hamilton in 1852 who first called this maxim 'Occam's Razor'.

Complicated history aside, the maxim that has reached us today seems to have a fairly canonical imperatival formulation:

The Razor: Do not multiply entities without necessity!

I am primarily interested in the 'entities' portion of *The Razor*, but will spend the rest of this section briefly commenting on the other parts of *The Razor*, if only to separate the issues arising (to the extent possible).

One cluster of issues arises from the 'without necessity' proviso. On the one hand, this proviso might seem to be too demanding. Perhaps it is not necessary to multiply entities, but doing so is still extremely helpful. In that case, one might say that there is still enough reason to multiply entities even if there is, strictly speaking, no necessity. On the other hand, the 'without necessity' proviso might seem not to be demanding enough. Perhaps it is necessary to multiply entities, but only in order to pass the time, or to fill the final page of your notebook. In that case, one should say that there is still not enough reason to multiply entities.

The underlying problem is that the term 'necessity' is *contextually sensitive*. So one needs to clarify the intended modality. Presumably it is some sort of rational/epistemic modality, requiring something like 'good enough reason'. But in that case there is a worry of vacuity, for one might think this: Do not *do anything* without good enough reason.

One might consider simply omitting the 'without necessity' proviso entirely. In this vein, one might understand all methodological injunctions as imposing *pro tanto* requirements on theorizing, each of which is capable of being outweighed by other factors (methodological and otherwise). So one might simply command, as a *pro tanto* requirement on theorizing: Do not multiply entities! When entities are multiplied but 'with necessity', one might say that the *pro tanto* requirement not to multiply entities has been outweighed by other considerations. Whether that improves the clarity or content of the principle turns on what clarity and content can be infused into the notion of a *pro tanto* requirement.

By my lights, one might do best of all simply to re-interpret all of this within a Bayesian framework, as describing an objective constraint on rational credence. From a Bayesian perspective, one might demand that a system of priors, in order to count as *rational*, be 'stacked' to favour more economical hypotheses. When entities are multiplied but 'with necessity', one might say that the total evidence now favours an initially disfavoured hypothesis. How such stacking might be implemented precisely is not a matter I can consider here.

Another cluster of issues arises from the notion of 'multiplication' in *The Razor*. Difficult issues arise as to whether it is possible to compare ontologies

Downloaded by [Rutgers University] at 18:15 16 December 2015

that are not related by the proper subset relation, and especially difficult issues arise as to whether multiplying *token* entities counts as defying the command of *The Razor*, or whether only multiplying entity *types* constitutes defiance. With token entities, if Ann posits a world filled with exactly 1,736,549 electrons, and Ben posits a world with 1,736,550 electrons (just one more), then it is hard to feel that Ben's theory is any way less economical than Ann's, or that Ben has multiplied entities in any way that calls for concern. Yet if Ann posits a world ruled by exactly one deity, and Ben posits a world ruled by a cabal of seventeen deities, then Ben's theory does feel less economical. Similarly, if Clare posits only the actual concrete cosmos, and David—I have in mind David Lewis, of course—posits infinitely many possible concrete cosmoi, then David's theory does feel less economical.[1] Overall, token numbers do not seem to matter when the ratios are small (e.g. 1,736,549 electrons versus 1,736,550 electrons), but do seem to matter when the ratios are large (e.g. one versus infinitely many cosmoi). This is perplexing.

With entity types, matters are even more perplexing because all entities fall under multiple types, ranging from the most general (*entity*) to the most specific (think of the type associated with a complete qualitative description of a thing). So if one is concerned only with the most general type (*entity*) then there is never type multiplication, while if one is concerned only with the most specific types, or concerned with any extra types whatsoever, then there is always type multiplication.[2] So, with entity types it seems that one must first identify the right level of type-generality before one even has a well-defined measure. There is a 'reference class problem' arising. To illustrate, suppose than Ann posits 10 types of fundamental particle while Ben posits an additional type of fundamental particle, the 'addon'. Should one think that Ben's theory has multiplied entity types by adding the type *addon*, or should one think that Ben's theory has not multiplied entity types since all he is adding is one more instance of *particle*?[3]

I propose to leave all of these perplexing matters aside to the extent possible, by simply continuing to work with the 'without necessity' proviso and the notion of 'multiplying', leaving further refinement of these notions for separate discussion (although issues about 'necessity' resurface in section 9, and issues about 'multiplying' resurface in sections 6–7). My focus is on the notion of 'entity' at work in *The Razor*. I think this notion needs refinement too, and in this case I have a specific suggestion on offer.

[1] Although Lewis [1973: 87] defends the ontological economy of his modal realism precisely for not violating qualitative parsimony: 'I subscribe to the general view that qualitative parsimony is good in a philosophical or empirical hypothesis; but I recognize no presumption whatsoever in favor of quantitative parsimony.' Nolan [1997] offers a reply, arguing that quantitative parsimony is relevant.

[2] Even if the extra posit *a* happens to be perfectly qualitatively indiscernible from an already posited entity *b*, there is still the new type of *being an entity identical to a*. So, if one posits a second sphere—Pollux—indiscernible from a first sphere—Castor—so as to reach Black's [1952] case of the two spheres, one has even then multiplied some sort of type.

[3] Relatedly, Paul [2013] discusses a notion of *categorical economy*. But if the categories themselves form a hierarchical structure (perhaps with *entity* as the most fundamental category, of which *object* is a subcategory), then a similar reference class problem arises. If I posit a category *property* alongside *object*, have I multiplied categories by adding *property*—or not, since I am merely adding another *entity*?

Downloaded by [Rutgers University] at 18:15 16 December 2015

3. The Laser

I am proposing to replace *The Razor* with:

The Laser: Do not multiply fundamental entities without necessity![4]

The Laser is just *The Razor* with the word 'fundamental' inserted. *The Laser* thus incorporates a distinction between fundamental and derivative (/non-fundamental) entities. I trust that this distinction is familiar and its meaning readily grasped. Of course there are disputes over which entities are fundamental, and over what makes an entity fundamental. But these are disputes that, by and large, take for granted that there is a distinction between the fundamental and the derivative, and concern only how the line is to be drawn and what falls on which side of the line. For instance, given that minds exist, there is a classical dispute about whether minds are fundamental or whether they are derivative from matter. Anyone who *understands* this dispute thereby understands the notion of fundamentality that it involves.

I am assuming that 'fundamental' and 'derivative' are predicates of entities. Anyone who understands the idea that particles are fundamental entities, or the idea that popsicles are derivatives entities, thereby understands this usage. I leave open how the applications of these predicates to entities is best accounted for. Perhaps one needs to start from a grounding operator over sentences [Fine 2001] or a grounding relation over facts [Rosen 2010], and then to recover the status of entities. Or perhaps one can just begin from a grounding relation over entities [Schaffer 2009], with the fundamental entities being the ungrounded ones. I need take no stand on these controversies here.

(The reader who truly does not grasp the notion of a fundamental entity will of course feel mystified by *The Laser*. She may still find that the discussion to follow sheds light on the notion, and moreover offers a role for the notion in making sense of rational theory choice. With that said, the discussion is not intended to convert those who reject its terms come what may. That is a hopeless task.)

