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Rational Theory Revision in Logic: Beyond Abductivism

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whose patience in teaching me
made all the difference.

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Aos onze anos de idade eu já desconfiava
Da verdade absoluta

At eleven years of age I was already suspicious
Of the absolute truth

As Aventuras de Raul Seixas Na Cidade de Thor,
Raul Seixas

Abstract

A recent trend in the philosophy of logic, under the title of "anti-exceptionalism", proposes that the epistemology of logic should be approximated to that of science: logical theories are not justified by *a priori* intuitions, but rather, as in the other sciences, by *a posteriori* (or empirical) evidence. How exactly the relation of logic and science is to be fleshed out by the anti-exceptionalist remains to be determined. An approach favored by many is to adopt "the abductive method" to select the best logical theory. This approach is not without its problems, or so it is argued herein. Anti-exceptionalism should not stand or fall on the merits of logical abductivism, or those of any method of theory revision in particular. Rather than defining anti-exceptionalism in terms of applying the scientific methodology of theory revision to logic, the present thesis proposes to define it simply in terms of rational theory revision. Such definition allows for divergent ontological and methodological views to fall under the scope of anti-exceptionalism. The present dissertation articulates what rational theory revision of logic looks like beyond logical abductivism.

Keywords: philosophy of logic, epistemology of logic, logical anti-exceptionalism, abduction, reflective equilibrium.

Resumo

Uma tendência recente da filosofia da lógica, sob a designação de "anti-excepcionalismo lógico", propõe que a epistemologia da lógica deve ser aproximada à das ciências: teorias lógicas não são justificadas por intuições *a priori*, mas ao invés, como nas outras ciências, por evidências *a posteriori* ou empíricas. Como exatamente a relação entre lógica e ciência será desenvolvida por um anti-excepcionalista ainda há de ser determinada. Uma abordagem preferida por muitos é adotar o "método abdutivo" para selecionar a melhor teoria lógica. É argumentado aqui que tal abordagem não é livre de problemas. Anti-excepcionalismo lógico não deveria suceder ou fracassar nos métodos do abdutivismo lógico, ou de qualquer método de revisão de teorias em particular. Ao invés de definir o anti-excepcionalismo em termos da aplicação do método científico de revisão de teorias à logica, a presente tese propõe definí-lo apenas em termos de revisão racional de teorias. Tal definição permite que diferentes visões ontológicas e metodológicas se enquadrem no escopo do anti-excepcionalismo. A presente tese articula o que seria revisão racional de teorias lógicas para além do abdutivismo lógico.

Keywords: filosofia da lógica, epistemologia da lógica, anti-excepcionalismo lógico, abdução, equilíbrio reflexivo.

Contents

0 Introduction

The main topic of this thesis is the revision of logical theories, and its aim is twofold: *first*, to present a critique of the current state of anti-exceptionalism and logical abductivism, and *second*, to propose a better account of theory revision in logic. This thesis is a challenge to the anti-exceptionalist treatment of logic as a science, by showing the limits of this analogy.

Recent trends in the philosophy of logic, under the title of "anti-exceptionalism", propose that principles of logic are not *a priori*, but rather, in naturalist fashion, justified by *a posteriori* or empirical evidence. This view opposes two traditions in the philosophy of logic, that of rationalism and that of semanticism. While rationalism tries to account for logic only in terms of intuitions, semanticism attributes the source of logical knowledge to linguistic proficiency. The anti-exceptionalists take both these accounts of logic to be wrong because neither view can account for the practice of logicians and their disagreements. They propose to adopt from the sciences a method of theory revision.

An approach favored by anti-exceptionalists is to explain logical knowledge in terms of what they take to be the methodology of justifying theory choice in science, that is, via abduction. Abduction is a mode of inference first proposed by C.S. Peirce, which, together with deduction and induction, are taken to be the sorts of reasoning involved in scientific inquiry. In recent literature, however, this term has lost its original meaning and has come to be employed in the justification of theory selection, as "Inference to the Best Explanation" (IBE, hereinafter). In this sense, the theory which provides the best explanation, judged according to certain theoretical virtues (simplicity, strength, empirical adequacy and so forth), is taken to be the

one most likely to be true.

The approach of justifying theory choice via IBE is common within the literature of scientific realism. In line with this, the view of logical abductivism has some problematic consequences, as it commits logic to a particular ontology. In light of this, the present thesis surveys different approaches to the problem of revising logical theories, finding that anti-exceptionalists conflate their views with abductivism at the cost of being committed to some form of realism about logic.

The larger argument of the thesis may be characterized in terms of four measures. *First*, it is maintained that by relying on scientific realism and IBE, abductivism in logic is a slippery slope towards a form of realism about logic. *Secondly*, it is argued that it is a mistake for anti-exceptionalism to be framed at all in terms of its likeness to science, for swapping one theory of science for another makes anti-exceptionalism a false doctrine. *Thirdly*, a new characterization of anti-exceptionalism in logic is suggested, taking logic to be rationally revisable and not to have a unique methodology. Anti-exceptionalism as an account within the epistemology of logic need not settle ontological disputes. *Fourthly*, further methodologies of theory revision for logic are analysed, namely, Lakatos' "proofs and refutations" as well as reflective equilibrium, arguing that these are more appropriate for logic.

1 The epistemology of logic

This present chapter situates different views in the epistemology of logic concerning the topics of logical disagreement and theory revision in logic. It introduces the epistemological challenge of "Agripas's trilemma" and surveys the current scenario regarding the foundation of logical knowledge. Two earlier views, those of logical rationalism and logical semanticism, take logical knowledge to be *a priori*. A third, more recent view takes logical knowledge to be rather *a posteriori* and thus revisable as in the case of the empirical knowledge of the sciences. The former views came to be called "logical exceptionalism" while the latter, "anti-exceptionalism", as it sees logic as not particularly exceptional in comparison to the several scientific disciplines.

1.1 Logical disagreements and theory revision

Disagreement in logic is nothing new. Millennia ago Megarians and Stoics already disagreed with Peripatetics about the nature of conditional declarative sentences; Medievals disagreed among themselves about how to make sense of the problem of the two Barbaras; and ancient and modern logicians disagreed about the validity of the existential import. Paradoxes have plagued logicians since they started counting heaps of sand and meeting lying Cretans.[1]

While there has been logical disagreement for as long as there have been logicians, the current story about revising logic occurs after the hegemony of "Classical

[1] The traditional version of Sorites Paradox involves a heap of sand from which one grain of sand is removed; admitting that a heap minus one grain is still a heap, if enough grains are removed, there will be only one left. Would one grain still be a heap? The traditional version of the Liar Paradox starts out with claiming that all Cretans are liars; what if a Cretan said so?

Logic" was established. Dissident logicians assumed the task of revising whatever it is that Classical Logic had become, be that description of logical facts or prescription for correct reasoning.

A logical system could be understood simply as an abstract structure (a "pure logic", following the terminology of Graham Priest (2006)), as studied by mathematical logicians, or as a theory of logic, which is a more robust theory, including a system of logic together with bridge principles, translation procedures to and from a natural language, and so on. In this sense, a theory of logic has a canonical application to adjudicating the validity of arguments, and not a merely instrumental use (such as in computer circuits or informational flow). While there is a slight disagreement about how to characterize this canonical application, Classical Logic is thought to be the first logic which is suitable to such an aim.

After the algebraization of logic in the second half of the 19th century, Classical Logic was (for a while anyway) deemed hegemonic, and logical disagreement could be understood with a new level of clarity and in direct comparison to a standard set by Classical Logic. Yet as it became clear that Classical Logic is not appropriate for every domain, new formalisms soon started to pop up. Some logics aim at extending Classical Logic by supplementing its language and thus allowing more arguments to be under its extension; while other logics deviate from Classical Logic by judging some arguments, which Classical Logic claimed to be valid, as invalid. A typical example of an extension of Classical Logic is modal logic (which extends the language of Classical Logic), while a typical example of a deviant logic is intuitionistic logic (which deviates from certain principles of Classical Logic). The label of "non-classical" is attributed to the latter group.

Still, Classical Logic remained pervasive. The task of non-classical logicians became to revise Classical Logic, in whatever role it came to play in relation to our reasoning practices, in our best description of them or even in our best description of some aspect of some mind-and-language-independent reality. In this context of logical disagreement and revision, it became relevant to develop an epistemology with respect to the justification of logical laws.

Marcos Silva (2020) notes that Agrippa's trilemma, which challenges any attempt to provide an epistemological foundation for our justification and beliefs (Silva 2020, 82), is particularly relevant to the issue of revising logic. Since logic plays a role in any theory choice or revision, and if the topic being revised is logic itself, infinite regress threatens. Such regress can be stopped by a self-evident axiom or another similar bedrock for justification, but such a strategy can be seen as arbitrary or dogmatic (Silva 2020, 82). Another strategy is to propose that beliefs are mutually founded, which leads to the problem of circularity. Given these three challenges, namely, infinite regress, circularity and arbitrariness, any epistemology of logic needs to respond to this trilemma.

The *first* type of response, those leading to infinite regress, is the one downright rejected. The *second* type of response to this challenge is to embrace a dogmatic view to stop infinite regress by taking logical axioms to be self-evident. This is the foundationalist view of logic. A *third* type of response is the anti-foundational view which embraces arbitrariness. These two views are presented in the following section, under the title of logical exceptionalism, which recently has been rejected as an adequate epistemology of logic. Section 1.3 then presents anti-exceptionalism as an alternative to these dogmatic or arbitrary foundations.

1.2 Exceptionalism

"Logical exceptionalism" names a more traditional view of logic than the more recent trend of "anti-exceptionalism".[2] As such, it is an anachronistic view, since no authors define their views under this label. Ben Martin and Ole Hjortland (2020a) list under this view both "logical rationalism" and "logical semanticism", which they use as motivation to propose their own anti-exceptionalist view, proposing an epistemology of logic by avoiding the pitfalls, in turn, of rationalism and sematicism.

In short, the exceptionalist about logic claims that "logic is different from the

[2] Williamson (2007) discusses "philosophical exceptionalism", goes on to use "anti-exceptionalism about philosophy" (Williamson 2013), and only then "logical anti-exceptionalism" or "anti-exceptionalism about logic" is used.

empirical sciences, perhaps by being *a priori*, analytic, necessary, normative (...)" (G. Russell 2014, 3).[3] Logical exceptionalism is also often stated as the view which takes logic to be exceptional in relation to the sciences. Exceptionalists affirm that "logical evidence is *a priori* and epistemologically basic" (Martin and Hjortland 2020a, 1), whereas scientific evidence is empirical. This particular characterization of logical knowledge in relation to science leads anti-exceptionalism to propose applying methods of theory selection and revision of science to logic, in particular IBE (under the label of logical abductivism),[4] but the proposal is not obligatory.[5]

Before unpacking anti-exceptionalism, however, it is pertinent to discuss rationalism and semanticism in detail, as the problems faced by these two views are those which anti-exceptionalism proposes to resolve.

1.2.1 Rationalism

On the rationalist view of logic, logical knowledge is foundational and necessary, and its evidence comes from *a priori* intuitions. So-called "logical laws" form the basis of logical knowledge and antecede any empirical experience. Such knowledge differs from scientific knowledge, which is based on empirical evidence and the theories of which are revisable.

Without delving too deeply into the history of logic, it is clear that Frege emerges as a prime example of an exceptionalist. In Frege, one finds an exceptionalist who presupposes "that logical knowledge is privileged in its foundational status" (Martin 2019, 3). While Frege is a known defender of Classical Logic, an exceptionalist is not necessarily committed to logical monism, or even to Classical Logic. As such, exceptionalist tendencies also appear in Dummett, who favors intuitionist rather than Classical Logic (Martin and Hjortland 2020a).

Steven Wagner (1987) presents the rationalist concept of logic, which takes logic

[3] The issue of normativity is somewhat curious, since there is a clear sense in which logic sets a normative standard. This does not mean that logic has some absolute normative force. For normativity in logic, see section 4.2 below.

[4] This approach is discussed in Chapters 2 and 3.

[5] Other recent views in the epistemology of logic which do not relate logic to science are discussed in Chapter 5.

to be concerned with "what counts as ideal justification" (Wagner 1987, 6), as opposed to everyday arguments. The epistemic goal of logic is justification of belief in clear inferential steps, and

> [a]ny deductive consequence C of a set Σ of statements can, on Frege's conception of logic, be mechanically calculated: a finite series of steps leads from premises in Σ to C, with each step governed by a rule the applicability of which can be recursively determined. Underlying this condition is the traditional assumption of the apodictic character of *a priori* knowledge. (Wagner 1987, 8)

Wagner deffends Frege's conception of logic arguing that First Order Logic is as good as it gets in regards to belief justification (in particular against Second Order Logic). He argues that in Frege's view, given that it is only concerned with ideal justification (perfect memory, attention, no time constraints, etc.), it does not make sense to consider alternative logic, "[b]ecause we cannot even imagine how to alter these, a Fregean viewpoint makes changes of logic impossible in a strong sense" (Wagner 1987, 20). Any difference in choice of logic is due to picking out a different epistemic goal for logic, so there is a change of topic (as it is said nowadays). Different choice of logic is due to a different conception of logic, to which one might "wonder whether the designation 'logic' still fits" (Wagner 1987, 25).

In light of Agripa's trilemma, the rationalist view appeals to a dogmatic/arbitrary response to stop the infinite regress of justification. While some embrace this wholeheartedly, the rationalist view is not as much in vogue as it once was, and a more naturalist view tends to be preferred. The discussion between Laurence Bonjour and Michael Devitt (2014) about whether or not there is *a priori* knowledge showcases this debate.

In broad strokes: Bonjour presents his rationalist view in which justification "in the most basic cases such reasons [for belief] result from direct or immediate insight into the truth, indeed the necessary truth, of the relevant claim" (Bonjour and Devitt 2014, 179). His view still leaves room for the revision (on empirical

grounds) of *a priori* knowledge.[6] Devitt criticises this view, claiming that intuitions are obscure and that naturalism can account for all knowledge without appeal to the *a priori*. While knowledge from logic and mathematics might seem to escape a naturalist picture, Devitt attempts to show that this "troublesome knowledge could be empirical after all" (Bonjour and Devitt 2014, 185), appealing to the thesis of holism.

Bonjour further argues that the kind of holistic knowledge employed by Devitt needs an *a priori* foundation somewhere (in order for any kind of revision to be possible, usually related to the correctness of the rules which allow revision), and thus rationalism cannot be avoided. Devitt replies by defending the holistic approach against the problem of rule-circularity, and accuses Bonjour's account of suffering from it (as rational insight justifies other rational insights). If he is correct, it seems the dogmatic reply to Agripa's challenge does not work even against infinite regress.

Beyond these naturalist challenges to rationalism, Martin and Hjortland (2020a) point out that rationalism cannot account for disagreement in logic. How might it be explained that different logicians have different intuitions? They take it that it cannot be that the many logicians who propose different logics are just talking past one another. Wagner (1987) already noted that this is due to a change in the conception of logic, but anti-exceptionalists try to resist calling this disagreement mere "verbal disagreement".

Whether or not rationalism is taken as cogent on its merits, it has certainly fallen out of grace, if not in general, at least within the philosophy of logic. Rationalism has been confronted by the semanticists view (in the manner of logical positivists) and more recently by a naturalist view (already mentioned). If, on the one hand, rationalism seems to provide logic with a quick and easy epistemology, on the other, it has not fared well historically.

[6] And in this he diverges from the usual rationalist creed; more on this in Section 4.3.

1.2.2 Semanticism

Semanticism, while still an exceptionalist view of logic, challenges the rationalist view by denying that intuitions provide justification for logical knowledge. Rather, "we can gain evidence for the truth or falsity of a logical sentence simply by understanding the meaning of its constituent parts" (Martin and Hjortland 2020a, 4). Devitt calls this view "moderate empiricism", and claims that for it,

> *a priori* reasons, rather than constituting insights into reality, reflect only linguistic or conceptual conventions or are merely matters of definition. The basic idea of moderate empiricism is to explain *a priori* reasons in a way that drastically undercuts their significance. For this purpose, the most standard version of moderate empiricism appeals to the concept of analyticity. (Bonjour and Devitt 2014, 182-183)

As logical knowledge is taken to be analytic, logic is still exceptional. Since the basic rules and axioms of logic come from conceptual conventions, this account is rather deflationary, which tendency is characteristic of logical positivism. The positivitst theory of meaning separates statements in two kinds: synthetic and analytic. The truth of synthetic statements can be directly verified empirically, while the truth of analytic statements can be inferred from the meaning of the terms involved. Logical truths are of the former kind, and empirical considerations have no bearing on their truth.

Criticism of this view comes again, albeit not exclusively, from a naturalist perspective, most notably W.V.O. Quine's criticism of the demarcation of analytic and synthetic knowledge. Specifically in logic, Martin and Hjortland (2020a) claim that this view also cannot account for logical disagreement; because when logicians disagree, they do not present "the meaning of the propositions under dispute" (Martin and Hjortland 2020a, 9) as evidence in their arguments. Logical disagreement is not a disagreement in meaning.

With regard to Agripa's trilemma, the semanticist answer is to embrace arbitrariness to stop circularity, and so it is thought to be insufficient, insofar as it is a

form of skepticism about validity and logic.

1.3 Anti-exceptionalism

Given the problems with the two traditional views of the epistemology of logic, a more recent trend, drawing from naturalism, presents itself as a better account of the epistemology of logic. Based on a naturalistic attitude, anti-exceptionalist views aim to avoid the pitfalls of rationalism and semanticism, by providing an account of logical knowledge that can withstand Agrippa's trilemma.

Anti-exceptionalism grows out of Quine's naturalism, in particular as it relates to the holistic approach to knowledge. Notably, Quine placed logic in the same web-of-belief as empirical knowledge, thus claiming that logic is un-exceptional. The revision of logical theories is akin to the revision of scientific theories.

As mentioned, the semanticist view of logic takes logical knowledge to be analytic, and thus separate from knowledge of the empirical world. Quine argues, in "Two Dogmas of Empiricism", both against the cherished analytic/synthetic distinction and against the dogma of reductionism, which is the belief that analytic statements are reducible to logical truths. His arguments are summarized herein, to flesh out his holistic view of knowledge, which is embraced by anti-exceptionalists.

Quine elaborates three different renditions of the analytic/synthetic rejecting each in turn. In its first version, the distinction is made in terms of meaning, where "a statement is analytic when it is true by virtue of meanings and independently of fact" (Quine 1951, 21). In this definition, noteworthy is the distinction between meaning and reference. For example, the meanings of "creature with a heart" and "creature with a kidney" are different, but the reference is the same, as one does not find creatures with hearts without kidneys and vice-versa. Yet once this distinction is made, "it is a short step to recognizing as the business of the theory of meaning simply the synonymy of linguistic forms and the analyticity of statements; meanings themselves, as obscure intermediary entities, may well be abandoned" (Quine 1951, 22-23).

Continuing the attempt to explain the distinction between analytic and synthetic statements, the second version is articulated in terms of synonymy, in particular, cognitive synonymy. To start off, two classes of analytic statements are defined, those logically true and those "that [...] can be turned into a logical truth by putting synonyms for synonyms" (Quine 1951, 23). An example of the first kind is "no unmarried man is married", while an example of the second is "no bachelor is married", where "bachelor" is a synonym for "unmarried man". This way, the issue of analyticity turns into an issue of synonymy, which "has still to be clarified, presumably in terms relating to linguistic behavior" (Quine 1951, 24).

What is needed is an account of how these synonyms come to be defined, which itself does not rest on a previous notion of synonymy. Such an account is not found either in a notion of paraphrase, Carnap's notion of explication or in a notion of definition, as these accounts depend on a prior relationship of synonymy.

> The *definiens* may be a faithful paraphrase of the *definiendum* into the narrower notation, preserving a direct synonymy as of antecedent usage; or the *definiens* may, in the spirit of explication, improve upon the antecedent usage of the *definiendum*; or finally, the *definiendum* may be a newly created notation, newly endowed with meaning here and now. (Quine 1951, 27)

Not all is lost, however, as "some progress might be claimed in having reduced the problem of synonymy to a problem of wordhood" (Quine 1951, 28) regarding interchangeability. Taking "word" for granted, "[t]he question remains whether interchangeability *salva veritate* [...] is a strong enough condition for synonymy" (Quine 1951, 28), where synonymy is taken to be cognitive synonymy.

Quine concludes that it is indeed strong enough, but only on the assumption that

> we are working with a language rich enough to contain the adverb 'necessarily', this adverb being so construed as to yield truth when and only

> when applied to an analytic statement. But can we condone a language which contains such an adverb? Does the adverb really make sense? To suppose that it does is to suppose that we have already made satisfactory sense of 'analytic'. (Quine 1951, 29)

And thus this second attempt fails, as it begs the question. Moreover, in such extensional language, "[t]here is no assurance here that the extensional agreement of 'bachelor' and 'unmarried man' rests on meaning rather than merely on accidental matters of fact, as does extensional agreement of 'creature with a heart' and 'creature with a kidney' " (Quine 1951, 30). So in the end, "extensional agreement falls far short of cognitive synonymy of the type required for explaining analyticity" (Quine 1951, 30).

Having reached a dead end in trying to explain analyticity in terms of cognitive synonymy, Quine attempts, in the third version of the explanation of the distinction between analytic and synthetic statements, to tackle analyticity via semantical rules. He argues that the difficulty of defining "S is analytic for L", where S is a statement and L an artificial language is as difficult as for ordinary language statements. When dealing with artificial languages, it seems plausible to define analytic statements as those which as specified semantically via rules to be so. Yet this is not sufficient, as "[i]nstead of appealing to an unexplained word 'analytic', we are now appealing to an unexplained phrase 'semantical rule' " (Quine 1951, 33). While supposing that "the truth of a statement is somehow analyzable into a linguistic component and a factual component [...] it next seems reasonable that in some statements the factual component should be null; and these are the analytic statements" (Quine 1951, 34). This is not the case, however; analyticity cannot be explained this way.

Quine concludes, in arguing against this first dogma of empiricism, that the analytic/synthetic distinction does not hold up to scrutiny. Rejecting this dogma is only part of Quine's aim in this essay, for there is yet another issue that must be addressed: the dogma of reductionism, which is "the belief that each meaningful statement is equivalent to some logical construct upon terms which refer to immediate experience" (Quine 1951, 20). Both dogmas are closely related, in that the

verification theory holds that "the meaning of a statement is the method of empirically confirming or infirming it" (Quine 1951, 35) and "[a]n analytic statement is that limiting case which is confirmed no matter what" (Quine 1951, 35).

There is a final attempt to save the notion of analyticity by accepting the verification theory as adequate, "[f]or a statement may be described as analytic simply when it is synonymous with a logically true statement" (Quine 1951, 35). Yet to do so would require adopting reducionism as a dogma, which Quine rejects, as he holds that "our statements about the external world face the tribunal of sense experience not individually but only as a corporate body" (Quine 1951, 38).

In rejecting these two dogmas, Quine presents an alternative proposal for empiricism without dogmas.

One aspect of his substitute picture is (confirmational) holism. The starting point of his account is a "man-made fabric which impinges on experience only along the edges" (Quine 1951, 39). This "fabric" is sometimes referred to as "field" or web-of-belief. In his view, science depends both on language and on experience, but this does not entail that these two aspects can be taken separately: "The unit of empirical significance is the whole of science" (Quine 1951, 39). In this way, Quine saves empiricism by relying on experience to revise scientific theories, while rejecting the two dogmas against which he has argued.

The most important aspect of Quine's approach to theory revision is how the field is revised given new input from experience: "A conflict with experience at the periphery occasions readjustments in the interior of the field" (Quine 1951, 39). In Quine's holism, "[n]o statement is immune to revision" (Quine 1951, 40) and "[a]ny statement can be held true come what may, if we make drastic enough adjustments elsewhere in the system" (Quine 1951, 40). Since there is no distinction between analytic and synthetic statements, logic must be placed in the same web-of-belief; and since logic is the most distant from all experience, it is placed in the center of this web. Precisely to the point, logic is not immune to revision.

It is worth mentioning that Quine's own view on the topic of logic's place in

the web-of-belief is not clear-cut. As Jack Arnold and Stewart Shapiro (2007) argue, there are two Quines, a logic-friendly one and a radical one. While the former accepts that logical truths are analytic in the traditional sense, the latter includes logic in the web-of-belief, making it not immune from revision. For present purposes, it is the view of the radical Quine which has been consequential for the development of anti-exceptionalism about logic.

Quine maintains that there is no univocal way to revise the statements on the web-of-belief, because no particular data entails a modification on a specific part of the web. Due to its interconnectedness, "experience (including, of course, that associated with scientific testing) does not confirm or disconfirm individual beliefs per se, but rather the set of one's beliefs taken as a whole" (Chakravartty 2017, 17).[7] If the web-of-belief is in need of revision, there is no unique best way to revise it. At best, Quine suggests the principle of minimal mutilation, which leads him to maintain Classical Logic at the center of the web-of-belief, as this revision would cause too much disturbance elsewhere.

