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**THE PROBLEM OF FUTURE CONTINGENTS AND THE
METAPHYSICS OF INDETERMINACY: A DEFENSE OF
ŁUKASIEWICZ'S THREE-VALUED LOGIC**

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Abstract

*This paper examines the problem of future contingents, which asks how we ascribe truth values to contingent statements about the future, given that classical logic assumes that every statement is either true or false (the principle of bivalence). Aristotle's sea battle paradox in *De Interpretatione* was aware of this problem and suggested that such statements may be an exception to the principle of bivalence; later logical traditions largely ignored this view. This gave rise to the fatalistic argument, which claims that if future statements are already true or false, then the future is fixed and genuine contingency is impossible. Using conceptual and logical analysis, the paper reconstructs the fatalistic argument, explains Jan Łukasiewicz's three-valued logic as a response, and critically examines five major objections raised by Tomberlin, Quine, Prior, MacFarlane, Belnap and Green, and Barnes and Cameron. The aim is to determine whether the fatalistic argument is logically valid and whether Łukasiewicz's solution successfully avoids fatalism. In doing so, the paper explores Łukasiewicz's three-valued logic (L_3) as an alternative logic, identifies a limitation in the principle of bivalence, and thereby rejects universal bivalence. It also finds that the major objections do not decisively undermine L_3 , as claimed. Instead, Łukasiewicz's logic has the important advantage of rejecting some inference rules in classical logic, such as *ex falso quodlibet*. The study concludes that, despite criticisms, Łukasiewicz's three-valued logic remains one of the simplest and most philosophically convincing responses to Aristotle's problem.*

Keywords: future contingents; bivalence; three-valued logic; Łukasiewicz; logical fatalism; supervaluationism.

Introduction

The problem of future contingents is one of the oldest in Western philosophy. It concerns whether statements about future events already possess a definite truth value before the events actually occur. The discussion begins with Aristotle in Chapter 9 of *De Interpretatione*, where he examines the proposition, "There will be a sea battle tomorrow." Aristotle argues that if such a proposition is already true or false before the event takes place, then either the battle must necessarily occur or it must necessarily fail to occur. If this were so, genuine contingency would disappear, and the future would already be fixed (Aristotle, *De Interpretatione* 18a28–19b4). Although scholars disagree about Aristotle's final position, many interpret this passage as suggesting that propositions about future contingent events do not yet have a determinate truth value. This interpretation appears to qualify the principle of bivalence, according to which every proposition is either true or false. This resulted in a later and long-lasting position in classical logic, retaining bivalence as a universal principle. For example, Gottlob Frege regarded every well-formed proposition as having exactly one of two truth values, true or false, and treated these truth values as logical objects fundamental to reasoning (Frege, *Basic Laws of Arithmetic* §5; *Grundgesetze*, vol. 1, pp. xvi–xvii).

However, in 1920, an alternative was proposed by Jan Łukasiewicz. In "On Three-Valued Logic". He introduced a logical system containing three truth values: true (1), false (0), and a third value ($\frac{1}{2}$), commonly interpreted as "possible" or "indeterminate" (Łukasiewicz, 1920, 87). Future contingent propositions are assigned this third value until the relevant event occurs. His system can be said to have addressed this traditional fatalistic argument while preserving a formally precise semantics.

Thus, this paper defends Łukasiewicz's three-valued logic against later criticisms. It does so in the following structure: the next section reconstructs the fatalistic argument derived from the principle of bivalence and argues that, given the assumptions of classical logic, it is logically valid rather than fallacious. Section 3 explains Łukasiewicz's three-valued semantics and shows how it addresses the fatalistic conclusion. Section 4 examines several important objections and competing theories, including James E. Tomberlin's claim that fatalism depends on a modal fallacy; Willard Van Orman Quine's criticism that introducing a third truth value confuses questions of knowledge with questions of reality and merely replaces one logical system with another; Arthur Norman Prior's tense-logical account, which attempts to preserve bivalence without embracing fatalism; and more recent proposals by John MacFarlane, Nuel Belnap, Mitchell Green, Elizabeth Barnes, and Ross Cameron. Section 5 evaluates the logical costs of Łukasiewicz's system, particularly its rejection of some classical validities. Section 6 compares the three-valued approach with supervaluationist accounts of semantic indeterminacy. The paper concludes that Łukasiewicz's account, despite the criticisms, remains one of the most coherent and philosophically compelling responses to the problem of future contingents.

