The ontology of a theory

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Abstract

This paper defends two claims about the criterion of commitment of W.V.O Quine. The first claim is that the criterion can be made extensional. The second is that a proper formulation becomes an analytic truth. We spend a few preliminary sections clarifying our intended notion of ontological commitment. We will not go very far in our investigation of the criterion if we do not distinguish (1) the things a theory postulates, (2) what its adherents, or anybody else, believe in, and (3) which of these entities we have *compelling reasons* to accept. A look at [Quine 1953] shows that the criterion concerned the postulation of entities by theories, but it is often misread as an attempt to say something about either (2) or (3). The core of the paper is an exposition of two formulations of the criterion. I first state a schema improving on that of [Scheffler and Chomsky 1959]. The second formulation is a single principle and construes commitment as a relation between theories and predicates: ontological commitment to the entities that satisfy a given predicate. Both criteria are extensional and are formulated for *constructional systems*, in the sense of [Carnap 1928] and [Goodman 1951], rather than for theories construed as interpreted sets of sentences. This solves a problem raised by [Halvorson 2019]. Their analyticity is substantiated by showing that their most controversial consequences are instances of Tarski's Convention (T).

1 Introduction

If there is one thing metaphysicians seem to agree upon, whatever their style and persuasion, whether analytic or 'naturalistic', it is the slogan that the ultimate ontology of the world cannot just be 'read off from physics' [Ladyman and Ross 2007, p. 118]. What the reading off would consist in is seldom explained. But there seems to be at least one notorious culprit at which we can confidently point our fingers: W.V.O. Quine [1948, 1953, 1960] and his criterion of ontological commitment [Esfeld 2018, p. 2]. A variety of philosophical arguments have been put forward to show that the criterion is insufficient, or too restrictive. They add up to many technical investigations, purporting to prove that the formulations given by Quine [1953] do not live up to his extensionalist aspirations [Scheffler and Chomsky 1959] [Cartwright 1954] [Parsons 1970].[1] This paper examines the original criterion of commitment and the arguments of its enemies. The verdict it reaches is a defense of the old orthodoxy against the new orthodoxy.

My first and more modest claim is that the good old criterion is intelligible, extensional, and plausible. But my main contention is that it is, in fact, a truism. A proper formulation of the criterion is as bold a claim as that rich people are not poor, rain falls from the clouds, and Monsieur de Lapalisse had to be alive sometime before he died. With a bit of jargon, what I will defend is that the criterion of ontological commitment turns out to be an analytic truth. Informal polling of friends and colleagues suggests that the second claim sounds provocative. How do you explain, I have been asked, that the best and the brightest in philosophy write entire books against a tautology? My go-to reply is that the sociology of philosophy is not my area of expertise. But if steered into a quiet corner and asked whether I am really in earnest, I would add that the formulations of the criterion in [Quine 1951b, 1953] are impressionistic. They paint with a broad brush but they do not make much sense, if interpreted literally. To restate them soundly is not trivial. This difficulty explains why a self-described admirer of the approach of [Quine 1948], like Van Inwagen [2009], asserts that the criterion does not exist. Another source of confusion is the misidentification of the criterion with a program to regiment physics. One is a standard for what some specific theories assume to exist. The second is an approach, or the beginning of an approach, to settle questions about the world.[2] My defense of the criterion consists of two parts. The first order of business is to state the criterion precisely. My claim that the criterion is an analytic truth, when stated properly, requires that I state it properly. I propose two different formulations. The first is a sentential schema using an infinity of unary predicates for commitment to specific entities, relative to a manual of translation. In the technical sense of [Quine 1960], a translation manual is a function between pieces of a foreign language and pieces of English. The schematic criterion employs a notion of ontological commitment relative to such an interpretation. That is, commitment is relative to a translation function from the language of the theory to English.[3] The second precisification of the criterion is a single principle. It encapsulates much of the content of the previous

[1] These formulations fail to conform to his long-standing policy of extensionality [Quine 1951b, 1951c, 1954 2008] on at least three counts: (1) ascription of ontological commitment does not allow for the substitution of coreferential expressions *salva veritate*, (2) a notion of synonymity seems to figure implicitly, (3) modal locutions are employed (cf. section *2.2*).

[2] To clarify the distinction, it is illuminating to look at some philosophers that accepted the criterion of commitment but did not subscribe to the regimentation program. For example, Nelson Goodman adopts a form of the criterion of commitment in [Goodman 1951, p. 51]. But Goodman is thoroughly opposed to the view that physics is the ultimate arbiter of what there is [Goodman 1978, pg. 77]. Carnap, who is often presented as the main foe of Quine's metaphysical program, writes in footnote 3 of [Carnap 1950] that '*W.V. Quine was the first to recognize the importance of the introduction of variables as indicating the acceptance of entities*'. That the criterion is not the point under dispute is also reiterated by Quine: '*If I understand him correctly, Carnap accepts my standard for judging whether a given theory accepts given alleged entities*' [Quine 1966, pg. 128].

[3] The schema can be said to be analytic in the sense that every instance of it is analytic.

schema but is concerned only with some ontological commitments: ontological commitment to the entities that satisfy some open formula $\phi(x)$ for variable 'ϕ'. We end up with two distinct but overlapping formulations. For a theory T that is either devoid of semantical vocabulary, or that can develop a modest part of its own theory of truth and satisfaction, commitment to things of some sort and commitment to the things falling under a predicate for that sort amount to the same thing. We show indeed that, for many theories, we can deduce all instances of the schema from the second criterion and some bridge principles.
In stating both, I have tried to remain faithful to the main ideas of [Quine 1939, 1947, 1951a] and to meet his standards of philosophical clarity [Quine 1951b, pg. 92]. This entails renouncing all intensional contexts. I have also abstained from notions of analyticity and synonymy - even though I am obviously happy to make claims of analyticity myself. I need only to appeal to one special case of synonymy: that holding between a phrase from ordinary language and a predicate of a first order theory that has been chosen to abbreviate it by convention. This is a notion that Quine [1951a, pg. 6] found perfectly clear.
The second part surveys the most prominent objections of which I am aware, in light of our analysis of the criterion of commitment. If the criterion is analytic, they must be retraceable to some fundamental misunderstandings about the criterion and what it is meant to do. Three aspects stand out as often misunderstood: (a) the fact that the criterion applies to the commitments of theories and not to those of persons, (b) that it applies to first order theories and not to all type of theories, (c) that it reports what theories assume to exist rather than what we *ought* to believe exists. Therefore, before we attempt to state or defend the criterion, let me begin with some conceptual analysis.[4]

1.1 Three types of ontological commitment

Before defining ontological commitment, I need to point out that the phrase, as it is used now, is ambiguous. In the hands of a contemporary philosopher, 'ontologically committed' can mean at least three different things. Let me illustrate the difference with three examples. They are representative, in the sense that I could have extracted them from an issue of a generic journal.

(1) Bohmian mechanics is committed to points of configuration space

[4]**The detailed structure of the article** The first two sections review the main obstacles to making the criterion extensional [Chomsky and Scheffler 1959] [Cartwright 1954]. I also motivate the constraints (a)-(c) on a proper formulation of the criterion. I lay much stress on the fact that the criterion applies to theories and not to the commitments of the theorists, philosophers, scientists, or in general men and women in the street and that the theories to which it applies must be in the notation of the predicate calculus. The criterion is not meant, therefore, to apply to spoken language, beliefs, songs, poems, questions, combinatory logic, the lambda calculus, second order languages, the equations that physicists write on their blackboards, or anything else that isn't a first order theory. I will cite passages from [Quine 1936, 1947, 1951b] in aid of this interpretation and discuss passages that seem to suggest the contrary. In the second part, I define manuals of translation and specify the schema. Later I define a binary predicate - holding between theories and phrases from ordinary language - and use it to formulate an extensional version of the criterion. The third section is a short argument for their analyticity. In the last section, I respond to other prominent critics.

(2) David K.Lewis was committed to flying donkeys and pink elephants
(3) As naturalists, we look at physics to determine our ontological commitments.

The attentive reader will notice some differences in the way the notion of commitment is understood in (1), (2), and (3). The first statement is concerned with the commitments of a particular theory. Nothing is said in (1) about whether quantum theory is plausible, implausible, part of the scientific consensus, a risky conjecture, or the delusion of a crank. That the theory is committed to configuration space is not a value judgment. Whether we accept or reject the theory is irrelevant. This is the central notion of ontological commitment in this article. The commitments of a theory in this sense are roughly speaking what the theory 'says exists'. This notion is different from that in (2). In (2), we find a mention of the commitments of an individual. Frank Jackson has something like this in mind in the opening of his paper *Ontology and paraphrase* [1980].

> It is persons who are ontologically committed. But a person is not ontologically committed by virtue of his character, his height [...] or whatever, but by virtue of the sentences he assents to. [ibid., p. 1].

This citation is not meant as an exhaustive explanation or endorsement of the second notion's clarity or intelligibility. What sort of sentences we need to assent to, and what sort of assent is required to create a commitment remains to be explained. It will not do to say that someone is committed to electrons if and only if they say that electrons exist. If this were the case, the matter would be straightforward. We would only need to go to a person and ask: 'do electrons exist?'. If they said 'yes', they would be committed, if not, they would not be. This would be clear enough, but it does not mirror at all how philosophers ascribe commitment to each other and to third parties. Philosophers speaking in this vein often commit a person when an existence claim follows from their explicit assertions, in a suitable sense of 'follow', that is, either follows logically or is 'analytically entailed'. (Notice that the notion of logical consequence involved must be one appropriate to ordinary language and not to a formalized language). However, in practice, a person with contradictory beliefs, for example, someone that denies one of their ontological commitments, is rarely considered to be committed to the existence of absolutely everything. Commitment is denied even though every statement follows from their assertions. In practice, an ascription of ontological commitment seems to rely on a dose of psychological speculation about how the person would change their mind, when discovering unexpected implications of their beliefs. It is not easy to specify what exactly the algorithm is supposed to be, and I will not try further.
Sentence (3) marks a second and even more pronounced shift in the use of the expression 'ontological commitment'. It is natural to suppose that a person has strong reasons, or at least faces pressure, to accept the logical implications of the beliefs he or she holds firmly. We are accountable for them, in the sense that logical consistency requires us to either radically revise our premises, or else embrace the conclusion. In analogy with this observation, it feels natural to say that someone professing to accept the consensus of our best science on

any subject is then committed to take at face value every particular scientific discovery, such as the genetic inheritance of traits or the absence of time-reversal symmetry in certain atomic processes. But notice that this is strictly speaking an extension of the primary usage of 'ontological commitment'. These results and findings do not follow from the mere statement that one defers to the best science, or any other belief that a singularly ignorant naturalist may hold. The ignorant naturalist is in the same boat as the theologically illiterate catholic, that professes to believe whatever is declared *ex cathedra*, but is not informed as to what most of the dogmas of the catholic church are. This usage seems to slide more and more in the direction of a normative notion of commitment. We are now referring to what we ought to believe rather than to what we do believe in. Long forgotten is what the theory says. Nowhere is this clear as in the familiar trope of 'a guide to ontological commitment'. As it turns out, the pious do not use the expression in connection with high priests and sacred books as much as philosophers of science do. Gabriele Contessa writes, for instance, that:

> Contrary to the constructive empiricist, observability is not an adequate criterion as a guide to ontological commitment in science [2006, p.1]

The claim here cannot be that observability by the naked eye is an inadequate guide to what is postulated by scientific theories or by scientists *,i.e.,* that scientific theories postulate unobservables. This is obvious and is not denied by the constructive empiricist(s). The claim can only be that observability is an inadequate guide to what we should believe *,i.e.,* that we should believe in the existence of some entities that are not observable by the naked eye.[5] This sort of claim is not to be confused with the sort mentioned earlier; for example, the assertion that physics postulates elementary particles or regions of spacetime.
To summarize our discussion so far: we have distinguished three meanings of the phrase 'ontological commitment'. We first have what I will refer to as theory commitment, then what we might call personal commitment and thirdly a form of prescriptive commitment. I have introduced them in this specific order to illustrate how a careless writer can gradually shift from one to the other. Later, I will argue that some philosophers do switch notion without advertising a change of subject. Specifically, the proposal of [Jackson 1980] and is critique of [Quine 1948, 953] is marred by his failure to appreciate these distinctions. My immediate concern is to defend that the criterion of commitment of Quine [1939a, 1953] is best understood as a criterion of theory commitment. There is not, in my view, a formulation for personal commitment that holds water. This has been the implicit assumption in the technical literature on the criterion [Kemeny 1954][Cartwright 1954][Chomsky and Scheffler 1957] [Church 1958] as well as in some recent articles and surveys [Rayo 2007] [Bricker 2016].[6]

[5] A few readers have expressed skepticism about the existence or prevalence of a prescriptive meaning of 'ontological commitment'. Exhibit B is the occurrence of the phrase 'ontological commitment' in an article of Stephen Yablo *Does Ontology rest on a Mistake?* to be discussed below in section 1.3: '*to determine our ontological commitments, we have to ferret out all traces of non-linearity from science*' [Yablo 1998, p.1]. A third mention of the criterion as a 'guide to our ontological commitments' is in [Esfeld and Oldofredi 2018, p.14]

[6] Note that none of these articles draws the distinction, or attempts to defend their choice.