From Quine, anti-exceptionalists take the lesson that logic and science are closer together than once thought, that logic is revisable, and that the method of revision of logic is not exceptional, and neither is the kind of evidence which prompts this revision. They do not take from Quine's method of theory revision (in terms of minimal mutilation), however, choosing instead a more recent method of scientific theory revision.[8] Moreover, while Quine maintained Classical Logic as the correct theory of logic; for recent anti-exceptionalists, non-classical logics have been taken as more serious challenges.[9]

It is not uncommon to find definitions of anti-exceptionalism, such as the view in which "theories of logic, not unlike scientific theories in general, are chosen on the basis of abductive arguments" (Hjortland 2017a, 2), or that which claims that "we can use normal scientific standards of theory comparison in comparing the the-

[7] In contemporary discussion, this is known as "underdetermination of theory by data" and it is related to the Duham-Quine thesis.

[8] This method of revision is discussed at length in Chapter 2.

[9] This is not to say that all anti-exceptionalists adopt non-classical logics.

ories generated by rival consequence relation" (Williamson 2017, 334). Most anti-exceptionalist hold logic to be a science (or at least continuous with a scientific picture of the world), and as such logical theories should face the same theory selection criteria as scientific ones. The method of theory selection to which they allude is "Inference to the Best Explanation" (IBE) or abduction.[10]

The temptation of treating logic as science perhaps stems from the attempt to approximate the success of logic to that of the sciences. That is to say, logic is progressing:

> Science is often distinguished from other domains of human culture by its progressive nature: in contrast to art, religion, philosophy, morality, and politics, there exist clear standards or normative criteria for identifying improvements and advances in science. (Niiniluoto 2015, 1)

For logic to be like science, it must fulfill the same standards or normative criteria for identifying improvements as the sciences do. Progress is taken to be "a result-oriented concept, concerning the success of a product relative to some goal" (Niiniluoto 2015, 7), and under the view of scientific realism, the goal of science is the "success in knowledge-seeking or truth-seeking" (Niiniluoto 2015, 5). Logical anti-exceptionalists, when adopting abduction as the method of theory revision, presumably share not only the method, but also the aim of science, with scientific realism, namely, to find true theories, but in this case, about validity.

The topic of progress in philosophy has also received increased attention. While in some sense it seems obvious that philosophy is not progressing, since "[t]here has not been large collective convergence to the truth on the big questions of philosophy" (D. Chalmers 2014, 5), this negative answer to the question of progress is trivial. For the most part, any progress in philosophy comes in the form of convergence on negative or conditional theses, rather than on positive ones. In philosophy, the progress comes in the form of "sophisticated disagreement".

[10] A clarification of terminology is presented in Section 2.1.

> It is sometimes said that an obsession with truth reflects an overly scientistic conception of philosophy. (D. Chalmers 2014, 14)

More interestingly, David Chalmers asks "why is there less convergence in philosophy than in the hard sciences?" (D. Chalmers 2014, 16). His initial explanation is that the method of philosophy does not lend itself to the kind of truth needed for a clear sense of progress, and that "[i]t is natural to hope that new methods might produce further progress" (D. Chalmers 2014, 22). As Timothy Williamson (2017) kickstarts the project of anti-exceptionalism about logic (specifically the type of anti-exceptionalism which proposed to use abduction as a method of theory selection) from a general anti-exceptionalism about philosophy, anti-exceptionalism of this type seems to follow this trend rather well, since it proposes to apply scientific method to logic.

The view which has gained more traction is the one that relates logic and science, but this need be not the only anti-exceptionalist view. Jack Woods (2019b) presents reflective equilibrium[11] as a method of theory revision that might be considered by an anti-exceptionalist. Such a method of revision does not aim at selecting theories with increasing degree of "truth", but to revise theories so that they become more adequate to current practice. While the connection of reflective equilibrium to logic is not new (having been supported by Dag Prawitz (2007) and Michael Resnik (2004), for instance), the connection to anti-exceptionalism has only recently been receiving notice.

These two anti-exceptionalist views (one which adopts IBE and the other which adopts reflective equilibrium) are similar in aim, that is, proposing how logic is revised, but may differ regarding the method of revision. Woods (2019b) introduces the terminology "whole theory comparison" and "piece-meal approach" when it comes to the revision of logical theories. The first compares how logical theories as a whole (such as the theory of classical logic, or of intuitionistic logic) deal with some issue, while the second seeks to repair problems in the current theory (whichever

[11] The terminology is due to Rawls (1971), in the context of revision of normative theories, but is already anticipated by Goodman (1955).

it may be) step by step.[12] Woods points out that abduction is a kind of revision following whole theory comparison and reflective equilibrium follows a piecemeal approach. While Woods rejects the appropriateness of the latter method for anti-exceptionalism, in Chapter 6 it is argued that both approaches may indeed fit under the same description.

Given that exceptionalist views of logic are no longer in vogue (at least among philosophers of logic), the catch-all terminology of "anti-exceptionalism" is relatively uninformative. To call "anti-exceptionalists" only those who relate logic with science is uninteresting, so the present thesis will present a richer version of anti-exceptionalism which makes room for diverging views on the nature of logic and of the chosen method of revision.

To review, rationalism and semanticism (which have been, according to Martin and Hjortland (2020a), the most prominent views in the epistemology of logic) have both been found wanting. Anti-exceptionalism presents itself as a better account of logical knowledge, and currently presents the method of theory revision to be abduction. While not a new idea, the view that logic is revised by reflective equilibrium has not been explored to the same extent. This seems to be as good of an insight into the progress of logic as any other. As such this thesis proposes broader characterization of logic anti-exceptionalism, one in which theory revision in logic can be achieved by different methods.

While no one is a self-proclaimed "logical exceptionalist", there are plenty who are "non-anti-exceptionalists". It could well be that this is due to the mischaracterization of anti-exceptionalism in terms of the IBE and abductive methodology of science. Were this view to be called simply logical abductivism, it would leave space for more views to fall under the label of anti-exceptionalism.

The two exceptionalist views are exceptionalist not because they do not claim that logic is a science, but because they do not take logic to be rationally revisable: rationalism takes logic not to need revision, while semanticism does not allow revi-

[12] For example, by finding out how to remove the law of the excluded middle from a classical theory and which modifications are necessary for this, given the need to deal with intuitions about vagueness – there is no alternative theory to compare it with.

sion, only choice of framework. The two anti-exceptional views presented here, to wit, abductivism and reflective equilibrium, are anti-exceptional not because they claim that logic is a science, but because they claim that logic can be rationally revisable.

The thesis organizes itself in the following manner. Chapter 2 discusses abduction and IBE and presents methodological problems for the view of logical abductivism. Chapter 3 argues that were logical abductivism the only anti-exceptional account, anti-exceptionalism would be a precarious position, as it would be equated with realism about logic (in a specific sense). This problem might have been due only to the chosen account of science, so this chapter further discusses more broadly the analogy of logic and science, by exploring other accounts of science and what they would mean for logical anti-exceptionalism. Chapter 4 presents further challenges to logical abductivism and to the analogy between logic and science, thus motivating a new definition for anti-exceptionalism about logic, opening the field for piecemeal methods of theory revision, which are presented in Chapter 5. Finally, Chapter 6 concludes that these pieacemeal approaches are better suited for logical theory revision than logical abductivism.

2 Logical abductivism

Last chapter introduced the issue of revision of logical theories, presenting Quine's holism as the precursor to logical anti-exceptionalism. The present chapter concentrates on one anti-exceptional account of logic, that of logical abductivism, which takes logic and science to be connected via an account of explanation. It is argued that logical abductivism is not methodologically sound for logic. *First*, "abduction" is surveyed from C.S. Peirce's original proposal to the current use as synonymous with Inference to the Best Explanation (IBE) and it is maintained that these two senses, being different, should not be conflated. *Second*, logical abductivism is presented and it is argued that the sense of abduction employed by anti-exceptionalists is that of IBE. *Third*, it is argued that logical abductivism encounters some methodological problems, namely, the logic in the background problem and a problem related to the selection of logical evidence.

2.1 From Peirce's abduction to Inference to the Best Explanation

Logical abductivism is the view that an abductive methodology can be used to account for the revision of logical theories. It is noteworthy that the philosophical literature contains other uses of the term "abduction" than that of the anti-exceptionalists. As the matter of terminology is treacherous, it is prudent to distinguish among them. *First*, there is Peirce's original sense which relates to the context of discovery,[13] in which "only abduction has the power to amplify knowledge, for

[13] The context of discovery stands in opposition to the context of justification. For more on this distinction, see Schickore (2018).

its meaning is to formulate hypotheses" (Rodrigues 2011, 132). *Second*, there is the sense of "inference to the best explanation" (IBE), mentioned often in the literature on scientific realism. There is perhaps yet a *third* sense, used by some logicians, most notably Hjortland (2017a), Williamson (2017), Priest (2016) and Martin (2019, 2020). These four authors are then proponents of logical abductivism. The current section argues that the "abductivism" in "logical abductivism" is tantamount to abductivism in the second sense, that of IBE. On a terminological note, "abductivism" is used in the sense of abductive methodology in logic, while "IBE" is used in the sense of abductive methodology in science. The proponents of abductivism in logic are called "logical abductivists", while the proponents of IBE in science are called "scientific realists". The Peircean sense of abduction is called "Peirce's abduction".

Simply put, IBE is the methodology which claims

> that scientists judge that the theory which would, if correct, provide the best explanation of the available evidence is also the theory that is likeliest to be correct. (Lipton 1993, 91)

This "best explanation" is one which possesses more theoretical virtues (simplicity, accuracy, scope and so on) than the competing explanations. The slogan of IBE is that "explanation is a guide to truth", and once a best explanation is selected, one should have confidence that this explanation is true (or close enough). It is common to call "abductive argument" the process of selecting this best explanation. IBE is more fully characterized below, but first it is relevant to distinguish IBE's abduction from Peirce's abduction. Douven (2017) notes that "in the historically first sense, [abduction] refers to the place of explanatory reasoning in generating hypotheses, while in the sense in which it is used most frequently in the modern literature it refers to the place of explanatory reasoning in justifying hypotheses" (Douven 2017, 1).

In its original sense, proposed by Peirce, "abduction" is one of three types of inferences used in the sciences, the other two being deduction and induction. While deductive arguments assume hypothetically the truth of the premises and derive the

truth of the conclusion, induction proceeds by generalizing from many particular observations to a rule (which is not guaranteed to be true). Abduction, in turn, is the kind of reasoning that generates hypotheses, that is, proceeds by going from the particular to a rule which would make it a matter of course that the observation would be true. For example, from Rodrigues (2011):

Deduction
All the beans of this bag are white. These beans are from this bag. $\therefore$ These beans are white.

Induction
These beans are from this bag. These beans are white. $\therefore$ All the beans of this bag are white.

Abduction
All the beans of this bag are white. These beans are white. $\therefore$ These beans are from this bag.

With these three kinds of inference in place, science proceeds by the use of abduction to formulate hypotheses for some given data, to the point of postulating what could have been the case such as to produce the data observed. From such hypotheses, via deduction, testable predictions are extracted, which then get tested by induction, which awaits for the desired phenomena to be observed. If the induction fails, another hypothesis needs to be formulated and tested, in a cycle which one hopes will come to a fixed point. The conclusion of this process cannot be guaranteed by necessity, for such necessity is only ever warranted by deduction inference.

While Peirce held induction and abduction to be two different kinds of inference, Gilbert Harman (1965) argued that induction (or more specifically "enumerative induction") is a specific case of the more general inference of abduction, or "Inference to the Best Explanation". Peter Lipton (2000) similarly claims that IBE derives from Peirce's abduction, in that both are part of an account of inductive inference. This claim can be understood in terms of both induction and abduction being a kind of ampliative reasoning. Yet, abduction in the sense of IBE is not an ampliative kind

of inference, and is not the same as abduction in Peirce's sense of the word.

Mousa Mohammadian (2021) gives a historical account of the shift from Peirce's abduction to IBE, highlighting important differences in each method, criticizing in particular those who assume "usually without argument, that abduction and IBE are virtually identical" (Mohammadian 2021, 1). Mohammadian contextualizes these two methods in terms of the distinction between the context of discovery and the context of justification (with subsequent exclusion of the context of discovery from considerations within the philosophy of science) and the problem of underdetermination of theory by data.

Peirce's abduction "is a two-phase process of *generating* explanatory hypotheses to explain a given phenomenon and *ranking* these hypotheses in order to adopt the most pursuitworthy hypothesis for further considerations" (Mohammadian 2021, 2). In Peirce's mature theory of abduction, abduction is not understood in formal terms,[14] but taken to be the first stage of scientific inquiry. Regarding the generating of explanations, while "there is a very large pool of possible-to-imagine explanatory hypotheses for any surprising phenomena" (Mohammadian 2021, 5), scientists are guided by insight[15] and only formulate a handful of plausible explanations.

In a second stage, these hypotheses are narrowed down for testing, because it is not feasible to test them all. Theoretical virtues might be used to organize the priority of testing of hypothesis, but "having a higher rank does not make a hypothesis more likely to be true" (Mohammadian 2021, 7, emphasis removed). This is one major point of divergence between abduction in Peirce's sense and in IBE.

Continuing the process of scientific inquiry,

> [a]fter abduction, we derive necessary and testable consequences of the highest-ranking hypothesis through deduction, which constitutes the sec-

[14] The formal structure of abduction is shortly presented above merely to show how it differs from deduction and induction. The development of Peirce's notions of abduction is a topic of its own, which goes beyond the scope of this discussion.

[15] Mohammadian (2021) presents Peirce's account of insight, but it is beyond the scope of this text to undertake such task.

> ond stage of scientific inquiry, and take them as predictions. Induction, according to Peirce, is the third and the final stage of scientific inquiry and consists of testing those predictions to see whether they are true or false. (Mohammadian 2021, 7)

It becomes clear that deduction, induction and abduction are different kinds of inference. Mohammadian (2021) comments that in IBE, deduction and induction are built into the method, and thus it is misleading for logical abductivists to call IBE simply "abduction".

Mohammadian takes Lipton's account of IBE as the one to be analysed (among other proponents), since he claims this is the most full-fledged one available. IBE also provides a process for filtering possible explanations, but unlike abduction, there are three parts to the process: a plausibility filter, a filter to select the theories which can account for the data,[16] and a third filter, which is a "procedure for selecting the best of these empirically equivalent candidates" (Mohammadian 2021, 10). It is in this third filter that explanatory virtues are employed. The highest ranking theory, then, is the best explanation.

Although both abduction and IBE contain a process of ranking hypotheses and use theoretical virtues to guide a kind of theory choice, in abduction this process only selects theories worth of further pursuit, while in IBE this process selects "the best explanation". This difference is related to where in the process of scientific inquiry the ranking of hypothesis happens, which is where

> there are two significant and related differences between the ranking processes in abduction and IBE with respect to when they are done and what they rank. In abduction, hypotheses-ranking is done before conducting empirical tests and hence it ranks untested hypotheses. In IBE, however, hypotheses-ranking is done after conducting empirical tests and it ranks successfully tested hypotheses that are—at least so far—empirically equivalent. (Mohammadian 2021, 16-17)

[16] It might be worth reminding that the data itself is theory-laden.

In particular, "[f]or Peirce, since a hypothesis that is ranked is yet untested, whether it ends up in a higher (or a lower) rank has neither anything to do with the understanding that the hypothesis (if true) would provide nor with its probable truth" (Mohammadian 2021, 17).

Mohammadian (2021) proposes that the differences in hypothesis-ranking of abduction and IBE can be understood in terms of two historical developments, namely, the abandonment of distinction between the context of discovery and context of justification, and the problem of underdetermination. Regarding the first development, Mohammadian comments that this distinction was abandoned by Hempel in developing the hypothetico-deductive model of explanation, and since Lipton's IBE is meant to substitute Hempel's account of explanation, this distinction is abandoned by Lipton as well.

The second development, which is the more relevant one, relates to the fact that it is possible for the same data to support two different explanations. The data underdetermines theory choice. This was not "an issue"[17] of which Peirce would have been aware.

> Peirce believes that by the end of scientific inquiry, all the hypotheses that are abductively proposed to explain a phenomenon will be rejected inductively—i.e., through empirical tests—except for "the sole true explanation" of the phenomenon. (Mohammadian 2021, 17)

Once this issue is known, "Lipton includes a hypotheses-ranking process for empirically equivalent candidates after empirical tests in his account of IBE" (Mohammadian 2021, 17). It should now be clear that abduction and IBE are distinct processes, and only the latter relates to "theory choice". More needs to be said, still, about IBE and its connection to scientific realism.

As anticipated, IBE not only selects "the best explanation", but claims that this best explanation is the one more likely to be correct. The sense of correctness of

[17] How far underdetermination is a problem depends on the underlying metaphysical view of science. Chapter 3 presents views for which underdetermination is not an issue.

a theory is taken to be truth, and not mere empirical adequacy.[18] The reference to truth is related to the view of scientific realism,[19] which "is a positive epistemic attitude toward the content of our best theories and models, recommending belief in both observable and unobservable aspects of the world described by the sciences" (Chakravartty 2017, 1). Although there are different definitions of scientific realism, they all aim at producing true descriptions of both observable and unobservable[20] aspects of the world.

Lipton (2000) articulates what is a good explanation using the notion of a likeliest explanation and loveliest explanation. The former relates to an explanation being more probable to be true and the latter to an explanation "that would, if correct, provide the greatest degree of understanding" (Lipton 2000, 187). The claim of IBE is that loveliness is a guide to likeliness: the explanation that provides more understanding is closer to the truth.

As indicated by Lipton (2000), this account faces the challenge of identifying explanatory virtues that provide a greater degree of understanding (the identifying challenge), showing that loveliness matches likeliness (the matching challenge), and showing that scientists are in fact guided by loveliness to reach likeness (the guiding challenge). Lipton (2000) presents a reply to these challenges, which need not be of particular concern herein, other than to say that the theoretical virtues which are taken to be a guide to a good explanation are such as "scope, precision, mechanism, unification and simplicity" (Lipton 2000, 187).

What is more, since for "the best" explanation to be found, one would need to know all possible option, IBE can perhaps be understood, more modestly, as "inference to the best of the available competing explanations, when the best one is sufficiently good" (Lipton 2000, 184). Lipton (1993) argues similarly that if scientists are reliable in ranking and evaluating theories, then this comparative evalua-

[18] Lipton (1993) tries to argue that this correctness could instead be taken to be "empirical adequacy" (rather than truth) and thus compatible with Bas van Fraassen's constructive empiricism, but it is doubtful that he is successful. Were the measure of correctness of scientific theories just empirical adequacy, there would be no need for the third filter.

[19] Scientific realism is not the only view which adopts a realist attitude towards the unobservable aspects of scientific theories, it is the view that does so through an account of explanation.

[20] More on this distinction is presented in section 3.3

tion (choosing the best theory among different options) implies absolute evaluation (choosing the best theory, among even ones not considered).

Worth highlighting are the main assumptions of IBE: *first*, scientific theories aim at truth (and not usefulness or mere empirical adequacy); *second*, theories can be ranked following theoretical virtues; *third*, scientists are reliable in selecting the most explanatory theory; and *fourth*, such a procedure guarantees the truth (or approximate truth) of the best theory selected. Not surprisingly, IBE assumes the view of scientific realism, which in turn, uses IBE as a methodology of theory selection.[21]

Rorty (1990) sums up well the realist view of science, saying that such a view holds science to be successful in attaining knowledge and long lasting agreement only because it is " 'guided' to such agreement by the way the world is in itself" (Rorty 1990, 49). In the scientific realist view, or so Rorty claims, the world directs us to a correct description of itself, which is explained "on the basis of something called 'the relation of scientific inquiry to reality'–a relation not possessed by all other human activities" (Rorty 1990, 54). Such relation of scientific inquiry is IBE.

> Thus we might maintain that science is a progressive activity with respect to the aim of truth, even if scientists are never in a position rationally to assert that the best theory of the moment is actually true. (Lipton 1993, 93)

By going beyond accepting empirically equivalente theories and recommending one such theory as best, IBE becomes committed to reality beyond what is observable (which is constituted by the proposed entities of scientific theories), and thus to scientific realism. In this view, science progresses towards the theories which better corresponds to "reality".

[21] This is not a surprising view within the literature on the philosophy of science, but it is a point which logical abductivists might want to resist. The connection of IBE and scientific realism might be resisted, in particular, by claiming that there is an anti-realist version of IBE. Yet doing so is not an uncontroversial view of science, as claimed by logical abductivists. Uncontroversially, scientific realism is the major opponent view of anti-realist accounts of science, as, for example, both instrumentalism and constructive empiricism are incompatible with IBE and scientific realism. Instrumentalism does not hold that scientific theories are truth-apt, while constructive empiricism holds that in its unobservable aspect, scientific theories can only be empirically adequate.

While one might try to consider an account of IBE without scientific realism, this cannot be the case. Lipton (1993) proposes a "constructive empiricist IBE", but such attempts does not seem successful,[22] and it is moreover, besides the point. IBE as a methodology was proposed exactly to go beyond empirically equivalent explanations, and thus it seems strange to propose a method of theory choice that uses theoretical virtues if the aim is not truth, but mere empirical adequacy. It would be easier to abandon an account of explanation and simply stop the theory choice at the second filter, settling for accepting this underdetermination. Scientific realism is what warrants IBE's methodological step of going beyond empirical adequacy and choosing a single best theory. IBE's major feature is to use an account of explanation to guide theory choice towards the theory closer to truth, instead of accepting the skeptic stance of underdetermination of theory by data. It does not make much sense to hold that explanation is a guide to some other standard besides truth. Explanation as a guide to usefulness? Explanation as a guide to prediction and control?

Summing up this section, the main takeaways are that there are two senses of abduction, (1) the historical view of Peirce, which takes abduction to be a heuristic step in scientific methodology (which also includes induction and deduction); and (2) the more recent view of IBE. IBE takes it that explanation is a guide to truth, thus the theories which offer better explanations are closer to the truth; "explanatoriness" can be ranked and selected by scientists using certain theoretical virtues. IBE assumes the metaphysical view of scientific realism, since IBE takes theories to be true even in its unobservable aspects. The next section introduces logical abductivism and shows that the sense of abduction used is that of IBE, even though it does not meet the three challenges presented (identifying, matching and guiding).

[22] This point will not be argued here. Suffice for present purpose to consider that if one holds that explanation is a guide to truth, yet does not believe in this sense of truth (which constructive empiricists do not), then what is explanation a guide for?

2.2 From Inference to the Best Explanation to logical abductivism

Abduction as a method of theory selection in logic is widespread among anti-exceptionalists (notably by Williamson (2017), Hjortland (2017a) and Priest (2016)), though not uncontested (for example, by Woods (2019a), G. Russell (2018a) and Hlobil (2020)). From self-proclaimed anti-exceptionalists, noteworthy is that there is no independent argument for the acceptance of abduction in logic methodology, and all accounts rest on presumed similarity between logic and science to motivate abduction for logic.[23] Such claims include:

> Theories of logic, not unlike scientific theories in general, are chosen on the basis of abductive arguments. (Hjortland 2017a, 2)

> The abductive methodology is the best science provides, and we should use it. In particular, we should use it when comparing the theories generated from a given set of premises by rival consequence relations. (Williamson 2017, 334-335)

> Arguably, the correct theory has to be determined by abduction (...). (Priest 2020, 1)

In the need for a new epistemology of logic, as was presented in Chapter 1 above, the logical abductivists propose to borrow what they claim is the method of theory revision of the sciences: IBE.

One important first point is that for the abductivists, the object of study of logic is validity, which is not constrained to one specific formal system ("validity-in-$\mathfrak{L}$", as it is said, or "pure logic"), but rather, there is a general sense of validity *simpliciter*, whose properties and inferences are to be discovered and formalized.

[23] This is not to assume that IBE is the correct view of science, but only to suppose, as logical abductivists do, that it is. The present text does not assume that any particular view is correct.

> A logical theory is not merely a logical system. (...) A logical system can be a proof theory, a model theoretic relation, an algebra, etc. But unlike a logical theory, a logical system is not necessarily applied to anything. (Hjortland 2017a, 5, n. 5)

Logic at the level of a logical system consists only of setting up formal logical structures which are of mathematical interest. A logical theory, in contrast, encompasses more than just a logical system, including, for example, an intended interpretation of the connectives and operators such that the logical system becomes applied to an intended domain. Beyond a specific application, anti-exceptionalists seek a theory about general validity, which is not domain specific (sometimes referred to as "all-purpose logic" (Field 2009), "logic in its canonical application" (Priest 2006) or "One True Logic"). It is at this last level that logical theories are said to be like scientific theories.

Directly following a Quinean thread, as discussed in Chapter 1 above, Williamson (2007, 2013) argues for anti-exceptionalism regarding philosophy, and later specifically about logic (Williamson 2017). For Williamson, "the evaluation of logics is continuous with the evaluation of scientific theories, just as Quine suggested" (Williamson 2017, 334). Yet Williamson does not accept Quine's method of revision, proposing rather specifically the abductive method of theory selection for logical theories, where he similarly argues that the best theory can be chosen on the basis of an "inference to the best explanation". For him, the theoretical virtues used in such arguments are: fit with the evidence[24] (or at least consistency with the evidence), (deductive) strength, simplicity, elegance and unifying power. Once more, Williamson sides with Quine in maintaining a particular role for logic in the web-of-belief, adding that because logic is specially relevant for mathematics, Classical Logic should not be revised in its role as the canon of inference.