The Fatalistic Argument from Bivalence

The traditional argument for logical fatalism begins with the principle of bivalence, which states that every proposition is either true or false. To express this logically, let P represent the proposition: "There will be a sea battle tomorrow." The argument may be stated as follows:

1. Either P is true today, or P is false today. (*Principle of Bivalence.*)
2. If P is true today, then there will be a sea battle tomorrow. (*Truth corresponds to reality*)
3. If P is false today, then there will not be a sea battle tomorrow. (*Falsity corresponds to non-occurrence*)
4. If a proposition is true or false at one time, its truth value does not subsequently change. (*Permanence of truth*)
5. Therefore, it is already settled today either that there will be a sea battle tomorrow or that there will not be one.
6. Hence, the sea battle is either inevitable or impossible. (*Logical fatalism*)

As already noted, the roots of this argument lie in Aristotle's discussion of future contingents in Chapter 9 of *De Interpretatione*. Aristotle considers whether the proposition "There will be a sea battle tomorrow" is already true or false before the event occurs. Meanwhile, the fourth premise in

the above argument expresses a standard assumption of classical semantics rather than a principle explicitly formulated by Jan Łukasiewicz. Classical logic assumes that truth is stable. That is, a true proposition cannot later become false, and a proposition that is false cannot later become true. Combined with the principle of bivalence, this assumption implies that every proposition about the future already has a fixed truth value. Consequently, every future event appears to be determined in advance.

Łukasiewicz reconstructs this line of reasoning to show that logical fatalism follows from the assumptions of classical two-valued logic. He argues that the argument is valid if those assumptions are accepted. The only effective way to preserve genuine contingency, therefore, is to reject the unrestricted application of bivalence to future contingent propositions. His solution is to introduce a third truth value, according to which propositions about contingent future events are neither true nor false until the relevant event occurs (Łukasiewicz, "On Three-Valued Logic" 87). Subsequently, we will see if he was able to achieve this goal sufficiently.

Łukasiewicz's Three-Valued Solution

Łukasiewicz's logical system (L_3) replaces bivalence with a three-valued semantics. For atomic statements:

1 (true) – assigned to statements that are actually true (past or present facts, necessary truths)

0 (false) – assigned to statements that are actually false

$\frac{1}{2}$ (possible/indeterminate) – assigned to future contingent statements

The truth tables for negation ($\neg$) and implication ($\rightarrow$) are as follows (Łukasiewicz 1963, 132):

P	$\neg p$
1	0
$\frac{1}{2}$	$\frac{1}{2}$
0	1

P	q	$p \rightarrow q$
1	1	1
1	$\frac{1}{2}$	$\frac{1}{2}$
1	0	0
$\frac{1}{2}$	1	1
$\frac{1}{2}$	$\frac{1}{2}$	1
$\frac{1}{2}$	0	$\frac{1}{2}$
0	1	1
0	$\frac{1}{2}$	1
0	0	1

In Łukasiewicz's three-valued logic (L_3), disjunction and conjunction are however defined from

$$p \vee q =_{\text{df}} (p \rightarrow q) \rightarrow q$$

implication and negation. Disjunction is defined as $p \vee q$, while a conjunction is

defined as $p \wedge q =_{\text{df}} \neg(\neg p \vee \neg q)$. These definitions produce the familiar maximum and minimum truth-value functions over the three truth values: true (1), false (0), and indeterminate ($\frac{1}{2}$).

$$p \vee \neg p$$

Consequently, the law of excluded middle, $p \vee \neg p$, is no longer a tautology.

$$\text{If } p = \frac{1}{2},$$

$$\text{then } \neg p = \frac{1}{2},$$

and also evaluates to $\frac{1}{2}$ rather than 1.

Future contingent propositions may therefore remain genuinely indeterminate instead of being forced into either truth or falsity. Since the principle of bivalence no longer holds universally, the first premise of the fatalistic argument fails. As a result, the inference to logical fatalism is blocked. Łukasiewicz also defined possibility (M) and necessity (N) operators, giving his three-valued logic a modal interpretation that distinguishes contingency from both necessity and impossibility (Becchi 2006, 3). This supplies a formal, truth-functional semantics for “possible” that classical bivalent logic, on its own, cannot provide.