Quine [1939a, 1948, 1960] himself has been less than transparent about whether he intended his criterion as a criterion of personal or of theory commitment. Sometimes we can make sense of his particular statements, though in general, we must distinguish them from the criterion, as Quine [1947, 1953] articulates it elsewhere. Once or twice a claim can be construed as an application to personal commitment, under special circumstances. But what he says cannot always be saved. For example, most introductory books in metaphysics tell us that the *locus classicus* for the criterion is *On What there is* [1948]. In my view, not only does that paper fail to contain a proper formulation of the criterion of commitment, as found in earlier papers, and in the book Quine [1953], what it says about commitment is misleading and contradicts what Quine [1953] says elsewhere. The paper sometimes blurs the distinction between formal and ordinary language, which has led some of his readers astray. One problem with some attacks on the criterion, as we will see, is that they attempt to torture a sentence drawn from Quine [1939, 1948, 1960] to make it into a criterion of personal or prescriptive commitment. Shortcomings of the straw man version are then imputed back to formulations in Quine [1953] that are immune to them. In the next section, I will review the formulations given in Quine [1939a, 1948, 1953 1960] and make a case rather for a criterion of theory commitment.

1.2 The case for a criterion of theory commitment

In this section, I will appeal to textual evidence from the earliest articles of Quine [1939a, 1948, 1953] and to philosophical arguments to the effect that, whatever his original intentions may have been, theory commitment is preferable to personal commitment for the purposes of a useful criterion. On the first side, there is no shortage of evidence that the criterion of Quine [1953] was intended to apply to theories. We can look, first of all, at a canonical statement of it.[7]

> Entities of a given sort are assumed by a theory if and only if some of them must be counted among the values of the variables in order that the statements affirmed in the theory be true.
> [Quine 1953, p.103]

Quine [1953] says on the same page that '*the above criterion applies in the first instance to discourse and not to men*'. The impression that theory commitment is what is intended is strengthened by a remark in *Carnap on Ontology*: '[...] *when I inquire into the ontological commitments of a given doctrine or body of theory, I am merely asking what, according to that theory, there is*' [Quine 1951, p.1]. But it is true that in other places, Quine [1939a, 1948, 1960] makes similar remarks in connection with personal commitment. It is only natural to ask whether they are meant as reformulations of the same principle, or as

[7] Minor variations on the same theme can be found in other papers of the same period: '*The ontology to which an (interpreted) theory is committed comprises all and only the objects over which the bound variables of the theory have to be construed as ranging in order that the statements affirmed in the theory be true.*' [Quine 1951b, p.1]

supplementing it. For example, the earliest published remarks on ontological commitment are in *A logistical approach to the ontological problem* [Quine 1936].

> We may be said to countenance such and such an entity if and only if we regard the range of our variables as including such an entity.
> [Quine 1936, p. 3]

A similar statement is in *Word and Object* [1960]:

> Insofar as we adhere to this notation [of quantification theory], the objects we are to be understood to admit are precisely the objects which we reckon to the universe of values over which the bound variables of quantification are to be considered to range.
> [Quine 1960, p. 223]

Nelson Goodman formulates a similar criterion for commitment, or the recognition of entities: '*if we use variables that we construe as having entities of any given kind as values, we acknowledge that there are such entities*' [Goodman 1951, p. 24]. For example, if we use variables with classes or sets as values, we are acknowledging that there are classes. In a footnote from the second edition of *The Structure of Appearance*, Goodman notes his debt to the criterion in [Quine 1953] but specifies that '*in my version (whatever may be the case in his [Quine's]), commitment occurs not with the use of certain characters called variables but only with express assignment of values to these variables*' [ibid.]. The difficulty with taking these statements seriously as criteria of personal commitment, as we have defined it, is that most assertions of existence do not seem to involve the use of variables, in the sense in which the term is used in mathematical logic. If I say 'rabbit exist' or 'there is a rabbit in the garden', I am committed to the existence or rabbits. But in uttering these sentences, I do not employ variables in the sense of the marks 'x', 'y','z', 'w'''', 'n', 'r', or any other expression that could be said to call for rabbits as values. In other words, these criteria presuppose the apparatus of quantification theory, but most people commit themselves by speaking in ordinary language. Predicate logic is rarely, if ever, resorted to. Quine [1939a] is aware that '*the formulation at which we have arrived is adapted only to those familiar forms of language in which quantification figures as primitive and variables figure solely as adjuncts to quantification*' and prefaces it with the disclaimer: '*ensuing considerations will likewise be limited to languages of that sort*' [1939a, p.3]. However, how this limitation is to be effectuated for the speech of an ordinary speaker is unclear. The second formulation in [Quine 1960] is even more careful because it begins with the clause '*insofar as we adhere to this notation [of quantification theory]*'. The question, again, is how this stipulation is to be interpreted. If 'adhering to this notation' means that the criterion applies only to those of us that express all their beliefs in first order logic, then the clause makes the assertion vacuously true. A better interpretation might be that the principle implicitly applies only to a specific situation. Maybe we need an exercise of methodological doubt before it makes sense for us to invoke it. When in the

philosophy classroom, we should first suspend our beliefs, except those we can formulate clearly and distinctly in a first order system. Whether on this or another interpretation, a criterion of personal ontological commitment has not been found. But I should insist that there is not a similar obstacle for theory commitment. We can separate first order theories from other types of theories and formulate a criterion of ontological commitment for first order theories.
In the interest of fairness, let us consider now what epicycles could be added to land on a criterion of personal commitment. Various writers have attempted to get around the fact that naive formulations apply, or seem to apply, only to formal theories. Two approaches stand out. (a) One is to interpret 'variables' more generously and insist that, contrary to appearances, the criterion applies to ordinary language. (b) The second concedes that the criterion does not apply to everyday speech but tries to apply it after translating ordinary language into a formal language. The defenders of the first approach can find support for their line of attack in the already mentioned article *On What there is* [Quine 1948]:

> We can very easily involve ourselves in ontological commitment by saying, for example, that the *there is something* (bound variable) which red houses and red sunsets have in common; or *that there is* something which is a prime number larger than a million. But this is, essentially, the only way in which we can involve ourselves in ontological commitments; by our use of bound variables.
> [Quine 1948, p. 3]

The reference to bound variables in this passage is enigmatic. The expressions in italic are examples of ordinary English. The reason is not English has nothing resembling a bound variable. One might say that English has a close analog to the bound variable in the pronouns 'he', 'she', 'it' etc. For example, in (4)

(4) There is a man in the street and I don't like him

the last occurrence of 'him' is bound by the quantifier 'there is a man'. The difficulty is that these examples of existentially quantified sentences do not employ pronouns. Where in the phrase 'there is something' is the analog of the bound variable? Moreover, the idea of applying the criterion to ordinary statetements such as 'there is a prime larger than a million' contradicts the passage from [Quine 1939a] cited earlier, restricting the scope of the criterion to formal theories. There are other assertions of Quine [1953] in *Logic and the Reification of Universals* that would now require reconciliation. For example, there is the assertion that the criterion applies to theories and not to men. There is also the claim: '(...) *it is to the quantificational form of discourse that our criterion of ontological commitment primarily and fundamentally applies*' [Quine 1953, p.105]. Here the adverbs 'primarily' and 'fundamentally' intimate that, at best, any application of the criterion must be 'derivative' and indirect. Can we resolve these apparent inconsistencies? As I said earlier, my suggestion is that it is *On what there is* that needs to give way. The paper is undoubtedly one of the most famous and influential of Quine's career, but there are independent reasons to take the details of what it says with a grain of salt. Quine [1939a, 1943], by the time he wrote [Quine 1948], had already published two relatively technical discussions of ontological commitment: one in the *Journal of Symbolic Logic* and one in the proceedings of the 1936 Congress for the Unity of Science. Participants to the latter were mainly members of the Vienna Circle. *On what there is*, instead, appeared in the *Review of Metaphysics*. The journal was not publishing primarily analytic philosophy in 1948.[8] Moreover, Quine [1948] makes no use or mention of the special symbols '$\wedge$', '$\neg$', '$\vee$', '$\exists$' and '$\forall$' of mathematical logic; even when giving an illustration of the theory of descriptions. Everything is described in English. Quine [1948] probably assumed that the editors and the audience for the journal were not familiar with the notation of symbolic logic. This reinforces the impression that *On what there is* was a popularization of his ideas on commitment rather than a definitive statement of them. This much for the first approach. What about the second, the more indirect approach? The most common strategy of this kind is to assume that for every informal theory T, there is a first order theory T' that is its regimentation in first order logic. The obvious further assumption is that the ontological commitments of T are identical to those of T'. This strategy has a fighting chance to work, but only under one assumption: that all assertions can be reformulated without loss in predicate logic. By translated without loss, I mean translated into a synonymous sentence or an equivalent description of the same fact. Now, this is a contentious assumption, but maybe not an altogether indefensible one. I tend to consider this second proposal more promising, but it faces several challenges that need to be mentioned. The first challenge comes from plural sentences. Orthodoxy has it that plurally quantified sentences are not committed to classes, but that they often can do the job of quantification over classes of individuals. Other delicate cases for the thesis involve the quantification of variables (*i.e.,* pronouns) in predicate and sentential positions:

(5) I have become something that you are not: a doctor
(6) He believes something crazy: that Bob murdered the captain

This last example is tied to the problem of whether ordinary language disposes of substitutional quantification. Perhaps these difficulties are illusory, or maybe they are real but can be overcome. An idea in this direction, for example, would be to relativize commitments to regimentations. In this paper, I put this strategy aside. Quine [1953, 1960] himself was skeptical that there could be a matter of fact about the correctness of a regimentation. He insisted that the commitments of a regimentation are transferred only to those that explicitly underwrite it.[9] This has not discouraged philosophers from ascribing

[8] As one would expect of a journal devoted to metaphysics founded in 1947.