The Razor and *The Laser* deliver different measures of ontological economy. *The Razor* measures the ontological economy of a theory by the entities it posits, while *The Laser* measures the ontological economy of a theory by the fundamental entities it posits. (Concerns about the meanings of 'necessity' and 'multiplying' remain: see section 2. I am postponing these to the extent possible.) Since every fundamental entity is an entity, but not *vice versa*, *The Laser* delivers a more specifically targeted measure.

By the lights of *The Laser*, derivative entities are an 'ontological free lunch', in the sense that they are genuinely new and distinct entities but they cost nothing by the measure of economy.[5] *The Laser* thus incorporates an

[4] This follows up on an earlier suggestion of mine [Schaffer 2007: 189], offered as a way of steering between mereological nihilism and metaphysical scepticism. See also Schaffer [2009: 361], Cameron [2010: 262–3], and Bennett [manuscript: ch. 7].

[5] The notion of an 'ontological free lunch' comes from Armstrong [1997: 12], who goes on to add: '[W]hatever supervenes . . . is not something ontologically additional to the subvenient, or necessitating, entity or entities. What supervenes is no addition to being.'

Downloaded by [Rutgers University] at 18:15 16 December 2015

implicit distinction between *the commitments* of a theory, and *the cost* of such commitments. By the lights of *The Laser*, derivative entities are additional commitments, but they cost nothing. More precisely: derivative entities cost nothing *further*, beyond the cost incurred for positing their fundamental grounds.

(Once one learns from *The Laser* how to separate the commitments of a theory from its costs, further accounting principles come into view. *The Razor* prices fundamental entities 1:1 with derivative entities (full price). *The Laser* prices fundamental entities 1:0 with derivative entities (free lunch). But derivative entities could be priced in many other ways, including at half-price, at a variable discount scaled to their level, or even by an alphabetic (/non-numeric) policy on which derivative entities have a cost that is considered only if the fundamental costs are tied. The arguments I give for preferring *The Laser* to *The Razor* are intended to generalize and to favour pricing derivative entities as uniformly free, but I leave the generalization to the reader. I will note when accounting principles other than those of *The Razor* and *The Laser* may hold appeal. But for the most part I will speak of *The Laser* just as comparatively preferable to *The Razor*, and recommend replacing the latter with the former, without committing to *The Laser* being absolutely best from among all possible principles. Indeed, I will float a further replacement accounting principle at the close, in section 11.)

So, in order to display how *The Razor* and *The Laser* can pull apart, imagine that Esther posits a fundamental theory with 100 types of fundamental particle. Her theory is predictively excellent and is adopted by the scientific community. Then Feng comes along and—in a moment of genius—builds on Esther's work to discover a deeper fundamental theory with 10 types of fundamental string, which in varying combinations make up Esther's 100 types of particle. This is intended to be a paradigm case of scientific progress in which a deeper, more unified, and more elegant theory ought to replace a shallower, less unified, and less elegant theory. Feng's theory is evidently better in every relevant methodological respect.

Yet if one counts by total entities, as per *The Razor*, one will get the case of Esther and Feng *backwards*. For Esther's total ontology is actually a proper subset of Feng's. Feng believes in everything Esther believes in (both token-wise and type-wise): he believes in her particles, the atoms they compose, the chemicals they comprise, and the organisms they form, etc. Plus Feng believes in more: he also believes in the strings underneath it all (he believes in these types, and in their tokens). So, by the lights of *The Razor*, Feng's theory is an affront to ontological economy for positing these additional strings. It is to be strongly dispreferred, all else equal. This is obviously backwards, as far as sound methodological counsel is concerned.

Feng's theory is obviously no affront to ontological economy, but—when judged purely by the methodological virtues—is evidently a more economical, tighter, and more unified improvement. It is *The Laser* that gets this right. Feng has actually incurred more commitments (he also has the strings) but at a lower total cost. When comparing Esther's ontology to Feng's, the right point of comparison is with the fundamental entities they posit. What should be compared for economy are Esther's 100 types of fundamental

Downloaded by [Rutgers University] at 18:15 16 December 2015

particle with Feng's 10 types of string. That is, what should be compared for economy are the fundamental entities.

I think that the case of Esther and Feng already reveals how *The Laser* is an improvement over *The Razor*. The reader who agrees may take the matter as settled. But for the reader unconvinced by this first line of argument, I have two further lines of argument to offer.

4. The Analogy with Conceptual Economy

Ontological economy—which *The Razor* and *The Laser* both aim to measure—is sistered to conceptual economy. Both measure aspects (ontological and conceptual) of the total economy of the theory. It is defeasibly reasonable to expect that the apt measures of economy will be parallel between these cases. That is, it is defeasibly reasonable to treat ontological economy and conceptual economy as relevantly analogous. I now (extending an argument in [Schaffer 2012: 87–8]) offer a second line of argument for preferring *The Laser*, based on an analogy with conceptual economy.

With conceptual economy, the right measure of economy is readily apparent. Compare these:

The Conceptual Razor: Do not invoke concepts without necessity!

The Conceptual Laser: Do not invoke primitive concepts without necessity!

By a 'primitive' concept, I mean a concept that is not defined in other terms but rather is introduced without definition. Primitive concepts are to ideology what fundamental entities are to ontology, and defined concepts are to ideology what derivative entities are to ontology. In both the ontological and conceptual domains, one finds a division between *the basis* (fundamental entities, primitive concepts) and *the superstructure* (derivative entities, defined concepts).

It should be readily apparent that *The Conceptual Laser* is preferable to *The Conceptual Razor*. Consider the following case (a partial conceptual analogue of the case of Esther and Feng). Georg has developed a decent regimentation of set theory. He invokes 10 primitive concepts, and from those 10 primitives he can define 40 other useful set-theoretic concepts. Hamsa though—in a moment of genius—builds on Georg's work to discover a beautiful axiomatization with just a single primitive notion. With her single primitive, Hamsa can define ninety-nine other useful set-theoretic concepts, including all forty of Georg's set-theoretic concepts.

Evidently, Hamsa's theory is methodologically preferable to Georg's on every relevant measure. Hamsa has provided an ideologically elegant approach *par excellence*, finding a single primitive notion through which she can define every concept Georg employs, and others besides. This is as good as it gets.

Yet if one counts by total concepts invoked, as per *The Conceptual Razor*, one will get the case of Georg and Hamsa *backwards*. For Georg's total

Downloaded by [Rutgers University] at 18:15 16 December 2015

ideology of 50 concepts is actually a proper subset of Hamsa's total ideology of 100 concepts. Hamsa invokes every concept Georg invokes: she invokes the 10 concepts Georg treats as primitive and the forty other concepts he treats as defined. She invokes strictly more: she also invokes her magnificently powerful primitive, and 49 further concepts she can define. So, by the lights of *The Conceptual Razor*, Hamsa's theory is an affront to conceptual economy for invoking an additional 50 concepts. This is obviously backwards, as far as sound methodological counsel is concerned.