Another such abductive proposal for a theory selection is that of Priest (2016). In his model, theories are evaluated by different criteria (which in turn are given

[24] In this point, it is notable that "fit with evidence" becomes a theoretical virtue, and not part of the second filter of IBE.

different weights) and a simple calculation suffices to adjudicate which is the more suitable theory. The exact criteria are not particularly relevant to the discussion of the model, so he claims, but the mentioned criteria are: adequacy to the data,[25] simplicity, consistency, (expressive) power and avoidance of *ad hoc* elements. By Priest's application of an abductive argument, Classical Logic should be revised in favor of a non-classical one.

Hjortland (2017a), when discussing the revision of logic, also adopts what he calls "the standards of scientific method" (Hjortland 2017a, 3) deferring to Williamson's (2017) abdutive account, which is also for the most part accepted by Priest (2016). Regarding the revision of Classical Logic, Hjortland sides with Priest, in arguing that it should be revised, but argues instead in favor of a kind of logical pluralism. The disagreement between Priest and Williamson regarding which logic is best following an abductive argument relates to the point of preferring the deductive strength of Classical Logic versus preferring an unrestricted truth predicate. Williamson's argument in favor of Classical Logic has to do with its fundamental character, but Hjortland argues that theories of truth are as fundamental to logic as a theory of validity. Hjortland's abductive argument leads thus to a kind of pluralism in which "validity is not a monolithic property" (Hjortland 2017a, 25). In other words, within one logical theory, there are different properties of validity which can hold for different parts of the language.

While the use of abduction in logic might constitute yet a new sense of this term (such that it is neither Peirce's abduction nor IBE), this emergence of a new sense seems not to occur. Due to the fact that abductivists talk about "comparing" and "choosing" different theories, it seems that the sense of abduction used by anti-exceptionalists is that of IBE, rather than Peirce's sense of formulating hypotheses. Moreover, logical abductivists do not discuss the role of deduction and induction as part of their scientific process. Could there be room to use Peirce's notion of abduction related to logical theories? Surely![26] This is just not what is done by logical abductivists.

[25] Chapter 3 below discussed more explicitly what logical abductivists take this data to be.
[26] Peirce's abduction is discussed again in passing in Chapter 5, and again in Chapter 6.

Such is the state of abductivism within logic: while opinions diverge on the specifics of what an abductive argument looks like in logic, by and large, abduction is accepted as the way to select logical theories. Having analysed IBE, scientific realism and their assumptions, it remains to be seen whether the match between IBE and logic is as unproblematic as assumed by the proponents of abductivism in logic.

Scientific realists accept that IBE is a better model of explanation,[27] because it provides "good reasons to believe that well-supported theories are likely to be at least approximately true" (Lipton 2000, 191). The commitment that abductive selection criteria has to scientific realism is conveniently suggested by Douven (2017),[28] and so, based on the reliance on abduction as a method of theory selection in logic, there is reason to suspect that logical abductivism is committed to scientific realism.

The rest of this section focuses more on logical abductivism from the perspective of scientific realism. It analyses whether IBE in logic fulfills the criteria noted in the end of section 2.1 above. For logic, these would mean that: *first*, logical theories aim at truth; *second*, logical theories can be ranked following theoretical virtues; *third*, logicians are reliable in selecting the most explanatory theory; *fourth*, such a procedure guarantees the truth (or approximate truth)[29] of the best logical theory selected.[30] Initially it is argued that, as it stands, the second and third criteria, which are the ones related to logical practice, do not fit the current state of logic as a discipline, insofar as they go against certain claims made by logical abductivists. Since the objections raised herein can be resolved as logical abductivism becomes a more robust view, they are put aside. Then, the first and fourth points, which are related to the metaphysical aspect of IBE as a methodology, are discussed. Since these two claims are easily accepted by logical abductivism, this section concludes

[27] As opposed to the enumerative-inductive model, the hypothetico-deductive model, or the deductive-nomological model, for instance. Payette and Wyatt (2018) argue against the nomological-deductive model for logical explanation.

[28] Douven (2017, section 3.2).

[29] This sense of "true theory" is different than the sense of "true sentence" or "true proposition" used to evaluate the validity of arguments in-$\mathfrak{L}$, where "true" and "false" are the names to logical values.

[30] Since logical theories are about unobservable aspects of the world, the commitment to truth about unobservables should go without saying.

that logical abductivism, rather than Peirce's account of abduction, is indeed the intended use of IBE in logic.

The second criteria, about ranking theories by theoretical virtues, is related to what Lipton (2000) called the identifying and the matching challenge. IBE relies on there being agreement among scientists about what the theoretical virtues are and in ranking theories regarding their explanatory powers. If considering the applicability of IBE to logic, it is quite relevant to see if logic fulfills this criterion. There is not, however, agreement about the theoretical virtues that can be used to evaluate the explanatory force of different logical theories. In particular, the criteria of strength is contentious: while both Priest and Williamson take as a "virtue" that a logic has power/strength,[31] Gillian Russell (2018a) argues that this can also be taken as a "vice".

Worse still, it is even claimed that no such agreement is even necessary.

> As Priest points out, such a model [of theory selection] can be devised in any number of ways. It should be clear, however, that even if we agreed on the general outline of a model for theory selection, we need not agree on the criteria or their weights. (Hjortland 2017a, 4)

This indicates a lack of understanding of IBE as a method in the sciences, and how it is justified. If logical theories cannot be ranked following theoretical virtues, IBE does not serve as a reliable method of theory selection in logic. This ranking must not be done at the individual level, as there should be community agreement on this. Logical abductivism is a much weaker view if it does not advocate an unified abduction method such as proposed by scientific realism. This need not be the end of IBE in logic, for it is an easily corrected matter, since the community could eventually come to settle on a specific set of virtues.

The third criteria relates to selecting the best theory, akin to the matching challenge presented by Lipton (2000), which tasks logic also fails to perform. Since there

[31] This attribute is taken to be related sometimes to expressive power and sometimes as deductive strength. That classical logic is deductively strong makes it expressively poor (it cannot express contradictory statements, for instance).

is no agreement regarding which are the theoretical virtues of logical explanation, nor on how to rank theories, it is no surprise that there is no agreement on the best theory. Recall the disagreement between Williamson, Priest and Hjortland on the issue of which logical theory is to be preferred. While Williamson presents an abductive argument which favors Classical Logic, Priest concludes from his abductive argument that a non-classical logic is better. For his part, Hjortland advocates for a kind of intra-theoretical pluralism. It is apparent that the philosophy of logic has not yet reached the level of agreement of the sciences,[32] as is assumed by IBE advocates.

In summary, there is disagreement among logicians on how theories should be ranked according to theoretical virtue; and they are not yet in a position reliably to select the most explanatory theory. Since logical abductivism is a very new view, these two issues are not unexpected, and if such a unification is possible, then these problems can sort themselves through logical practice. Putting these issues aside, there is still the issue of whether abductivism in logic fits with the other two IBE assumptions: that theories aim at truth, and that the theory which provides the best explanation is the one most likely to be true.

The first criteria, namely, that logical theories aim at truth, seems to be the case for logic from the standpoint of abductivists, as they do agree that there is such a thing as a theory about validity *simpliciter* (and not only validity-in-L) and that such a theory is true (and not merely useful or empirically adequate).

The fourth criteria relates to using scientific (in this case, logical) practice to guide belief in the truth of theories, and does find support from abductivists.

> An assumption of this paper is that we can learn about logical epistemology by looking to the actual practice of logicians. What justifies this assumption? The simple answer is that the same considerations hold in the case of logic as they do in the empirical and mathematical sciences.

[32] It could be, of course, that there is more divergence in scientific practice than it is claimed by advocates of IBE, such that this is not a plausible account of science. Inasmuch as it is assumed uncontroversially by logical abductivists, however, this standard should be maintained as an expectation of IBE methodology.

> (...) One cannot be expected to make sound conclusions about how we come to be justified in believing scientific theories without taking notice of how scientists go about justifying their own theories (and indeed go about experimenting generally). (Martin 2019, 6)

The abductivist view of logic already fits with both the first and fourth criteria.

While the practice of logicians are, as of yet, too diverse for the level of agreement assumed by IBE, the second and third criteria are held on a promissory note. Overall, logical abductivism and IBE do fit together, from the standpoint of logical abductivism.

Logical abductivists do not make explicit their agreement on scientific realism, but as it stands, it is plausible to assume they do.[33] By accepting what they take to be "standard" account of science,[34] and thus choosing IBE as a method of theory choice, it does stand to reason that scientific realism is indeed their accepted account. Yet it is also not clear that they wholeheartedly agree with scientific realism, since so little is discussed on the matter.[35] If they do not, more reflection on IBE as a methodology for logic is due. If they do agree, such an agreement should be made explicit, and the four underlying assumptions that motivate IBE in logic should be laid out clearly. Instead, as it stands, it is only assumed that IBE provides the best method of theory revision in science, without mention of scientific realism and its metaphysical commitments.

There is also the matter of the connection between IBE and scientific realism, which, though well established in the philosophy of science, could be resisted. For present purpose, however, one need not assume that adopting IBE entails commit-

[33] Could there even be logical abductivism without scientific realism? No, because a pragmatic or instrumental choice of logic does not do the work needed to select the best theory for the canonical application, which is the aim of anti-exceptionalists.

[34] It is reported by D. Chalmers (2014) that 75% of the philosophers who replied to the 2009 PhilPapers Survey answered that they accept "scientific realism" (as opposed to "anti-realism" or "other") as the correct account of science.

[35] In particular, someone who is fine with scientific realism but is a logical anti-realist might be interested in separating the method of theory choice/revision of logic and science, without being necessarily labeled a "logical exceptionalist". One could also be a logical realist (about structure) without being a scientific realist (about entities), and as such keep the methods of theory choice separate.

ment to scientific realism. It is undeniable that there is a strong connection between both views, and as such if the logical abductivist assume, uncontroversially, IBE as the methodology of science, then it should be assumed, as uncontroversially, that IBE and scientific realism go hand in hand.

So if, on one hand, invoking IBE is supposed to be uncontrovertial, then so is the connection of IBE and scientific realism (since this is the mainstream view). If, on the other hand, the connection between IBE and scientific realism is to be resisted, then the invocation of IBE as uncontrovential is not true, and needs to be argued for or against. Strictly speaking, the best that can be done within the scope of this thesis is to suggest the connection, but not draw an entailment. This is enough. Section 3.1 below argues that scientific realism does the correct work for realists about logic, so the issue of IBE's commitment to scientific realism is not an issue for the logical abductivists which are also realists about logic. This would only be a problem for logical abductivits which are logical anti-realists. Can IBE support both realism and anti-realism? Perhaps, but the justification of IBE as a methodology for logic would need to be presented on its own merits, and not drawn from the justification of IBE in the sciences. This would be, however, to mischaracterize IBE from scientific realists for one's own aims in logic; such use of the label "IBE" would be disingenuous.

No alternative methodology for science is presented and analysed by anti-exceptionalists, which makes this kind of anti-exceptionalist the same as that advocating abductivism in logic. Attempting to fill this gap, Chapter 3 explores Lakatos' and van Fraassen's views of science, trying (and failing) to fit logic into these accounts. Before this, however, the rest of this chapter will indicate problems with logical abductivism from the standpoint of the epistemology of logic.

2.3 Arguments against logical abductivism

While logical abductivim is currently a popular view among those who express a view on the matter, there are, of course, criticisms of it as a method for logic put

forth by logicians themselves. The *first* one concerns the logic in the background problem, and the *second* one relates to selecting logical evidence.

The *first* issue, the background logic problem, is presented by Woods (2019a), and mentioned by Martin and Hjortland (2020a). The "logic in the background" refers to the logical principles which are supposed to be valid in the context of logical theory choice.[36] The problem runs as follows.

> [A]ny argument for a logical theory-choice will presuppose the validity of certain logical inferences. Yet, once the argument has motivated a particular theory choice, the resulting logic will either sanction or prohibit the inferences contained within the argument. If the recommended logic validates the argument, then the argument begs the question against those logics which don't recognise the inferences as valid, and if the recommended logic finds the argument invalid, it undermines its own supporting evidence. Either way, we find ourselves having to take a stand on matters of logical validity in order to provide evidence for a theory of logical validity. (Martin and Hjortland 2020a, 15-16)

This problem indicates that logic is quite the distinctive discipline: it must use its own theories to revise itself. Since it turns out that logic's epistemology might not be shared by other sciences, and seriously threatens the anti-exceptionalist project (or else logic might not be so unexceptional).

What is more, if it happens that logic A is revised in favor of logic B, it could turn out that logic B recommends the revision in favor of A, leading to revision cycles. While such cycles might, after some oscillation, reach some stability eventually, there could be "[a] worst-case scenario (...) where we simply flip back and forth between two logics (arithmetics), each of which is better according to the other" (Priest 2016, 52). At first glance, this issue need not be of worry, due to a lack of a case study that enables "a realistic discussion of how to proceed under such circumstances" (Priest 2016, 52).

[36] Given that IBE as a methodology has incorporated the inductive and deductive steps of Pierce's original scheme of science, this is not surprising.

Woods (2019a), however, presents an interesting example where "applying abductive methodology in order to evaluate [theories] with respect to an alternative results in a rational agent oscillating between the alternative and the starting logic" (Woods 2019a, 3). Such oscillation should be avoided if theory revision is to be rational. Wood's proposed solution is to constrain abductive theory selection by the principle of "logical partisanhood", which aims at allowing a theory to be partisan with respect to itself.

> Unless the output of weighing the merits of my background logic against an alternative—on one hand by the lights of my own background logic and on the other hand by the lights of the proposed alternative—agree that moving to the alternative is no worse than staying with our current background logic, we ought to hold fast to our background logic. (Woods 2019a, 3)

This criterion suggests that given two logical theories in dispute, revision should ensue only when one of the two theories fares better than the other, under the evaluation of both theories in dispute.

Wood's example of a revision cycle is Neil Tennant's use of the meta-rule Cut in his version of relevance logic. The derivability relation of Tennant's classical core logic is T, while the derivability relation of Classical Logic is C, where T is non-monotonic and non-transitive. To be able to use T in mathematics, Tennant proves Cut-Elimination for T (CET), and as a corollary, there is a recapture proof of C in T (CRT). The problem is that "Tennant's proofs of CET and CRT don't obviously avoid use of the monotonicity and transitivity properties which they're supposed to show can be eliminated" (Woods 2019a, 10). The revision cycle is this:

> we have two competing logics, T and C and two theoretical virtues: strength, cashed out as the ability to recapture uncontentious mathematical reasoning, and informativeness, cashed out in terms of how much information is guaranteed by some claim's provability. By C's lights, T

> and C are roughly equivalent with respect to strength (given CRT) and T scores higher than C on informativeness. However, by T's lights, C dominates T with respect to strength (since CRT isn't available to T) and, say, T still scores higher than C on informativeness. (Woods 2019a, 11-12)

If T were to be revised in favor of C, C would then recommend the revision of itself in favor of T, which would recommend its revision in favor of C.

Given this case, Wood points out that "the mere possibility of these decision-theoretic cycles is already disturbing enough and points to a deep problem with applications of abductive methodology in the case of logic" (Woods 2019a, 19). Yet he urges:

> If we are to take seriously the idea that we should choose a logic the way we would choose any scientific theory, and if we view this method as a way of constructing justifications for revision, then we need to be able to run the abductive comparison without serious risk of decision cycles. (Woods 2019a, 20)

His suggestion is, then, to patch up the simple abductive criteria with the principle of partisanhood, by requiring revision only when both L and L' agree that one of them does better (thus T would not revise itself in favor of C, and neither would C in favour of T).

Whether this procedure is a plausible solution to the background logic problem is yet to be determined. To be determined as well is whether or not this solution is compatible with the anti-exceptionalist quest for logic and science to share a method of theory choice. Woods' proposal seems to be to add a fourth filter in theory selection for logic beyond the three filters of IBE. The solution of the logic in the background problem would come at the cost of the exceptionality of method. Regardless, if the logic in the background problem cannot be solved by logical abductivism, anti-exceptionalism will not have met Agrippa's challenge, for circularity threatens.

The *second* issue for logical abductivism relates to the point of what counts as "data" when formulating abductive arguments for selecting logical theories. There is not enough agreement on this aspect to justify IBE in logic. The method of IBE in science is intended to rank explanations after they pass the second filter, that of empirical adequacy, in case there is underdetermination of theory by data. In logic, however, there is no such underdetermination, since there is yet to be a case where the exact same "data" leads to two different choices of logical theories. Hlobil (2020) argues that the choice of logical evidence is directly related to one's "conception of logic", which opinion already assumes a best logical theory. Circularity again threatens. If Hlobil is correct and there is no underdetermination of theory by data in the case of logic, applying the method of theory choice of IBE to logic is unnecessary.

Martin (2019) says that "[t]he relevant data sometimes include conceptual intuitions and the meaning of important mathematical (and logical) terms, but also puzzles resulting from past logical and mathematical postulations, linguistic judgments, and successes within the mathematical sciences" (Martin 2019, 16). What should it be? How can IBE be a unified method of theory ranking and selection, if there is no agreement on what data logical theories should explain?[37] It turns out that it cannot.

Hlobil (2020) argues that "[d]ifferent conceptions of logic lead to different views about which data logics should explain" (Hlobil 2020, 2), and thus that abduction cannot serve as a neutral method to select the best logical theory. Before applying an abductive argument to choose the best theory, there must be agreement on what the theories in dispute are explaining, which is exactly the second filter of IBE. The logical abductivists, even though they agree on using IBE in logic, do not agree on what Hlobil calls a "conception of logic", which influences directly the data each abductivist is trying to account for. The adoption of a conception of logic already determines the evidence which justified theory choice in logic, and in turn the evidence determines which logic comes out as best in an abductive argument.

[37] More on logical evidence is discussed in Chapter 3, in particular section 3.2 and 3.3.

IBE as a method does not do any work in the process of theory choice.

Hlobil (2020) discusses four different conceptions of logic: the Semantic Conception of Logic, the Epistemic Conception of Logic, the *ancilla scientiae* Conception of Logic and the view of Logic as the Science of What Preserves Truth. While Williamson holds the *ancilla scientiae* Conception of Logic, Priest holds the Epistemic Conception of Logic. Their choice of "best" theory being classical or paraconsistent is not at all surprising, as they use different data to motivate their abductive arguments.

> Williamson's framing of the issue is reflected in which data he deems relevant in an abductive comparison between LP and classical logic, namely data that speak to the usefulness of classical mathematics (and classical entailments more generally) in non-logical theories. Facts about good reasoning do not count as data. (Hlobil 2020, 12)

The failure of a unified "logical abductivist" view was already mentioned at the end of section 2.2, where the present disagreements within logic were assumed to be eventually resolved in favor of a unified logical practice. Given Hlobil's argument, it seems that this will not be the case, as there can be no cohesive abductivist account. The problems of applying IBE to logic cut deep. It could be, of course, that one might come up with an example of how the same evidence in logic leads to underdetermination, and thus IBE can be fruitfully applied as a method of selecting between two logical theories. Until such case is presented, however, it seems that IBE is not an adequate method of theory selection for logic.

In light of these problems for logical abductivism, and also some of the current mismatch between IBE and logical abductivism regarding the justification of abduction as a methodology, it could well be that logical abductivism would be better served by constituting a new sense of "abduction", distinct both from Peirce's and IBE's abduction. This third sense of abduction could, for instance, allow for the fourth filter of partisanhood (Woods 2019a) and allow for divergence in logical evidence and non-convergence of practice; it could be that underdeterminacy is not a

problem for logical theory choice, or is a problem solved by a different mechanism than IBE. Perhaps explanation in logic is different than scientific explanation, and thus there is no unified account with the sciences. How much this third sense of "abduction" could be said to be "scientific" would remain to be seen. The analogy of logic and science seems to be stretched thin. Regardless, this is not what has been done by logical abductivists. They do maintain the connection of logic and science, and thus, should own up to the commitments of their chosen account of science.

In short, section 2.1 presented Peirce's abduction as a process of generating hypotheses and IBE as a method of ranking and choosing theories within science, stressing that these are distinct senses of "abduction". Section 2.2 presented the view of logical abductivism, arguing that while there is not enough unity in logical practice, abduction as used by logical abductivists is indeed a case of IBE, rather than Peirce's abduction. If this is not the sense of abduction that logical abductivist want to endorse, then this should be made clear and their use of IBE needs to be better justified beyond an invocation of "normal scientific standards of theory comparison" (Williamson 2017, 14). Section 2.3 argued that logical abductivism faces two particular issues: the logic in the background problem and the evidence problem. Employing IBE for logical theory choice seems to put the anti-exceptionalist project in an odd position: either endorse IBE in logic and face the two issues presented, or else to articulate a new method of abductive theory choice for logic, one which would be exceptional in relation to the sciences. The next chapter explores the anti-exceptionalist insight of treating logic as a science in more depth, arguing that as it stands, logical abductivism (and more broadly, current anti-exceptionalism) is committed to some from of realism about logic, akin to scientific realism in the sciences.

3 Logic as science

Last chapter presented logical abductivism and argued that, as it stands, it suffers from some methodological flaws. While IBE in science is a well established methodology, the logical counterpart is not yet, arguably, up to standard. The current chapter explores the anti-exceptionalist slogan of "logic as science" in more depth, particularly as it relates to the ontology of logic. *First*, it is argued that logical abductivism is a slippery slope towards realism about logic. *Second*, anti-exceptionalism is compared with two standard theories of science, Imre Lakatos' sophisticated methodological falsificationism and van Fraassen's constructive empiricism, and is also argued that under such views the analogy between science and logic fails. It seems that under the current slogan, anti-exceptionalism is a metaphysical doctrine of realism about logic, insofar as it can only be associated with scientific realism. Given that in science theories must foremost be empirically adequate, claiming that the method of theory choice in logic is like science works only once one adopts a form of realism about logic, which is realism about an unobservable aspect of the world.

3.1 Scientific realism

Last chapter presented doubts about the suitability of logical abductivism as a method of theory revision in logic on epistemological grounds. The present section presents doubts related to the ontological commitments of such a method of revision. The invocation of IBE from the sciences does a lot of work in justifying the employment of this method in logic as well. As such, the ontological commitments

of IBE, that is, scientific realism, cannot go unaddressed.

Recalling from the last chapter, scientific realism holds that claims of scientific theories are true (even claims about unobservables), and logical abductivism holds the same for logic: logical theories make true claims about validity. This aspect of both views make it so that IBE is the appropriate methodology for selecting the theory which is closer to the truth, in either science or logic.

As already argued, the logical abductivist account of science comes entirely from the scientific realist account, as scientific realists are the only ones who defend IBE (as presented in section 2.1). It thus stands to reason that the anti-exceptionalist adoption of the epistemology of scientific realism also leads to a commitment to its ontology. In its ontological aspect, scientific realism can be characterized by the "belief in both observable and unobservable aspects of the world described by the sciences" (Chakravartty 2017, 2). Under the assumptions of both anti-exceptionalism and scientific realism, a kind of realism about logic emerges as one is encouraged to believe in the truth about the unobservable aspect of logical theories. This should not be surprising, since the view of progress that anti-exceptionalism wants to emulate in logic (as discussed in section 1.3 above) is similar to the position that "the argument for progress in science (...) can fairly be taken to stand or fall on the merits of realism" (Norris 2012, 179).

The connection between scientific realism and logical realism is already indirectly proposed by Michaela McSweeney (2018), who characterizes a logical realist by, among others, the belief that one is "not sure what the world fundamentally consists in, but it has some structure and science is going to help figure out what that is" (McSweeney 2018, 5). So while scientific realism is not committed to reality having a structure per se, if one adds logic into the mix, this becomes plausible. McSweeney also notes the similarity between what she calls "metaphysical logical realism" (MLR) to anti-exceptionalism.

> Why should we care whether MLR is true? One reason is that it may conflict with various assumptions that are often made about logic; e.g. that

> logic is topic neutral (or, relatedly, that it is perfectly general); that it is ontologically neutral (it doesn't commit us to any particular ontology); that inquiry into logic is special and distinct from other kind of theoretical inquiry; that logic is not revisable; and that logic is wholly *a priori*, whereas other kinds of inquiry are not. All of these assumptions might be motivated by thinking that logic has nothing to do with the world. As we will see, MLR locates logic, or at least, structure that logic reflects, in the world, and hence, if MLR is true, there is no immediate reason to think that inquiry into logic is special and distinct from other inquiry into reality. (...) Neo-Quinean and other "anti-exceptionalist" philosophers of logic reject some or all of these assumptions, but not, typically, for the same reasons that the metaphysical logical realist does. (McSweeney 2018, 1-2)

So just as for the metaphysical logical realist, the logical abductivist holds that logic has something to do with the world (in its structural aspect, and not merely in a normative role). While McSweeney does not claim that anti-exceptionalists are metaphysical logical realists, they are only one step away. This gap can be bridged by the commitment to the methodology of IBE and its underlying scientific realist assumptions.

While the connection between anti-exceptionalism and realism about logic might sound like a mere suggestion, the literature confirms this connection. The two most prominent logical abductivists, for example, hold unabashedly realist views of logic.

> (...) Williamson thinks of a logical theory as a theory of unrestricted generalizations. These generalizations are not specifically about properties of arguments, sentences, propositions; they are generalizations about absolutely all things in the world. (Hjortland 2017a, 5)

Priest too, gladly grants that "[t]he account of validity offered here is a realistic one" (Priest 2006, 186). For him, however, no specific account of realism is endorsed.