[9] '*Polemical use of the criterion is a different matter. Thus, consider the man who professes to repudiate universals but still uses without scruples any and all of the discursive apparatus which the most the most unrestrained of platonist might allow himself. He may, if we train our criterion of ontological commitment upon him, protest that the unwelcome commitments which we impute to him depend on unintended interpretations of his statements. Legalistically his position is unassailable, as long as he is content to deprive us of a translation without which we cannot hope to understand what he is driving at.*' [Quine 1953, p. 105]

him the view all the same.[10] This concludes our discussion of the problems that face us when interpreting the criterion as a criterion of personal commitment. Another misconception that needs to mentioned is that Quine [1953] gave a criterion of prescriptive commitment. This fallacy is often due to a confusion with the program of settling ontological questions by regimenting physics and could have been averted by paying attention to a remark[11] in [Quine 1948]:

> Further, I have advanced an explicit standard whereby to decide what the ontological commitments of a theory are. But the question what ontology to adopt still stands open, and the obvious counsel is tolerance and an experimental spirit. [Quine 1948, p. 19]

But the exact opposite, that the point of the criterion is to choose what ontology actually to adopt, is an idea that is alive and well in the philosophy of physics. For example, prefacing a defense of wave function realism in quantum mechanics, Jill North [2013] sketches a route to extract metaphysical conclusions from a physical theory. The gist of her proposal is that, in order to infer an ontology from the formalism of a fundamental theory, we need first to (a) reformulate the laws in a form that is *invariant* and *geometric*, and then (b) accept the existence of everything the geometrized laws presuppose under such as formulation. North briefly contrasts this approach with a method she attributes to Quine [1953]. The subject of her description seems to me to a hybrid between the criterion of commitment and what I have referred to before as the regimentation program.

> We can think of this [*North's proposal*] as an updated version of Quinean ontological commitment. Not: what there is, is what the values of the variables range over, so that we first render our theory in (first-order) logic and then see what the values of the variables are. Rather, what there fundamentally is, is given by the (best invariant formulation of the) dynamical laws, so that we first render our fundamental theory in geometric terms and then infer the structure and ontology presupposed by the laws. [North 2013, p.7]

Certainly, whether a theory is formulated (a) geometrically and (b) in a formal logical system are two independent considerations. The options are not mutually exclusive. The point of the criterion lies in the second step: the inferring of the ontology presupposed by the laws. Quine [1953] is simply pointing out that regimented theories leave no ambiguity about what is assumed to exist. Another instance of this fallacy is in a chapter of [Eddy Chen 2019], introducing his important work on the nominalization of quantum mechanics. Chen [2019] seems to equate the criterion of commitment and the first premise of a popular construal of the indispensability argument for mathematical entities:

[10] For example, Asay [2010, p.1] says that '*On the Quinean view, one's ontological commitments are determined by the regimentation into first-order logic of a theory that one accepts*'. Sider [1999, pg. 22)] writes: '*W.V. Quine said that the ontological commitments of a theory are the values of the bound variables in a first-order rendition of theory*'.

[11] Notice that Quine [1948] reverts to speaking of the ontological commitments *of a theory*.

(P1) We ought to be ontologically committed to all and only the entities that are indispensable to our best theories of the world. (*Quine's criterion of ontological commitment*) (Chen 2019, pg.7)

Again, before we can argue about what entities are 'indispensable' to a theory, or better, indispensable to natural science, we need to be clear about what is postulated by the various competing theories, dispensably or not. The latter is the much more modest role that Quine [1953] attributes to the criterion.

1.3 Two applications: [Yablo 1998] and [Jackson 1980]

The distinction between personal and theory commitment already allows us to deal with some influential objections to the criterion in [Yablo 1998] and [Jackson 1980]. Yablo [1998] cites a passage[12] from [Quine 1953] saying that a parent telling the story of Cinderella to his or her child is not committed to the existence of fairies. This is uncontroversial since the parent does not assert that the fairy godmother turned a pumpkin into a carriage but simply pretends to. He or she narrates the story to amuse the child. Yablo [1998] extends this uncontroversial observation, with some plausibility, to metaphors, for example, to particular utterances of 'Alice is on fire' and 'Jimmy is a real bulldozer', said of humans not undergoing combustion. The point is that these utterances are not made to express a sincere belief in their literal content. But Yablo [1998] wants to conclude that, since the authors of these utterances do not commit themselves to bulldozers, an exception must be allowed in the criterion of commitment. He infers from these apparent exceptions that applications of the criterion of commitment require a prior criterion to distinguish literal from metaphorical speech (a criterion that, said in passing, Yablo [1998] does not believe exists). It should be clear, assuming that I have not mischaracterized the argument in [Yablo 1998], where the fallacy lies. We do not need to include any such caveat in a criterion of *theory commitment*; and there is no evidence that Quine [1953] contemplated such a restriction himself. A sentence S in predicate logic remains committed to the existence of whichever values of its bound variables are required for it to be true. For example, sentence (7)

(7) $$\exists x \text{ (Pumpkin Coach } x \wedge \text{Enters } cx))$$

is committed to the existence of a pumpkin coach. Whether a given person commits himself or herself to pumpkin coaches, by uttering (7) depends on the speech act. In other words, whether (7) is spoken as a metaphor, a joke, a test of the microphone ,etc., is not relevant to its ontological commitments. It is only relevant to whether we can impute its commitments back to the

[12] *The above criterion of ontological commitment applies in the first instance to discourse and not to men. One way in which a man may fail to share the ontological commitments of his discourse is, obviously, to take an attitude of frivolity. The parent who tells the Cinderelly story is no more committed to admitting a fairy godmother and a pumpkin coach than to admitting the story as true.* [Quine 1953, p.103]

speaker.[13] Jackson [1980] is concerned, on his part, with a dilemma that has worried other critics of the criterion [Azzouni 2004] [Horgan e Potrc 2006] [Sider 1999]. The trouble is this. In ordinary life, we have formed the habit of quantifying over things that a materialist would be repugnant to admit. Typical examples are opportunities, chances, differences, rainbows, and stuff that is likewise uncomfortably intangible. The dilemma is that these sentences themselves seem uncontroversial, but their commitments feel intolerable to some.

> There is a fundamental question for the Referential theory. We play fast and loose with the referential apparatus of our language. And when we do so, we do not discriminate between definite singular terms and bound variables. We all, rightly, assent to such sentences as '*There are* many differences between cricket and baseball', '*Mr. Pickwick* is Dicken's most famous character, '*There is* a good chance that she will come', [...] and so on. [Jackson 1980, p.2]

The advice I would give to a fly trapped in this particular bottle is to surrender and admit the existence of the things above. We can acknowledge that there are pains in the foot, smiles, chances of winning the lottery, differences of opinion, economic recessions while explaining how their existence is grounded in facts about concrete entities such as books, minds, and brains [Schaffer 2009]. Surely, it is implausible to treat these entities as somehow floating in a vacuum, alongside the basic building blocks of the material universe. But in my view it is precisely in this connection that the notion of 'paraphrase' is useful. The systematic paraphrase of sentences about less intangible entities into sentences about more tangible entities, as pointed out by [Alston 1958], does not permit to dispense with any assumption of existence. Still, it explains how facts about dubious entities *reduce* to facts about entities that seem familiar and understood. We can start from a materialistic language and introduce progressively new notions and new defined occurrences of the quantifiers. For precisely this reason, I will later formulate the criterion to apply to constructional systems: a set of sentences and a system of definition by abbreviation, rather than simply to sets of sentences. But this programmatic proposal for reconciling us with the existence of opportunities, differences of opinion, and fictional characters is not one that [Jackson 1980] was ready to accept. Jackson [1980] dismisses the option of admitting the entities on the list as 'extravagant'. He is adamant

[13] Azzouni [2004], Maddy [1996], and Asay [2010] discuss whether the quantifiers 'there is' or 'there exist' carry ontological commitment or whether ontological commitment can be 'expressed' in natural language. I confess that I have not the slightest idea of what they mean. One may attempt to interpret the expression 'carrying ontological commitment' as follows. A generalized quantifier could be said to 'carry ontological commitment' when its successful application to a predicate requires that the predicate have a nonempty extension. In this sense, 'some', 'many', 'a few' are ontologically committing expressions, but 'all', 'most', and a substitutional quantifier are not. Certainly, such a notion cannot be extended to personal commitment. Whether a person incurs an ontological commitment to electrons does not rest solely on what they say - on the sentences they utter - but also on the speech act. No linguistic expression could ever guarantee that a person has an ontological commitment, any better than a linguistic expression could ever guarantee sincerity or the absence of sarcasm.

that no spooky entity be admitted 'into the ontology' and equally adamant that ordinary assertions of 'there exist opportunities' and 'I have a pain in my foot' are literally true.[14] So, how does Jackson [1980] propose to reconcile these two assertions? If I understand his suggestion, Jackson [1980] attempts to solve the problem by tinkering with personal ontological commitment. He attributes to [Quine 1948] the view that ordinary speakers are ontologically committed to what is quantified over in the sentences they assent to, and emphatically repudiates it. In its place, Jackson [1980] proposes a criterion of personal commitment according to which a speaker is committed only by making metalinguistic assertions about the naming and denotation of certain terms. Speakers admit things in their ontologies not by assenting to 'there are fictional characters' but by assenting to the sentence "fictional character' applies to some object'. All other assertions are qualified as 'ontologically unserious'.

Jackson's [1980] overuses of the phrase 'admit into our ontology' is, in my view, one cause of his failure to see that his 'solution' does not deliver on its promises. First of all, to maintain that there are no such things as opportunities and that the sentence 'there exist opportunities' is true is impossible. From the truth of 'there exist opportunities' follows the existence of opportunities. It is a matter of framing an appropriate instance of Tarski's Convention (T):

(8) The sentence 'opportunities exist' is true-in-English iff opportunities exist.

From (8) and the assumption that 'opportunities exist' is true, we get that opportunities exist. Since to 'admit something into our ontology' merely means admitting that it exists, it seems that at least us, the philosophers, looking at language from the sidelines, have admitted opportunities into our ontology. But even if we had not, what would be the point? If opportunities exist, establishing that ordinary speakers are not committed to them is a pyrrhic victory. If they exist, again, as Jackson [1980] himself has to admit, on pain of inconsistency, what is the incentive for ordinary speakers to stubbornly refuse to acknowledge that they do? The only thing that the criterion of personal commitment in Jackson [1980] seems to afford to ordinary people is a sort of blissful ignorance. That said, regular folks must be prepared to go some distance to maintain even that. Does Jackson [1980] want them to accept sentence (9) and (10)?

(9) Yeah, Mr. Pickwick is a fictional character, but he is not called 'Pickwick'

(10) Sure, there are opportunities, but I wouldn't use the word 'opportunity' to describe them ('opportunity' does not really apply to opportunities)

[14] One may ask whether, by 'admitting into the ontology', Jackson [1980] means the same as what Quine [1948] meant. No sign of a difference in terminology is to be found in the paper, unlike for some other writers to be discussed later. (Jackson explicitly brings up degrees of being and substitutional quantification and dismisses both as possible solutions) No doubt, if Jackson [1980] had always replaced in his head the phrase 'admitting into the ontology' with its plain equivalent 'to say that there are', he would have found his brand of doublethink much harder to maintain. But a striking feature of discussions of ontological commitment is the power of pretentious jargon to make entirely incoherent proposals sound plausible.

It must take a considerable amount of 'ontological seriousness' to accept statements such as (9) and (10). For (9) and (10) fly in the face of platitudes about reference that are no less obvious than instances of convention (T).[15] But be assented to they must; least our man or woman in the street commit themselves, even by the lights of Jackson [1980]. This concludes our analysis of two critiques resting on the confusion between personal and theory commitment. The idea in [Jackson 1980] is to avoid assuming the commitments of a theory that one accepts by fidgeting with the definition of personal commitment. Under many disguises, this fallacy keeps popping up at regular times in the literature [Azzouni 2004] [Horgan e Potrc 2006].[16] But it is by no means the only fallacy that we will need to deal with. Another large class of dubious arguments begins by redefining the words 'ontological commitment' to mean something other than 'what a theory says exists'. Before we consider these arguments in detail, and before we formulate the criterion, it useful to be explicit about what *we* mean by 'ontological commitment'. I try to show that my use is identical to the use that [Quine 1951b, 1953] made of the term 'ontological commitment'.