Objections and Replies

4.1 Tomberlin's Modal Fallacy Objection

James Tomberlin, in *The Sea Battle Tomorrow and Fatalism*, argues that the assumption that Aristotle's sea battle paradox will lead to fatalism is a fallacy, and there is no need to create a system to accommodate a fallacious assumption (Tomberlin, 1971, 353). He then presented Aristotle's argument to show that it is invalid. The argument holds thus:

1. If it is necessarily true that there will be a sea battle tomorrow, then there will be a sea battle tomorrow
2. There will be a sea battle tomorrow.
3. Therefore, necessarily, there will be a sea battle tomorrow.

Let ‘it is necessarily true that there will be a sea battle tomorrow’ be $\sim P$ and ‘there will be a sea battle tomorrow’ be P , the argument can be rewritten as:

$$\begin{array}{c} (\sim P \rightarrow P), \\ P \\ \therefore \sim P \end{array}$$

For Tomberlin, the argument is clearly invalid because it is a formal fallacy to infer $\sim P$ from the two premises (Tomberlin, 1971, 353). Meanwhile, the rule of modus ponens allows us to infer the consequent of a conditional statement only when its antecedent is affirmed. Hence, to infer $\sim P$ from $(\sim P \rightarrow P)$ and P is a misuse of the rule of modus ponens and as such, a fallacy of affirming the consequent. By implication, if the inference is a fallacy, drawing a fatalistic conclusion from Aristotle's argument is a fallacy. Hence, Tomberlin concludes that there is no need, at all, to try to create a system that can show that some statements, for instance, contingent statements, are not necessarily either true or false, to avoid falling into the problems of pre-determinism and fatalism (Tomberlin, 1971, 353). He then concluded that, though systems of many-valued logics are interesting, there is absolutely no need to create them, since there is no problem their creation will address (Tomberlin, 1971, 354).

While Tomberlin's criticism succeeded in simplifying a modal reconstruction of fatalism. This study argues rather that the argument developed by Łukasiewicz is different. It is grounded not in an inference from truth to necessity but in the combined force of bivalence and the permanence of truth. Consequently, Tomberlin's objection does not undermine the version of the fatalistic argument that motivates Łukasiewicz's rejection of unrestricted bivalence.

4.2 Quine's Objections: Epistemic Confusion and "Changing the Subject"

Willard Van Orman Quine raises two distinct objections to Łukasiewicz's three-valued logic, and these should be considered separately. The first concerns the relationship between truth and knowledge. Quine argues that bivalence is a principle about reality rather than about human knowledge. In his view, propositions concerning future contingent events are already either true or false, even if we do not yet know which. Introducing a third truth value, therefore, mistakes an

epistemic limitation, our lack of knowledge, for a metaphysical feature of the world (Quine, 1970, 84).

This objection, however, assumes precisely what is in dispute. Quine presupposes that the future is already fully determinate. Łukasiewicz rejects this assumption. He argues that at least some propositions about contingent future events are neither true nor false because the relevant state of affairs has not yet been determined. The third truth value, therefore, represents objective indeterminacy rather than human ignorance. As Storrs McCall observes, Łukasiewicz's proposal is grounded in the view that some future possibilities remain genuinely open until they are realised (McCall, 2003, 43). The disagreement is therefore primarily metaphysical rather than epistemological. Quine's first objection begs the question by assuming that every future event already possesses a determinate truth value.

Quine's second objection is methodological and presents a more substantial challenge. In *Philosophy of Logic*, he argues that changing the truth tables of logical connectives such as "not", "or", and "if" does not demonstrate that classical logic is mistaken. Instead, it simply assigns different meanings to those connectives. According to Quine, the many-valued logician is therefore no longer discussing the same logical system but has effectively changed the subject (Quine, *Philosophy of Logic*, ch. 6). This criticism deserves careful consideration. Indeed, negation and implication in Łukasiewicz's system behave differently from their classical counterparts when applied to propositions with the third truth value. Nevertheless, Quine's criticism succeeds only if classical bivalent semantics is already adequate for every proposition. That assumption is precisely what Łukasiewicz denies. If some propositions are genuinely neither true nor false, then the classical truth tables are incomplete because they specify the behaviour of logical connectives only for the values true and false. Extending those truth tables to include a third value does not necessarily change the subject; rather, it may be understood as extending classical logic to accommodate a wider range of propositions.

Quine's methodological objection, therefore, does not resolve the disagreement. Instead, it returns the discussion to the same underlying metaphysical question raised by his first objection: whether there are genuinely indeterminate propositions to which classical two-valued semantics does not apply. If such propositions exist, then Łukasiewicz's three-valued logic offers a coherent extension of classical semantics rather than an entirely different subject.