> For, as I observed, the situations about which we reason are not all actual:

> many are purely hypothetical. And one must be a realist about these too. There are numerous different sorts of realism that one might endorse here, many of which are familiar from debates about the nature of possible worlds. One may take hypothetical situations to be concrete non-actual situations; abstract objects, like sets of propositions or combinations of actual components; real but non-existent objects. I will not address the question of which of these accounts is correct here. Any of them will do, as long as they provide for an independent realm of situations; and hence a determinate answer to the question of which theory is correct (even if our theories do tie, epistemically). (Priest 2006, 207)

Independently of which realist account of logic one adheres to,

> the question arises as to the criteria one should use to determine which theory is correct. The answer to this (...) is that one decides on the basis of which theory is overall simplest, most adequate to the data, least *ad hoc*, and so on. (Priest 2006, 174)

It seems then, at least in the case of Priest, logical realism and scientific realism goes hand-in-hand. Even if logic is not taken to be empirical, there is realism involved.

> In other words, validity, on these accounts, is a relationship between abstract objects. As usual, we may take these all to be sets. If this is so, then, at least if one is a standard platonist about these things, the truth of claims about validity cannot change. Claims about mathematical objects are not significantly tensed: if ever true true, always true. (Priest 2014, 220-221)

With Priest and McSweeney in mind, the connection of realism about logic and abductivism is rather predictable. These considerations suggest that it is not so implausible to think of anti-exceptionalism in terms of realism about logic, in which

a logic "is true in virtue of correctly capturing the structure of reality" (McSweeney 2018, 3).

Of course, from this brief discussion, all that can be said is that realism about logic and scientific realism are likely compatible.

A stronger claim is that scientific realism (once science also emcompasses logic) leads to realism about logic, which is what the remainder of this section argues. By invoking IBE as a method of theory choice, logical abductivists bring in all the metaphysical baggage of realism into logic (which is what justifies IBE as a method in the first place). If one is already a realist about logic, this is no extra baggage at all. If one wants to resist being committed to realism about logic, however, one would also have reasoning to resist logical abductivism. For what would justify the use of IBE in logic, if not some form of realism?

Hjortland and Martin[38] propose a distinction between two varieties of anti-exceptionalism: metaphysical and epistemological. Compared with science, metaphysical anti-exceptionalism holds that the content of logical theories is unexceptional, while epistemological anti-exceptionalism holds that the justification of logical theories is unexceptional. Yet it is not clear such a distinction can be maintained.

It stands to reason that logical abductivism would fall within epistemological anti-exceptionalism. Yet as argued above in Chapter 2, what relates the evidence for a theory and "the best explanation" as the method of theory choice employed by logical abductivists is exactly realist assumptions about the subject matter of science (even in its unobservables aspects). As thus argued, logical abductivism falls also within metaphysical anti-exceptionalism. Can another account of science be applied such that epistemological and metaphysical anti-exceptionalism do not amount to the same view? This chapter argues,"No".

Epistemological anti-exceptionalism is the claim that logic has the same kind of relation to evidence as other sciences. Claiming that evidence for logical theories are akin to the evidence of the scientific kind, which lends itself to a particular kind

[38]In unpublished work, but already presented in Hjortland and Martin (2019).

of knowledge generating process is a strikingly similar view to that which Richard Rorty (1990) presents as (scientific) realism. The claim of scientific realism, according to Rorty, is that scientists come to a long-lasting agreement on how the "world is in itself" (Rorty 1990, 49), guided by "the relation of scientific inquiry to reality" (Rorty 1990, 54), which no other area of knowledge possesses. Claims of evidence and method in science quickly turn into metaphysical claims.

The remainder of this chapter explores two other views of science, concluding that anti-exceptionalism about logic only makes sense in terms of logical abductivism. It seems then that epistemological anti-exceptionalism is simply covert metaphysical anti-exceptionalism; no variety of anti-exceptionalism is metaphysically uncommitted.[39]

In sum, by presupposing IBE, logical abductivism leads to a form of realism about logic. This should come as no surprise, since IBE as a methodology relies upon the community of scientists/logicians to converge in the same theory, which is taken to be indicative of the truth of the theory.

> Because of the reference to truth or correctness, large collective convergence to the truth requires a degree of realism about the domains in question. (D. Chalmers 2014, 6)

That this claim holds for logical abductivism as well is only a matter of course: for logical abductivism to be justified as a methodology it is assumed that there is (or will be) a large collective convergence on the One True Logic.

The reliance on IBE as a method of theory selection and the attempt to make logic empirical (on par with scientific evidence) underpins a realist attitude about logic, specifically realism about validity (this point is further clarified in the following sections). It is noteworthy that both kinds of realism, logical and scientific, is realism about unobservables, and thus in a way is counter to Quine's original empiricist inclination. While this need not be a negative feature of abductivism in logic, it

[39] It would indeed be ingenuous to claim that scientific epistemology has nothing to do with ontology!

certainly is worth considering in detail when deciding how logic is to be revised. In light of the problems for logical abductivism presented in Chapter 2, it is no longer clear that logical abductivism is the most satisfactory solution to the issue of how to revise logic, inasmuch as it turns anti-exceptionalism about logic into a metaphysical doctrine, and not merely an epistemological one. The ontological commitments of anti-exceptionalism should not be glossed over.

The claim that IBE applies to logical theory choice is a shortcut to providing logic with an epistemology which is not supposed to be obscure. This section tried to read as much into this claim as possible, to the point that logical abductivism becomes a version of realism about logic. If one wants to claim that IBE is adequate for logic, and that validity is a mind-dependent phenomena[40] (rather than accepting a form of realism about logic), then this account of evidence needs to be made explicit, as it would not be appropriate to use as evidence the wide variety of evidence claimed by logical abductivists thus far. Perhaps this is what epistemological anti-exceptionalism is about, which would still depend on IBE's account of explanation, which might imply realism of some sort after all.

If one is trying to account for the progress of logic similarly to the sciences, it could be fruitful to consider views of science other than IBE's. The next two sections do precisely this, in an attempt to make sense of anti-exceptionalism about logic without logical abductivism, and without realism about logic. First, by considering how logic as a science fits under Lakatos' sophisticated methodological falsificationism, and then by considering van Fraassen's constructive empiricism.

[40] Could IBE be an account of explanation about both mind-dependent and mind-independent phenomena? IBE uses an account of explanation to arrive at truth, so perhaps this depends on the account of truth which is adopted, which could differ from that of the scientific realist. This discussion falls outside of the scope of the present thesis. Whatever this view turns out to be, it would certainly be a very different kind of IBE, not at all "standard".

3.2 Lakatos' sophisticated methodological falsificationism

Without getting into the question of how to demarcate science,[41] two main points are worth highlighting at the onset. First, Lakatos' account of the progress of science does not require "collective convergence" of opinion to select theories, and second, the notion of progress is not linear, due to the inherent possibility of the revival of old theories. It is argued herein that in trying to fit logic in this view, a better account of evidende in logic is needed, which would also require realist assumptions about logic to be made.

Lakatos (1978) characterizes a research program as being constituted by a hard core of basic assumptions and an outer belt of auxiliary hypothesis, along with a heuristic which indicates which paths to be further pursued and which to be avoided. Such an account will be presented for logic; it is argued that this view is compatible with the assumptions of anti-exceptionalism presented in Chapter 2 (without the scientific realist assumptions needed to support logical abductivism). This view, however, needs a stronger account of evidence for logical theories, one suitable for a progressing research program, so that the succession of theories are not merely *ad hoc* fixes of previous ones. Such an account of evidence cannot be given without bringing back assumptions of realism about logic.

One of Lakatos' chief insights was to:

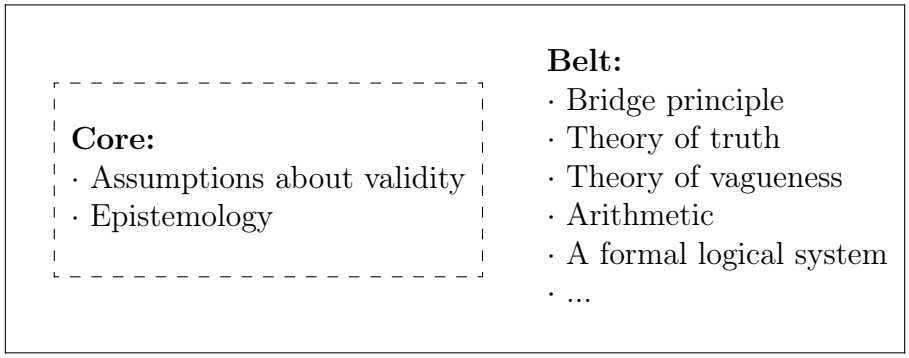
> [shift] the problem of how to appraise theories to the problem of how to appraise series of theories. Not an isolated theory, but only a series of theories can be said to be scientific or unscientific: to apply the term 'scientific' to one single theory is a category mistake. (Lakatos 1978, 34)

Accepting the view of science proposed in sophisticated methodological falsificationism, it is not logical theories that should be evaluated, but instead logical research

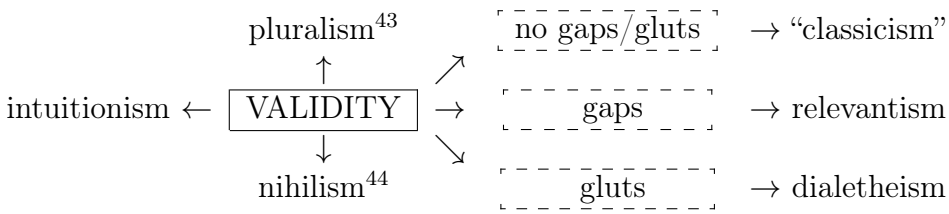
[41] Since this is a question that Lakatos himself thought beside the point, what is important instead is demarcating mature from immature science.

programs. Such evaluation, in turn, is done by looking at how within one such program, one theory was replaced by the next one, in a process of historical reconstruction. While a theory is an explanation of facts and prediction of outcome, a research program consists of a series of theories which can be rationally reconstructed.

The hard core of a research program contains the basic assumptions and is immune to revision, while the outer belt of auxiliary hypothesis indicates what can be modified and suggests novel experiments. It stands to reason that for the liking of anti-exceptionalists, the hard core would include minimal assumptions about the phenomenon of validity (validity is truth preserving and there is a best standard logic, or an all-purpose logic which can describe it). The auxiliary belt contains, perhaps, a favorite formal system $\mathfrak{L}$, a bridge principle,[42] a theory of truth, a theory of vagueness, an arithmetic, a favorite set theory, and so on. The research program of logic would look like this:



In this simple initial picture, at least some different research programs emerge, as different assumptions are made about the phenomenon of validity by different views from the literature:



[42] A bridge principle fills the gap between logical principles and belief revision.
[43] See section 4.1.1.
[44] See section 4.1.2.

Given this initial set up, a brief rational reconstruction can account for how the classical orthodoxy has arranged its protective belt to deal with the issues of different paradoxes (restricting the domain of logic), the transparent truth predicate (relying instead on a hierarchy of languages), vagueness (again, focusing the scope of logic to non-vague sentences) and set theory (proposing a favorite axiomatization). These are instances of the heuristic of the program, which turns anomalies into positive evidence in support of the program.

Regarding scientific progress, research programs may be both theoretically and empirically progressive. A research program is theoretically progressive "if each new theory has some excess empirical content over its predecessor, that is, if it predicts some novel, hitherto unexpected fact" (Lakatos 1978, 33), while it is empirically progressive "if some of this excess empirical content is also corroborated, that is, if each new theory leads us to the actual discovery of some new fact" (Lakatos 1978, 34). This can be summarised in the following scheme:

Theory$_1$:		Theory$_2$:
Corroborated facts: A	$\rightarrow$	Corroborated facts: A
Predicted facts: A		Predicted facts: A,B

Theoretically progressive program

Theory$_1$:		Theory$_2$:
Corroborated facts: A	$\rightarrow$	Corroborated facts: A,B
Predicted facts: A,B		Predicted facts: A,B

Empirically progressive program

Theory$_1$:		Theory$_2$:
Corroborated facts: A	$\rightarrow$	Corroborated facts: A,B
Predicted facts: A,B		Predicted facts: A, B, C

Theoretically and empirically progressive program

With this setup, a program is said to be progressive if it is both theoretically and empirically progressive, and is said to be degenerating if not. If at least theoretically progressive, the program is said to be scientific, if not, then it is pseudoscientific. If a program is only theoretically progressive it is said to be immature science. This can be summarized in the following table:

	Theoretically progressive	Empirically progressive
Degenerating program		
Scientific program	✓	
Pseudoscientific program		✓
Progressive scientific program	✓	✓

In the anti-exceptionalist account of logic under sophisticated methodological falsificationism, what kind of progress do logical theories make? Does each new logical theory on a program predict new empirical content?[45] Does it corroborate already predicted facts? To answer these questions one needs to look at logical evidence and prediction.

Section 2.3 showed that there is no agreement among anti-exceptionalists as to what exactly the evidence of logic is. For the present purpose, Hjortland's (2019), Martin's (2020) and Martin and Hjortland's (2020a) views will be considered. Martin (2020) considers the evidence used by Priest in defence of dialetheism, which includes "logical paradoxes, linguistic judgments, and successes within the mathematical sciences" (Martin 2020, 22). A case example of how paradoxes are used as data is as follows.

> The Liar paradox, the sorites paradox, and Russell's paradox figure prominently in debates about logic. There is general acceptance within the logical literature that these paradoxes constitute data which logics must accommodate, and that these data can pose problems for certain logics. For example, that classical logic, when combined with a transparent truth predicate and standard arithmetic, trivializes. Consequently, proponents of these logics must recognise these potential troublesome cases by either altering their overall theory in order to accommodate the paradoxes, or explaining away their apparent deviancy (such as by deeming the troublesome sentences meaningless). (Martin and Hjortland 2020a, 12)

[45] At this point, it would be interesting to ask what research programs are part of the discipline of logic. The diagram above should provide some clue, but the present proposal need not be exhaustive.

Hjortland (2019) generalizes the kinds of evidence and includes others, noting that not all logicians consider all kinds of evidence appropriate for logic. The kinds of evidence are: *first*, pre-theoretical intuitions, which are "intuitions about the validity or invalidity of arguments in natural language" (Hjortland 2019, 259); *second*, compatibility with non-logical theories, including scientific theories and mathematics; *third*, meta-linguistic theories, which include "theories about vagueness, theories about truth, theories about properties" (Hjortland 2019, 262), such as in the separated citation above, which included arithmetic. Given these kinds of evidence, is logic empirically progressing? What would it even mean for a logical theory to predict new facts and to have predicted facts be corroborated?

Even if a logical theory can corroborate evidence, in what sense is this empirical corroboration? Are paradoxes empirical? Are intuitions? It seems strange to say that a theory is empirically adequate to non-empirical evidence. Even if taking corroboration of non-logical theories, what exactly is the evidence? The fact that theories are corroborated? The theories themselves? Both of these seem to be the wrong "kind" of thing to count as "empirical fact". The anti-exceptionalist view of logic tries to make logic at least empirically progressive by making logical theories "fit the data", but if this "data" is not completely empirical, is this successful? Even under the view of Williamson, who claims that logic is about everything, it is clear that logical theories do not try to fit every observational sentence under its scope, as this would be a never ending task. To claim that logic is empirically progressive would require an unusual interpretation of "empirical". It thus seems that logic is not empirically progressing and the best anti-exceptionalists can hope for is that logic constitutes immature science.

Thus the most important point for logic is not if it is empirically progressing, but whether it is theoretically so. For this to be the case, logic needs to create new predictions, and not merely fit old data into theories. Martin and Hjortland (2020b) propose an account of logical anti-exceptionalism "according to which logics are engaged in both a process of prediction and explanation" (Martin and Hjortland 2020b, 1), which they call "logical predictivism".

They claim that logical theories, such as classical logic at its onset, are built to account for inferential steps in mathematics. Taking a initial set of mathematical proofs, one can extract structural proof steps from them in the form of logical rules, and postulate a prediction, which take the form of:

> Steps within informal proofs of the form
>
> $$\begin{array}{l} \varphi \\ \underline{\text{If } \varphi \text{ then not } \psi} \\ \psi \end{array}$$
>
> are found acceptable by mathematicians.
>
> (Martin and Hjortland 2020b, 10)

Such predictions are then tested "against further informal proofs which haven't yet been relied upon to motivate the logician's theory" (Martin and Hjortland 2020b, 10). If a logical theory bears out this prediction, then it is said that the theory is better than a theory which fails in prediction.

> [T]he logician will need to look at instances of "pseudo-proofs", where mathematicians judge that inferential mistakes are being made. If the result of this search finds instances that fit the predictions, then the theory finds itself further supported and, inversely, if the result of this search consistently finds instances that contradict the predictions, then the theory faces problems. (Martin and Hjortland 2020b, 10)

Their proposal tries to supplement the overall anti-exceptionalist view by showing that logic is scientific in the sense of making predictions. Consider three aspects of this proposal.

First, these predictions do not need to be compared to mathematical proofs which are presented in a time after the prediction is made. These predictions are only "retrodictions". Explicitly, they

> do not require the data against which a prediction is tested to be unknown at the time of the theory's formulation for the prediction to be novel; as the so-called temporal interpretation of predictive novelty requires. Instead, we only require that the theory was not constructed specifically to fit that data (...). (Martin and Hjortland 2020b, 4)

This is not the same sense of prediction which Lakatos assumes of science. In fact, theories which can only accommodate already known facts are not theoretically progressive by definition.

Second, Martin and Hjortland claim that

> there is no absolute value against which theories' predictive successes are judged, the level of predictive success, and thus the strength of evidence for a logical theory, is judged by comparison to that of other theories. Consequently, as with theories in other areas of inquiry, logical theories are assessed on the basis of their success relative to competitors. (Martin and Hjortland 2020b, 13)

Such is not the assumption of Lakatos', who does maintain basic criteria of theory evaluation. It is not by comparing two degenerating programs that one finds that one is "less deteriorating" than another. Logic should also meet this basic standard.

> Of course, there may be some minimal criteria, or basic level of predictive success that any theory must meet in order to even be part of the conversation of theory choice, but what these requirements would be exactly are at present unclear. (Martin and Hjortland 2020b, 13)

Under their view such predictive criteria are indeed unclear. Perhaps operating on the assumptions that predictions should be made about future practice could be of help.

Third, as Martin and Hjortland note, "mathematical proofs cannot serve as the sole arbiters of a successful theory of logic" (Martin and Hjortland 2020b, 15), as un-

derdetermination threatens theory choice.[46] Further evidence might be drawn from vernacular inferences and from non-direct evidence. As they also note, there is in principle nothing that guarantees that mathematicians' judgements and vernacular arguments are reliable data. The mathematician's judgments, at least, have a better claim as reliable guide informal proof steps, which cannot be extended to vernacular arguments, since "when we have good reasons from empirical findings to believe it isn't" (Martin and Hjortland 2020b, 17). Yet the predictivists assume this to be the case, leaving an argument for such reliance on a promissory note. Can this note ever be cashed out?

They claim "that a presumption of reliability for such judgements (from certain agents) is a prerequisite for the current methodology to make sense" (Martin and Hjortland 2020b, 17), but why make this assumption? The anti-exceptionalist does not want to claim that vernacular arguments are valid because people are competent speakers of a language or because people have "clear and distinct" intuitions about logical validity.[47] What other alternative is there? What could guarantee a connection between everyday speech and the unobservable phenomena of validity? Could it be the anti-exceptionalist version of realism about logic creeping in?

The other source of evidence proposed by predictivism is non-direct evidence, which, as discussed already above, is non-empirical. Such care for empirical evidence is not even assumed by them.

> Particularly, in suggesting that logical theories appeal to judgements regarding arguments, the current proposal opens up the possibility that *a priori* evidence does indeed play a role within logical theory choice (...). (Martin and Hjortland 2020b, 29)

The predictivist model admits of *a priori* evidence, and it makes no new novel predictions, only predictions in respect to already available data. This clearly differs from the Lakatosian criteria of progress. By its nature, predictivist methodology is

[46] See section 2.1.

[47] As laid out in Chapter 1, these were the views of semanticism and rationalism, respectivelly.

ad hoc in Lakatos' sense, in as much as it corroborates already available facts, and is hence not theoretically progressive.

Under anti-exceptionalism, logic is thus neither empirically nor theoretically progressive, constituting a degenerating program. A Lakatosian reading of "logic as a science" does make sense of logical disagreements (which are due to a divergence in the core of the programs), but unless one is satisfied with the conclusion that logic[48] is a degenerating program of research, a better account of evidence/data in logic and prediction might well be presented. Recall that for Lakatos, the interesting issue is not if something is a science or not, but whether a program is deteriorating or progressing. If anti-exceptionalism would want to turn logic into a mature science, they still have some way to go.[49] The only way to proceed so seems to be in insisting that logic is empirical in a very strong sense, which would require a different approach to evidence than what is provided by anti-exceptionalists thus far.

Noteworthy is that in the Lakatosian picture, there is a difference between revising a theory within a research program and choosing between competing programs. While the process of revision is about adjusting the theories within a program to maintain theoretical and empirical progress, the choice of research program is about accepting the core of the program. Only the latter is a case of whole theory comparison, while the former is a case of piecemeal revision (borrowing again the terminology from Woods (2019b)).[50] Lakatos' account makes sense of theory choice and theory revision while keeping them separate. IBE, and thus logical abductivism, seems to treat them as the same. Note further that on Lakatos' view scientists do not easily abandon one program to join another, as is the abductivist proposal of theory revision. Scientists usually stick with their program until the dying end, proposing new theories within their program until it deteriorates. While theory revision within a program is only a matter of course, theory choice in terms of a research program is a very costly revision. Regarding Lakatos' account, it is argued in Chapter 5 that

[48] It should be clear that this is logic under the view of anti-exceptionalism, not mathematical logic, and not even all views of philosophical logic.

[49] It is doubtful how plausible this is. More on the empirical aspect of logic is discussed in the next section, together with van Fraassen's constructive empiricism.

[50] On piecemeal revision, see Chapter 5 below.

logic is a better fit with the method of mathematics than with that of science.

3.3 Van Fraassen's constructive empiricism

The current section presents van Fraassen's constructive empiricism, which is known to be the "adversary" view of scientific realism. Unsurprisingly, it is argued herein that "logic as a science" does not work under this view. For constructive empiricism, progress is marked by improved empirical adequacy, and this standard cannot be met by logic. The kinds of evidence of logic presented by anti-exceptionalists cannot be granted under the constructive empiricist view.

Some key tenets of constructive empiricism are in direct opposition to those of scientific realism: *first*, scientific theories are not build under a "logical snapshot" picture (where axioms are laid out and consequences follow); *second*, scientific theories do not aim at truth, but merely empirical adequacy; *third*, empirical adequacy is the only measure of success of a theory, theoretical virtues have no place in selecting theories. Only the first two of these points are discussed in relation to logic. The last point, while relevant to the clash between constructive empiricism and scientific realism, need not be evaluated with regard to logic; since it is argued that logic does not fit the constructive empiricist account in the first two features, and thus the last one is beside the point.

Van Fraassen presents his view both as a response to the failure of positivism and as a refutation of scientific realism. The main problem of positivism was their theory of meaning,[51] which claimed that language could be separated into theoretical and non-theoretical terms. While he grants that scientific realists are also trying to present an account of science that is better than positivism, they have made the mistake of overcorrecting.

> The logical positivists, and their heirs, went much too far in this attempt to turn philosophical problems into problems about language. In some cases their linguistic orientation had disastrous effects in philoso-

[51] Already discussed in section 1.3 above.

> phy of science. Scientific realism, however, pursues the antithetical error of reifying whatever cannot be defined away. (van Fraassen 1980, 4)

One way to make sense of these three views is to see how each answers these two questions:

> Can we divide our language into a theoretical and non-theoretical part? (...) [C]an we classify objects and events into observable and unobservable ones? (van Fraassen 1980, 14)

Positivism would answer both questions with "yes", constructive empiricism answers "no" and "yes", respectively, and scientific realism would answer "no" to both. Van Fraassen thus aims to keep the best aspects of positivism, that is, its commitment to the distinction between observables and unobservables, while rejecting their theory of meaning. He claims that "[his] own view is that empiricism is correct, but could not live in the linguistic form the positivists gave it" (van Fraassen 1980, 3). It is fine to admit that "[a]ll our language is thoroughly theory-infected" (van Fraassen 1980, 14), but also that "[t]he fact that we let our language be guided by a given picture, at some point, does not show how much we believe about that picture" (van Fraassen 1980, 14). Scientific theories need to account only for what is observable, and the scientific activity is one of construction rather than one of discovery.