1.4 The ontology of a theory

In the preceding section, we have decided to formulate a criterion of theory commitment and briefly described commitment as 'what a theory says exist'. The metaphor of what a theory says can be dispensed with. The notion we have in mind could be expressed just as well by speaking of what a theory assumes the existence of, treats of, postulates the existence of or simply of what it postulates. Elementary arithmetic treats of natural numbers and integers. Geometry treats of points and lines. The kinetic theory of gases postulates molecules, to which it ascribes positions and velocities. From the point of view of grammar, the predicates, 'assumes', 'postulates' and so on, form a sentence when applied to a singular name and a plural noun such as 'numbers', 'neutrinos' and so on.[17] This stipulation makes sense, of course, only on the condition that these phrases all mean the same thing. A critic may reply that the list we have given is not at all a list of synonyms. In particular, there is something to be said for the feeling that the words 'assumes', 'treats of', and 'postulates' are not precisely synonymous. There are certainly contexts in which one word is more appropriate than the others. To say that a theory *treats of* something suggests

[15] Horgan e Potrc [2006] embark on a project to reconcile the truth of ordinary assertions such as 'I have two hands' with existence monism: the view that the only thing that exists is the entire cosmos. To do so, they invoke what they call a 'contextual semantics'. The main idea seems to be that truth coincides with a particular form of correct assertability. They do not lay much stress on the fact that they must renounce almost all instances of convention (T) for ordinary language. According to their theory, the sentence 'there are two hands' is true in an everyday context, even though there are no hands. To the extent that convention (T) is a prerequisite of a good semantics, what they propose fails as a semantics of English.

[16] The argument in Azzouni [2004] strikes me as similar to that in Jackson [1980]. Azzouni [2004] wants to 'drive a wedge' between the 'taking true of mathematics' and a commitment to mathematical entities. He asserts that the bridge is the criterion of commitment. But this is a mistake. The bridge is an instance of Tarski's Convention (T).

[17] We disregard the topic of singular ontological commitment [Jubien 1974]

that it is its main business to deal with these things, rather than an accident or a peripheral concern.[18] To say that the theory *postulates* certain entities, on the other hand, suggests that the assumption of the existence of these entities is a speculation, not an uncontroversial fact of life. By interchanging two of these expressions, we can turn an anodyne statement into something funny or pompous. For example, few of us, at a party, would describe sentence (11) below

(11) There is still a bottle of mineral water in the fridge

by using sentence (12):

(12) Sentence (8) postulates the existence of a fridge.

Similarly, sentence (13) feels much less awkward

(13) Celestial mechanics treats of planets and postulates forces

than sentence (14), where the two expressions of commitment are inverted:

(14) Celestial mechanics treats of forces and postulates planets.

These objections do not seem to me to be decisive. These differences in tone seem to lie more in the pragmatics or the conversational norms attached to these sentences than their semantics or truth conditions. They can all be explained by positing what [Grice 1989] calls conventional implicatures attached to different commitment expressions.[19] For example, (12) seems true. It is strictly speaking the case that (11) postulates the existence of fridges. The fact that something sounds funny, or is not the most pertinent thing to say, does not make it false. But to cover my bases, let me stipulate that I will use 'postulates' as a technical term. It is understood that any such nuance or implicature is suppressed. This usage seems to me to be similar to that of other terms in philosophy. For instance, philosophers of language use 'says that' and 'asserts that' as interchangeable; notwithstanding my linguistic intutitions that 'Maria asserted that it's raining' suggests greater confidence than 'Maria said it is raining'. (After all, the adjective 'assertive' is used to describe greater confidence in one's assertions, more than the tendency to make many assertions) On the left-hand side of preliminary versions of the criterion, the official predicate I will use is 'postulates the existence of'. Quine alternates in [1951] between 'assumes' and another variant: 'presupposes the existence of'. But I avoid speaking of presuppositions of existence to prevent confusion with such talk of presuppositions as when we say that the use of a description presupposes the existence of a unique bearer or that the infamous question 'did you stop beating

[18]More importantly, the claim that a theory 'treats of' something seems to affirm the existence of what it treats of. For this reason, Quine [1960] sometimes speaks more accurately of what it 'treats or purports to treat'.

[19]I find nothing wrong with the defeasing clause: '(11) postulates the existence of fridge, but of course fridges are not theoretical entities but only ordinary objects'.

you wife?' presupposes that the interlocutor did beat his wife.

Remark: The notion of ontological committment is also tightly related to the idea of the ontology of a theory. In my usage, 'ontology' is always syncategorematic. To say that a certain entity is part of the ontology of a theory T is merely to say that T is committed to the existence of those entities.

1.5 Other notions of ontology and commitment

In the preceding sections, we made clear that the ontological commitments we intend to discuss are the ontological commitments of theories and not those of people. This idea has been clarified further by identifying commitment with postulation or 'what a theory says there is'. Let me try to show that these clarifications are not otiose. A number of writers speak of the ontological commitments of theories, but they seem to be concerned with something else. For example, Agustín Rayo [2007] begins his article on commitment by defining the ontological commitments of a sentence as 'what the truth of [the] sentence demands of the world' (pg.1). It is unclear to me, since 'ontological commitment' is actually a neologism of Quine [1948], whether Rayo means that as a new stipulation or as a description of the prevalent usage of the term. When I turn to [Quine 1968], I see little evidence for the second interpretation:

> When I inquire into the ontological commitments of a given theory I am merely asking what, according to that theory, there is.
> [Quine 1968, pg. 126]

W.V.O Quine has tried to convey what he meant by ontological commitment by various paraphrases over his career: the entities a theory 'countenances', the entities it 'treats of' or 'purports to treat of' [Quine 1980, p. 103], what it 'assumes to exist' [*ibid.* p. 102], 'presupposes' [*ibid*, p. 102], 'posits' [Quine 1960], what exists 'from the point of view of a given language' [Quine 1966, p. 68], what a theory 'says there is' [Quine 1968]. Nowhere in his corpus can I find an identification of the commitments of a theory with 'what its truth demands of the world'. By itself, this observation is not proof that Rayo's formula isn't a merely verbal variant or an equivalent reformulation.[20] We have before us two options or two interpretations of Rayo's definition. Either the notion of commitment in [Rayo 2007] is meant to diverge from that of [Quine 1951b, 1953], in which case we do not need to concern ourselves, or it is a part of the theory of [Rayo 2007] that they must be applied in the same circumstances. Looking at the phrase 'demands of the world', the latter assumption does not seem entirely plausible. The metaphor of what a sentence demands of the world to be true is vaguer than that of what the sentence simply 'says'. But testing my linguistic intuitions against specific circumstances, relying on what I intuitively associate with the word 'demands', I would, say that the truth of

[20] I have used the expression 'postulates the existence of' to define ontological commitment. To my knowledge, W.V.O Quine himself never did. But I would certainly defend its appropriateness since 'postulates' is a synonym for the expressions cited above.

(15) $\exists x$ (Elephant x)

demands that sentence (15) itself exist. It also requires that the word 'Elephant' exist and that the letter 'l' exist. But sentence (15) certainly does not postulates the existence of sentences, predicates, or letters. (15) is not a sentence of syntax. It is concerned with animals and not with words. Since the topic of (15) is elephants, or in general, what animals there are, while sentence (15) is not an elephant, (15) does not postulate its own existence. We can say that (15) is committed to elephants or that it postulates elephants because (15) requires elephants as possible values of its bound variables. But for the same reason, (15) does not postulate linguistic expressions since their availability as possible values of the bound variables is irrelevant to its truth or falsity. This counter-example rests entirely, of course, on my intuitive understanding of the words 'demands of the world'; it can be nullified simply by specifying better what is meant by 'demands'. But then an intuitive understanding of what the truth demands of the world cannot be relied upon later to attack the criterion of ontological commitment we will formulate. Bradley Rettler [2016] and Ross Cameron [2010a] are much more explicit in their intent to use the word ontological commitment to mean something different than what it meant for Quine [1953]. Cameron [2010a] considers the ontological commitments of a sentence S to be the things that ground the truth of S. But he concedes that an inflexible critic, who held fixed as a *stipulation* that the ontological commitments of a theory are what the theory says there is, would force him to restate his conclusions in different words.[21] This implicitly concedes the point that really matters to us. Cameron [2010] has no objection to the view that the criterion of Quine [1953] reports what a sentence says there is. We may have reservations about the wisdom of redefining technical terms to mean something else, thereby engendering the illusion of a disagreement with those that persist in using them with their ancient meaning.[22] But it is clear that, if one mentally translates the technical terms from his idiolect to ours, there is no residual conflict with the main theses of this paper. What Cameron [2008, 2010a, 2010b] is pushing is a variant of the position of [Schaffer 2009] we have endorsed earlier. This is the idea that one can reconcile a relatively diverse ontology, and a permissive attitude in admitting ordinary objects as existing, with order and control in our theories, and even a sense of economy, by explaining how things are grounded in a selected class of fundamental things [Schaffer 2008], or how truths about

[21] Cameron, Ross (2010). How to have a radically minimal ontology. *Philosophical Studies* 151 (2):249 - 264. These points are on page three. Readers are invited to check for themselves.

[22] For example, Baron [2011] has written a paper in defense of indispensability arguments in mathematics that explicitly rejects, for the sake of the argument, the criterion of [Quine 1953] but attempts to replace it with the truth-making criterion above. He attributes the latter to [Armstrong 2004] and to [Cameron 2008, 2010a, 2010b]. This assumes implicitly that the two criteria are not speaking of apples and oranges. It is almost impossible at some point not to lose track of who is on the same side of whom in this debate. What is clear is that the truth-making criterion is an incredibly poor criterion of what a sentence says there is. What grounds the truth of a sentence is usually not among what the sentence says there is . For example, the truth of the sentence 'there is a red table in the kitchen' is grounded in facts about the disposition of molecules but does not postulate the existence of molecules.

derivative things are grounded in truth about the fundamental things [Cameron 2010a], or, in our case, how ordinary objects arise as logical constructions out of other things. There are differences in detail between how I see this intuitive idea and what [Schaffer 2008] and [Cameron 2010a] have in mind, particularly in the moral I would draw in concrete cases, but none that makes any difference to the topic of this paper. Rettler [2016] has an even more elaborate scheme to decide what meaning to attach to the phrase 'ontological commitment', that I will not attempt to summarize. Rettler [2016] argues that his scheme sanctions his usage of 'the ontological commitments of S', again, in the sense of 'what grounds the truth of S' and admits that the latter phrase is not coextensional with 'what the sentence S says there is'. Then, it seems me that the same considerations apply as in the case of Cameron [2008, 2010a, 2010b]. In both cases, the only thing that matters for our purposes in this paper is that we be clear about what means what. The debate about the ontology of this or that physical theory would probably be in a better shape if the truth-maker theorists and us could decide who gets to use the phrase 'ontological commitment' by a coin toss or something of the sort. Maybe the adult thing to do, to avoid endless confusion, is just to concede to the truth-maker theorists the exclusive usage of the phrase 'ontological commitment'. We can retreat to speaking of postulation, or what a sentence 'says', or to the synonyms listed in the previous section. (We could then speak of a criterion of postulation). In the rest of this paper, we will follow the example set by [Quine 1948] in connection with the word 'exists':