In the conceptual domain it should be obvious that it is only *primitive concepts* that count against the conceptual economy of the theory. Defined concepts are available for free. Of course they are additional concepts. They are not to be identified with the concepts from which they are defined. (For instance, *overlap* and *proper parthood* are distinct concepts in mereology, not to be identified with each other. It is just that one can define either in terms of the other.)[6] Defined concepts are precisely the sort of conceptual addition that do not count against conceptual economy, by any measure apt for the conceptual side of the ledger.[7]

On the conceptual side of the ledger, the distinction between commitments and costs is obvious. If a theory defines a given *concept* then it recognizes that concept and in that sense incurs a conceptual commitment. For instance, classical mereology is conceptually committed to all sorts of concepts, including *overlap*, *proper parthood*, and *parthood*. But if a theory *defines* a given concept, it pays no price for that commitment. For instance, if *proper parthood* is taken as primitive, then *overlap* and *parthood* are freely available for definition.

It may be worth considering a further illustrative case on the conceptual side. So, imagine again that Hamsa, with her single magnificently powerful set-theoretic primitive, has managed to define her 100 concepts of set theory. Irina also invokes the very same primitive as Hamsa does, but she manages to define only 49 of the 99 concepts that Hamsa defines. Is there any sense in which Irina's approach boasts greater conceptual economy, simply because Irina has not seen how to put her one primitive to quite as much useful work as Hamsa has? Evidently not: Hamsa and Irina invoke exactly the same number of primitive concepts—namely, one—and hence exactly the same beautifully streamlined ideology.

Here is a different way to put the comparison between Hamsa's and Irina's ideologies. Imagine that one has just started to theorize about mereology, with *proper parthood* as one's lone primitive notion. One then sees how to define *overlap*. It would be deeply confused to think, 'Alas! I have suffered a setback! The conceptual economy of my theory has been compromised!' Likewise, one might imagine that Hamsa has reached Irina's

[6] Strictly speaking, the interdefinability of overlap and proper parthood holds only given certain background assumptions (in place in classical mereology), but the specific details are inessential to the point in the main text.

[7] In a similar vein, Cowling [2013: 3893] writes:

> [O]nly primitive ideology represents a potential cost to theories. After all, non-primitive ideology admits of definition in terms of primitive ideology and therefore "comes for free" once granted the analysans. So understood, the only substantial questions about ideological commitments are questions about which primitive concepts occur within a theory.

Downloaded by [Rutgers University] at 18:15 16 December 2015

position of defining 49 concepts from her one primitive, and then—unlike Irina—sees how to define additional concepts. Surely Hamsa has made an advance, and has in no way compromised the conceptual economy of her theory, so long as she continues to operate with just one primitive notion the whole time.

Or imagine now that Juan invokes the very same primitive as Hamsa and Irina do, but he refuses in principle to define any further concepts whatsoever, and insists on writing everything out in terms of his one and only primitive concept. (Proofs that Hamsa delivers on a single page of her graceful book occupy chapters of Juan's weighty tome. Or so rumour has it: no one in their right minds actually attempts to work through Juan's proofs.) Is there any sense in which Juan's approach boasts greater conceptual economy? Evidently not, even though Hamsa invokes 100 total concepts and Juan invokes just one of those concepts. Hamsa and Juan invoke exactly the same number of primitive concepts—namely, one—and hence exactly the same beautifully streamlined ideology. Juan's approach is merely more laborious, not more parsimonious.

So I conclude that *The Conceptual Laser* is preferable to *The Conceptual Razor*, and by analogy conclude that *The Laser* is preferable to *The Razor*. Arguments by analogy are of course defeasible if relevant reasons for resisting the analogy can be offered, but the burden is on those who would resist the argument to provide such reasons.

5. Bang for the Buck

Ontological economy—which *The Razor* and *The Laser* both aim to measure—is connected to fruitfulness. Theories are not supposed merely to be economical (both ontologically and conceptually); they are also supposed to be *fruitful* (or fecund, or strong). Often these virtues trade off: the less that is included in the basis, the less that might bear fruit. It is defeasibly reasonable to expect that the apt measure of economy will be well integrated with measures of fruitfulness. That is, it is defeasibly reasonable to think of ontological economy and fruitfulness as flowing from some single underlying virtue, such that trading one for the other might result in more or less of this single underlying virtue. (The single underlying virtue is the coin by which the trade-offs might be commensurate.) I now offer a second line of argument for preferring *The Laser*, based on integration with fruitfulness.

Return again to the conceptual side of the ledger, and think again of Hamsa with her single magnificently powerful set-theoretic primitive, by which she has managed to define 99 further concepts of set theory. Hamsa's approach is evidently fruitful, and part of the fruitfulness of her approach is that she is able to define so many further concepts. Her approach is even more fruitful to the extent that these further concepts turn out to be useful: they capture important ideas, streamline the proofs, etc.

On the conceptual side, one can see that defined concepts—far from being a cost in economy to the theory, as *The Conceptual Razor* would have it—are actually a gain in fruitfulness for the theory (especially when those

Downloaded by [Rutgers University] at 18:15 16 December 2015

further concepts are useful). Defined concepts not only cost nothing in economy; they represent the very fruit one wants a conceptual system to bear. So, on the conceptual side one wants theories like Hamsa's, which invoke a sparse handful of primitives, to define an abundance of helpful further concepts. What one wants on the conceptual side is to maximize 'bang for the buck', where the buck (the cost) is measured by primitive concepts, and the bang (the benefit) is measured by the range of useful concepts that can be defined.

> *Conceptual Bang for the Buck*: Optimally balance minimization of primitive concepts with maximization of defined concepts (especially useful ones).

Classical mereology is a paragon of a theory that scores highly with respect to *Conceptual Bang for the Buck*. A single primitive notion is introduced, such as that of *proper parthood*. (*Improper parthood* and *overlap* can work equally well in this setting.) From this single primitive, all sorts of other useful mereological concepts can be defined. Whether classical mereology is ultimately to be accepted or not is a further question, but even its detractors ought to admit that it is a beautiful bit of machinery.

In order to preserve the guiding analogy between conceptual economy and ontological economy, I propose that what one wants on the ontological side is equally to maximize 'bang for the buck', where the buck (the cost) is measured by fundamental entities posited, and the bang (the benefit) is measured by the range of useful entities that can be derived (see also Schaffer [2009: 361, 2012: 88]):

> *Ontological Bang for the Buck*: Optimally balance minimization of fundamental entities with maximization of derivative entities (especially useful ones).

Derivative entities are part of what makes a package of fundamental entities fruitful. They show that these fundamental entities can be used to produce something.