4.3 Prior's Tense-Logical Alternative

Arthur Norman Prior developed tense logic as an alternative response to the problem of future contingents. His system introduces temporal operators such as F ("it will be the case that") and P ("it has been the case that") in an attempt to preserve the principle of bivalence without accepting logical fatalism. Prior's central insight is that the fatalist conflates two distinct claims: that it is true today that P will occur, and that P is already true today. According to Prior, these claims are not equivalent because the truth of a future-tense statement depends on its temporal context rather than on the future event already being determined (Prior, 1967, 113).

On Prior's account, a statement such as F(P) ("It will be the case that P") may be true at present even though P itself remains contingent. The truth conditions of the tensed proposition do not require the future event to be fixed in advance. In this way, Prior maintains that every proposition remains either true or false, thereby preserving bivalence while avoiding the conclusion of logical fatalism.

Although Prior's solution is both elegant and influential, it succeeds only by abandoning an assumption that Łukasiewicz regarded as fundamental to classical semantics, namely the permanence of truth. Within Prior's tense logic, the truth value of a tensed proposition may change as time passes and events unfold. A proposition that is true at one time may not have been true at an earlier time because its truth is relative to temporal perspective rather than permanently fixed.

The difficulty is that the fatalistic argument is usually understood to concern eternal propositions rather than ordinary tensed sentences. Classical bivalence is traditionally applied to propositions whose truth values are independent of the time at which they are asserted. For example, the sentence *"There will be a sea battle tomorrow"* may be reformulated as the eternal proposition *"A sea battle occurs on 21 December 2024."* Once expressed in this form, the proposition appears either true or false regardless of the time at which it is considered. Prior's temporal analysis, therefore, no longer removes the original difficulty, since the fatalist can simply restate the argument in terms of eternal propositions.

Łukasiewicz responds by rejecting the assumption that even such eternal propositions concerning genuinely contingent future events already possess determinate truth values. From his perspective, Prior's tense logic relocates the problem rather than solving it. Instead of questioning the universal application of bivalence, it modifies the logical treatment of temporal expressions while leaving the underlying issue unresolved. It is also possible to interpret Łukasiewicz's own three-valued system as a truth-functional tense logic in which $F(P)$ receives the value $\frac{1}{2}$ whenever P refers to a genuinely contingent future event. On this interpretation, L_3 constitutes not merely an alternative to tense logic but a competing account of temporal truth itself.

4.4 Contemporary Alternatives: Relativism, Branching Time, and Bivalentist Compatibilism

Recent discussions of the sea-battle problem have moved beyond the simple choice between unrestricted bivalence and Łukasiewicz's three-valued logic. Several contemporary philosophers have attempted to preserve bivalence, or something very close to it, while avoiding logical fatalism. Three approaches deserve particular attention. The first is the relativist semantics developed by John MacFarlane. MacFarlane argues that the truth of a future contingent proposition may depend on the context of assessment rather than solely on the context in which it is uttered. According to this view, a statement about a future event need not possess a single absolute truth value at the time it is made. Instead, it may be correctly evaluated differently from different temporal standpoints. Thus, a statement uttered today about tomorrow's sea battle may be neither determinately true nor determinately false when first asserted, yet it may later be correctly judged true or false once the relevant events have occurred (MacFarlane, 2003, 321–22). This approach preserves the intuition that the future is genuinely open while also explaining why retrospective assessments of past predictions appear legitimate.

From the standpoint of Łukasiewicz's theory, however, relativist semantics achieves the same result by introducing a considerably more complex semantic framework. Rather than assigning an indeterminate truth value to future contingent propositions, it makes truth itself relative to a context of assessment. If one is already prepared to revise the classical conception of truth, Łukasiewicz's three-valued logic provides a simpler explanation. By assigning the value $\frac{1}{2}$ to future contingents, L_3 captures the openness of the future without abandoning the idea that truth itself is absolute.

A second influential approach is the branching-time semantics developed by Nuel Belnap and Mitchell Green. On this account, time is represented as a branching tree in which each branch corresponds to a different possible future. A proposition concerning the future is true at a given moment only if it is true along every future history that extends from that moment, and false only if it is false along every such history. Since some future histories include the sea battle while others do not, the proposition *"There will be a sea battle tomorrow"* is neither true nor false at the present moment. Belnap and Green further argue that attempts to identify one privileged future branch, the so-called "thin red line", lack justification within the branching model itself (Belnap and Green, 1994, 370–71).