> However, Wyman, in an ill-conceived effort to appear agreable, genially grants us the nonexistence of Pegagus and then, contrary to what *we* meant by nonexistence of Pegagus, insists that Pegasus *is*. Existence is one thing, he says, and subsistence is another. The only way I know of coping with this obfuscation of issues is to *give* Wyman the word 'exist'. So much for lexicography; [...] [Quine 1948, p.4]

2 Two formulations of the criterion

In mathematical logic, by a 'theory' it is often meant a set of sentences - that is, sequences of symbols built by the usual rules of construction out of a stock of basic predicates $P^n_0 ..., P^n_k$, the variables $v_0, v_1, v_2 ...$, a choice of truth functional connectives and the quantifiers $\exists$ and $\forall$ [Shoenfield 1967, chapt. 2].[23] Occasionally, it is stipulated that the set of sentences must be closed under logical consequence. But it is clear enough that a notion of commitment, or of postulation, cannot apply to purely formal theories by themselves. We need to specify at least two other pieces of information. One ingredient is obvious. We

[23]Constants and function symbols are optional, and we follow [Quine 1940] in treating them as dispensable. The identity symbol '=' is often included by stipulation in the list of predicates. [Halvorson 2019, chapt. 2] attaches great importance to the idea that a theory T is an ordered pair of a class of sentences T' and a *language* L. But we may point out that we can extract a language L from the class T' by counting in L the symbols that occur in the sentences of T'.

need an interpretation of the basic undefined symbols. It makes no sense, for example, to ask what entities are postulated by a theory with (16) as an axiom:

$$\exists x \; \exists y \; (\mathrm{P}x \wedge \mathrm{H}xy)) \tag{16}$$

independently of a specification of what the predicates stand for. The theory will postulate certain things if 'Px' and 'Hxy' are interpreted as 'is round' and 'is larger than'; *other* things if 'Px' and 'Hxy' are interpreted as 'is male' and 'is the parent of'. This observation is often repeated in the literature. For example, Cartwright [1954] speaks of the commitments of 'interpreted theories'. The only thing that remains to be explained, in this connection, is what are 'interpreted theories', or alternatively, what qualifies as an 'interpretation' of a formal theory. This task will be taken up in short order. The second element that we need is less standard. My contention is that, in order to assess the ontology of a theory, we need to consider not only the interpretation of the primitive vocabulary but also the interpretation of the predicates introduced by definition. This, of course, presupposes some device to keep track of all the notation that is introduced by definitions stipulated within the system. To keep track of definitions, we will, as announced earlier, adapt, and give a rational reconstruction of the notion of *constructional system* from the old books [Carnap 1928] and [Goodman 1951]. This second point - the interest in the interpretation of defined vocabulary - can be motivated by considering a few examples. Let us limit ourselves, at first, to explicit definitions. We may ask fairly reasonably: does the ZFC system of set theory postulate the existence of natural numbers? The standard answer seems to be 'yes'. But if we were to look for the predicate 'Number x' in the primitive notation, and for the sentence '$\exists x$ Number x' among the theorems, we will look for a long time. What a set theorist, or a textbook writer, does is construe certain sets as number and identify the clause 'Number x' with a certain formula of the language of set theory. A further trouble is that there are several ways of going about it. According to some reconstructions, a natural number is the singleton of its predecessor. For others, it is the set of the numbers less than it and, according to the older reconstructions of [Frege 1900] and [Russell 1917], a natural number is neither. A fourth line is taken by the skeptics [Benacerraf 1965] [Forster 2003], who insist that sets cannot be numbers and that some sets are at best 'facsimiles' or 'implementations' of numbers. We are interested in what systems 'say there is' and not in the nature of numbers. It seems natural to count a system as postulating numbers only when it introduces the predicate 'Number x' as shorthand for some condition and implies a theorem that abbreviates to '$\exists x$ Number x'. The consistent skeptic, on the other hand, should refrain from introducing the predicate 'Number x', or at least make clear that the predicate is not to be understood in its ordinary sense. To make the point clearer, consider a similar case discussed in the opening of [Goodman 1951]. The issue is how to define the notion of point in a system of geometry. [Goodman 1951, chapt.1] discusses two adequate but incompatible approaches to define 'Point x'. One is due to [Whitehead 1917] and construes points as certain shrinking classes of regions with certain properties [see Varzi 2019]. Goodman [1951] contrasts it with the treatment of points as pairs of intersecting lines and a mathematical physicist may add other examples, for example, of the reconstruction of a smooth manifold from an algebra of operators. Most systems of geometry, of course, treat relations between points as primitive. Consider a particular system T. Does the question of whether T postulate points require a prior decision about what constitutes a point? Or should we count as committed to points only theories that treat the notion of point as primitive? The latter course seems to trivialize legitimate questions, such as whether 'there are points in noncommutative geometry' [Huggett, Lizzi and Menon 2020]. The first runs together two issues that, in my view, are better kept distinct. It is convenient to treat separately the issue of what entities a theory says there are, by its own light, and the ultimate adequacy of its reconstructions and identifications. We may frame this point as a last terminological stipulation about postulation. We understand 'T postulates points' as meaning 'T postulates things that T says are points' and we do not commit ourselves either way about whether the things it talks about are really points, or even would be points if the theory were true.[24] This stipulation is all the more reasonable if, as I believe, there are no conclusive tests of whether a reconstruction is to be adopted or not. Constructional definitions can often behave like postulates in that we are justified in adopting or rejecting them according to whether the total theory T 'works'. (If two definitions both 'work', we may never know which one is right). These two scenarios, of numbers in set theory and the logical construction of points out of various pointless materials, suggest a revision to standard criteria of postulation. We want to attribute commitment to collections of postulates and definitions; rather than only to a collection of postulates in primitive notation. The role of definitions becomes more consequential when we enlarge our attention to include definitions in context alongside explicit definitions. A contextual definition is a rule of abbreviation that goes beyond the stipulation that a certain segment of text is always replaceable by another. The paradigm of such definitions - to use the expression of [Ramsey 1931] - is the Russellian theory of descriptions: an algorithm to transform a statement that employs a description operator into a statement that uses only existential quantification

[24] The constrast between the two attitudes is evident when we look at the question of what to do with manifestly *inadequate* definitions. Two things can be true at once: (1) a predicate can be *intended* as an explication of a pretheoretical term, but (2) it may fail, as an explication, to satisfy even basic criteria of *adequacy.* Consider a theory T that introduces 'point' as an abbreviation of 'banana consumed between the 4th of May 1943 and the 7th of July 1946'. Does T postulate the existence of points relative to the interpretation of 'Point x' as meaning *spacetime point*? This depends on what we mean by 'postulates'. A similar scenario arises for a theory T$'$ that takes 'Point x' as primitive but postulates its coextensionality with the above predicate of bananas. We seem to have two options: (A) to ascribe ontological commitment to points only when 'Point x' is introduced or characterized adequately or (B) also when 'Point x' is only *intended* to stand for points. This gives us, in my opinion, two distinct senses of postulation; that we may call postulation *de re* and postulation *de dicto*. This distinction appears to me to be the analog for theory commitment of the distinction of [Szabo 2003] between 'believing in' and 'believing that there are'. For a more useful and interesting example, consider a theory T$''$ that introduces the term 'heated body' as 'body with a high concentration of caloric'. Can T$''$ quantify over heated bodies or not? In what follows, I will propose a criterion for postulation *de dicto*; but a criterion for postulation *de re* can be obtained by integrating a criterion of the adequacy of a characterization or explication.

and identity. The idea that definitions in context are the crucial tool to perform ontological reductions has been defended in the early days of analytic philosophy [Russell 1914] [Carnap 1928] [Ayer, chapt. 4] and the same phenomenon has received renewed attention in the work of Barrett and Halvorson [2017] and Halvorson [2019]. The latter concentrate on translations of theories about points into theories about lines, and *vice versa* [Barrett and Halvorson 2017]. They notice that, in a sense, a theory of lines can introduce apparent quantifiers over geometrical points; but that the latter quantifiers are suppressed when the sentences are rewritten in primitive notation. The legitimacy of these apparent quantifications over points, on one side, and their eliminability by contextual rules, on the other, appear as two faces of the same coin. It is maybe simpler to consider an analogous example given in [Quine 1963, chapt. VI]. [Quine 1963, pp. 119/f] is concerned with rational numbers and integers rather than with points and lines, but the philosophical moral is the same. It is not difficult to set up an algorithm to reduce a sentence about rationals to a sentence about integers. We need (a) to replace everywhere a quantifier '$\exists r$' ranging over rationals with a string of two quantifiers '$\exists n \exists n'$' ranging over integers and (b) express the various algebraic operations as conditions on the numerators and denominators. For example, (17) is merely the abbreviation of (18):

(17) $$\exists r \text{ (Rational } r \wedge r \cdot \frac{5}{7} = \frac{3}{4} \text{)}$$

(18) $$\exists n \ \exists n' \ (n \cdot 5 \cdot 4 = n' \cdot 7 \cdot 3)$$

The important question, for our purposes, is the following: should we say that a constructional system C that proves (17), that is, a system that proves (18) and abbreviates it as (17), postulates the existence of rational numbers? The most plausible answer, in my view, is 'yes'. But let me explain some of the assumptions that, in my view, force our hand in this direction. There is no inconsistency or incoherence in considering a constructional system C that talks about strings of symbols of its own expanded vocabulary. All the symbols that appear within definitions exist, they are not made of thin air, and we can assume that they are in the domain of discourse of a theory written in primitive notation. The syntax of the expanded language can be described in some such theory. For at least a part of it, assuming enough set theory in the background, we may want to define a truth predicate or adopt one as primitive. The simplest approach is, of course, to stipulate that an abbreviated sentence is true if and only if its definitional expansion is true, using a truth predicate for the primitive language. The crucial issue is whether we maintain all the cases of Tarski's Convention (T), such as (19), also for the extended truth predicate:

(19) $$\text{True '}\exists r \ (\textit{Rational } r \wedge r \cdot \frac{5}{7} = \frac{3}{4})\text{'} \leftrightarrow \exists r \ (\text{Rational } r \wedge r \cdot \frac{5}{7} = \frac{3}{4})$$

We can derive (19) from a formalization of the claim that a sentence is true if and only if its abbreviation in C is true. In particular, we can derive it from:

(20) Sentence *(18)* is true if and only if *(17)* is true

It seems to me that both (19) and (20) are analytical consequences of the adequacy of the definitions in system C. But, if the truth of (18) and the adequacy of the definitions stipulated within C imply analytically that there are rational numbers, it seems difficult to deny that (18) and C combined postulate rational numbers. To avoid this conclusion, the only option seems to be to extend the skepticism of [Benacerraf 1965] and [Forster 2003] about the explication of 'natural number' to a general skepticism about contextual definitions in general. A sentence and its abbreviation by common methods of contextual definition cannot describe the same state of affairs; one can be true and the other false. This skepticism about contextual definitions requires a ban of useful methods in many areas of mathematical logic, or at least a significant reevaluation of their importance. In model theory, it is common to translate statements about polynomials of a fixed degree into statements about their coefficients. In systems of geometry quantifying only over points [Tarski and Givant 1999] one can introduce quantification over geometrical figures such as triangles, rectangles, cubes, and other polyhedra by paraphrasing them away as covert quantifications over their vertices. Goodman [1948, 1951] was already in a good posture in this respect, since its own standard of 'adequacy' for a constructional definition was a loose form of 'extensional isomorphism'. Hence his claim that the symbol '$=_{df}$' in a constructional system is not to be read as 'is nothing more than' but rather as 'is mapped to' [Goodman 1972, p.18]. We clearly do not have space in this paper to take up the question of what sorts of definitions are acceptable or what different purposes they might serve. The difference between considering contextual definitions as inadequate, as accounts of the notions involved, and lowering the bar for 'adequacy' seems, at any rate, largely verbal. Once again, stipulation may be preferable to controversy and an intricate argument for a view or another. We will stipulate that, in the constructional systems that we are interested in, the symbol '$=_{df}$' shall be read in the strong sense of 'is nothing over and above'.[25] This leads us to ascribe to systems such as C a commitment to whatever is quantified over in the abbreviated notation; and leave to another day, or to the good sense of the reader, whether such systems are sound, understood in this stronger sense.[26]

[25] To borrow an expression from [Carnap 1936], the adequacy of '$=_{df}$' expresses in a formal mode what, in the material mode, different authors call 'identifications' [Dorr 2016], 'real definitions', 'just-is statements' [Rayo 2013] or 'generalized identities' [Correia 2017]. To define 'bachelor' as 'unmarried man' is adequate if to be a bachelor is to be an unmarried man. Maybe this explanation is an explanation of the clearer in terms of the obscure, but it contributes to indicate the sort of notion of constructional definition we have in mind.