Pure set theory—with the null set treated as a fundamental entity—is a paragon of a theory that scores highly with respect to *Ontological Bang for the Buck*. A single primitive entity is introduced, namely the null set. From this single primitive, an entire transfinite hierarchy of pure sets can be derived through the operation of set formation. Whether pure set theory so understood is ultimately to be accepted is a further question; but, rather than seeing it as an ontologically hideously costly theory for bearing proper-class-many entities, I see it as a beautiful bit of machinery for building so much from so little.[8]

I am saying that *Ontological Bang for the Buck* is a plausible methodological underpinning for unified considerations of ontological economy and

[8] And if the null set can itself be grounded in or identified with something already recognized, then pure set theory would be doing better still. (For instance, Lewis [1991: 13–14] proposes identifying the null set with the fusion of all individuals.) For present purposes, the key points are that *The Laser* treats pure set theory, with the null set treated as fundamental, as a paragon of ontological economy, while also making sense of the further pressure to treat the null set as grounded in or identical with something already recognized (if possible).

Downloaded by [Rutgers University] at 18:15 16 December 2015

strength. I now add that if the single underlying methodological virtue is *Ontological Bang for the Buck*, then what it underlies is *The Laser* and not *The Razor*. *Ontological Bang for the Buck* pressures one to minimize fundamental entities (that's the buck), and thus supports a specific methodological injunction not to multiply such fundamental entities where possible. It supports no methodological injunction against derivative entities, but actually *favours* the generation of derivative entities (that's the bang).

Overall, bang-for-the-buck methodology across the ontological and conceptual sides of the ledger recommends a sparse *restrictivist* view of the basis (both the primitive concepts and the fundamental entities), coupled with an abundant *permissivist* view of the superstructure (both the defined concepts and the derivative entities). In place of desert landscapes, I suggest that one cultivate a taste for *fruitful orchards*, and seek theories whose slender trunks still have the strength to support branching and blossoming canopies:

> Give me the splendid silent sun, with all his beams full-dazzling;
> Give me juicy autumnal fruit, ripe and red from the orchard;
> Give me a field where the unmow'd grass grows;
> Give me an arbor, give me the trellis'd grape;
> (Walt Whitman, 'Give me the Splendid, Silent Sun')

6. Eliminating Derivative Entities as False Economy

So far, I have contrasted *The Razor* with *The Laser*, and offered three reasons to prefer *The Laser*: the argument from the case of Esther and Feng (section 3), the argument from the analogy with conceptual economy (section 4), and the argument from the integration with strength and an overall bang for the buck methodology (section 5). What would follow if these arguments were granted? I turn now to the implications for replacing *The Razor* with *The Laser*.

Metaphysics, being largely devoid of empirical data, must often resort to methodological principles to decide between theories. Principles of ontological economy thus play a major role in contemporary debates. In so far as *The Razor* is the wrong measure of ontological economy, these debates have been distorted by demands for false economies. Theories that merely multiply derivative entities (which count against economy by *The Razor* but not by *The Laser*) are rejected on poor grounds.

By way of illustration, there has been a movement to posit only fundamental entities, and to eliminate nonfundamental entities altogether, parading under the banner of improved ontological economy. Thus in the concrete realm, *mereological nihilists* have posited only fundamental entities—which they might take to be a plurality of point particles, or the entire cosmos—and rejected any further entities—be these proper wholes formed by their point particles, or proper parts cut from their vast cosmos—on the command of *The Razor*. Williams [2006: 494] provides a representative passage:

> The microphysical mereological nihilist denies the existence of ordinary objects. For her, strictly and literally speaking, there are no tables, chairs, or human animals; nor galaxies, planets, molecules of water or oxygen atoms.

Downloaded by [Rutgers University] at 18:15 16 December 2015

> This world-view has a certain spartan appeal as a no-nonsense uncompromising physicalism. Those who love desert landscapes should applaud the elimination of mereological composition from the fundamental furniture of the world (along with much else).

Likewise, some have felt a comparable motivation to reject set theory, since to accept set theory is to posit an entire transfinite hierarchy of entities.[9]

If I am right that derivative entities do not count against ontological economy, then this line of reasoning should be abandoned: eliminating derivative entities for the sake of ontological economy is as misguided as eliminating defined concepts for the sake of conceptual economy. There may, of course, be other reasons to prefer mereological nihilism or to reject set theory. My point is that *The Razor* should no longer be wielded for this purpose.

Instead of viewing classical mereology and set theory as ontologically profligate and thus suspect theories, I suggest that we view these theories as paragons of methodological virtue. These are beautiful and powerful theories, and their beauty and power is revealed in how much bang for the buck they deliver. By my lights, the classical mereologist and the set theorist need not lead a fraught existence, skulking in imminent danger of failing to reveal a necessity for the dazzling abundance of entities they deliver. Rather, they may stand secure as shining exemplars of virtue, for delivering so much from so little.

(The reader who is already inclined to admire classical mereology and to regard set theory as safe from elimination may consider this to be a fourth argument for preferring *The Laser* and associated bang-for-the-buck principles. These principles help to explain the virtues of these theories. But, since these matters remain controversial, I label this a mere implication, leaving open whether or not it is advantageous.)

7. Eliminating Derivation Relations as False Economy

Those who would eliminate derivative entities for the sake of 'economy' may claim a second sort of economy. For they eliminate not only the derivative entities; they also eliminate the relation of derivation by which the derivative entities derive. This thought is already explicit in the Williams passage above (section 5), and the two-pronged quest for economy is explicit, for instance, in Horgan and Potrč's [2012: 18] defence of 'existence monism' (only the

[9] Relatedly, Lewis [1986: 2, cf. 1991: 6] thinks that set theory is ontologically very costly, but still worth the price overall:

> Set theory offers the mathematician great economy of primitives and premises, in return for accepting rather a lot of entities unknown to *Homo javenesis*. It offers an improvement in what Quine calls ideology, paid for in the coin of ontology. It's an offer you can't refuse. The price is right; the benefits in theoretical unity and economy are well worth the entities...

I find Lewis's attitude baffling: by Lewis's lights, the ontological cost is 'rather a lot'—indeed proper-class-many—entities. That's an inconceivably high ontological cost! How can a mere 'economy of primitives and premises' be worth such an inconceivable price? I am saying that set theory is far less costly. Pure set theory (with the null set treated as fundamental) has proper-class-many *commitments* but these come at a vastly more affordable ontological *cost*: just one primitive entity, the null set.

Downloaded by [Rutgers University] at 18:15 16 December 2015

cosmos exists) over my 'priority monism' (the cosmos and its proper parts exist, but the latter depend on the former):

> By embracing existence monism one eliminates from ontology two kinds of unneeded theoretical baggage: not only the putative, ontologically precise, objects that are proper parts of the whole cosmos, but also the putative relation of ontological priority between the cosmos and those putative proper parts. Yet more reason to embrace existence monism, on grounds of yet more comparative theoretical simplicity.

Anyone who posits both fundamental and derivative entities should regard these entities as *connected*, and in particular should regard derivative entities as *dependent on*, *grounded in*, and/or *generated from* the fundamental entities (see, generally, Schaffer [2009, forthcoming]). Perhaps this relation connecting the fundamental to the nonfundamental must itself be a fundamental entity, and so perhaps there is some prospect of a real improvement in economy (by the very lights of *The Laser*) in eliminating this relation?