Van Fraassen aims to maintain the primacy of the distinction between observable and unobservable, while rejecting the positivist's structure of how theories are formulated. In defense of the first point (upholding observable/unobservable distinction), he admits (as critics of positivism often claim) that there is no clear-cut point which separates observable and unobservable phenomena, but argues that this admission does not mean that the distinction does not hold true. Constructive empiricism asserts that scientific theories aim at empirical adequacy (that is, adequacy to observable facts), rather than truth (which seeks to accommodate unobservable statements as well).[52] Regarding the second point (rejecting the "logical snapshot" picture of theories), he says:

[52] This is the major point of disagreement between van Fraassen and scientific realists, but it

> Impressed by the achievements of logic and foundational studies in mathematics at the beginning of this century, philosophers began to think of scientific theories in a language-oriented way. To present a theory, you specified an exact language, some set of axioms, and a partial dictionary that related the theoretical jargon to the observed phenomena which are reported. Everyone knew that this was not a very faithful picture of how scientists do present theories, but held that it was a 'logical snapshot', idealized in just the way that pointmasses and frictionless planes idealize mechanical phenomena. There is no doubt that this logical snapshot was very useful to philosophical discussion of science, that there was something to it, that it threw light on some central problems. But it also managed to mislead us. (van Fraassen 1980, 64)

Van Fraassen proposes a new picture of what a theory is, one which is not presented in terms of a logical snapshot. In constructive empiricism, "[t]o present a theory is to specify a family of structures, its models; and secondly, to specify certain parts of those models (the empirical substructures) as candidates for the direct representation of observable phenomena" (van Fraassen 1980, 64). The current section explores whether logic under the anti-exceptionalists view fits the constructive empiricist standard for science, finding that it does not.

It is thus useful to further elaborate on the topic of observation and empirical adequacy. Van Fraassen differentiates between observable quantities and defined quantities. Time and position constitute the basic quantities, and he designates "as basic observables all quantities which are functions of time and position alone" (van Fraassen 1980, 59-60).

> These include velocity and acceleration, relative distances and angles of separation—all the quantities used, for example, in reporting the data astronomy provides for celestial mechanics. (van Fraassen 1980, 60)

need not be of concern in the present context. Van Fraassen admits that theoretical criteria can be heuristic, but as criteria for theory choice, only empirical adequacy matters. For more on this issue, see Lipton (1993) and van Fraassen (2001).

Defined quantities are those which are experimentally accessible (thus require hypothesis plus data), such as "mass, force, momentum, kinetic energy" (van Fraassen 1980, 60).

Defined quantities are expressed in terms of counterfactuals (what would happen under different circumstances). For example, mass.

> The core of truth behind them is that mass is experimentally accessible, that is, there are situations in which the data about the basic observables, plus hypotheses about forces and Newton's laws, allow us to calculate the mass. We have here a counterfactual: if two bodies have different masses and if they were brought near a third body in turn, they would exhibit different acceleration. (van Fraassen 1980, 60)

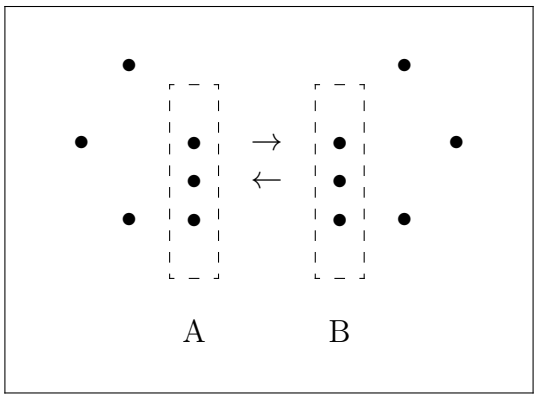
Different theories define mass differently.

> In the theory of McKinsey, Sugar, and Suppes, as I think in Newton's own, each body has a mass. But in Hermes's theory, the mass ratio is so defined that if a given body never collides with another one, there is no number which is the ratio of its mass to that of any other given body. In Simon's, if a body X is never accelerated, the term "the mass of X" is not defined. In Mackey's any two bodies which are never accelerated, are arbitrarily assigned the same mass. (van Fraassen 1980, 60)

Though these theories diverge in theoretical aspect, "from the point of view of empirical adequacy, they are indeed equal" (van Fraassen 1980, 61). There is thus "a division between that description taken as a whole, and the part that pertains to what is observationally determined" (van Fraassen 1980, 63).

In constructive empiricism, a theory is specified as a family of models, some of which are called appearances (which are described in experimental and measurement reports) and some of which are indicated as empirical substructures, which are "candidates for the direct representation of observable phenomena" (van Fraassen

1980, 64). A theory is empirically adequate if there is an isomorphism between appearances (A, in the figure below) and the empirical substructures (B, in the figure below).



Here a first problem for a view seeking to reconcile anti-exceptionalism and constructive empiricism shows itself. Even if logical models can be presented, what would the appearance of logical theories be? Are the kinds of logical evidence admitted by anti-exceptionalism suitable for a constructive empiricists account? What would be the empirical substructures of logical theories? What phenomena would logical theories try to model adequately? Vernacular arguments, mathematical practice, or both?

Recalling Hjortland's (2019) survey of evidence for logical theories, it is appropriate to assess whether such evidence can be used as data in a constructive empiricist view of logic. Is logical evidence observable? As already discussed, the three kinds of evidence presented by Hjortland (2019), namely, pre-theoretical intuitions, compatibility with non-logical theories and meta-linguistic theories, are non-empirical and non-observable. While non-logical theories could include observables (were the theories scientific), constructive empiricism directly rejects such use of empirical import from other theories, since there is a rejection of the "logical snapshot" formulation of theories and since one cannot separate the empirical and theoretical aspects of a theory. Moreover, the desire for a unified scientific account of the world, such that coherence with different theories count towards the truth of a theory under consideration, is derived from the scientific realist assumption. More on this below.

Noting this issue with the non-observable or non-empirical character of the ev-

idence logicians actually use, some anti-exceptionalist reverted back to accepting *a priori* evidence (per the rationalists), and still insisting that the abductive method is suitable for theory choice.[53] As long as not all evidence is *a priori*, then does anti-exceptionalism still holds?

The *a posteriori* evidence often used comes from mathematical practice and from linguistic data, thus perhaps this kind of evidence is apt to be called observable. Even so, it is also admitted that people do not actually reason according to deductive logic.[54] The anti-exceptionalist project is not to model natural language or to describe the way people consistently reason invalidly. There seems to be no observed regularity in need of a scientific theory to account for it. And even were there such regularity, for constructive empiricism not all observed regularities of nature are in need of explanation anyway.[55]

There is of course room in constructive empiricism for unobservables. Theoretical entities are postulated to explain the observed regularity.

> A current view, not altogether uncontroversial but still generally accepted, is that theories account for the phenomena (which means, the observable processes and structures) by postulating other processes and structures not directly accessible to observation. (van Fraassen 1980, 3)

Since validity is not the observed phenomenon, it must be what does the explaining. It is supposed to be a postulated unobservable which can explain something observed. Validity is not that which needs to be explained, it is what does the explaining. It would be a category mistake to assume the opposite, such as is made by Martin and Hjortland (2020b).

> Validity is a technical term introduced by the logical community, with the attempt of discovering some substantive property of arguments which can be explained. In so introducing this concept, **the community is**

[53] That this is a questionable appropriation of IBE as a methodology is discussed in section 2.3.
[54] On the normativity of logic, see section 4.2.
[55] This assumption is one which logical anti-exceptionalism again shares with scientific realism.

> **hypothesising that there is some genuine phenomenon to be explained** behind the everyday talk of some claims "following from" others. (Martin and Hjortland 2020b, 12, emphasis added)

Validity is postulated as a theoretical term that corresponds to a "genuine" unobservable phenomenon. Once "validity" becomes what needs to be explained, and not what does the explaining, the realist picture of anti-exceptionalism becomes all that more apparent. The anti-exceptionalist methodology of assuming that there is such a phenomenon of validity goes against the constructive empiricist view of science, since the development of "an empiricist account of science (...) must involve throughout a resolute rejection of the demand for an explanation of the regularities in the observable course of nature, by means of truth concerning a reality beyond what is actual and observable" (van Fraassen 1980, 203).

It could still be asked if the notion of validity can be incorporated under the constructive empiricist view of science, once validity is re-framed to be only a theoretical term and not a "genuine" phenomenon. Yet the anti-exceptionalist view not only assumes that there is an observed regularity in reasoning (besides evidence otherwise),[56] but that there is a common cause to all the regularity observed.

> To the anti-realist, all scientific activity is ultimately aimed at greater knowledge of what is observable. So he can make sense of a search for common causes only if that search aids the acquisition of that sort of knowledge. (...) As a theoretical directive, or as a practical maxim, the principle of the common cause may well be operative in science—but not as a demand for explanation which would produce the metaphysical baggage of hidden parameters that carry no new empirical import. (van Fraassen 1980, 31)

Is "validity" a useful fiction, or is it just metaphysical baggage? Given that the constructive empiricist either rejects the kinds of evidence adopted by anti-exceptionalists

[56] More on the regularity of reasoning practices is discussed in Chapter 4.

or claims that there is not enough observed regularity to be accounted for, and that the postulation of "validity" as a phenomena does not aid in the acquisition of observable knowledge, it seems that it is only a metaphysical article of faith.

In conclusion, "validity" as a phenomenon cannot be created as part of an empiricist view of science: it is neither observed as a regularity, nor sufficiently useful in a unified account of many contexts where one might be arguing.[57] The main issue for the ill match between constructive empiricism and anti-exceptionalism is the assumption of unification of different argumentative contexts. Van Fraassen gives logic a break:

> Theoretical entities introduced by logicians in their models of language (also called 'formal languages') include domains of discourse ('universes'), possible worlds, accessibility ('relative possibility') relations, facts and propositions, truth-values, and, lately, contexts. As might be guessed, I take it to be part of empiricism to insist that the adequacy of these models does not require all their elements to have counterparts in reality. **They will be good if they fit those phenomena to be saved**. (van Fraassen 1980, 134-135, emphasis added)

So what is the phenomenon anti-exceptionalists are trying to save? It cannot be "validity". If anti-exceptionalists are trying to save all the data they claim by the same theory, no wonder no logical theory is up to the task.[58] Constructive empiricism rejects the need for a unified model, as their view of science does not aim at a "super theory", only at theories which can save appearances. If insisting in treating logic as a science (as a discipline that aims towards theories of validity), one must reject the need for common cause and accept that not all domains of logic might be unified, that is, the logical evidence might need to be restricted to specific domains.

> Why should scientists want a single theory to cover disparate domains of phenomena, rather than a different, empirically adequate theory for each

[57] Perhaps if the scope of what logic is about is restricted, then it does make sense to talk about "validity" such as in the "conceptions of logic" discussed by Hlobil (2020).

[58] See section 4.1.2 for a discussion of logical nihilism.

> such domain? For the realist the motive is clear; for a theory cannot be true unless it can be extended consistently, without correction, to all of nature. But surely it is possible to have a lot of theories, each with its individual sorts of models, more or less overlapping in their domains of application—all empirically adequate, but impossible to combine into a single picture? (van Fraassen 1980, 86)

A kind of logical relativism would be the best account of logic which the constructive empiricism can offer. Too many anti-exceptionalist assumptions had to be given up for this to be the case, however, such as the rejection of "validity" as a phenomenon and rejection of common cause. This is absolutely not surprising, given the arguments from Chapter 2 above that logical abductivism is a version of scientific realism. Perhaps this logical relativism could be admitted as an anti-exceptionalist view, once anti-exceptionalism is re-defined away from its conflation of science with logic.

3.4 Interlude

What happens if we ignore the constructive empiricist's aim of empirically adequate theories? Maybe there is a good case of IBE as a methodology even for non-empirical theories. This section presents the case of theory selection in high energy particle physics.

While the idea of using criteria other than adequacy to empirical observation in science is indeed popular, it does not make it correct, and even scientists have been recognizing this. In *Lost in Math: How beauty led physics astray*, the physicist Sabine Hossenfelder criticizes the current method of theory assessment in her own field of high energy physics, which she claims is guided by considerations of beauty. She notes that in "some areas of physics there hasn't been new data for decades" (Hossenfelder 2018, 16) and that "[i]n the absence of guidance from experiments, theorists use aesthetic criteria" (Hossenfelder 2018, 16) to guide research, in particular simplicity, naturalness, and elegance.[59]

[59] "These terms are never defined, strictly speaking, and I won't attempt to define them either;

Such guidance, however, has not provided any new confirmed hypothesis for a long time: "If we are starved of data and need a theory to decide where to look for new data, mistakes in theory development can lead to a dead end" (Hossenfelder 2018, 41). It sounds like high energy physics is a degenerating research program.[60]

> The Higgs boson, proposed independently by several researchers in the early 1960s, was the last fundamental particle to be discovered (in 2012), but it was not the last particle to be predicted. Last predicted—in 1973–were the top and bottom quarks, whose existence was experimentally confirmed in 1995 and 1977, respectively. In the late 1990s, neutrino masses–whose theory goes back to the 1950s–were added after experiments confirmed them. But since 1973 there hasn't been any successful new prediction that would supersede the standard model. (Hossenfelder 2018, 55)

No new data has been available for high energy physics, and moreover, it is doubtful that it will ever be. To continue to test the new predictions, one would need to reach Planckian energies, yet

> [i]f we wanted to directly reach Planckian energies, we'd need a particle collider about the size of the Milky Way. Or if we wanted to measure a quantum of the gravitational field–a graviton–the detector would have to be the size of Jupiter and located not just anywhere but in orbit around a potent source of gravitons, such as a neutron star. Clearly these aren't experiments we'll get funded anytime soon. Hence many physicists are pessimistic about the prospects of testing quantum gravity, which leads to

I will just tell you how they are used" (Hossenfelder 2018, 189). In particular, naturalness "is an attempt to get rid of the human element by requiring that a 'natural' theory should not use cherrypicked assumptions" (Hossenfelder 2018, 91). "The naturalness criterion, however, is useless without further assumptions, assumptions that require making an unexplained choice and thereby bring back cherry-picking. The problem is, there are infinitely many different ways for something to be due to chance, and so the reference to chance itself already requires a choice" (Hossenfelder 2018, 91-92).

[60] Recall from section 3.2 that a research program is on which neither corroborates nor predicts new facts.

> a philosophical conundrum: if we can't test it, is it science? (Hossenfelder 2018, 178-179)

Even so, some scientists persist in theorizing, as even "[w]ith naturalness now contradicted by observation, many physicists think that the only alternative to 'natural' laws is that we live in a multiverse" (Hossenfelder 2018, 118). That such is the conclusion of much of the scientific community is a puzzlement for Hossenfelder. If departing from non-empirical criteria for scientific assessment, one arrives in a scenario in which such empirical assessment is not ever possible (due to the ever expanding universe and inaccessibility of other universes),

> [i]t is unclear what problem naturalness or the multiverse is even trying to solve, since neither one is necessary to explain observations. (Hossenfelder 2018, 118)

Either way, it seems indeed that "beauty led physics astray".

Given the lack of recent data in theoretical physics, "[s]ome philosophers are proposing to weaken the scientific method so that scientists can select theories by criteria other than a theory's ability to describe observation" (Hossenfelder 2018, 41). Is this ever warranted? What, then, of logic, which starts out with a scarcity of data? Is beauty alone a good enough criteria? Logical abductivism[61] seems to allow for it. Yet in what way is this science?

Three views of "logic as a science" have been explored in this chapter (scientific realism, sophisticated methodological falsificationism and constructive empiricism). It was argued that anti-exceptionalism only promptly fits within the scientific realist view of science. While sophisticated methodological falsificationism can grant the kinds of evidence anti-exceptionalists want, it dooms logic to be only a degenerating

[61] At least in understanding of logical abductivists who do not claim some "core" theoretical virtues that every theory must meet.

research program. Constructive empiricism cannot even grant such evidence exactly because it rejects the realism that is needed. Comparing logic to science places onto logic a burden of empiricalness that it cannot hope to meet.

Anti-exceptionalism in the form of logical abductivism cannot push out logic to the edges of the web-of-belief, and so of course their preferred method of theory revision needs to be holistic, drawing from indirect data. Quine's method of revision did not require there to be a "best theory", since for him theory revision could be done in different ways. There was no revision towards "truth", only a suggested principle of minimal mutilation. His framework allowed freedom in revision which IBE does not. Since IBE as a methodology is taken to be a solution to the problem of underdetermination of theory by data, none of this is surprising.[62] Peirce's original abduction principle also allowed for more freedom than IBE. Both Peirce's and Quine's methodological remarks about science could apply to logic, without needing to bring in talk of theoretical virtues and scientific realism into logic.

That logic is not empirical in the scientific sense does not mean empirical considerations have no bearing on logic, it just means that the only way to get to the view that logic is a descriptive science is to assume that it describes some unobservable aspect of reality.[63] Does the "realist" cost of logical abductivsm pay off? It seems not to, given the problems presented in section 2.3. The characterization of theory revision in logic as akin to science in any strict sense does not add value to the view of anti-exceptionalism. Next chapter proposes a new definition of anti-exceptionalism, which does not rely on an analogy with science, and still makes sense of theory revision in logic, without falling into rationalism or semanticism.

[62] As presented in section 2.1.

[63] One might prefer to say that logic is indeed empirical, but not descriptive, in which case the analogy with science also fails.

4 Logic as something else

Last chapter argued that a plausible interpretation of the view that logic is a science is tantamount to some form of realism about logic. While the "logic as science" view has not, and will not, be argued against; such a conclusion is a difficult one for the anti-exceptionalist about logic to accept. Chapter 1 presented anti-exceptionalism about logic as being a view which attempts to avoid both the rationalist and semanticist predicaments. So while rationalism takes it that one's intuitions are the sole guide to the One True Logic, and theory revision is not possible; anti-exceptionalism takes abduction to be the right way to get there. Both views are more alike than they seem at first.

The attempt to turn logic into a science has failed because of the difference between how logic and science connect with evidence. This could be either because logic and science deal with different types of evidence, or because, while they deal with the same type of evidence, the access to such evidence cannot be accounted for by the same means. Logical disagreements are not only about what is the best theory to account for some evidence, but also about what counts as evidence in the first place.[64] Scientific theories answer ultimately to what is observable and to empirical data. One does not need to embrace a realist view about logic to account for theory revision in logic and logical disagreements. There are many views which fall between this foundationalism and anti-foundationalism about logic. This gap is wide enough for different ontological views about logic, and more importantly for present discussion, more than one method of theory revision.

[64] Arguably, this is also true in the sciences, although not according to IBE's account.

Foundationalism	(very wide gap)	Anti-foundationalism

The current chapter motivates an alternative definition of logical anti-exceptionalism by presenting some issues which are particularly problematic for the abductivist account of logic. It divides itself in three main sections. *First*, logical pluralism (4.1.1) and logical nihilism (4.1.2) are presented as alternative and equally plausible solutions to what motivated anti-exceptionalism in the first place. *Second*, alternative accounts of logic are presented, which do not take logic to be a descriptive discipline, but a normative one (4.2). *Third*, a different definition of anti-exceptionalism about logic is proposed, in terms of rational theory revision, rather than in terms of "scientific" method of theory revision (4.3). Within the scope of this new definition, more than one method of theory revision is available for logic, without needing to settle ontological issues.

4.1 Further arguments against logical abductivism

Chapter 1 presented the motivation for the anti-exceptionalist view of logic in terms of accounting for logical disagreements and theory revision in logic. Chapters 2 and 3 re-framed the discussion in terms of logical evidence and how a logical theory might account for this. The anti-exceptionalist account of logic is not the only dealing with these epistemological issues. The present section presents two alternative accounts of logic which can be said to explain logical theory revision and disagreement. While logical abductivism (as the most robust representative of anti-exceptionalism) proposes that logical theories can be revised and this is what accounts for logical disagreement, logical pluralism embraces logical disagreement and rejects the need for theory revision: there is more than one correct logic. Logical nihilism, in turn, maintains there is enough evidence to claim that there simply is no logical theory that can fulfill the canonical application desired.

4.1.1 Incompatibility with logical pluralism

Logical pluralism is a view which is motivated by the same epistemological issues of logical anti-exceptionalism. Pluralists present both an account of validity (in the form of a "canonical application", and not mere instrumental use of logic) and of logical disagreement (some disagreements are linguistic, but there are also deeper disagreement motivating pluralism). Instead of putting forth an argument why one logical theory is better than another, pluralists take it that more than one logic may be correct at once.

If this pluralist insight is correct, and more than one logical theory could be adequate, there cannot be "an abductive best", as current logical abductivists claim. In particular, Priest (2006) already argues, against logical pluralism, to this exact point. For him, there is only one logical theory which is correct for the canonical application of logic, and thus pluralism is wrong. Given that abductivism and pluralism deliver different explanations for logical disagreements, it is relevant to adjudicate which view can better account for them.

Still, given the attention logical abductivists give to logical practice (in particular Martin (2020) and Martin and Hjortland (2020a)), their story needs to account for pluralism. How does the possibility of logical pluralism fit into their "data"? Are all these experts (logical pluralists) simply misguided (as Priest would have it)? The conciliation of abductivism and pluralism is a point that needs to be fleshed out by their account: either rejected or explained.[65] It seems, as Priest points out, that pluralism and abductivism are incompatible. Hjortland (2017a) proposes a kind of intra-theoretic pluralism, which might be incorporated into the abductivist account. It would be interesting to see this done.

Either way, both replies to pluralism seem to weaken the abductivist position. If on one hand pluralism is rejected, as by Priest (2006), then it must be explained why natural language reasoning guides logic choice, but not that of experts; or explained why some experts are so misguided about the nature of logic and how

[65] Why would an anti-exceptionalist view of logic aim to account for some logical disagreement but not others?

such misguidedness is not an issue for abductive methodology. If pluralism gains enough traction within philosophy of logic, dismissing their view seems a rather *ad hoc* move, and the abductivist view of logic becomes an even less plausible account. If, on the other hand, pluralism is incorporated into abductivism, there needs be a better story to be told about what would constitute "the best explanation", such that the method of theory selection no longer selects just one theory as best.[66]

When considering pluralism in the sciences, there are different views allowing for it (for example, both views presented in chapter 3). It is, however, worth highlighting that the view of science adopted by logical abductivists is that of IBE, which does not allow for more than one theory to be equally correct. In rejecting IBE and logical abductivism, a logical anti-exceptionalist could have a better account of pluralism within logic in an analogous way to science.

4.1.2 The threat of logical nihilism

Another topic within the epistemology of logic posing a challenge to logical abductivism, and the anti-exceptionalist aim in general, is logical nihilism. This subsection presents how nihilism is an issue for logical abductivism, and how this method cannot defend itself against the threat of nihilism, when other methods can. G. Russell (2018b) presents the nihilist view as a possible reply within the monism vs. pluralism debate. What if both views are wrong? Logical nihilism proposes "that there are no laws of logic, so that all candidates—e.g. the law of excluded middle, *modus ponens*, disjunctive syllogism et. al.—fail" (G. Russell 2018b, 308). That is to say, there is no logical theory that is true in the sense that abductivist claim: "the extension of the relation of logical consequence is empty" (G. Russell 2018b, 310). The reason for this is simple, there have been counter-examples to every putative logical law.

The problem for abductivism lies in having to select which of the proposed counter-examples the nihilist presents should not count as "data" in their abducted

[66] This might mean abandoning the IBE method of the sciences and developing a form of abduction specifically suitable for logic.

argument, or having to explain how come every logical law has been falsified. The most plausible reply would be to give an account of why such evidence can be dismissed.

G. Russell (2018b) resists the nihilist view by borrowing from Lakatos' view of mathematics and the method of lemma-incorporation, and claiming that the counter-examples proposed by nihilist is just one step in the methodology of logic. This method of theory revision is presented in Chapter 5 below. Such a reply is not available for the abductivist, however, since the method used by G. Russell is not one which is compatible with abductivism (as is argued in section 5.2).

Relatedly, Prawitz (2007)[67] presents an analogy between valorative nihilism and logical nihilism, arguing against both views, to the point that rational discussion can be had about both ethics and logic. Valorative nihilism holds that valorative propositions ("Sweden should invest in nuclear energy", "It is not fair to persecute someone for racial reasons") do not have truth values and can be evaluated only in terms of esteem. In this view, "we cannot consider value judgments as objects in a rational discussion in the usual sense" (Prawitz 2007, 128). For valorative nihilism, one cannot argue for or against fundamental judgments, only the relation between them. The best one can argue for is a coherent set of judgments. Similarly for logical nihilism, "we can argue that something is logically true, deducing it from a more fundamental logical axiom with the help of some basic inference rules, but we cannot argue in favor of the correctness of these axioms and fundamental rules; it is not befitting to ask if these are true or not" (Prawitz 2007, 132).

Prawtiz takes that while there is no clear-cut distinction between factual propositions and valorative ones, this does not mean that such distinction does not exist.[68] He argues that logical propositions fall into the valorative side of this distinction, that is, logical propositions are not objectively factual, such as the propositions of empirical science or mathematics. While the propositions used in science can be

[67] This is a Portuguese translation of the original "Om moraliska och logiska satsers sanning" (1978). The citations herein are translated to English from Portuguese, and not from the original.

[68] In this point, he echoes a view of van Fraaseen (presented in section 3.3 above), who claims that even though there is no clear-cut distinction between observable and unobservable vocabulary, the distinction still holds.

verified by looking at the world, and mathematical propositions can be verified by looking at the axioms, logic can appeal to neither. Since the evaluation of both value and mathematical judgments rely on logic, logical nihilism is a serious issue that should not be dismissed.