[26] The observant reader may protest that this view conflicts with the goal to make precise the slogan that the entities postulated by a theory are those that need to be admitted in the range of its bound variables. The quantifiers defined by contextual abbreviation can be considered mere notation. It is for good reason, says the skeptic, that the model theory of the primitive language ignores them. The variables that abbreviated quantifiers are binding do not have 'values' like real quantifiers. For the skeptic, to attempt to quantify over, or refer to, entities in the world by using abbreviated notation is like attempting to see by painting oneself a pair of eyes or shooting with one's fingers. But their objections is, in my view, a

In the next section, we define the two auxiliary notions that are needed to state the criterion. A notion of 'interpretation' that is suitable for our purposes, but that also respect the extensionalist scruples of [Quine 1953], can be found by looking at the work of Quine [1960] himself. A manual of translation is a function that correlates portions of ordinary English to portions of the language under investigation. Relative to such a specification, we can interpret predicates such 'Px' and 'Hxy' in (16) and determine what it postulates. A constructional system C is a system of postulates and definitions. We will identify 'definitions' with transformational rules for rewriting expressions of an expanded language into expressions of a restricted language and discuss the formal constraints on a set of rules that sets definitions apart from arbitrary sets of transformations.

2.1 Manuals of translation and constructional systems

In the second chapter of his book *Word and Object*, Quine [1960] uses a famous thought experiment to illustrate his theory of meaning. An anthropologist is sent to the jungle to chart the language of an isolated tribe. There are, by assumption, no bilingual speakers or translations into intermediate languages. The linguist can only observe the natives' behavior to guess what their words mean. By looking at when they use certain sounds, what they point to, and how they correct her own attempts at using these words, the linguist guesses that a certain word means 'house', 'I', or 'rabbit'. Quine [1960] calls these guesses 'analytical postulates' and a collection of analytical postulates determines a 'manual of translation'. A formalization of the latter is a function from segments of text or speech in a foreign language to speech in English. Quine [1960] held that there will be more than one manual of translation that can be said to be correct, but we need not follow him on this point. The notion manual of translation is perfectly neutral. Quine [1960] ends up extending the notion of translation to cover mappings from arbitrary languages to English and even mappings of English into English. We will need mappings that associate to the predicates of a formal system a certain interpretation in ordinary English.

Definition 1. *A manual of translation* is a function f from the open formulae of a first order language L into grammatical phrases of English such that:*

(1) L associates to the primitive predicates of L an English phrase that has one of the forms (a) $Is + D + N$, (b) $Is + Adj$, (c) a verb V or (d) a logical compound of the above that has been built from phrases of the type (a)(b)(c) by combining them with words such as 'and', 'or', 'but', 'all', 'for some'.

(2) To the open formulae $\phi(v_1, ..., v_n)$ of L, f assigns a logical compound of the above that has been built from the translations of the primitive predicates by corresponding uses of 'and', 'or' 'not', 'all', 'it is not the case that'.

manifestation of deep prejudices against abbreviated notation. We can extend predicates for naming, the assignment and satisfaction by contextual definition to the wider language; and we can formulate the criterion in terms of the values of the variables (*see* the appendix).

Let me admit that there is a certain vagueness in my definition of a manual of translation since the list of logical particles is not exhaustive. Neither do I indicate which pairs of logical words, such as 'and' and 'but', or 'some' and 'there is', can be used interchangeably. Thirdly, what it means to construct a phrase in a 'corresponding manner' is left unspecified. It seems to me that these details could be filled in a fuller treatment of translation manuals, but that to do so requires much more sophistication about the syntax of English than it is appropriate for a metaphysics paper or than it is necessary to make my approach plausible.[27] A few worries may be assuaged by making clear that my approach does not require that the translation be defined on all the formulae of L. There are certain distinctions that one can make by using variables x, y, z, and parentheses that seem to be lost when returning to the pronouns 'him', 'her' and 'it'; unless one represents grammatical sentences in the form of trees. But we will see that for our purposes, partial interpretations are sufficient.
Without being as sophisticated, it is clear that the manual that the linguist of the thought experiment of [Quine 1960] is writing up will not exactly determine a function from expressions to expressions, but rather a function from expressions to equivalences classes of expressions. Each entry in the dictionary for the language jungle will have underneath it several equivalent translations in English. For example, the same word may be translatable as 'bachelor' and as 'unmarried male'. This means that f implicitly postulates certain relations of synonymy for English. As for manuals themselves, Quine [1960] will hold that there are several equally correct ways to carve up the language; the realist about meaning and reference will hold that there is only one. We do not need to concern debate the point in this paper. For the realist about meaning and reference, a constructional system C has a determinate ontology. The theory postulates what it postulates under the single correct manual of translation f. For the antirealist about meaning and reference, the system C has no determinate ontology. C has an ontology relative to different acceptable choices of f.[28] Who is right is not the concern of a criterion of ontological commitment.
The second piece of machinery that we need to clarify in this section is the notion of a constructional system. For Carnap [1928] and Goodman [1951] a constructional system C was only a system of definitions; but, for our purposes, it is more convenient to construe C as an ordered pair $\langle T, D\rangle$ of a set of postulates T and a set of definitions D. What we now need to do is clarify what sort of thing 'definitions' are and lay down conditions for a set of definitions to form a system. My proposal is to identify definitions with a set of formal rules for rewriting expressions into other expressions. The notion of a transformation rule originates in the work of [Carnap 1936] and [Post 1943]. Chomsky [1957] has

[27] Chomsky and Scheffler [1959] notice that problems of this sort arise because English is the metalanguage in which we are formulating the criterion. The problem could be sidestepped by formulating the criterion in a first order language that has been augmented with a stock of English predicates. In this case, the notion of a manual of translation reduces to that of a 'reconstrual' in the sense of Quine[1975] and Halvorson[2019, chapt.4].

[28] This may illuminate the problem raised in [Broogaard 2008] of reconciling the criterion of commitment with the doctrine of the relativity of ontology in [Quine 1969].

used such transformational rules to analyze certain aspects of ordinary language, such as the transformation of a declarative sentence into a question or in the passive form. In the formulation of [Chomsky 1957] a rule is given by specifying (a) the set of strings of symbols to which it applies and (b) how it transforms a string of the form specified in (a). To write specific examples, Chomsky [1957] uses the symbol '+' for concatenation, and the arrow '→' means 'rewrite as'. We can easily rewrite the Russellian theory of descriptions in this formalism[29]:

$$(+ (+ \imath + Variable + \ Formula +) \ + \ Formula +) \tag{1}$$

$$\begin{gathered}(+ (+ \imath + X_1 + X_2 +) + X_3 +) \\ \rightarrow \exists + X_1 + (+X_3 + (+ \wedge +X_2 + \wedge + \forall + y + (+X_2 + \supset +(+X_1 + = +y+)+)\end{gathered}$$

Chomsky [1957] refers to a system of rewriting rules as a 'grammar'. A grammar determines a set of definitions only under certain circumstances. On the left side of the arrow symbol '→', within the rules of the system, we must find sentences of a language L'. Repeated applications of the rules must reduce a sentence of L' into a sentence of the language L of T in an unambiguous fashion. The grammar gives us a function f_C from sentences of L' into sentences of L. A second constraint is that f_C be what Halvorson [2019, chapt.4] following Quine [1975] calls a reconstrual of L' into L. This means, loosely speaking, that f_C is a map that respects the logical structure of L'; so that apparently valid inferences are valid. A *modus ponens* in L' turns into a *modus ponens* in L, and so on.

Definition 2. *A constructional system is a pair $\langle T, D\rangle$ of a first order theory T and a grammar D. Let L be the language of T and L' be the smallest language that contains all the predicates on the left side of the rules of D. C is a constructional system if and only if:*

(1) Every formula of L' can be transformed into one and only one formula of L by repeated applications of the transformational rules in D.

(2) The induced function f_C satisifes the condition for being a generalized reconstrual as set out in [Washington 2018] and [Halvorson 2019, chapt.6]

On this notation, the term $f_C(\phi)$ stands for the sentence of L that the formula ϕ of L' abbreviates in C. Let us also use T_C and D_C for the first order theory and the grammar that compose C. Before moving on to formulating a criterion of postulation, we can extend the notion of interpretation to constructional systems and correct some of the deficiencies of our first attempt.

Definition 3. *A manual of translation for a constructional system C is a function f from the open formulae of the expanded first order language L'_C into grammatical phrases of English such that:*

[29] There are subtleties about the choice of the quantified variable that we are ignoring

(1) L associates to the primitive predicates of L an equivalence class of English phrases of the form (a) $Is + D + N$, (b) or $Is + Adj$, (c) or a verb V or (d) a logical compound that has been built from phrases of the type (a)(b)(c) by combining them with words such as 'and', 'or', 'but', 'all', 'for some'.

(2) To the open formulae $\phi(v_1, ..., v_n)$ of L, f assigns a logical compound of the above that has been built from the translations of the primitive predicates by corresponding uses of 'and', 'or' 'not', 'all', 'it is not the case that'.

These two notions, of translation manual and constructional system, will be used to formulate the criterion. Before I propose the two solutions that I find satisfactory, let me begin with the problem. If we confine ourselves to terms and predicates, what they name and what things they apply to, and renounce concepts, meaning, propositions, and the like, can we formulate claims about what a theory T postulates? An old dispute concerns whether the criterion can be made extensional in this sense. The next sections reviews once more the difficulties of the standard formulations and the desiderata to be satisfied.

2.2 The extensionality of the criterion

The problem of making the criterion extensional can be put in two ways, or better, there are at least two aspects to it. Cartwright [1954] appeals to the distinction in a paper of Quine [1953b] between the theory of reference and the theory of meaning. The theory of reference concerns itself with truth, denotation, and the application of predicates to objects. The theory of meaning deals rather with synonymy, meaning, and analyticity. Quine [1953b] makes it abundantly clear that, in his opinion, things stand ill with the theory of meaning. To use notions from the theory of meaning in explicating other concepts is worse than useless; unless one first gives an analysis of them in previously understood terms. In other papers from the same collection, Quine [1953b] launches an equally sustained attack on intensional operators. An intensional context '$\phi[s]$' is an expression that changes semantic value, for example, it goes from true to false, when s is substituted by a coreferential term t. It is disconcerting, therefore, to see that naive formulations of the criterion of commitment flirt with the theory of meaning at every turn. It suffices to look closely at one.