To see what has gone wrong, return again to the story of Hamsa and Juan (section 5). Hamsa invokes her single magnificently powerful set-theoretic primitive which she has used to define 99 further useful notions. Juan invokes the very same primitive, but refuses to define any further notions whatsoever. Evidently, Juan's perverse resistance to invoke defined concepts does not help his theory to achieve any greater conceptual economy. By the apt measure of conceptual economy, Hamsa's approach and Juan's approach are on a par, each costing exactly one primitive concept. But now imagine that Juan's resistance to invoking defined concepts stems from his underlying rejection of any relation of *definition* between concepts. Juan claims to have a methodologically preferable theory, not on grounds of invoking fewer concepts, but on grounds of doing without the definition relation. Has Juan at last gained the upper hand?

It seems to me evident that Juan would not have gained the upper hand by claiming to eliminate the notion of a definition altogether. But it is difficult to explain why this is so. I want to say that *The Conceptual Laser*—the apt measure of conceptual economy—already builds in a distinction between primitive and defined concepts. That there can be definitions is *presupposed* in the statement of *The Conceptual Laser*, and hence constitutes part of the fixed background against which conceptual economy is measured. Methodological maxims are not necessarily metaphysically neutral. Perverse enough hypotheses can be 'off the charts' for methodological evaluation, in so far as they violate presuppositions of that very methodology.

Thus, imagine that Keisha enters the debate with even stranger views than Juan's. Keisha is not aiming to eliminate definitions and work only with primitive concepts. She is a conceptual nihilist who has set out to eliminate concepts altogether. I cannot describe how she would proceed; nor can I imagine what it would take for her to succeed. But I can imagine at least that she is driven by the thought, 'If I can eliminate concepts altogether my theory will automatically do better than Hamsa's theory or even Juan's

Downloaded by [Rutgers University] at 18:15 16 December 2015

theory, on grounds of perfect conceptual economy: *zero*.' It seems to me that Keisha is deeply confused. Measures of conceptual economy presuppose that there are concepts to be measured. Likewise, *The Conceptual Laser* additionally presupposes that there are both primitive and defined concepts, only the former of which are to be measured.

Likewise, if Luke—in a move analogous to Juan's—accepts the very same fundamental entities as Feng does (the 10 types of string) but refuses to generate any further derivative entities altogether, he gains no advantage whatsoever. He gains no advantage from doing without the derivative entities, since (by *The Laser*) only fundamental entities count against economy. And he gains no advantage from doing without *derivation*, since that is part of the fixed background against which ontological economy is measured.[10]

(For the not-yet-convinced, I offer a backup move: even if one thinks that Juan has gained some methodological advantage over Hamsa by rejecting the very notion of definition, this must be weighed against the methodological disadvantage Juan faces when he tries to write his hideously cumbersome proofs. Analogously, even if one thinks that Luke has gained some methodological advantage over Feng by rejecting the very notion of dependence, this must be weighed against the methodological disadvantage Luke faces when he tries to write out his semantics. Surely the total methodological situation will still favour Feng and Hamsa in the end, although for me this is a backup move; my preferred view is that Juan and Luke gain nothing whatsoever, so that there is no need even to consider weights.)

8. The Overgeneration Objection

So far, I have made my case for preferring *The Laser* to *The Razor* (sections 3–5), and considered the implications of *The Laser* for certain contemporary debates (sections 6–7). I conclude by considering four objections. The first objection is that bang-for-the-buck methodology invites one to spuriously overgenerate derivative entities. Thus, consider a methodologically beautiful theory such as classical mereology, and let us suppose that one is looking at atomistic models and taking the mereological atoms to be the fundamental entities.[11] Classical mereology is an *extensional* theory, and one which—given the atomistic assumptions in play—generates 2^n-1 total entities out of n atoms. But why not generate more?

So, let us imagine that Mohammed upholds classical mereology for its theoretical beauty, while Naoki proposes a rival theory that she calls *doubled mereology*. Naoki's doubled mereology is not an extensional theory, and in particular has a 'mirror-image' operator that maps every nonatomic

[10] The notion of a *fundamental* (as opposed to a *derivative*) entity is built into *The Laser* from the start. So, anyone who accepts the terms in which *The Laser* was stated has already accepted a fundamental/derivative distinction, and should thereby accept the concomitant notion of a derivation relation.

[11] These assumptions are doubly problematic, in connected ways. There are non-atomistic ('gunky') models of classical mereology, featuring endless proper-parthood chains. And for this and other reasons it may be wrong to think of the mereological atoms as what is fundamental in mereological structure. Certainly, classical mereology does not make any explicit claims about the direction of dependence. Indeed, elsewhere [Schaffer 2010] I argue that it is the maximal whole that is fundamental in mereological structures. For present purposes, I can remain neutral on these issues: the example in the main case is just an illustrative example.

Downloaded by [Rutgers University] at 18:15 16 December 2015

individual to its numerically distinct 'mirrored counterpart' that has exactly the same proper parts (double application of this operator, like double application of negation, returns the original). For every nondegenerate plurality of atoms, where classical mereology has a single sum, doubled mereology has a pair of sums. Doubled mereology seems like a needlessly complex and relatively ugly rival to classical mereology. But—the overgeneration objection runs—bang-for-the-buck methodology perversely gives Naoki's doubled mereology the upper hand over Mohammed's classical mereology, since, given a fixed collection of fundamental atoms, doubled mereology gets double the bang for the same buck.[12]

(Doubled mereology is just the beginning of the trouble. For doubled mereology has its own doubled rival, which has its own doubled rival, *ad nauseam*. But for present purposes it is enough to consider doubled mereology.)

I offer two replies to the overgeneration objection, of which the first is to emphasize the parenthetical '(especially useful ones)' in *Ontological Bang for the Buck*, and to point out that the extra sums generated by doubled mereology have not been put to any use. As such, the methodological gain involved in harvesting such inedible fruit is minimal. It is akin to defining concepts which one then never uses. (Of course, the defender of doubled mereology might try to find new work for her extra sums. But, to the extent that she can actually find real work for them to perform, doubled mereology ought to start looking more promising.)

The second reply, which is connected to the first, is to emphasize that ontological economy and strength—as jointly encoded by *Ontological Bang for the Buck*—are hardly the only methodological principles. What is really ugly about doubled mereology emerges if one actually attempts to axiomatize the theory. Classical mereology is standardly axiomatized with a plausible *supplementation axiom*, which entails extensionality. Doubled mereology would need to involve less plausible and presumably more complicated axioms. This loss of initial plausibility and axiomatic elegance should more than offset the minor gain in power. (If one could conjure up an equally plausible and elegant axiomatization of doubled mereology, it also ought to start looking more promising.)

In fact, classical mereology is the maximally permissive system that still obeys extensionality (it balances universal composition with extensionality). So a very plausible way of seeing the underlying methodological beauty of classical mereology is that it strikes a further optimal balance, namely that between maximizing bang for the buck and preserving the plausibility and axiomatic elegance of an extensional treatment. Indeed, both mereology and set theory are *maximally permissive, given the demands of their associated extensionality principles*.