The strategies for arguing against valorative and logical nihilism are similar: "to show that we can in fact argue in favor of the correction of logical laws" (Prawitz 2007, 132-133). For both logical and value judgments, Prawitz notes that it is easier to agree on the truth of particular instances than on the truth of the general law that might compel one to agree to the particular instance (in logic, this is known as the Achilles and Tortoise problem).[69] Thus, it seems that one argues not for logical or value judgments because they accord to more basic principles, but rather that the principles are accepted because they agree with particular judgments.

> In the same way, we can argue against a system of basic moral or logical laws, if, from them it follows that (a) some particular actions which we consider unjust are just, or the opposite, some actions which we consider just are unjust; or (b) some particular reasoning which we consider wrong are right, or the opposite. On the other hand, if the valuation which we effectively do of particular actions, or the evaluation which we in fact do about the validity of particular reasoning, then they are in accordance with what we can deduce from a moral or logical system, then this is an argument in favor of that system. (Prawitz 2007, 137)

Such is also the relation that science has to its theories: scientific laws have to accord to the observation sentences.

Such a relation should not be taken too seriously, as "this comparison is evidently precarious" (Prawitz 2007, 138). He notes that the judgment of empirical proposi-

[69] This problem was originally presented by Lewis Carroll (1895). In the dialogue, Achilles tries to convince the tortoise to accept an instance of *modus ponens*, which the tortoise resists. The dialogue plays with the idea that one can only be forced to accept *modus ponens* as a law once one already accepts it as a law. There is a distinction between accepting particular arguments and accepting the general logical form of the argument (one can accept all instances of *modus ponens* that are presented, and still not grant that *modus ponens* is a general logical law).

tions is done in accordance with observation, which is independent of those doing the observing, while moral and logical judgments are more susceptible to theory.

> Even being true, as pointed out above, that we are always totally sure of our moral and logical judgments in particular cases, and that we test general principles from these judgments, it is also true that we, on the contrary, are almost always guided by general principles when taking a position in a particular case. (...) This implies that the place occupied by particular values and inferences in moral theories and logic, respectively, is afterall very different from the place observational sentences occupy in empirical theories. Because, even being true that our observations depend in part in the theories we believe, it does not seem reasonable to think that those things which we observe are in fact modified on the basis of theoretical observations – it is undeniable, however, that the way we valuate or reason is influenced by considerations of logic and moral philosophy. (Prawitz 2007, 138)

This distinction between the kind of "data" used in logic and in the empirical sciences has already been noted in Chapter 3.

Prawitz concludes that value judgments and logical judgments are very similar, in that both are about action.

> In moral philosophy and in logic, we put our actions in a broader context, trying to better understand their purpose and find general rules for the activity as a whole. Because of this, it is only natural that our valuations and our way of reasoning be influenced by the principles we reach through ethics and logic, even though these principles are, in their own turn, the fruit of a reflection of this same activity and obtain their validity by being tested from it. (Prawitz 2007, 139)

He concludes that the method appropriate for both is that of reflective equilibrium, which is discussed in section 5.2 below.

Logical nihilism, by noting that any logical law has counterexamples, poses a serious problem for any attempt at epistemology of logic. To resist nihilism, these counterexamples need to be taken seriously: either dismissed in a way that they do not threaten the possibility of logical knowledge, or incorporated into the account. Both replies to logical nihilism presented herein rely on improvement of the logical theory in light of counterexamples, and both disagree with logical abductivism on the method of theory revision. It is unclear how logical abductivism might reply to the threat of nihilism, but it seems relevant that it does so.

4.2 The normativity of logic

The logical anti-exceptionalists slogan rejects that logic is normative:

> Exceptionalism about logic is the view that logic is different from the empirical sciences, perhaps by being (...) normative (...). By contrast anti-exceptionalists deny—to varying degrees—that logic has the properties attributed by exceptionalists. (G. Russell 2018a, 3)

Yet there is a clear sense in which logic is normative: people reason, and in doing so, infer correctly and incorrectly.[70] To say that "logic is normative" can amount to different views, depending on what is claimed logic is normative for. Without delving too deep on the question of the normativity of logic, there is a clear sense in which the anti-exceptional account of logic needs to account for the normative role of logic, not the least given the kinds of evidence that are claimed that logic answers to (which includes both mathematical practice and everyday reasoning).

While there is an abductive account of this normativity presented by Priest (2014), it is not clear if there is agreement among logical abductivists regarding Priest's proposed account of the normativity of logic. As discussed in Chapter 2 above, there is reason to think Williamson would disagree with this account, in particular, because he takes mathematical practice to guide logical theory choice,

[70] Whether or not there is a connection between correct reasoning and deduction inference is not a topic which falls within the scope of this discussion.

and not the other way around. Given the different conceptions of logic which Priest and Williamson endorse, it seems there is not bound to be one single abductive account of the normativity of logic.

Priest (2014) presents three senses of "logic": *logica docens*, *logica utens* and *logica ens*. While the first "is what logicians claim about logic" (Priest 2014, 212), which gets taught in textbooks, the second "is constituted by the norms of an inferential practice"' (Priest 2014, 219). Priest admits to inventing the third sense, "logic itself", which is "what is actually valid: what really follows from what" (Priest 2014, 212). This last sense of logic is exactly the realist assumption highlighted in Chapter 3.

It is a fact that *logica docens* has been revised throughout history.

> [O]ne needs only a passing acquaintance with logic texts in the history of Western logic to see that the *logica docens* was quite different in the various periods. The differences between the contents of Aristotle's *Analytics*, Paul of Venice's *Logica Magna*, the Port Royale *Logic, or the Art of Thinking*, Kant's *Jäsche Logik*, and Hilbert and Ackermann's *Principles of Mathematical Logic* would strike even the most casual observer. (Priest 2014, 213)

Priest claims, moreover, that this process of revision has been rational, following a form of abductivism, as presented in Chapter 2. *Logica docens* is the theory of deductive inference: "The true *logica docens* depends on the facts of validity" (Priest 2014, 223), that is, depends on *logica ens*.

Logica utens, is not "a matter of descriptive cognitive psychology (...) for the simple reason that we know that people often reason invalidly" (Priest 2014, 218), it is a normative notion, which "is constituted by the norms of an inferential practice" (Priest 2014, 218). This too can be revised: "[w]e determine what the best theory of reasoning is (the best *docens*), and simply bring our practice (*utens*) into line with that" (Priest 2014, 220).

The normative aspect of logic is dependent on the descriptive one. His account has it that one should reason in the way that deductive reason is established to be,

which is clearly a revisionist project: it claims people should reason following what experts determine and suggests that people should revise their reasoning practice.

Again, it is not clear that this is the overarching position of logical abductivism, since Williamson's view seems to be incompatible with Priest's. It remains to be seen what other anti-exceptionalists have to say about the normativity of logic.

Priest comments that what *logica ens* is depends on the account of validity; but in standard accounts (proof theoretic and model theoretic) the account does not change. At best, one may revise the language used to talk about *logica ens*, "[a]nd a rational change of *logica utens* may occasion such a change" (Priest 2014, 223). Priest, of course, notes the circularity involved, but comments that it is no vicious circle, as he is not a foundationalist: "there is no privileged point where one can ground the entire enterprise, and from which one can build up everything else" (Priest 2014, 223).

The sense of logic which Priest calls *logica ens*, being admittedly invented by him, is a particular assumption he makes about logic. What if there is no "*logica ens*"? That there is such a thing as a *logica ens* seems to be an assumption of logical abductivism (as discussed in Chapter 3), but it is not an assumption shared generally within philosophy of logic. The present section further explores views which have a different account of the normativity of logic, ones which do not assume there to be a *logica ens*.

As presented in section 4.1 above, Prawitz (2007) claims logic to be a normative discipline rather than a descriptive one, explicitly rejecting the analogy between logic and science. This is not an outlier view. There are other accounts of logic which claim that logic is normative, while also holding that logical theories can be revised, not claiming logic to be a (descriptive) science. Two such accounts are presented below, in order to further motivate the withdrawal from the analogy between logic and science.

For starters, Catarina Dutilh Novaes (2015) presents a novel account of the normativity of logic, which takes logic to be normative neither for thought nor for

everyday speech.

> Depending on one's answer to the question of what logic is normative for, different accounts of the nature of this normativity will be required. Questions such as 'where do the laws of logic come from?' are bound to be more adequately treated once the presumed normative remit of logic is clearly delineated. (Dutilh Novaes 2015, 588)

In her account, logic is normative, but "rather than for mono-agent mental processes, (deductive) logic in fact comprises norms for specific situations of dialogical interaction, in particular special forms of debates" (Dutilh Novaes 2015, 588). Through a historically informed rational reconstruction of the history of logic, Dutilh Novaes defends that deductive arguments "correspond to specific kinds of dialogues, which have both an adversarial and a cooperative component" (Dutilh Novaes 2015, 599). From this perspective, bridge principles can be easily formulated where "the normative claims in question will no longer pertain to thought and belief, but rather to dialogical situations, and moreover that they will involve multiple agents" (Dutilh Novaes 2015, 592).

Dutilh Novaes and French (2018) also maintain that

> a deductive proof or argument—the object of study of logic par excellence—is an inherently dialogical, multi-agent notion, given that it is essentially a piece of discourse aimed at a putative audience, typically composed of 'stubborn' (but not necessarily unhelpful) interlocutors. (Dutilh Novaes and French 2018, 132)

On their view, mathematical proofs internalize the figures of Prover and Skeptic, to the point that a proof is a dialogue between them, where the Prover tries to prove a claim, while the Skeptic resists the proof by showing counter-examples or asking for justification of proof steps. The main features of a deductive proof are that

> it starts off with certain premises; it proceeds through necessarily truth-preserving inferential steps; these steps should be individually evident and explanatory. (Dutilh Novaes and French 2018, 134)

In this scenario, "a deductively valid argument can be viewed as a winning strategy" (Dutilh Novaes 2015, 596) for Prover.

It should be clear that this view diverges from Priest's (2014) attribution of *logica utens*. While for Priest *logica utens* relates to people's reasoning practices, he does not go into detail about what this particular inferential practice is. It stands to reason that this inferential practice relates to vernacular inferences, that is, everyday speech, as discussed in Chapter 2.

For Dutilh Novaes (2015) logic does not relate to everyday reasoning, but is rather "essentially restricted to specific circles of specialists" (Dutilh Novaes 2015, 602).

> [T]he emergence of a framework where an argument counts as legitimate only if there is not a single possible counterexample to it, such as the frameworks of classical logic and Euclid-style mathematical demonstration, creates a niche of specialists, and does not seem to have much bearing on the argumentative and reasoning practices of humans in general. (Dutilh Novaes 2015, 602)

As both Priest (2014) and Dutilh Novaes (2015) discuss, in research on the psychology of reasoning, most notably the Wason selection task,[71] humans reliably fail at

[71] The Wason card test is a logical puzzle designed to test subjects' grasp of deductive reasoning. As Priest (2014) explains it: "There is a pack of cards. Each card has a letter on one side and a positive integer on the other. Four cards are laid out on the table so that a subject can see the following:

A K 4 3

The subject is then given the following conditional concerning the displayed situation: If there is an A on one side of the card, there is an even number on the other. They are then asked which cards should be turned over (and only those) to check this hypothesis. The correct answer is: A and 3. But a majority of people (even those who have done a first course in logic!) tend to give one of the wrong answers: A, or A and 4." (Priest 2014, 218)

these abstract logic tests. While Priest (2014) takes this to be evidence that *logica utens* can (and perhaps even should!) be revised following *logica docens*, Dutilh Novaes (2015) concludes that such "bad reasoning" is because general human inference practice is not deductive at all.

> It would seem that the ability to argue and reason deductively is not something that arises 'spontaneously' from more mundane argumentative practices. (Dutilh Novaes 2015, 602)

Thus while Priest (2014) presents a revisionist view of *logica utens* (since its revision follows *logica docens*), Dutilh Novaes recommends no such prescription. Logic is normative in some specific and specialized contexts.

> [L]ogic is in fact a normative codification of specific dialogical practices, i.e., the practices having given rise to the deductive method and traditional logic. (Dutilh Novaes 2015, 607)

Logica utens is then restricted to the practice of a select few, who become experts by learning how to play the game. There is no distinction between *logica docens* and *logica utens*. Logic can be rationally revised, as it historically has been, to improve the kinds of dialogues where logic happens.

The dialogical aspect of proofs is further discussed in section 5.1, where Lakatos' method of proofs and refutations is explored as a method of theory revision in logic. Chapter 5 also discusses a view, developed by Resnik (2004), in which deductive argumentation is taken to be a learned activity, and as such any revision of logic should be done in light of such learning.

Another account of the normative role of logic is that of Silva (2020), who presentes a neo-pragmatist account, claiming that "logical principles should be taken as rules with normative power which constitute and correct out practice in a sphere of public discourse" (Silva 2020, 83).[72] Silva proposes a "hinge" epistemology for

[72] The citations herein are translated to English from the original Portuguese.

logic. Drawing from Wittgenstein the notion of hinge propositions, Silva proposes that logical principles should be treated as such. Hinge propositions are propositions which are exempt from doubt and are necessary to evaluate the truth of other propositions:

> [J]ustification and knowledge are possible, just as doubt, only within the limits determined by taking the hinge [propositions] as guaranteed. They play a regulative, or normative, role in evaluating the quality of other assertions and other rational practices. (Silva 2020, 90)

Silva focuses also on the view of logic as a human enterprise, which is determined by one's upbringing and education, and liable to revision.

> Here, it is important to emphasize the social dimension of logic, the absorption of rules by observation and instruction and the possibility of mutual correction in ruled communal practice, which presuppose training by transmission, instruction and immersion in a human community. (Silva 2020, 85)

In this last aspect, he draws directly from Robert Brandom's logical expressivism, stressing that "[l]ogical systems express some commitments and norms of discussions and everyday rational practices" (Silva 2020, 94).

Silva also rejects the analogy between logic and natural sciences, especially as it relates to theory revision:

> The approximation to be done of logic in relation to the sciences is not with the natural sciences, but with the normative sciences such as judicial, political and ethical ones. When a general system of regulation does not fulfil its normative role, it should be reviewed in face of current practice. (Silva 2020, 85)

Silva's proposal is explicitly anti-realist, in that he holds that "logical principles should be taken closer to ethical principles than to scientific laws, since they do

not need to describe any facts of reality, but normatively guide our decisions and behaviors" (Silva 2020, 95).

Silva presents a non-metaphysical view of logic, while also resisting a skeptic view towards logic.

> The emphasis needed to make logical revision possible, without identifying logical activity with a metaphysical activity, should not be put in the investigation of a deep or hidden law of nature or reality, but in an equilibrium of human practice based on complex social and linguistic interactions (...) It is a false dichotomy to think that the nature of logic has as foundational either arbitrary rules of empty symbolic manipulation or on the ultimate reality of things. (Silva 2020, 89)

Precisely at this last point, Silva's view of logic is a reply to Agrippa's trilemma, as he seeks to make logical revision neither arbitrary, nor circular, nor lead to an infinite regress of justification. It is worth pointing out that while both Silva's and Dutilh Novaes' views are anti-realist, their respective accounts differ on what logic is normative for. While for Silva logic is normative for public everyday discourse (in this Silva seems to agrees with Prawtiz), for Dutilh Novaes logic is normative only for very specialized dialogues.

Still on the issue of the normativity of logic, it is worth mentioning that within Peirce's classification of heuretic sciences, he includes logic as a normative discipline, on par with ethics and aesthetics (which fall under the class of Philosophy, as distinct from both Mathematics and the Special Sciences) (Burch 2021).

These alternative accounts presented do not depend on the description of logical facts or on an explanation of some kind of evidence to account for logic. A logical theory becomes canonical through a contingent process of human history. It seems that the logical abductivist's account of evidence is not needed to make sense of logical theorizing and logical practice. Anti-exceptionalism might benefit from allowing non-foundational approaches to theory revision to fall under its scope. The analogy between logic and science might have been heuristically useful, but one should not

be bewitched by it. With these wheels set in motion, the next section presents a new definition of anti-exceptionalism.

4.3 Towards a new definition of anti-exceptionalism

Given that anti-exceptionalism attempts to supplant the place of rationalism and semanticism in epistemology of logic, it is fair to ask if it is up to the task. The current thesis has so far argued that anti-exceptionalism is in a precarious position (both regarding the methodological issues of logical abductivism and the ontological commitment of anti-exceptionalism), and perhaps the answer to this is "no, anti-exceptionalism does not fare better than the previous alternatives". This section presents a new definition of anti-exceptionalism, such that, even though it is a more encompassing view that does not cut the current epistemological scenario neatly, it makes sense of theory revision in logic.

The proposal herein is that anti-exceptionalism should be defined in terms of rational theory revision in logic, rather than in affinity with science.[73]

> **Definition.** *Anti-exceptionalism about logic* is the view which takes logical theories to be rationally revisable.

No account of logical ontology needs to be declared or presupposed, no particular method of revision needs to be indicated.

Last chapter claimed that it is a methodological problem for logic to claim that "logic is a science"; in proposing a novel definition there is a similar but opposite threat, which is to miss the mark and define anti-exceptionalism as too different a view than the current proposal. This is not the case. The definition keeps within Quine's intentions (presented in section 1.3): logic and science are not different kinds of disciplines, logic is revisable, the method of revision of logic is not exceptional, and neither is the kind of evidence which prompts this revision. This definition also attempts to account for logical knowledge in a way that is neither dogmatic, nor

[73] Some views of science hold that not even science is rationally revisable; see Feyerabend (1993).

circular, and not leading to infinite regress.

The definition is philosophically interesting because it allows to differentiate logical anti-exceptionalism from logical abductivism. This section argues: *first*, that this definition is adequate in terms of the many issues raised regarding the anti-exceptionalist project; *second*, that this definition makes sense of logical rationalism and semanticism; *third*, that many of the views so far exposed (and some which are still to be presented) fall within the scope of this definition; and *fourth*, that other views within logical epistemology do not to fit this label.

First, to recap, Chapter 1 presented anti-exceptionalism as a view which seeks better to account for disagreement in logic as well as to offer an account of theory revision. Chapter 2 presented the "logic in the background problem" and a problem regarding evidence in logic. The new definition of anti-exceptionalism proposed herein is suitable for clarifying these issues. Theory revision can be obtained in terms of different methods; disagreements naturally arrive from such revision; the "logic in the background problem" and the problem with selecting adequate evidence are suspended and solved differently by each methodology.

Second, regarding rationalism and semanticism, these labels become obsolete, inasmuch as anti-exceptionalism makes claims about theory revision and not explicitly about the source of logical evidence. So while a rationalist such as Bonjour might be counted as an anti-exceptionalist, since he accepts the fallibility of intuitions, others such as Frege and Wagner will not be anti-exceptionalist (which is to their liking). Semanticism might also allow for theory revision: change of language, change of logic. Such revision need not be, however, rational, unless one is engaged in "conceptual engineering". Some versions of semanticism can plausibly also be anti-exceptional.

Third, the proposed definition fits with many of the views presented so far: Quine's holism (section 1.3), logical abductivism (section 2.2), Prawitz's (2007) view (section 4.1, Dutilh Novaes' (2015) dialogical conception of logic (section 4.2), Silva's (2020) neo-pragmatist view (section 4.2), Resnik's (2004) non-cognitivism about logic (section 5.2 below), Read's (2019) take on anti-exceptionalism (section

5.1 below), Martin and Hjortland's (2020b) predictivism (section 3.2), as well as with the Lakatosian version of anti-exceptionalism both in science (section 3.2) and mathematics (section 5.1 below). While these views diverge widely regarding the evidence and the method which elicit theory revision, each of them proposed that logic is rationally revisable and presents guidelines of how such revision might happen or has already happened.

Fourth, it is worth discussing views which are not anti-exceptional. The views considered here are: logical pluralism, instrumentalism about logic (the denial of a canonical application), and the naturalist project of Lorenzo Magnani (2015).

Logical pluralism is incompatible with logical abductivism. For the same reason (namely, that pluralists do not revise logic, but rather accept more than one logic as correct), this view is incompatible with anti-exceptionalism. Instead of putting forth an argument of why one logical theory is better than another, pluralists take it that more than one logic is correct. Perhaps for them theory revision comes in the shape of allowing more logics to fall within their pluralism, or removing some logic from their set of available theories. Perhaps such selection is also rational, but it is not so in the sense proposed so far.

Instrumentalism about logic is the denial of anything like a "canonical application" for logic. Logic can only be applied in specific domains for instrumental use. Such a view falls outside the scope of the proposed definition, because the kind of theory choice for specific application is pragmatic, and not related to theoretical development.

Logic could, of course, in principle be rationally revised by a logical instrumentalist or pluralist. Yet this would not amount to the same sense of revision. For instance, J.C. Beall and Greg Restall (2006) set out three different logics within their pluralist view of logic (classical, intuitionist and relevant logic), given what they take logical consequence to be (it must be necessary, normative and formal). It is one thing to revise logic within their framework (for example, by changing their favorite relevant logic), and quite another thing to revise their whole scheme in favor of logical monism. Although the former is only a case of revising a logical system

(and not logical theory), the latter, while it does involve revising a logical theory, would come at the cost of claiming their own definition of logic was downright wrong (which seems unlikely), or that the disagreement comes from divergence of meaning about what "logical consequence" is. These two cases would not amount to rational theory revision.

Magnani (2015) explores how one might naturalize logic, and rejects both the approach of reflective equilibrium and that of mathematical logicians in trying to account for reasoning. His approach returns to Peirce's abduction and proposes to naturalize logic in terms of the cognitive sciences. The fact that humans do not reason well deductively is simply because deductive logic is not the correct logic to understand reasoning (a similar point was discussed in section 4.2). No deductive logic will account for reasoning, because reasoning is fallacious and this is due to cognitive makeup of "beings like us". Logic is not to be revised to avoid paradox and fallacies. This is the wrong project in which to be engaged.

> Mainstream logic is clearly historically related to conscious and propositional thinking and it seems to disregard the subconscious and prelinguistic levels of thinking. This fact leads to the following dilemma: rules of logic are thought of as having something to do with how human beings actually think as practical agents, then by and large they are too complex for conscious deployment. On the other hand, unconscious performance or tacit knowledge is a matter of certain things happening under the appropriate conditions and the right order, but it is unlikely to suppose that this is a matter of following rules (an inclination which seems embedded in a considerable part of contemporary computer science). (Magnani 2015, 18)

The dilemma can be clarified by naturalizing logic, but not within the confines of deductive logic, whose rules of inference can account only for very specific cases of reasoning.

Given the rejection of deductive logic as the correct account for human reason-

ing, Magnani proposes to adapt Peirce's abduction to deal with everyday reasoning (and not only scientific theory development). It should be clear that this project of revision is not one that falls within the scope of the proposed definition of anti-exceptionalism.

Still on the topic of naturalistic views of logic, it is worth pointing out that similarly to rationalism, depending on how theory revision is proposed, it might or might not amount to an anti-exceptional view. On its own, the "naturalist" label is unhelpful to adjudicate the revisability of logic: while Quine is both a naturalist and also an anti-exceptionalist, Magnani is a naturalist but not an anti-exceptionalist. While "rational revision" would always fit a naturalist account of logic, depending on the account of logic adopted, it could be that a view would fall outside the scope of anti-exceptionalism. Rational revisability, while a necessary feature, is not on its own enough to define anti-exceptionalism.

Another naturalist anti-exceptionalist is Penelope Maddy (2002). For Maddy (2002), to revise logic would take "more than observation and experiment; it would take a revision of our most basic ways of thinking" (Maddy 2002, 78). Similarly to Magnani, revising logic would amount to revising rationality itself. Maddy talks about "knowers like us": "any discursive intellect, whatever its forms of intuition, is required to judge by these forms, and thus is bound by the laws of logic as inevitable patterns of its mode of thought" (Maddy 2002, 67). Given that logic is naturalized, will not be easily revised, and any change that might occur will not be by rational process, as it would go against the rational standard in place. Yet, for her, there is a sense in which logic, in the sense of the deductive theory which governs discursive intellect, can be revised (in this point her view differs from Magnani). Classical logic, as the current appropriate theory, relies on some linguistic extensions (to get the stock of logical connectives), idealizations (such as bivalence and truth-functional conditional) and assumptions about the domain of logic (the domain is non-empty and well-behaved), such that it is conceivable that given different idealizations and assumptions, logic might come to be revised.

To define anti-exceptionalism as the view which seeks to "naturalize" logic would

be an even broader (and much more ambitious) definition. The definition proposed in this section seems to "cut" the realm of possible theory revision in an appropriate way, such that the method of rational theory revision becomes the most interesting aspect of the view, and not the mere fact that logic can be revised. The fact that some projects do not fall within the scope of anti-exceptionalism should be taken as indication that the proposed definition is not too broad.

In summary, this section proposed a new definition for "anti-exceptionalism about logic" in terms of rational theory revision in logic, and it was argued that this definition characterizes the current scenario of the epistemology of logic in an interesting way. This definition does not get into particular ontological or methodological issues, since it does not advocate a particular method of theory revision.

While the old definition of anti-exceptionalism (from Martin and Hjortland (2020a)) looks something like this:

| Rationalism | |- - - - - - - - Anti-exceptionalism - - - - - - - - - -| | Semanticism |

The new definition proposed herein is this:

<< more foundational views			more non-foundational views >>	
Rationalism, naturalism	Abductivism		Semanticism	Nihilism

|- - - - - - - - - Anti-exceptionalism - - - - - - - - -|

Beyond logical abductivism, then, there are plenty of views which advocate for rational theory revision in logic. While logical abductivism makes perfect sense as a method of theory revision for some views which fall under the scope of realism about logic, there are other rational methods of theory revision which do not carry the weight of such realism (and might yet carry a different baggage). The next chapter explores two such methods: proofs and refutations, and reflective equilibrium.