> Entities of a given sort are assumed by a theory if and only if some of them must be counted among the values of the variables in order that the statements affirmed in the theory be true.
> [Quine 1953, p. 103]

In the same paper where these distinctions are drawn, *Notes on the theory of reference* [Quine 1953b], Quine [1953b] convinces himself, that this way of putting things meets his strict requirements of extensionality.

> The notion of ontological commitment (...) belongs to the theory of reference because to say that a given existential quantification

> presupposes objects of a given kind is to say simply that the open sentence which follows the quantifier is true of some objects of that kind and none not of that kind [Quine 1953,p.131].

This claim does not withstand close scrutiny. Take the existential sentence '$\exists x$ Centaur x'. The open formula that follows the quantifier is the predicate 'Centaur x', and the sentence itself postulates the existence of centaurs. But the predicate is true of no object of that kind. If the clause demanding that the predicate apply to objects is deleted, it turns out that '$\exists x$ Centaur x' postulates centaurs, but also purple cows, goblins, even prime numbers greater than two, and so on. A quick fix is to state that a theory T postulates dogs, or purple cows, when each model of T contains entities in the domain of discourse that the theory 'treats' as dogs or as purple cows. To treat some individuals as purple cows can be interpreted as the requirement that some objects satisfy the predicate 'Purple Cow x' in every model $\mathcal{M}$ of T, whether or not the individuals in $\mathcal{M}$ are in fact purple cows. The trouble is then that '$\exists x$ Hund x', in the obvious German interpretation, ceases to count as a sentence postulating dogs. There are two approaches to deal with this further difficulty that strike me as promising. One is to momentarily forget dogs and retreat to the binary predicate 'T postulates the existence of entities satisfying predicate s' for various choices of s. The second option is to isolate across languages all the predicates that mean 'x is a dog'. But this reliance on the synonymy of predicates seems *prima facie* to be a capitulation and to accept part of the theory of meaning without explanation.
A minor problem is raised by the mention of 'kinds' and 'sorts' in the two paragraphs above. It seems that Quine [1953] is quantifying over universals to express the universal quantification implicit in the criterion of commitment. For every sort of entity s, a theory T postulates entities of sort s if and only if entities of sort s are in the range of the variables. Church [1958, p. 1013/f] suggests to read this literally and construes ontological commitment as a relation between a theory and an attribute. This means that the criterion of postulation that [Quine 1953] wants to use to prove that the sentence '$\exists x$ Dog $x \wedge$ White x' does not postulate whiteness and dogkind is itself postulating whiteness and dogkind. This unwelcome outcome can, again, be avoided in two ways. If we turn to the predicate 'T postulates the existence of entities satisfying predicate s', we can quantify only over predicates rather than over sorts, kinds or attributes. The other option, as we will see, is to follow Scheffler and Chomsky [1959] and state the criterion as a schema rather than as a single universally quantified sentence.
The most pressing matter is how to deal with the expression 'postulates'. If taken as a binary predicate obtaining between a theory and a plurality of individuals, it is clear that it is not extensional. It is entirely possible that the plurality of Italians that voted for Gino La Trippa for mayor of Rome in 1957 is identical to the plurality of Italians that believe Elvis is still alive. But to postulate the existence of an individuals of the first kind is not the same as postulating an individual of the second kind. This means that we must find some other way to segment sentences that contain the word 'postulate'. One option has already been noted and consists in embedding 'postulates' in the context 'T postulates

the existence of entities satisfying predicate s', but it is not the only option. A method to reconstruct a much larger class of occurrences of the word 'postulates' is due to Scheffler and Chomsky [1959] and is defended in the next section. The idea is to treat the predicate 'T postulates dogs' as an unbreakable one-place predicate.[30] This has some intrinsic plausibility, and we can compare it with what Goodman [1972] says of the predicate 'x is a picture of Don Quixote':

> Occasionally the objections is raised that to speak of descriptions of the world implies that there is such a thing as the world. One might as well point to pictures of Don Quixote to prove that there is one and only one such person. 'Picture of Don Quixote' and 'description of the world' are one-place predicates and are better replaced by 'Don-Quixote-picture' and 'world-picture'. [Goodman 1972, p.4]

The analogy will be exploited momentarily in our schema of commitment. Terence Parsons [1967] expressed the majority opinion when he wrote that to formulate a meaningful notion of ontological commitment requires to move into the domain of the theory of meaning. But it seems to me that such pessimism is premature, and solutions that would have satisfied Quine [1953] are at hand.

2.3 Scheffler and Chomsky 1959

It seems to me that a good step in this direction has been made by Israel Scheffler and Noam Chomsky [1959] in their article *On What is Said to be*. The solution I have in mind is only one of three that they suggest, and they do not lay particular stress on it. But I believe that it is the most promising and that it has not received enough attention. I will now briefly describe their solution and note one remaining difficulty that it still faces. The solution is based on two main ideas: treating 'postulates' as syncategorematic and reformulating the principle as a sentential schema. To treat 'postulates' as syncategorematic is to treat it as a fragment of a larger predicate and to deny that by itself, it has any semantic interpretation. Scheffler and Chomsky [1959] apply their criterion to unary predicates of the form 'T postulates the existence of tables', 'T postulates the existence of centaurs' and 'T postulates the existence of purple cows'. One cannot bind a variable in the illusory second slot of the predicate 'postulates' to form a sentence, for example, to form the formula $\ulcorner \exists x \exists yy$ Postulates $xyy \urcorner$. The restriction on quantifying in means that a criterion must have the form of a schema rather than a quantified statement. For every choice of a noun word such as 'dog', 'house', 'electron' and so on, the schema specifies an instance for the postulation of those entities. To reduce the temptation to view these words as standing in the position of a bindable variable, Chomsky and Scheffler [1959] rewrite their predicates in the form 'T makes a table-assumption', 'T

[30] One can already expect the objection that that to treat these predicates as distinct obscures their obvious connection and that such an infinity of independent predicates would be 'unlearnable'. But to treat these predicates as unary does not mean that there isn't some uniform process by which they are constructed from their components. It means that they are not obtained by saturating one open slot of the binary predicate 'postulates'.

makes a house-assumption', and so on. They proceed to specify the schema. Their criterion is formulated for theories T and I will put aside the problem of extending it to a constructional system C, for the moment. Scheffler and Chomsky [1959] say that T *yields* formula ϕ if and only if ϕ is a theorem of T.

Criterion of commitment schema (Scheffler and Chomsky) 1. .
T makes a ...assumption iff it yields a statement of the form '$\exists x$ (x is a ...)'.

Let us look at a particular example. For instance, let us use the schema to formulate a criterion for ontological commitment to tables.

(21) T makes a table-assumption if and only if T yields '$\exists x$ (x is a table)'.

The criterion of [Scheffler and Chomsky 1959] deals well with the second and the third problem discussed in the last section, about the generality and the intensionality of postulation. However, it is still inadequate in connection with the first problem of predicates in a foreign language. For example, the criterion of Scheffler and Chomsky [1959] rules that sentences (22) and (23):

(22) $\exists x\ \exists y$ (Hund $x \land$ (Hausaufgabe $y \land$ Ißt xy))

(23) $\exists x$ Gavagai x

are not committed to dogs, or to rabbits. The needed medicine is, in my view, a relativization to manuals of translation from the language of the theory to English. The next section formulates our schema of postulation.

2.4 The schema of ontological commitment

The material presented in the last two sections has been a preliminary to a formulation of the schema below. Let us remind ourselves that a system C determines a theory T_C in a language L_C and a reconstrual f_C of an expanded language L'_C into L_C. The dummy symbol 'NP' stands in the position of a plural noun of English. We assert every sentence that can be obtained replacing 'NP' with such a noun in the schema illustrated below:

Criterion of commitment schema 1. *A constructional system C postulates the existence of NP relative to manual f if and only if there is an open formula $\phi(x)$ of the language of L'_C such that $f(\phi)= NP$ and $T_C \vdash f_c(\ulcorner \exists x\ \phi(x) \urcorner)$.*

For example, if a manual f for C translates $\phi(x)$ as 'electron' or 'is an electron', C abbreviates $\ulcorner \exists x\ \phi(x) \urcorner$ by the formula θ of L and $T_C \vdash \theta$ then C postulates electrons. The schema can be applied to prove that a constructional system that has (18) as a formal theorem and that abbreviates (18) by (17) postulates the existence of rational numbers. A system C that has (18) as a theorem, but introduces no abbreviations, does not. This seems to me to be the correct result and introduces order on this point. Halvorson [2019] has defended that examples such as (17) and (18) render untenable the idea that the formalization of scientific a theory is sufficient to read off the ontology of the regimented theory from its formalism. From the quantifiers in primitive notation, one is not able to infer what further entities are recognized by the introduction of definitions and abbreviations. Halvorson [2019] seems to think that this observation is a game-changer for such debates as that between the [Quine 1953] and the nominalist [Field 1980]. But it seems to me that ascribing commitment to constructional systems allows us to maintain, against Halvorson [2019], that once a physical theory is formalized, its ontology becomes manifest.

> Supposing that $\exists x \exists y$ deserves to be called a quantifier, then we need to rethink the notion of the 'ontological commitments' of a theory - and along with that, a whole slew of attitudes towards ontology that come along with it. (...) For example, some philosophers argue that we should believe in the existence of mathematical objects since our best scientifc theories (such as general relativity and quantum mechanics) quantify over them. Others, such as as Field(1980) attempt to 'nominalize' these theories - i.e, to reformulate them in such a way that they do not quantify over mathematical objects. Both parties to this dispute share a common presupposition: Once a theory is regimented in first-order logic, its ontological commitments can be read off from the formalism. But this presupposition is brought into question into question by the fact that first-order theories can implicitly define new quantifiers. [Halvorson 2019, p. 127/f]

The point of the passage above is well taken. But it seems to me that the proper way to formulate the point is not that regimentation in first order logic is insufficient to specify a precise ontology, but rather that a complete regimentation of a physical theory consists of reformulating the theory as a constructional system C. The idea that physical theories are constructional systems has concrete implications for specific debates in the philosophy of physics. For example, it indicates a clear sense in which a theory that does not seem to assume *local beables* at the outset[31], dispensing with them in favor of regions and predicates of configuration space, could via constructional definitions postulate tables, chairs, boxes, and magnets relative to C. Unfortunately, an exploration of this topic is beyond the scope of this paper. The next section outlines a second approach to reformulate the criterion. Its main advantage is that it does not need to be formulated in a schematic form. We give a formulation of it and discuss its relation with the schema that has been presented in this section.