It would be nice to be able to show that all of the methodologically most virtuous theories can be described as 'maximally permissive, given certain plausible independent constraints'. But I am unsure as to whether or not this holds in general (this should be read as an invitation to those who would

[12] More precisely, where classical mereology returns $2^n-(n+1)$ composites from n atoms, doubled mereology returns twice this many composites from n atoms.

Downloaded by [Rutgers University] at 18:15 16 December 2015

level the overgeneration objection, to display a methodologically excellent theory that does not fit such a description). Accordingly I reserve, as a last resort, a line of retreat in which one jettisons *Ontological Bang for the Buck* (and the associated argument for *The Laser*) but still upholds *The Laser* for other reasons (sections 3–4). *The Laser* itself is compatible with regarding the multiplication of derivative entities as purely neutral, or even as costly for some other independent reasons (but just not as costly as fundamental entities, so that there is no collapse into *The Razor*). As such, the overgeneration objection does not touch *The Laser* itself. Again, this is a backup move: my preferred view is that overgeneration is always balanced out by other constraints.

(Some may even be attracted to alternative pricing policies at this point, to avoid overgeneration by introducing some discounted but still non-zero price for derivative entities. I do not think this is needed, and think that the analogy with conceptual economy from section 4 tells strongly against everything but the zero price policy. But the person attracted to alternative pricing policies may still agree with my main thesis that *The Laser* is preferable to *The Razor*, even if she holds out hope for a still better third option.)

9. The Instability Objection

I turn to considering a second objection, which I owe to Michael della Rocca [2014: 284–8]. The second objection is *the instability objection*, which maintains that my criticism of *The Razor* is unstable. I say this: 'Generate derivative entities where possible (all else equal): derivative entities represent a fruitfulness-making feature of the fundamental entities posited.' The instability objection asks whether or not it is rational to posit derivative entities. If it is, then they are posited with (rational) necessity, and so do not violate the command of *The Razor* after all. If not, then they are not posited rationally in the first place, and so should not be posited at all.[13]

With the instability objection, issues about the 'without necessity' proviso resurface. I think that derivative entities are posited with rational necessity, but not with the kind of rational necessity that *The Razor* allows one to recognize, so that they do still violate the command of *The Razor*. In order to build up to this reply, it might help first to consider some bad moral advice. So imagine that Oleg advises us to *never use anyone's property without necessity!* Patrice replies that this is bad advice, and that better advice would be to *never use anyone else's property without necessity!* Surely Patrice is right. There is clearly a distinction between using one's own property (this is generally permitted) and using someone else's property (this is not generally permitted). To give the right moral accounting principles, so as to make sense of why certain actions are right or wrong, and which actions are right or

[13] Della Rocca [2014: 290–2] goes in for the latter position, positing an 'existence monist' ontology, on which the one and only individual is the one whole (see also Horgan and Potrč [2012]); although his concluding 'apocalyptic' view goes even further beyond pluralism and monism, since 'relations between a thing and its properties are, like other relations, to be rejected' so that 'perhaps it cannot be the case that there is even one thing.'

Downloaded by [Rutgers University] at 18:15 16 December 2015

wrong in the first place, one cannot count all property equally. But now imagine that Oleg defends his bad advice by accusing Patrice of holding an unstable view. He asks, in a given case where the property happens to be one's own, whether or not it is rational for one to use their property in that case. If not, he says, *just as I advised!* If so, he says, *just as I advised: my 'without necessity' proviso was triggered, so I permit the use of one's own property!* Surely something has gone wrong. But what exactly?

It is useful to think of these bits of advice as imposing *pro tanto* requirements (section 2). Oleg is then saying that it is *pro tanto* required that one never use property, but that in cases of using one's own property the requirement is especially liable to be outweighed. What Oleg is saying is wrong in three respects. First, it is implausible as a *pro tanto* requirement. Second, it is wrong in so far as violations of *pro tanto* requirements have two signature features: they are explained by the need to uphold separate weightier norms, and they involve a residual bad-making feature in so far as the original norm is violated (it is regrettable if I must take your property to help the needy, and you may be owed some compensation for your loss). Yet there are no signs of norm violation when one uses one's own property (one need not appeal to a separate weightier norm, or feel any sense of regret). Third, and perhaps most deeply of all, it is wrong in so far as Oleg is, in the ultimate account, drawing a distinction between one's own property and others but just hiding it within his 'without necessity' proviso. He is clearly accepting Patrice's better view in all but name, and just hiding that fact by letting his 'without necessity' proviso save the letter of his bad advice when needed. Given Oleg's views of the *pro tanto* norms surrounding property, he should not be allowed to recognize a normative distinction based on who owns the property at all. In the cases where Oleg says '*just as I advised: my "without necessity" proviso was triggered, so I permit the use of this property!*', Patrice should rejoin, 'Oleg is not entitled to this understanding of "without necessity" in so far as it requires my theory, not his.' Patrice is right that one may use one's own property; but Oleg has no way to understand this in his own terms, for a crucial part of the reason why one may use one's own property is that doing so does not violate any norms of property use in the first place.

With the case of Oleg and Patrice in mind, it might help as well to consider how an analogous instability objection might play out on the conceptual side of the ledger. So consider Hamsa again, with her brilliant treatment of set theory via a single primitive, which she has used to define 99 further useful notions. And return to her debate with Juan, who has taken up Hamsa's primitive notion but refuses to define any further notions whatsoever. Juan can prove everything that Hamsa can (in principle at least). It is just that his proofs are horridly complicated in comparison. Juan declares: *never invoke concepts without necessity!* Hamsa replies that this is bad advice, and that better advice would be to *never invoke primitive concepts without necessity!* Surely Hamsa is right (or so I consider obvious). But now imagine that Juan defends his bad advice by accusing Hamsa of holding an unstable view. He asks, in a given case where the concept is defined, whether or not it is rational to define that concept. If not, he says, *just as I advised!* If so, he says, *just*

Downloaded by [Rutgers University] at 18:15 16 December 2015

as I advised: my 'without necessity' proviso was triggered, so I permit the invocation of this concept! Surely something has gone wrong.

Again it is useful to think of these bits of advice as imposing *pro tanto* requirements. Juan is then saying that it is *pro tanto* required that one not invoke concepts, but that in cases of invoking defined concepts the requirement may be outweighed. What Juan is saying is implausible as a *pro tanto* requirement. Moreover, neither of the signature features of norm violation are present in the invocation of derivative concepts: one is free to define concepts without needing to first argue that separate weightier norms make this possible, and one need not feel intellectual regret for having done so. Finally, and perhaps most deeply of all, Juan is not entitled to an understanding of 'without necessity' that uses the norms that Hamsa recognizes but that Juan does not recognize. Hamsa is right that it is rational to define concepts, but Juan has no way to understand this in his own terms, for a crucial part of the reason why it is rational to define concepts is that doing so does not violate any norms of conceptual economy in the first place.