5 Piecemeal approaches

The previous chapter has explored the issue of the normativity of logic related to logical abductivism and proposed a new definition for anti-exceptionalism, allowing for any method of rational theory revision, and not only ones deemed fit for science. The current chapter presents two methods of theory revision and argues that these are fit for logic. Both methods can be grouped under the label of "piecemeal approaches" (following the terminology of Woods (2019b)), and while not being "scientific", they are nonetheless rational. These two methods revise a current theory step-by-step instead of aiming at a total revamp (such as in the whole-theory comparison methods of revisions, such as logical abductivism).

The first method is that of Lakatos in *Proofs and Refutations* (1963a, 1963b, 1963c, 1964)[74] as a method for theory revision in mathematics. The second, reflective equilibrium, is defended in logic most notably by Prawitz (2007) and Resnik (2004), by borrowing a method of revision for normative disciplines. For both these views, in order to revise a theory, one must tweak the currently accepted theory in a series of changes guided by trying to match the theory to informal "intuitions". While in whole-theory comparison, two theories are directly compared in light of a given set of criteria; in the piecemeal approach, there is no other theory to compare with the current one, small changes being made to the current theory and its consequences analysed and further corrected. More importantly, what "guides" the revision is the practice of a community, instead of truth or empirical adequacy, which are external to the practice. In piecemeal approaches to revision, there is no end goal to revision;

[74] The original material was published between 1963-1964 in *The British Journal for the Philosophy of Science*, and later published as a book. The references herein will be to the series of articles.

theories are, and will remain, constantly changing. It is not the aim of this chapter to endorse any particular method, but only to propose that they are plausible methods of revision for logic.

5.1 Proofs and refutations

Lakatos' view of science, which was presented in Chapter 3, already showcases a piecemeal aspect of theory revision. While it is possible to compare whole theories (or rather, "research programs"), within a single research program theory revision is piecemeal. That is, the theories within the research program progress by changing some theoretical aspects to fit the new data, but also by excluding new data, when the cost of theoretical revision is excessive. Even though it was argued in Chapter 3 that Lakatos' sophisticated methodological falsificationism is not a good fit for logic, this was not because of the "dynamic" aspect of theory revision, but rather because of the kind of "data" upon which scientific theories rely. Lakatos' method of revision of mathematical theories is very similar to his method of scientific revision, but relies on a different kind of data, as mathematical data is not empirical.

It is especially worth considering Lakatos' view on mathematics when parsing the issue of the demarcation of logic, because logic and mathematics can be said to be similar in many relevant senses. Priest and Thomason (2007) and G. Russell (2018b) have already explored some of the aspects of Lakatos' view as it relates to logic. When explored in more depth, the similarities are even more useful to the discussion of theory revision in logic.

This section investigates the proposal that logic is revised as in mathematics, through a constant process of proofs and refutations. Chapter 3 has argued that Lakatos' method for the sciences is not a good fit for logic, specifically on account of the kind of falsifier needed to refute scientific theories. The falsifiers of the method of mathematics, however, are appropriate for logic. A similar view has already been briefly discussed by Stephen Read (2019), who argues that logic is as *quasi-empirical* as mathematics, that is, "[m]athematics and logic may both be *a posteriori*, but it

does not follow that they are empirical" (Read 2019, 298).

Read notes the importance of distinguishing the empirical from the *a posteriori*, and argues that the sense of *a posteriori* applicable to logic (as to mathematics) is the pre-Kantian term, used by Aristotle and the medievals. This sense is recovered by Lakatos, who

> introduced the term 'quasi-empirical' to capture the fact that mathematics, in its actual practice, did not consist simply in deriving theorems from axioms and first principles (what he dubbed the "Euclidean model") but had to argue for those first principles, and indeed, motivate the very concepts involved, by a dialectical process of proof coming up against refutation, daring speculation challenged by dramatic counterexamples and criticism. (Read 2019, 302)

Read notes that the sense of abduction that is more appropriate in the discussion of logic is Peirce's original sense of creating hypothesis,[75] which is close to Aristotle's "distinction in his *Posterior Analytics* between demonstration *why* something obtains and demonstration simply *that* it obtains" (Read 2019, 300), which is in turn similar to Lakatos' methodology in mathematics. Counter Williamson,[76] Read argues that logical truths do hold in virtue of meaning (and thus logic is analytic in a particular sense), but agreeing with Williamson, he holds that its methodology is falabilist, as in science and mathematics. This section discusses Lakatos' methodology of mathematics in more depth and how it relates to logic.

Lakatos' aim in *Proofs and Refutation* is to present an alternative to both a dogmatist and a skeptical view.

> The dogmatists hold that by the power of our human intellect and/or senses — we can attain truth and know that we have attained it. The sceptics on the other hand either hold that we cannot attain the truth at all (unless with the help of mystical experience), or that we cannot

[75] Rather than the sense of IBE, which has been introduced in Section 2.1.
[76] Williamson's view has been presented in Section 2.2.

> know if we can attain it or that we have attained it. In this great debate, in which arguments are time and again brought up-to-date, mathematics has been the proud fortress of dogmatism. (Lakatos 1963a, 6)

His aim reflects well the position of logical anti-exceptionalism from Chapter 1, which proposes that neither rationalism nor semantics is the correct view of logic. Lakatos intends to show that mathematical knowledge is not built "through a monotonous increase of the number of indubitably established theorems" (Lakatos 1963a, 6), but rather through a continuous process of proofs and refutations. It is the proposal of this section that the method proposed by Lakatos is a kind of piecemeal theory revision, one which is also suitable for logic.

Lakatos presents, through dialogue format (taking place in a classroom, between a Teacher and many students), a rational reconstruction of Euler's Theorem concerning polyhedra. The reconstruction starts from a problem, a conjecture and a proof.

Problem. Is there a relationship between the number of faces (F), vertices (V) and edges (E) of polyhedra, which might enable one to classify them as regular in a similar way that one can use edges and vertices to classify polygons?[77]

After some trial and error, one might come up with this:

Conjecture 1. For any polyhedra, $V - E + F = 2$.

The Teacher then proposes a proof:

Proof. (Step 1) Imagine a hollow polyhedra, such that it can be flattened if one face is removed (fig. 1 flattens a cube). If $V - E + F = 2$ holds for the original polyhedron, when $V - E + F = 1$ holds for the flattened version. (Step 2) Triangulate the flatted polyhedra (if needed) by drawing diagonal lines between two vertices (fig. 2). This will increase F and E by the same amount, so $V - E + F = 1$ still holds. (Step 3)

[77] Polygons can be classified in terms of the number of edges or vertices, such as: triangles, quadrangles, pentagons, etc.

Remove a triangle one by one. This can be done in two ways. If an edge is removed, then so is a face (fig. 3a). If two edges and a vertice are removed, then one face also is removed (fig. 3b). And so if $V - E + F = 1$ held before a triangle was removed, it still holds afterwards. For the last triangle, $V - E + F = 1$ also holds. $\square$

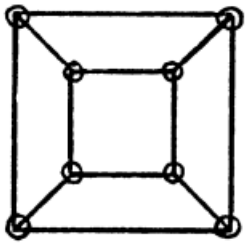


FIG. 1

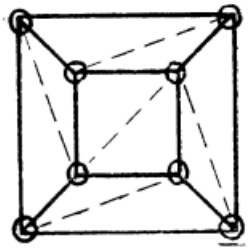


FIG. 2

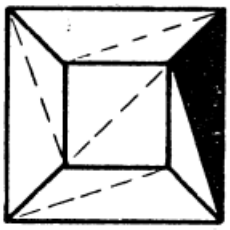


FIG. 3*a*

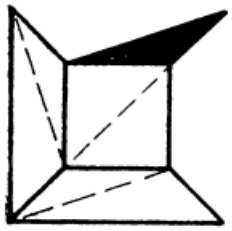


FIG. 3*b*

Having presented this proof, a pupil proposes to call this a Theorem, and not just a Conjecture. Other students, however, raise questions about the procedure, highlighting four lemmas of the proof:

> [A]re you sure, Sir, that any polyhedron, after having a face removed, can be stretched flat on the blackboard? [...] Are you sure that in triangulating the map one will always get a new face for any new edge? [...] Are you sure that there are only two alternatives — the disappearance of one edge or else of two edges and a vertex — when one drops the triangles one by one? [...] Are you even sure that one is left with a single triangle at the end of this process? (Lakatos 1963a, 9-10, emphases removed)

The Teacher says he is of course not sure. These four lemmas might be challenged by counterexamples, and need to be reformulated. For instance, it is possible to remove a triangle from within the flattened polyhedra, and thus remove a face without

removing any vertices or edges. Thus the third lemma of the proof is false. This does not point to the whole proof being false, if the proof can be improved upon.

Counter-examples are of two kinds: local and global. The local counterexample refutes a lemma (and thus the proof), while a global one refutes the main conjecture (but not the proof). Local counterexamples show that the proof does not prove the conjecture, while still allowing for the conjecture to be true. Local counterexamples thus allow for one to "improve the proof, by replacing the false lemma by a slightly modified one, which [the] counter-example will not refute" (Lakatos 1963a, 12). Global counterexamples show that the proof does not prove what it set out to do, but the proof might still hold for another domain.

A global (and not local) counterexample to Conjecture 1 are "nested cubes – a pair of cubes, one of which is inside, but does not touch the other" (Lakatos 1963a, 14) (fig. 5). In this example, if a face is removed, the figure cannot be flattened, and the proof does not apply. Another counterexample is "a star–polyhedron–I shall call it urchin" (Lakatos 1963a, 18) (fig.6), for which the conjecture is also false. In the face of counterexamples of this kind, different responses might be considered, such as the method of surrender, the method of monster-barring, the method of lemma-incorporation.

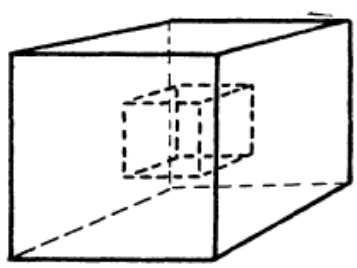


Fig. 5

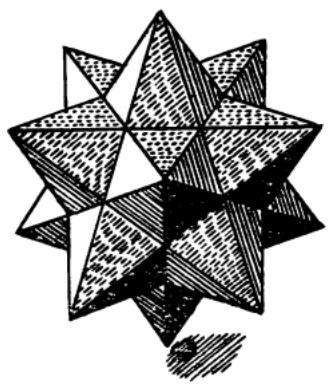


Fig. 6

The method of surrender is simply to take the counterexample very seriously, give up on the conjecture and consider it false. The method of monster-barring is to say that the counterexample is not a polyhedra, it is a monster and should be

ignored, and thus maintain that the conjecture is true. None of these seem very appropriate responses. A further possible response is lemma incorporation.

> Lemma incorporation involves giving a detailed proof of the original conjecture, and then seeking out the assumption—or lemma—that fails in the case of the monstrous counterexample. This assumption is then incorporated into a new statement of the conjecture. (G. Russell 2018b, 319)

In this response, the naive conjecture turns into a proof-generated theorem. One might fix a lemma, such as Lemma 3 (in the questions raised by the students above), where one might describe better the procedure of removing triangles from the outer rim first; or by adjusting of the domain of the conjecture, for instance, by defying polyhedra in some way (such as to say that the only objects that can be called polyhedra are those that can be stretched out on a plane). As such, the counterexample leads to the definition of "Eulerian polyhedra", which are those which respect the original conjecture.

This culminates in the method of proof-analysis. The improvement of the original proof either by local counterexamples or refining concepts by global counterexamples. Priest and Thomason (2007) and G. Russell (2018b) already employed this method to solve other issues in the philosophy of logic. The first uses Lakatos' notion of proof, in particular the circumstance that proofs are fallible, to propose that "paraconsistent logic allows for the recognition of a whole new mathematical realm, ripe for mathematical investigation" (Priest and Thomason 2007, 98); the later uses the method to argue against logical nihilism, to the point that the counterexamples to logical laws presented by logical nihilists should be used to improve logic by lemma-incorporation, not to be surrendered to (as presented in section 4.1.2).

Priest and Thomason's (2007) and G. Russell's (2018b) accounts of proofs and refutations stops at the point where it is established that proofs are not final and are fallible. For their purpose, perhaps such is enough. Lakatos' account, however, gets into much deeper issues, such as the meaning of terms, the infinite regress

of definitions, and the nature of mathematical growth. Piecemeal engineering of proofs is just the first interesting takeaway from Lakatos' view. In particular, Lakatos himself later points out the shortcomings of this simplistic view (Lakatos 1963c, section(d)).

Beyond these initial responses to global counterexamples, other possible responses are the methods of exception-bearing, of strategic withdrawal and of monster adjustment. What each amounts to is beside the point. All of which is to say that there is no such thing as a perfect proof; the rigor of proof analysis is unattainable and the method of proof-analysis is never finished. In the dialogue, the characters go on presenting many counterexamples to different proofs, conjectures and definitions. From one naive conjecture, different proofs lead to different theorems. While the naive conjecture was about polyhedra, the theorems which are elaborated in the rational reconstruction are, for example, about Cauchy objects, Geronnian objects and Legendrian objects.

Concept-stretching is another theme which is of interest to the proposed parallel with logic. Lakatos presents in a passage three different projects that a mathematician might work on. *First*, the aim of inquiry is to find out the "the domain on the naive conjecture" (Lakatos 1964, 296). *Second*, the aim of inquiry is "to discover the domain of truth of $V - E + F = 2$" (Lakatos 1964, 296). *Third*, the aim of inquiry is "to discover the secret of Eulerianness" (Lakatos 1964, 297). Parallels among these three aims appear within logic.

G. Russell (2018b), in using lemma-incorporation to resist logical nihilism, presented the following example. Take the naive conjecture of $\models \varphi \vee \neg\varphi$ (Law of Excluded Middle), and the following proof:

φ	$\neg\varphi$	$\varphi \vee \neg\varphi$
T	F	T
F	T	T

Logical nihilists then present the following counterexample from Strong Kleene Logic:

φ	$\neg\varphi$	$\varphi \vee \neg\varphi$
T	F	T
F	T	T
N	N	N

This counterexample shows that the hidden lemma of "all atomic sentences are only ever true or false", which lesson needs then to be incorporated into the conjecture, giving rise to the theorem: For all bivalent φ, $\models \varphi \vee \neg\varphi$.[78] This example would be akin to "discovering the domain of $V - E + F = 2$" (that is, discovering the domain in which $\models \varphi \vee \neg\varphi$ holds), but it does not improve upon the notion of validity, for example, since the meaning of "valid argument" does not change.

Another logic that resists the Law of Excluded Middle is intuitionistic logic. Starting from the same naive conjecture, $\models \varphi \vee \neg\varphi$, and being presented the following proof, offers a different reply to its rejection:

Proof. Suppose that $\varphi \vee \neg\varphi$ is false. Then both φ and $\neg\varphi$ are false, and if $\neg\varphi$ is false, φ is true. But this cannot be, since φ was already found to be false. Thus $\varphi \vee \neg\varphi$ is true. □

Intuitionists resist the use of the first step of the proof, to the point that the relation $\models$ between formulas cannot be established via *reductio ad absurdum*. There is a disagreement in the meaning of validity that cannot be easily fixed by lemma-incorporation. Intuitionists do not accept as valid some arguments established by certain classical proof steps. One way that classical and intuitionistic logic can be consolidated is by using a multi-conclusion sequent calculus, where a structural restriction (at most one formula on the right-side) can be used to define intuitionistic logic (Restall 2004), while classical logic uses no such restriction. This approach is akin to "trying to find the relation of F, E and V", that is, better understanding the relation between $\vee$, $\neg$ and $\models$. In this simple example, the same naive conjecture about the truth of LEM led to different developments within logic, as there is no unique response to a conjecture or proof.

[78] One could think that this amounts to changing the domain of logic, but this is not the case. It just means that there is a lot that fits under "logic" without being just "logic by similarity" (such as what logical rationalists might deem "non-classical logics").

Another case of the "proofs and refutations" method at work in logic includes Alfred Tarski's hierarchy of truth as a response to the Liar paradox, after which new avenues of inquire opened and hierarchies of truth become embedded in logical practice as we know of today. Read (2019) also presents the case study of how "the problem of the two Barbaras" from Aristotle's account of modal logic increased understanding of modality.

Yet the deeper disagreement in logic of interest to the logical abductivist is that of "discovering the secret of Eulerianness", that is, the secret of Validity. If the parallel between Lakatos' view of mathematics and the proposed Lakatosian view of of logic, this latter project is not particularly adequate, unless one had,

> fallen in love with the problem of finding out where God drew the firmament dividing Eulerian from non-Eulerian polyhedra. But there is no reason to believe that the term 'Eulerian' occurred in God's blueprint of the universe at all. (Lakatos 1964, 298)[79]

There is also no reason to believe that the term "valid argument" occurred in "God's blueprint of the universe". The best the logician can do is explore the domains of proofs and stretch concepts within logic: to find the domains of different "valid-in-L" theorems, to develop frameworks in which the logical relations of interest can be showcased, and to propose new definitions which make sense in these contexts.

As a bonus, Lakatos' view suggests a further criticism of IBE as used by logical abductivists. He says that "[f]acts do not suggest conjectures and do not support them either" (Lakatos 1963a, 303).[80] Inquiry starts from the naive conjecture, and

[79] This passage and the subsequent discussion are taken herein as suggesting that Lakatos held an anti-realist view of mathematics. Steiner (1983) offers an interpretation of this same passage in which Lakatos is taken to be a concept-realist. It is not the aim of this discussion to adjudicate the issue. It makes no difference for present purpose if Lakatos was a realist or not, since the method of theory revision he presents does not depend on this ontological assumption. The aim of this chapter is to propose "non-abductive" methods of theory revision for logic, and not explicitly anti-realist ones.

[80] This point where Lakatos criticises starting from "facts" is part of a longer criticism where he talks about "the myth of induction". It makes sense that this would work as a criticism against IBE, since IBE is explicitly an attempt to "improve" scientific induction, as presented in Section 2.1.

not from any "data". So while the logical abductivist might be right in that data might suggest a logical theory, the interesting aspect of logic would be to use proofs and refutations to stretch the concepts within logic in different, fruitful ways, and not simply "choose" the best naive conjecture one might come up with. The initial conjecture will probably not be very good, what is interesting are the definitions, proofs and theorems that will sprout from the method of proofs and refutations.

> If you have too much respect for facts, especially when they refute your conjectures, you will go on with pre-naive trial-and-error and look for another conjecture. But if you have a better heuristic, you at least try to ignore the adverse observational test, and try a test by thought experiment. (Lakatos 1964, 304)

For Lakatos, the interesting aspect of theory formation is not the initial conjecture which fits the facts, but rather how the conjecture can be improved upon. It is in this sense that it is a piecemeal approach, rather than comparing theories as a whole. Lakatos' view is thus incompatible with logical abductivism.

Granting a point to abductivism about logic, mathematics and science are very similar, inasmuch as

> both are characterised by conjectures, proofs, and refutations. The important difference lies in the nature of the respective conjectures, proofs (or, in science, explanations), and counter-examples. (Lakatos 1964, 304)

While in science the falsifiers of a theory are empirical, in mathematics, they are heuristic.[81] When associating logic and science, anti-exceptionalism would be better served by comparing logic to mathematics. This would amount to the same view, however, if one held that logic is empirical in a strong sense, such as, for example, Williamson, who holds that logic is about everything.

[81] While starting out using local and global counterexamples, Lakatos argues in the end that both are heuristic, and there is not much difference between them, since both contribute to the growth of knowledge.

The final discussion of *Proofs and Refutations* is about how to strike a balance between linguistic precision and growth of knowledge: "[a]s knowledge grows, languages changes" (Lakatos 1964, 324). While "refutation by counterexamples depends on the meaning of the terms in question" (Lakatos 1963a, 18) and there needs to be some point where there is agreement on the terms, this cannot come at the expense of halting the development of mathematics. After all, "[g]ibberish is safe from refutations, meaningful propositions are refutable by concept-stretching" (Lakatos 1964, 333). "[M]ild concept stretching is [...] a most important vehicle of mathematical growth" (Lakatos 1964, 336).

Concepts are also stretched in logic. The meaning of "conditional" has broken apart, and now there are as many implications as there are arrow symbols in LaTeX. While it used to be that logic was a discipline which sought after "logical truths", now it is a discipline more interested in the relationship between premises and conclusion, that is, validity. More of interest to anti-exceptionalism, the concept of validity itself, such as from Tarskian validity to substructural validities, has also been stretched. These concepts were stretched not in an arbitrary way, but in light of proof, refutation and meaning change, especially once there were enough technical tools to make sense of these different meanings.

While Lakatos presents a piecemeal approach to theorem revision (in the mathematical sense of improving upon the proof of Euler's theorem), the proposal of this section has been that logical theories (in the anti-exceptionalist sense) can also be improved by the same method, of using counterexamples to improve logical theories (such as in the example of G. Russell), but also to improve the concepts used within the discipline. In the view proposed herein logic is revisable, and there is a method to do so. This section argued only for the plausibility of "proofs and refutations" as a rational method of theory revision for logic, not for its endorsement. Next section presents another unrelated and also plausible method: reflective equilibrium.

5.2 Reflective equilibrium

Reflective equilibrium is a method of theory revision in the context of revision of normative theories. It was originally presented by John Rawls (1971) in *A Theory of Justice*, though a similar method was already presented in logic (not under this name) by Nelson Goodman (1955) in "The New Riddle of Induction". It has also been defended by Prawitz (2007) and Resnik (2004). Prawitz's view has been laid out in section 4.1.2 above to argue how such a method is adequate for logic, since there can be a rational debate about the correctness of logic. Here, the method of theory revision is presented for its own sake.

The general idea of reflective equilibrium is that there is a dynamic between a currently accepted theory and a new insight, such that, through small steps of revision, the theory comes to accord with these insights. While there is no "ism" that goes with the defense of this method, it is rather defended separately by different people. This method fits with slightly different views of logic, albeit perhaps all explicitly anti-realist ones (such as those presented in Chapter 4).

In what follows, Resnik's account of reflective equilibrium is presented, with support from Prawitz (2007) when needed, and the method will be criticized mainly through Woods (2019b).

The method of reflective equilibrium consists in bringing "theory" and "data" into equilibrium, that is, balancing the inferences permitted by the logical theory and the data (evidence) which must be accommodated, in successive steps of adjustment. Such data can be both normative (related to inferential practice) and metaphysical (related to intuitions).

> For a case where intuitions play a major role, take the common view among logicians that no formalism should count 'There are at least two individuals' as a logical truth. Some logicians base this upon the normative intuition that our inferential practice should not in itself decide questions of existence. While others appeal to the metaphysical intuition that there could be a universe containing fewer than two individuals, and

> some may appeal to both intuitions. (Resnik 2004, 181)

From this data, a logician makes up a logical theory, which consists in "a formal system, a semantics for it, an attendant metatheory and a translation method for formalizing informal arguments" (Resnik 2004, 180).

Such an initial proposal will not always be satisfactory, for it is possible that the logical theory produced involves some unforeseen and undesirable logical relationships, or again it might be that the system does not capture the initial intuition but shows itself to be too elegant to be discarded. In the first case, the theory needs to be changed to fit the data, and on the second, one might reject the data and keep the theory.

> The process comes to at least a temporary end when the logicians reach a state of 'reflective equilibrium', that is, one where they take their theory to reject no putative fact of logic that they are determined to preserve and to countenance none that they are determined to reject. (Resnik 2004, 181, emphasis removed)

The process of logical revision is thus a back-and-forth between theoretical and evidential considerations until an equilibrium is reached. The logical theory which comes out of this process might not be totally satisfactory for both sides, such that if given new evidence or new theoretical issues, the process continues until a new equilibrium is reached.

Of course any attempt to revise logic has to deal with some version of "the logic in the background" problem: how to revise logic if logic is used for such revision. Resnik is quite aware of this problem, and, moreover, is not satisfied with Quine's naturalistic answer to the problem. To avoid the version of the problem faced by Quine, Resnik takes "a non-cognitive (or non-factualist) approach to normativity, so that in the cases in question there is nothing to know, and no normative epistemological knowledge to naturalize" (Resnik 2004, 185). Rejecting Quine's approach,[82] Resnik attributes the normative force of logic to the practice of a community.

[82] While this is a point in which Resnik disagrees with Quine, it is also one in which logical

> If many members of a culture or at least enough of its influential members engage in an initially deviant conduct, the culture's norms may change to legitimate the conduct. This goes for methodology as well as for language and morals. (Resnik 2004, 186)

The revision of a normative system starts from the deviant behaviour on the part of some members of the community, generating new intuitions which further propel the system into reflective equilibrium. On this view, logic is anti-exceptional among the normative disciplines (as was defended by Prawitz (2007) in Chapter 4 above).