2.5 The second formulation of the criterion

Is it possible to write down the criterion at once, in terms of a more economical base of primitives? Our second approach allows us to formulate a criterion in a single fell swoop, as a single statement, and dispense with new predicates except for one. We want to see that, for constructional systems C that do not

[31] By which I mean, does not postulate them when construed as a bare theory T with no constructional definitions. I am alluding to wave function realism [Albert 1996] [Ney 2015]

have certain pathological properties, all the instances of the schema above can be deduced from the principle to be formulated in this section. The gist of the approach is to focus our attention on the relation between a theory and its predicates. The question 'what entities are there according to T?' can be recast, for the believer in universals, as 'what sorts or universals are exemplified in the world according to T?' [Church 1958]. Similarly, the question 'what entities does T say exist?' can be recast in terms of predicates as 'what predicates does T assume are satisfied?'. The second question is not exactly a reformulation of the first, and the criterion that we are about to formulate is not simply a condensation of the schema. A theory in a foreign language can postulate dogs without postulating entities that satisfy the predicate 'Dog x'. It is also possible to postulate entities that satisfy the predicate 'Dog x' by mentioning the predicate rather than by using it. For example, a theory T may possess a constant a denoting the predicate 'Dog x', a satisfaction predicate for English '$\mathrm{Sat}_1\ xy$' and have as a postulate '$\exists x\ \mathrm{Sat}_1\ xa$'. But it is clear that the two questions are tightly related and that a theory with either predicates from English and no semantical notions at all, or, alternatively, enough postulates to describe its own semantics, will postulate dogs if and only if it postulate entities satisfying the predicate 'Dog x'. This suggests a criterion in terms of the notion:

$$C \text{ postulates entities satisfying predicate } s \text{ under interpretation } f \tag{2}$$

The above is a predicate of three places that holds of a constructional system C, a predicate s, and a translation manual f. It is useful to insists on the point that the phrase 'postulates' appears as syncategorematic. To treat an expression as syncategorematic is to embed it in a complex predicate and never let it occur in isolation. The larger predicate can be adopted as an extralogical primitive, or it can be introduced by definition without ever mentioning the original phrase. Examples of syncategorematic phrases are the adjective 'false' in complexes such as 'false coin' and the word 'sake' in 'for the sake of'. The predicate 'false coin' functions as a single unit. It cannot be decomposed into the conjunction 'something that is false and a coin' [Quine 1960, pg. 94]. Etymologically, 'sake' descends from a word in old English that used to occur in isolation. It meant 'affair, legal action, thing', somewhat related to 'Sache' in German, but it now occurs only in the phrase 'for the sake of'.[32] When regimenting 'x did y for the sake of z', no one would construe it as (24), with 'the sake of z' treated as a description of an object, on par with 'the mother of z' or 'the book of z'. We would treat 'x did y for the sake of z' as a single three-place predicate (25):

(24) $\exists w\ (w \text{ is the sake of } z \wedge x \text{ did } y \text{ for } w)$

(25) x did y for the sake of z

When we say that C postulates the existence of entities satisfying s under f, we intend to use a predicate with three variables 'C','s' and f. We could rewrite the same predicate as 'C takes s to be have non empty extension under

[32] Oxford English Dictionary, second edition 1989

f' or simply 'T takes s to be non empty under f'. But, as we have seen, the simplest modification of the schema does not work:

Failed attempt at a criterion 1. *A constructional system C postulates the existence of entities satisfying predicate s relative to f if and only if there is an open formula $\phi(x)$ of the language L'_C such that $f(\phi)$=s and $\vdash \exists x\ f_C(\phi(x))$.*

A theory may postulate entities satisfying a predicate s by mentioning s and employing a satisfaction predicate. This leads to a disjunctive statement:

The criterion of ontological commitment 1. *A constructional system C assumes the existence of entities satisfying the predicate s relative to manual of translation f if and only if either (a) or (b) are the case:*

(a) There is an open formula $\phi(x)$ of the language L'_C with one free variable such that $f(\phi)$= s and $T_C \vdash f(\exists x\ \phi(x))$.

(b) L'_C has a constant a for s, a constant k for f, a satisfaction predicate Sat xyz relative to manuals of translation and $T_C \vdash \exists x\ Sat(x,a,k)$

For constructional systems that do not contain a satisfaction predicate, the criterion reduces to point (a). We obtain a generalization of the schema in the previous section. The relationship between the two is more complicated when C can describe some elementary syntax and contains a satisfaction predicate. In this case, the criterion does not supply enough information to recover all the instances of the schema. But we can call a C that employs *only English predicates* minimally adequate if it proves all sentences of the form:

$$(26)\ \ \mathrm{Sat}(x_1, ..., x_n, a, k) \leftrightarrow P^n\ x_1, ..., x_n$$

where k is a constant for the 'homophonic' or identity translation, and a is a name of the predicate P^n. In such cases, it is easy to see that we can deduce from the criterion of this section every instance of the schema that concerns C.

3 The analyticity of the criterion

A standard definition of an analytic statement is a statement that can be turned into a logical truth by substituting, for some of the expressions that occur in it, phrases with the same meaning [Quine 1953][Boghossian 1996]. To justify the view that every instance of our schema, for example, is analytic, we can reduce the claim of analyticity to a number of claims of synonymy. Almost each of the occurring expressions needs to be defined. This means analyzing into more basic notions such terms as 'constructional system', 'assume the existence of cows', 'manual of translation', and so on. The claims of synonymy that we will make can be left to the reader's linguistic intuitions to evaluate. We want each of our claims (a) to look like a plausible case of synonymy and (b), by aggregating together, we want to turn the two sides of the biconditional into the same sentence. This is almost the plan that we will execute. It turns out that the definition of 'constructional system' relies on such notions as that of a first order theory T_C. To define first order requires a cumbersome definition by induction and would make the resulting expanded biconditional too long to survey at once. I will instead attempt to establish as analytic, in the manner above, some intermediate claims and derive from them the particular instance of the schema. The first claim may be the least controversial:

(26) A constructional system C postulates the existence of cows relative to f if and only if C says that cows exist relative to f.

The second claim makes explicit what it means to say that cows exist:

(27) A constructional system C says that cows exist relative to interpretation f if and only there is some expression s that means 'cow' in f and some expression k that means 'exists' and C asserts an application of k to s.

To use (26) and (26) to deduce our instance of the schema requires some platitudes about first order languages (28) and (29). They can be deduced from a standard definition of a first order language and its interpretation.

(28) The only two expressions that mean 'exist' in a first order language L_C are the quantifiers '$\exists v$' and '$\neg\forall v\neg$' for a suitable variable v.[33]

(29) A constructional system C asserts an application of '$\exists v$' to a formula $\phi(v)$ if and only if it has as theorems both $\ulcorner\exists v\phi(v)\urcorner$ and $\ulcorner\neg\forall v\neg\phi(v)\urcorner$.

It is clear at this point that using analogs of (26)(27)(28) and (29), we can deduce the particular case of the schema of commitment from analytic statements. This concludes our case for its analyticity. A similar argument can be run for the criterion of commitment in terms of the postulation of entities satisfying a predicate. Let me conclude by considering some objections to the approach in this section. There is a growing number of philosophers that distinguish the 'implicit commitments' of a sentence from the 'explicit commitments of a sentence' [Bricker 2016]. A theory T implicitly committed to cows, in this terminology, is that formed only by the sentence (30) below:

(30) The first order sentence '$\exists x$ Cow x' is true

We assuma that T does not contain the disquotational schemata to infer from (30) that cows exist. Another example is given in [Rayo 2007]. The sentence

(31) $\exists x$ Parent x

[33]Fine[2009] gives an argument against the view that the quantifiers '$\exists x$' and $\exists y$ express a notion of existence. The reply I gave in earlier versions of this paper has been anticipated in [Warren 2019] and this discussion has been demoted to a footnote. The upshot was that some claims of existence in ordinary language are to be formalized with the plural quantifiers '$\exists xx$' and '$\exists yy$'. For example, the claims 'natural numbers exist' and 'integers exist' become '$\exists xx$ Natural Number xx' and '$\exists yy$ Integers yy' respectively. This preserves the intuition that the existence of integers entails the existence of the natural numbers and not *vice versa*.

seems to be implicitly committed to the existence of things that are children. But logic alone cannot extract from (31) an existential quantification over children. The last example of implicit commitment can be adapted from [Michaelis 2008] [Peacock 2011]. Consider a theory T that has as its only postulate

(32) $$\exists x \text{ Bachelor } x.$$

Suppose it does not possess a predicate 'Male x' or a synonym. Is it ontologically committed to male individuals? Partisans of implicit commitment answer 'yes' [*see* Bricker 2016]. These examples are threats to (26), and our understanding of postulation throughout the paper, only if we accept that 'postulation' means 'implicit postulation' rather than explicit postulation. We can, at any rate, immunize the criterion by insisting that we are giving a criterion of explicit commitment. Either we insist that 'postulation' means 'is implicitly committed to', or we disambiguate by stipulating that we will understand 'postulate cows' in the sense of explicit commitment or postulation. This protects (27) from the possibility of refutation. But then, the objection goes, have we not simply obtained an analytical criterion by making stipulation after stipulation? Have we not made the criterion useless since cases of implicit postulation such as (30) and (31) are as important as cases of explicit postulation? My view is that our clarifications have brought us only benefits. We have broken down complex notions, such as that 'postulation de re', from footnote 22, in terms of simpler notions, such as what we have called postulation 'de dicto' and the adequacy of definitions. The two pieces of postulation 'de re' are better dealt with separately with criteria for postulation and for constructional definitions. A similar approach pays off also in the case of implicit postulation. We can define implicit postulation in terms of postulation and analyticity as follows:

Definition 4. *A constructional system C is implicitly committed to NP if and only there is an extension T' that has been obtained from C by adding analytic statements and C' postulates the existence of NP*

This definition of implicit postulation seems to fit the cases in (30)(31)(32). If successful, it reduces the problem of determining implicit postulation to our schema of commitment and to criteria for recognizing analytic sentences. The remaining difficulties in this connection are likely due to analyticity rather than to postulation. Our approach also has the merit of respecting the intuition that

(33) $$\exists x \text{ Bachelor } x \wedge \forall x \text{ (Bachelor } x \rightarrow \neg \text{ Male } x)$$

postulates bachelors that are not males and does not postulate male bachelors. Objections in the literature are variants of those we have already dealt with.

4 Conclusion

The thesis that I have defended is unpopular but not entirely original. Alonzo Church [1958, p. 1009] already remarked that the criterion is 'straightforward and in a sense obvious'. He proceeded to give an amusing description of the contortions to which [Ayer 1947] and [Ryle 1951] were lead in an effort to assert simultaneously that sentences stand for propositions and that they do not; that attitudes such as 'desires' and 'wants' have intentional objects and that they do not. [Ayer 1947] and [Ryle 1951] appear to have blinded themselves with philosophical jargon, convinced that they can have their philosophical cake and eat it. We have seen that their contemporary epigones [Jackson 1980][Azzouni 2004] do not fare much better in this respect. The contributions of this paper have been an extension of the criterion to constructional systems and two ways to make it extensional. In earlier sections, I also distinguished what a theory says from what we should say there is and the criterion of commitment from the program of regimenting physics. The distinction between the criterion and the program was not drawn to distance myself from the program of regimentation. A loud denunciation of the criterion is often the preferred way to neutralize the results of regimentation by those that do not dare to reject outright either (a) the realist premise that part of fundamental physics gives us a literally true description of the world and (b) the old idea in analytic philosophy that the languages of mathematical logic are the best tool to make informal theories precise and explicit. The foes of regimentation must deny either (a) or (b). In this sense, the results of this paper bear on the program of regimenting physics.

5 Appendix: The range of the variables

In formulating the criterion, I have been neglecting for a while to speak of the range of bound variables. But it is not difficult to show that, under some mild Platonistic assumption, our criterion of ontological commitment can be reformulated in terms of what is in the range of the variables inside various models of the theory. The simplest method to account for apparent quantifiers in abbreviated notation is to use a trick. In model theory, the *Morleyfication* of T is roughly the theory that one obtains by adding as primitives all the predicates that could be defined: a predicate for each open formula [Lascar 2009, p.164]. Let me speak now of the *Morleyfication* of a constructional system:

The criterion of ontological commitment 2. *A constructional system C assumes the existence of entities satisfying predicate s relative to f if and only if there is an open formula $\phi(x)$ of the language L'_C such that:*

(1) T'_C is the theory in L'_C that one gets by adding the biconditionals asserting the equivalence of all the sentences in abbreviated notation to what they abbreviate in the language of T [we call this the 'Morleyfication' of C].

(2) $\phi(x)$ is a formula of L'_C that such that $f(\phi) = s$

(3) In every model M of T' there is an entity in the domain of the bound variables that satisfies $\phi(x)$ or satisfies $Sat(y, k)$ with k a name of ϕ in a standard formalization of syntax [see Quine 1940, chapt.7] .

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