Returning now to the ontological side of the ledger, consider Feng again with his brilliant treatment of physics via his 10 types of string, which he uses to ground particles, chemicals, organisms, etc. And consider Luke again, who takes up Feng's fundamental strings but refuses to derive any further entities whatsoever. Luke can do fundamental physics just as well as Feng can, and therefore can give causal/nomic predictions of everything that Feng can (in principle). Luke declares: *never multiply entities without necessity!* Feng replies that this is bad advice, and that better advice would be to *never multiply fundamental entities without necessity!* I have tried to make the case that Feng is right, and now I am ready to face the instability objection directly. So, imagine that Luke accuses Feng of holding an unstable view. He asks, in a given case where the entity is derivative, whether or not it is rational to posit that entity. If not, he says, *just as I advised!* If so, he says, *just as I advised: my 'without necessity' proviso was triggered, so I permit the positing of this entity!* I think that Luke has gone wrong in just the way that Oleg and Juan went wrong.

From the *pro tanto* perspective, Luke is saying that it is *pro tanto* required that one not posit entities, but that in cases of invoking derivative entities the requirement may be outweighed. What Luke is saying is implausible as a *pro tanto* requirement (or so I have argued). Moreover, neither of the signature features of norm violation is present: Feng is free to posit particles and chemicals formed from his strings, without needing first to argue that separate weightier norms make this possible, and without owing any intellectual regret for having done so. Finally, and perhaps most deeply of all, Luke is not entitled to an understanding of 'without necessity' that uses the norms that Feng recognizes but that Luke does not recognize. Feng is right that it is rational to posit derivative entities, but Luke has no way to understand this in his own terms, for a crucial part of the reason why it is rational to posit derivative entities is that doing so does not violate any norms of conceptual economy in the first place.

In general, to give the right account of a 'without necessity' proviso, one needs in the background *the right accounting principles for the subject* (be it

Downloaded by [Rutgers University] at 18:15 16 December 2015

the moral, the conceptual, or the ontological), in order to weight considerations properly. I think that derivative entities are posited with rational necessity, but not with the kind of rational necessity that *The Razor* allows one to account for or to recognize, so that positing such entities can still violate the command of *The Razor*. As such, *The Laser* represents a stable position (as does *The Conceptual Laser*, as does Patrice's sensible reply to Oleg). In short, derivative entities are posited *with a rational necessity that one needs the Laser to illuminate*.

10. The Special Sciences Objection

I move on to considering a third objection, which I consider the most worrisome. This third objection is the *special sciences objection*, which begins by noting that considerations of economy are part of sound scientific practice, not just in fundamental physics, but also throughout the special sciences. The chemist and the biologist use economy principles just as much as the physicist does. But—the objection continues—on the plausible assumption that chemicals and organisms are not fundamental entities, *The Laser* thereby fails to offer methodological guidance for the chemist or the biologist.[14]

I think that there are at least two sorts of case in which economy principles are invoked in the special sciences. One sort of case is illustrated by reasonable scepticism towards the claim that cryptids like Bigfoot exist. Thus, the biologist John Crane (quoted in [Goodavage 1996]) writes: 'There is no such thing as Bigfoot. No data other than material that's clearly been fabricated has ever been presented.' But note that the objection to Bigfoot is not that Bigfoot would be an additional entity. Indeed, I take it that—in ways that do not straightforwardly fit *The Razor*—a biologist would have no qualms whatsoever about positing one more squirrel, or one more species of roundworm. The objection is rather that believing in Bigfoot requires believing in various vast and improbable conspiracies. The simplest overall explanation for Bigfoot beliefs involves a cultural meme perpetuated in part by some hoaxes. This is an inference to the simplest explanation *but not one involving concerns about the multiplication of entities*. For this, neither *The Razor* nor *The Laser* is needed.[15]

[14] Indeed, as an anonymous referee points out, *The Laser* also fails to offer guidance to the physicist working on non-fundamental entities like planetary systems, and to the physicist who expects (perhaps based on historical induction) that whatever she is studying will eventually be shown to be non-fundamental.

[15] Here is a related but less fanciful case, which I owe to an anonymous referee. There is an ongoing debate as to whether the ivory-billed woodpecker has gone extinct. There have been no definitive sightings for decades, though there is a controversial 2005 recording that has been argued to be of an ivory-billed woodpecker. But in this case there seems to be no background methodological concern about ontological economy at all. Rather, the extinction hypothesis is simply offered as the most probable explanation for the lack of definite sightings, especially after extensive searches by various expert search teams (including multiple Cornell-organized teams in 2005–9). The Florida Ornithological Society Records Committee report from 2007 (at http://en.wikipedia.org/wiki/Ivory-billed_woodpecker) provides a useful summary of the considerations that are actually at issue in such a case:

> The species had not been documented to occur since 1944. The video documentation of the bird(s) from Arkansas, however, has been debated by many, although the record was accepted by the Arkansas Bird Records Committee. Our Committee felt that given the controversy of the Arkansas evidence, the species is best considered still extinct. Therefore only evidence that undoubtedly showed a living bird would be considered sufficient to accept a report.

Downloaded by [Rutgers University] at 18:15 16 December 2015

A second sort of case is illustrated by reasonable scepticism toward the claim that psychic powers like telekinesis exist (in telekinesis, one is supposed to be able to move physical objects directly by the mind, such as bending spoons purely by force of will). But note that one large part of the objection to telekinesis—and part of why it is standardly thought that only very strong evidence could support it—is that it seems to require positing some sort of additional fundamental mental force acting at a distance without physical mediation. So, part of the reason for rejecting telekinesis at the psychological level is to avoid ontological costs at the fundamental physical level. Both *The Razor* and *The Laser* suffice to capture this.

Putting the Bigfoot and telekinesis cases side-by-side, I am saying that there is a very strong methodological constraint operative in the special sciences, which is *to fit within the grounds provided by fundamental physics*. (In general, derivative entities impose an indirect cost, in terms of whatever fundamental entities serve as their grounds.) This is part of what makes telekinesis seem so implausible. But I am also saying that there is no further economy constraint on special science tokens or types. This is why biologists have no economy-based constraints against positing one more squirrel, or one more species of roundworm.

It would be nice to be able to show that every economy principle used in the special sciences is of one of these two types, or at least fits within the general methodological constraint of fitting within the grounds provided by fundamental physics. But I am unsure of whether or not this holds in general. This should be read as an invitation to those who would level the special sciences objection, to display a legitimate application in the special sciences that requires *The Razor* and cannot be handled with *The Laser*. Pending such an example, I tentatively conclude that *The Laser* represents progress.

(This is a second point at which alternative pricing policies might look attractive, with the thought that a discounted but still non-zero price for derivative entities would allow us to make even better sense of the special sciences. But, again, anyone who is attracted to alternative pricing policies may still agree that *The Laser* represents progress, even if she holds out hope for further progress still.)