In logic,

> [j]ust as we carry out this practice largely without thinking, we also revise it largely without thinking. We simply no longer accept specific inferential connections or, more frequently, we recognize new ones. Like changes in a language certain inferential practices may slowly and quietly become obsolete and new ones may unceremoniously evolve. (Resnik 2004, 189)

One practice might split into two, for example, the so-called Classical Logic and intuitionist logic nowadays constituting different practices, but both come from the same lineage. In this specific case of revision, intuitionist logic did not come about through a random change in inferential practice, but rather reflectively through a specific intuition. In general, when logicians propose changes, they don not do so completely freely, but only when there is a reasonable proposal for the solution of a tension in the current theory, that is, when there is a principled proposal of revision. In the case in question, for some there was too much tension between the theory of classical logic and the intuition (the data) that proofs should be constructive.

One worry is that the adjustment between theory and data is not univocal.

> [G]iven that there may be no uniquely optimal way of responding to intellectual problems whether they be in science or elsewhere, it is very likely

abductivists agree with him. The connection between abductivism and normativity has not been well delineated. Priest's view is presented in section 4.2.

> that revising inferential connections will be controversial. There seems to be no way of predicting when this sort of option will be attractive. (Resnik 2004, 190)

Since a proposal of revision goes against the grain, it will be rare that it occurs. This seems compatible with the way logic has been revised, especially considering that the revision is not of the instrumental use of logic, but of logic as a "canon of implication" (Woods 2019b).

For Resnik, then, the logic in the background problem is not an explicit problem, as it is for logical abductivism. Given the normative role Resnik takes logic to have, there is already a background logic in place. Resnik takes logic to be methodologically *a priori*, given its role in scientific practice. This notion of *a priori* is weaker than the traditional one. Given that empirical considerations may lead to the revision of current methodology, such methodology is not immune to revision on non-empirical grounds.

> Although it is difficult to see how a methodology for empirical theory testing can proceed without recognizing some fixed points, some *apriorities*, this doesn't mean that in developing a methodology or in discerning the so-called facts of logic we must depend upon *apriori* elements that transcend any methodology. (Resnik 2004, 184)

This is because:

> Instead of maintaining that we acquire norms through *apriori* means, I hold that we find ourselves with a collection of culturally conditioned norms and values, which we may or not modify in the light of experience, arguments, and changes in our condition. (Resnik 2004, 185)

As such, the revision of logical theories is given through empirical evidence, in the "anti-exceptionalist" fashion. Even though Resnik does not label his view as such

(and Woods rejects the method of reflective equilibrium as fit for anti-exceptionalism), it is perfectly plausible that he be considered an anti-exceptionalist.

Since Resnik (2004) holds logic to be normative, the question of the status of his view as anti-excepcional is warranted,[83] yet after Chapter 4 it need not be bothersome. Since Resnik's view holds logic to be not only revisable, but empirically and rationally so, it falls within the new proposed definition of anti-exceptionalism. This demarcation counters Woods' (2019a) position, which does not accept this method in his definition of anti-exceptionalism.

There are two problems raised by Woods (2019b) against the reflective equilibrium method of theory revision for logic. The first he calls "the degrees of freedom problem", by criticizing the open-endedness of the revision process; the second is the unsuitability of the method for an anti-exceptionalist position.

Woods claims the degree of freedom problem was raised originally by Crispin Wright as part of his criticism against Quine's views on logic, and was then refined by Shapiro (2000) in his criticism of Resnik (1999). The version presented herein follows Woods' presentation.

Woods (2019b) argues that this method of theory revision is too permissive in how logic is revised. Such liberty is available for reflective equilibrium because it both "(a) allows significant freedom in how to revise and (b) uses a logical theory to assess the reasonableness of various repairs" (Woods 2019b, 320). Given this liberty, a kind of guidance would be necessary, but this cannot be offered without abandoning anti-exceptionalism.

Wood presents reflective equilibrium in terms of *coherence* between data and theory, such that an equilibrium is reached when a prediction is in line with the considered data and when there is *confirmation* of the data by the theory. Woods then points out that any definition of the terms used by him (highlighted in italics above) presupposes an underlying consequence relation, which is just the logic in the background problem again. While such terms are usually considered fixed, when

[83] Hjortland and Martin (2019) indicate "normativity" as a characteristic of logic under exceptionalism.

revising logic, these are exactly the terms apt for revision.

Woods presents the view that there are too many options for how to augment the coherence of a theory given some data. For example, it is possible, in principle, to: (1) remove from the theory the part which leads to an undesirable prediction; (2) remove some data from consideration; (3) remove a prediction, leaving the rest intact; (4) remove the tension between theory and data, leaving the rest intact. In particular, while the last two ways of restoring equilibrium might work, they are "grotesque".

> It seems of rather little use to have a "coherent" system of beliefs when whenever we were faced with conflict we could always modify what we believe $\mathfrak{L}_G$ predicts so as resolve the "incoherence". (...) The process of reflective equilibrium is supposed to be a process by which we match theory to evidence and evidence to theory. It's pointless to engage in such a project if we can get ourselves into reflective equilibrium by simply revising away our beliefs about coherence or prediction. (Woods 2019b, 330)

Given this problem, Woods argues that one solution would be to explain how to justify the adjustment for coherence. Alternatives for this include: (1) idealization, (2) invocation of immediately obvious implications, and (3) the inclusion of other theoretical virtues.

First, idealization consists in defying the notion of implication (in the sense of predictions of a logical theory) and tension. In case such notions can be ideally defined, there would not be too much freedom, because the revision of the theory would already be established according to these definitions. Idealization is not available for logic, however, because the possibility of idealization requires an underlying notion of implication, Wood argues. This solution does not work in logic, for any attempt to define these terms would be circular.

Second, the invocation of immediately obvious implications consists in using a notion of depth to orient the revision of a theory, in such a way that revision is

guided by the depth of the piece of the theory to be reviewed. There would not be too many degrees of freedom, since the order of the revision would follow the order of depth. Woods argues that this approach is inadequate, because there is no epistemic justification for treating some implications that are more obvious than others as privileged. Moreover, most of the tensions in a logical theory are not obvious in this sense, nor are they even similar in their degree of "obviousness".

Third, the use of other virtues lead to the problem of oscillation, just as for logical abductivism (as discussed in section 2.3). Moreover, supplementing the revision method with other theoretical virtues (in IBE fashion) as evaluative criteria would not be enough to provide the guidance Woods requires. It would then be necessary some guidance in turn to justify the choice of the epistemic virtues. For logical abductivism, such justification can be borrowed from the sciences, but this move is not immediatly available for proponents of reflective equilibrium.

Woods maintains that the options for solving the logic in the background problem for reflective equilibrium either restrict the method too much, perhaps even to the point of mischaracterizing it, or are not in line with anti-exceptionalism. He concludes that "[t]here doesn't seem to be a reasonable way to salvage reflective equilibrium as a distinctive methodology for logical revision" (Woods 2019b, 338). Woods is thus a defender of the IBE method of theory revision for logic, together with the principle of partisanhood.[84]

A second problem Woods has with reflective equilibrium as a method of theory revision is that it is inadequate for anti-exceptionalism. His criticism is even broader than that: he argues that no piecemeal method of revision is suitable for anti-exceptionalism, since any solution to the degree of freedom problem would come with the cost of being exceptional. Accepting that Lakatos' method of revision in mathematics is a piecemeal approach to theory revision, this would be a problem for his view as well. Yet how much of a problem is too much liberty?

From the standpoint of piecemeal approaches, it seems that there is no problem at all, and even if there were a problem, there is a simple solution to it. Freedom

[84] See Section 2.3 above.

is a problem only from the perspective of logical abductivists, who aim for theories to be true, which aim traces back to the "underlying view of logic": revising theory towards the correct description of a mind-and-language independent reality. If logic is aiming at the one-and-only truth, then the method of revision which expands the possible accepted theories is a problem. Since the views which adopt the method of reflective equilibrium have a different aim for logic, freedom is not a problem for them, it is simply a feature of a plurality of available ways to bring about an equilibrium, and "the existence of an equilibrium does not guarantee, therefore, one absolute truth" (Prawitz 2007, 140).

For reflective equilibrium there is no problem with freedom to begin with. The method does not need such "guidance", since as Resnik (2004) discusses, while it seems that logic is freely revisable, "it will be rare that one will try to revise logic" (Resnik 2004, 190). Moreover, the overall view of logic which Resnik adopts assumes that a community self-corrects, so even if there is too much freedom at the start of the process of equilibrium, this excess soon becomes restricted by what is approved or not by the community.

Any proposal of revision is presented to the community of logicians, and it could be that the changes will be promptly accepted.

> When it does not, we have a small crisis on our hands. We can withdraw the inference, or suspend it while we try to understand why our audience rejects it or we can press on and hope that eventually our way of thinking will prevail. Of course, it might not prevail; we might be branded crackpots and ostracized. But if we do prevail, we end up modifying the practice itself. (Resnik 2004, 190)

Beyond the example of intuitionistic logic, which has become accepted by the community (albeit branching off on its own), the dialetheist project is another example in which theory revision received some support, but has not yet reached any large consensus (although it might have reached a point of equilibrium). As discussed by Prawitz (2007):

> We can, of course, imagine that two people might reach completely different equilibriums, and would continue to argue. Nothing that one might say could destroy the other's equilibrium, but their values and inferences show themselves to be totally different. (Prawitz 2007, 140-141)

Such "different equilibriums" seems to hold between some classical and non-classical logicians.

Freedom is also not a problem for the Lakatosian view proposed herein. It is a feature of his account of growth in mathematics that different adjustments in a proof lead to different theorems about different concepts. This is in no way a "problem". Moreover, Lakatos makes clear that one never arrives at a point where the concepts are so crystal clear as to have only one interpretation. There is no end to proofs and refutations, since concept-stretching is an ongoing process (Lakatos 1964, §9).

Moreover, even if there were an issue with freedom, the simple answer is that what "guides" revision is communal practice. This reply works both for reflective equilibrium and for Lakatos' method. The anti-exceptionalist view which demands the best theory relies too much on the underlying view of science, which as discussed in Chapter 3, is scientific realism.

Woods' criticism of using immediately obvious implications to guide revision seems to be a criticism of the notion of the methodologically *apriori* which Resnik employs, since defining some implications as more fundamental is exactly what Resnik does. Woods claims that there is no epistemic justification for this measure. However, Resnik already presents the "guidance" which Woods requires: the justification of keeping the logic in the background fixed is assigned to the community of logicians. As a normative discipline, the community hold a current standard which is used to evaluate any changes. Any change in the current standard occurs through time and is accepted by other logicians.

The fact that this justification is normative does not make it any less "anti-exceptional", unless for Woods "normativity" must be rejected outright, which points exactly to a difference in underlying view of logic. This does not seem to be the case,

however, since the assumptions Woods makes are the following:

> First, I assume that anti-exceptionalist views of logical theory choice are really about which logic to adopt as our most basic canon of legitimate deductive implication. [...] Second, anti-exceptionalist methodology aims to provide us with the ability to justify this or that logical revision. (Woods 2019b, 320-321)

Both these assumptions are compatible with reflective equilibrium.

The two approaches presented in this chapter share the view that logic is "not exceptional" in a sense distinct from the mainstream anti-exceptionalist trend of promoting IBE in logic. Logic is not exceptional "because it is akin to science", but because it is akin to mathematics or to normative disciplines. In both views, logic is taken to be a communal practice, which is learned and which is revised in the light of insight. Logic is a contingent development of human history, and not a reflection of some underlying aspect of nature. Of course this view of logic is divergent from that of logical abductivists, as they do not consider the normative role of logic to be relevant. This chapter is not a defense of these views, but merely the investigation of how logic is rationally revisable beyond borrowing the method of IBE from the empirical sciences.

While Chapter 3 argued that the slogan of "logic as science" is a slippery slope towards realism about logic, this pitfall can be avoided by adopting for logic a method of theory revision which does not seek to equate logic to the scientific (and thus empirical) standard of theory revision. The methods presented in the current chapter do not assume a final end-point to theory revision (such as a "true" theory), but to allow for a fixed point to be reached (although one might never be in a position to know if this is the case). They are rational methods of theory revision all the same. The next and last chapter of this thesis argues that piecemeal approaches to revision are preferable method for logic, as opposed to logical abductivism.

6 Anti-exceptionalism revisited

This thesis proposes not only to criticize logical abductivism, but also to provide an alternative account of theory revision in logic. The former task has been executed. Now, on to the latter.

To review, Chapter 1 raises the issue of revision of logical theories in light of Agrippa's challenge (presented on section 1.1): to offer an account which is neither dogmatic, nor circular nor leads to infinite regress. Chapter 2 presents two senses of the notion of "abduction", namely, the original sense of abduction (as hypothesis generation mechanism) and the more recent sense as Inference to the Best Explanation (as a theory selection mechanism), as well as logical abductivism. It was argued that logical abductivism follows IBE rather than the original sense of abduction, and that it suffers from certain methodological problems.

Chapter 3 explores the slogan of "logic as science" from three viewpoints in the philosophy of science, namely, scientific realism, sophisticated methodological falsificationism, and constructive empiricism; it was argued that logical abductivism only makes sense if paired with scientific realism, and is thus an ontological view, since it calls for some form of realism about logic. It was also suggested that this is a problem for anti-exceptionalism more broadly, since the presently available accounts of logical evidence only work for logic under logical abductist assumptions.

Chapter 4 proposes a new definition of anti-exceptionalism, one which does not determine any particular method of theory revision. This definition does not list properties which logical theories must or must not possess, and does not imply or presuppose any specific ontology for logic. In particular, this definition allows for

anti-realist views of logic to fall within the scope for anti-exceptionalism.

Chapter 5 presents two methods of rational theory revision for logic, beyond logical abductivism: "proofs and refutations" and reflective equilibrium. These two methods do not share with logical abductivism the presupposition that logic is related to science in any strict sense.

The current chapter, *first*, defends the methodologies presented in Chapter 5 as suitable for theory revision from an anti-exceptionalist perspective, replying more directly to Woods' (2019b) exclusion of these methods from anti-exceptionalism. *Second*, it presents a fuller account of what rational theory revision in logic amounts to. *Third* and finally, it argues in favor of piecemeal approaches (as opposed to logical abductivism) as more suitable methods for theory revision in logic.

6.1 A defense of freedom

In the end of the last chapter, it was mentioned that Woods (2019b) does not consider reflective equilibrium an apt method of theory selection for anti-exceptionalism, for it suffers from what he calls "the degree of freedom problem". Since Quine's method of theory revision (section 1.3) also suffers from this problem, it stands to reason that Quine's own account would not fall under anti-exceptionalism as he presents it. The rejection of Quine as an anti-exceptionalist is an odd corollary of Woods' view.

Chapter 5 argued that both methods presented, namely proofs and refutation (section 5.1) and reflective equilibrium (section 5.2), are apt methods for theory revision in logic. In this current section, it is argued that these methods fit within anti-exceptionalism as well, not only because of the new definition proposed (section 4.3). To this end, it is argued that freedom is not a problem for theory revision. In fact, it will be argued that freedom should be expected from any method of theory revision in logic.

To start, it is noteworthy that there is a problem akin to the degree of freedom problem within the revision of scientific theories: the underdetermination of theory

by data. Section 2.1 commented that abduction in the Peircean sense of generating hypotheses also allows for freedom (in the generating of hypotheses), and so in this sense, Pierce's abduction is somewhat similar to reflective equilibrium. Mohammadian (2021) notes that Pierce was unaware of the problem of underdetermination of theory by data, and consequently his abduction did not account for it. Abduction in the IBE sense, however, was elaborated exactly as a solution to the underdetermination problem. It is no surprise, then, that Woods, who defends logical abductivism, is dissatisfied with the degree of freedom allowed by reflective equilibrium.

As already noted, Quine also allows for freedom of revision, as he holds that there is no one best way to go about revising theories: "A good scientific theory is under tension from two opposing forces: the drive for evidence and the drive for system" (Quine 1981, 90). There is always a trade off in formulating a theory between empirical observation and theoretical laws. Moreover, "[t]he values that we thus trade off one against the other-evidential value and systematic value-are incommensurable" (Quine 1981, 90). Compounded with Quine's contribution to the Duhem-Quine thesis, which is presented as an argument against IBE and scientific realism regarding underdetermination of theory by data, it is clear that Quine would not support abductivism in logic.

Lakatos (section 3.2) and van Fraasen (section 3.3) also allow for a great deal of freedom in theory hypothesising/choice/revision.[85] In particular, in Lakatos' picture of science, it is expected that a multiplicity of different research programs run in parallel. While one might talk of "choice" regarding which program to join, there is no need to select one program as "the true" one, and moreover, each research program has freedom on how to respond to new evidence. Van Fraassen's standard for scientific theories is nothing more than empirical adequacy, and as has been noted several times, more than one theory can be empirically adequate. Within empirically adequate theories, there is freedom to adopt one theoretical framework or another. The "choice" of theory is not one in terms of "truth", but rather on theoretical commitment, which is given in terms of the pragmatics of experimental

[85] The difference between "theory revision" and "theory choice" is unclear. Talking about logic in terms of "revision" perhaps already borrows too much from the scientific framework.

design.

Unlike these views, IBE takes underdetermination to be an issue in need of a solution, where "the best" needs to be chosen among equally empirically adequate theories. Why assume this? Well, due to scientific realism, which holds that there is one complete description of a unified picture of nature.

More against Woods' point, logical abductivism does allow for freedom, both in evidence and in selection criteria (as discussed in sections 2.3 and 2.2, respectively). Once these parameters are chosen, "the best" logical theory is already evident. The freedom in logical theory choice is hidden one layer deeper than in reflective equilibrium. There is freedom to choose evidence and there is freedom in which theoretical virtues one finds more adequate.

At this point it is worth commenting that rationality and uniqueness should not be taken to be the same thing. The criterion of uniqueness is not what makes a method rational. Or was Quine's method of revision not already rational? The problem of theory revision cannot be freedom.

Even if logical abductivism, "proofs and refutations" and reflective equilibrium are on an equal basis regarding freedom, logical abductivism suffers from a further problem, that of the logic in the background. As indicated in section 2.3, if the circularity within logical abductivism cannot be in some way accomodated, this approach would not be a satisfactory solution to Agrippa's trilemma.

It seems that due to logic's role in theory revision, its own method of revision needs to be piecemeal. Piecemeal approaches to revision are neither circular, nor arbitrary, and do not lead to infinite regress. They are not circular because they do not assume that there is one **true** logical theory in order to revise logic; a logical theory might be currently adequate, but this might change. They are not arbitrary because there is a justification of how one logic came to be operational: it is a contingent development of human history, which comes from theoretical develpment and not from mere wild guesses. They do not lead to infinite regress because the justification of "theory choice" does not assume a logic, but rather assumes a communal practice.

Piecemeal approaches to theory revision are non-foundational solutions to Agripa's trilemma, which was outlined in section 1.3 as an aim for an anti-exceptionalist view of logic. In particular,

> [b]ecause of its emphasis on coherence, reflective equilibrium is often contrasted with *foundationalism* as an account of justified belief. Within foundationalist approaches, some subset of beliefs is considered to be unrevisable, thereby serving as a foundation on which all other beliefs are to be based. Reflective equilibrium privileges no such subset of beliefs: any belief at any level of generality is subject to revision, if revision will help to bring one's considered convictions into greater coherence overall. (Wenar 2017, 8)

This non-foundational approach to theory revision can be illustrated by "Neurath's boat":[86]

> We are like sailors who on the open sea must reconstruct their ship but are never able to start afresh from the bottom. Where a beam is taken away a new one must at once be put there, and for this the rest of the ship is used as support. In this way, by using the old beams and driftwood the ship can be shaped entirely anew, but only by gradual reconstruction. (Neurath 1973, 199)

While in science it could be said that the safe harbor for theory revision is the observable, in logic there is no safe harbor.

A final issue with regards to piecemeal approaches to theory revision is that there is a return to a dogmatist view, for theories are revised based on intuitions or insight. Such worries can be quickly laid to rest, for the role that intuitions play is not obscure: intuitions have to do with learned concepts and previous knowledge. There is nothing obscure about this.[87] While intuitions in the rationalist sense come

[86] The applicability of this analogy is already proposed by Hlobil (2020).
[87] Unlike the use of intuitions in logical abductivism.

from some *a priori* immediate source (section 1.2), intuitions in the non-foundational approaches to revision come from having learned to operate concepts of a language or how to operate within logical practice.

Regarding freedom, then, reflective equilibrium is not worse off than logical abductivism. Why should this view be rejected by anti-exceptionalism? It should not, unless there is some major (ontological) objection to the application of this method, such as, perhaps, realism about logic (section 3.1). Freedom in revision is compatible with indeterminacy, but does not entail it. If one thinks that only ever one right answer is true of logic, then one must be a realist of some sort. The lack of freedom of logical abductivism is, of course, an illusion, since once the correct logical evidence is selected, one's preferred logic will be selected as a matter of course.[88]

6.2 Growth vs. progress

Section 4.3 defined anti-exceptionalism in terms of rational theory revision, but not much was said about the "rational" part. Adopting the "scientific" standard of rational theory revision was not particularly adequate for logic (Chapter 3). This approach to rational theory revision seems to overlook that other disciplines also have methods of revision which are rational, and are not the same as in "science".[89]

Logical abductivism assumes that logical knowledge progresses (as discussed in Chapter 2), while the proposed view of proofs and refutations for logic assumes that logical knowledge grows (just like Lakatos' view of mathematics). Both these standards for knowledge are perfectly rational.

Progress is a goal oriented notion, which assumes there is a final end-point to revision, and that theory revision is approximating such a final point at each state. Growth assumes theory change, but is neither a goal oriented nor a finitive notion, since there is no end-point in sight; theories continue to grow. Logic grows through theoretical development. The current concepts which are used in logic are a

[88] See the discussion of Hlobil (2020) on section 2.3.

[89] It is, of course, possible to maintain that only science is rationally revisable. Yet to do so is to bring back the problem of the demarcation of science.

contingent development of human history. To say that logic progresses and that novel logical concepts map to truth about the world might lead to strange metaphysics.[90]

Much of Woods' (2019b) issue with reflective equilibrium is related to coherence. Quine's proposal of theory revision is already given in terms of coherence (and moreover in terms of minimal mutilation). Given that coherence is to be maintained once there is new input in the web-of-belief, there is growth. It is perfectly rational to maintain coherence when faced with new information (wasn't "unifying power" a virtue anyway?). What is the alternative to coherence of justification in logic? Correspondence? Logical realism threatens.

The difference between progress and growth is methodological. Progress assumes a particular ontology, which plays a methodological role in theory choice. Growth makes no such assumption. While progress assumes an end-point to theory revision (the one true theory), growth does not, but still allows for a fixed-point to be reached eventually. As far as the "growth" metaphor goes, while knowledge grows into different branches, in logic one can never know which one is the "one true branch" (or if there even is such a privileged branch). Both the standard of progress and of growth in logic lead to rational methods of theory revision.

6.3 The meta question

There is no principled reason (in logic, at least) to restrict freedom of theory revision. Arguments to restrict freedom in theory choice in logic must rest on argument for some form of realism about logic. Inasmuch as anti-exceptionalism about logic makes claims about theory revision, these ontological disputes should not determine the issue. Anti-exceptionalism is better served by a "prudent" approach to theory revision, such as the proposed definition in terms of rational theory choice.

Realist views of logic are compatible both with logical abductivism and with rationalism, so ontology on its own does not determine method.[91] Method might

[90] Perhaps possible worlds do actually exist.
[91] Although the exact account of how one accesses this realist unobservable realm might.

presuppose an ontology, such as logical abductivism presupposing a realism, and arguably reflective equilibrium presupposing anti-realism. Yet there are methods of rational theory revision for logic which do not make such presuppositions. One could even hold a form of realism about logic, but also hold that the access to evidence can never be warranted by "scientific" methodology. Methodology is all that can be had. Even if one does not agree with Resnik's or Prawitz's assumptions, it could still be that reflective equilibrium or proofs and refutations are as good as methods as logic might have. It could also be that logic needs a bespoke method of theory revision.[92] One should not hold so dearly to the methodological label of "anti-exceptionalist", but rather seek how to rationally revise logical theories.

Granting that logic does not fall within the "science" side of some kind of demarcation between science and not-science (Chapter 3), logic is philosophy after all. As such, perhaps the best that logic can offer is in terms of convergence on negative or conditional theses, rather than positive ones (using D. Chalmer's (2014) terminology).

One need not go so far as to claim that different logical theories are incommensurable to recognize that, having no sturdy empirical basis, logical disagreements are very theory-sensitive. In science, "facts" are already dependent on theory, but at least there is a shared empirical reality that determines minimally what science describes. Logic has only theory, so theory will determine evidence and evidence will determine theory. Neurath's boat indeed.

It is rare (and perhaps even impossible, if Hlobil (2020) has it right) that there is a neutral way to arbitrate logical disputes. The scarcity of actual cases of theory revision in logic can be better accounted for by the methodologies of reflective equilibrium and proofs and refutations, since both methods are able to sustain these disagreements and not dismiss them as errors.

[92] Such method could be, for instance, logical partisanhood (presented in section 2.3), which might not be a method similar to scientific ones (since it adds an extra filter to IBE) but still be fit for logic.

The issue of developing suitable theories is not unique to logic. Science faces the problem of induction; ethics faces the is-ought problem; and Achilles faces the problem of convincing the tortoise to accept *modus ponens* as a valid inference form. In the end, logic is not so exceptional.

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