Downloaded by [Rutgers University] at 18:15 16 December 2015

11. The Gunk Objection

I conclude by considering a fourth objection, which begins by claiming that it is possible that there be no fundamental entities, but rather a limitless descent of ever-more-fundamental entities. For instance, it seems possible for everything to be *gunky*, such that every part of everything has proper parts. On the assumption that proper parts are always more fundamental than wholes, gunky scenarios involve a limitless descent of ever-more-fundamental entities. Moreover—the objection continues—considerations of ontological economy are still operative even in gunky worlds, and so the *Laser* fails to illuminate theory choice at gunky worlds.

My preferred reply is that it is not possible for there to be a limitless descent of ever-more-fundamental entities: there must be a ground of being.

That is not to say that gunk is impossible, but rather that at gunky scenarios (and perhaps more generally) it is a mistake to think that proper parts are always more fundamental than wholes. There must be a ground of being, for the same reason that there must be a foundation for reasons (or so the epistemic foundationalist says): a baseless entity is analogous to a baseless belief. Likewise, there must be a ground of being, for the same reason that chains of definition must end somewhere: it is hard to see how meaning could ever have been infused into a limitless descent of definitions with no primitive basis. At any rate, while I cannot argue for a ground of being in any more detail here (though see Schaffer [2010: sec. 2.4, forthcoming]), I would just note that the objection has a presupposition I independently reject.

My backup reply—granting *arguendo* that there can be a limitless descent of ever-more-fundamental entities—is to extend *The Laser* in a natural way so that it is applicable to such scenarios. The natural extension of fundamentality principles to limitless descent scenarios is to look for *downward monotony*, replacing claims about what holds at the fundamental level with claims about what holds at some arbitrary level and at every level below it. One way to build this into a principle of comparative theory choice would be as follows:

> *The Phaser*: Theory *T1* is more ontologically economical than theory *T2* iff there is a level *L* such that, if *L* were fundamental, then the *Laser* would prefer *T1* over *T2*, and such that, for every level *L-* lower than *L*, if *L-* were fundamental then the *Laser* would prefer *T1* over *T2*.

The Phaser represents potential progress even beyond *The Laser*, applying even in cases with limitless descent, so long as there is some arbitrary level at which downward monotony in theory choice begins.

Indeed, in cases where there is a fundamental level, *The Phaser* collapses into *The Laser* (reinterpreted in the most natural way as a principle of comparative theory choice):

> *Phased Out*. If there is a fundamental level *L0*, then Theory *T1* is more ontologically economical than theory *T2* by the lights of *The Phaser* if and only if Theory *T1* is more ontologically economical than theory *T2* by the lights of *The Laser*.

Left-to-right. Suppose that *T1* is more ontologically economical than theory *T2* by the lights of *The Phaser*. Then there must be some level *L* such that, if *L* were fundamental then *The Laser* would prefer *T1* over *T2*, and such that, for every level *L-* lower than *L*, if *L-* were fundamental then *The Laser* would prefer *T1* over *T2*. This requires that, if *L0* were fundamental, *The Laser* would prefer *T1* over *T2*. Since *L0* is fundamental (by supposition), this entails simply that the *The Laser* would prefer *T1* over *T2*. In other words, theory *T1* is more ontologically economical than theory *T2* by the lights of *The Laser*, which was what was wanted.

Downloaded by [Rutgers University] at 18:15 16 December 2015

Right-to-left. Suppose that *T1* is more ontologically economical than theory *T2* by the lights of *The Laser*. It follows that there is a level *L*—namely the fundamental one, *L0*—such that, if *L* were fundamental then the *Laser* would prefer *T1* over *T2*, and such that, for every level *L-* lower than *L*, if *L-* were fundamental then the *Laser* would prefer *T1* over *T2* (since there is no level lower than *L0*, this latter condition holds vacuously). And so *T1* is more ontologically economical than theory *T2* by the lights of *The Phaser*, as was wanted.

Putting this together, I do not think that one needs to move beyond *The Laser*. But those who are more tolerant of the science fiction of limitless descent may dream of a natural generalization to *The Phaser*, which works as *The Laser* does when there is a fundamental level.[16]

Rutgers University

Received: August 2014
Revised: November 2014

Downloaded by [Rutgers University] at 18:15 16 December 2015

References

Armstrong, D.M. 1997. *A World of States of Affairs*, Cambridge: Cambridge University Press.
Bennett, Karen unpublished manuscript. *Making Things Up*.
Black, Max 1952. The Identity of Indiscernibles, *Mind* 61/242: 153–64.
Cameron, Ross 2010. How to Have a Radically Minimal Ontology, *Philosophical Studies* 151/2: 249–64.
Cowling, Sam 2013. Ideological Parsimony, *Synthese* 190/17: 3889–908.
Della Rocca, Michael 2014. Razing Structures to the Ground, *Analytic Philosophy* 55/3: 276–94.
Goodavage, Maria 1996. Bigfoot Merely Amuses Most Scientists, *USA Today*, 24 May 1996.
Horgan, Terry and Matjaž Potrč 2012. Existence Monism Trumps Priority Monism, in *Spinoza on Monism*, ed. Philip Goff, Basingstoke: Palgrave Macmillan: 51–76.
Huemer, Michael 2009. When Is Parsimony a Virtue? *The Philosophical Quarterly* 59/235: 216–36.
Lewis, David 1973. *Counterfactuals*, Oxford: Basil Blackwell.
Lewis, David 1986. *On the Plurality of Worlds*, Oxford: Basil Blackwell.
Lewis, David 1991. *Parts of Classes*, Oxford: Basil Blackwell.
Nolan, Daniel 1997. Quantitative Parsimony, *The British Journal for the Philosophy of Science* 48/3: 329–43.
Paul, L.A. 2013. Categorical Priority and Categorical Collapse, *Aristotelian Society Supplementary Volume* 87/1: 89–113.
Schaffer, Jonathan 2007. From Nihilism to Monism, *Australasian Journal of Philosophy* 85/2: 175–91.
Schaffer, Jonathan 2009. On What Grounds What, in *Metametaphysics: New Essays on the Foundations of Ontology*, ed. David Chalmers, David Manley, and Ryan Wasserman, Oxford: Oxford University Press: 384–423.
Schaffer, Jonathan 2010. Monism: The Priority of the Whole, *The Philosophical Review* 119/1: 31–76.
Schaffer, Jonathan 2012. Why the World Has Parts, in *Spinoza on Monism*, ed. Philip Goff, Basingstoke: Palgrave Macmillan: 77–91.
Schaffer, Jonathan forthcoming. Grounding in the Image of Causation, *Philosophical Studies*.
Spade, Paul Vincent 2011. William of Ockham. *The Stanford Encyclopedia of Philosophy (Fall 2011 Edition)*, ed. Edward N. Zalta, URL = <http://plato.stanford.edu/archives/fall2011/entries/ockham/>.
Willard, M.B. 2014. Against Simplicity, *Philosophical Studies* 167/1: 165–81.
Williams, J.R.G. 2006. Illusions of Gunk, *Philosophical Perspectives* 20/1: 493–513.

[16] Thanks to Karen Bennett, Ross Cameron, Michael della Rocca, Terry Horgan, L.A. Paul, Tatjana von Solodkoff, and two anonymous *AJP* referees for discussion.