Although branching-time semantics differs from Łukasiewicz's formal system, the two approaches produce remarkably similar results. In both theories, future contingent propositions fail to receive one

of the two classical truth values. Branching-time semantics, therefore, arrives at a conclusion closely related to supervaluationism, namely that future contingents are neither straightforwardly true nor false. Consequently, the distance between branching-time semantics and L_3 is smaller than is often assumed.

A third proposal has been advanced by Elizabeth Barnes and Ross Cameron. They argue that the openness of the future is compatible with unrestricted bivalence. According to their account, propositions concerning future contingent events may already be determinately true or false even though nothing presently grounds their truth. The openness of the future is therefore understood as a metaphysical issue concerning grounding rather than a semantic issue concerning truth values.

This proposal faces an important difficulty. If a proposition may already be true despite the absence of any present fact that makes it true, then truth no longer performs the explanatory role required by the traditional fatalistic argument. The connection between truth and reality becomes significantly weaker. Once this connection is abandoned, the resulting account becomes difficult to distinguish, at least with respect to future contingents, from Łukasiewicz's claim that such propositions lack determinate truth values before the relevant events occur. Barnes and Cameron therefore preserve the language of bivalence, but the practical consequences of their theory differ less from Łukasiewicz's position than they initially appear.

An Internal Difficulty: The Cost of the Third Value

A fair assessment of Łukasiewicz's three-valued logic (L_3) must recognise that it comes with a cost. If only the truth value 1 is treated as designated, meaning that only statements with the value 1 count as logically valid conclusions, then L_3 validates fewer logical forms than classical logic. This affects not only the law of excluded middle but also other important principles. One example is *ex falso quodlibet*, expressed as $(p \wedge \neg p) \rightarrow q$, which states that any conclusion follows from a contradiction. In classical logic, this formula is always true. However, in L_3 , if $p = \frac{1}{2}$, then both p and $\neg p$ have the value $\frac{1}{2}$, and their conjunction also has the value $\frac{1}{2}$. If $q = 0$, the conditional evaluates to $\frac{1}{2}$ rather than 1. As a result, *ex falso quodlibet* is no longer a tautology in L_3 . The same applies to several other forms of reasoning that are valid in classical logic once genuinely indeterminate propositions are introduced. This point has been widely recognised in the literature on many-valued logics.

This is a genuine limitation, and it is important to identify where the cost lies. Defenders of Łukasiewicz are not claiming that classical logic is mistaken in its treatment of ordinary reasoning about statements that are clearly true or false. On the contrary, L_3 agrees with classical logic whenever all propositions have the values true or false. This means that reasoning about the past, the present, and necessary truths remains unchanged. The difference arises only in arguments involving future contingent propositions. According to Łukasiewicz, this is not an arbitrary change but the central purpose of the theory. If some future propositions are genuinely indeterminate, then it is reasonable that logical reasoning involving them should be more cautious than classical logic permits. A logic that allowed every conclusion to follow from an indeterminate contradiction would treat indeterminacy in the same way as definite falsity, which is precisely the view Łukasiewicz rejected. Even so, this limitation strengthens rather than removes Quine's criticism, discussed in Section 4.2, that L_3 may be "changing the subject." Supporters of L_3 should therefore acknowledge that adopting a three-valued logic is a significant revision of classical reasoning rather than a minor adjustment. They must also provide independent metaphysical reasons for believing that some future contingent propositions are genuinely indeterminate, instead of defending L_3 simply because it avoids fatalism. The strongest reason remains the one originally given by Łukasiewicz himself: if the future were already completely determined, it would be difficult to make sense of genuine human freedom or objective chance. A logic that reflects this view should therefore avoid assigning definite truth values to propositions about a future that has not yet been settled.

Indeterminacy Without a Third Value? The Limits of Supervaluationism

Some philosophers have tried to explain future contingents without rejecting bivalence by adopting supervaluationism instead of approaches such as branching time or relativism. According to the standard supervaluationist view, a statement about the future is true if it is true under every acceptable way of making the future precise, false if it is false under every such interpretation, and neither true nor false if the different interpretations produce different results. In this way, supervaluationism introduces a truth-value gap rather than a third truth value. The difficulty, however, is that this truth-value gap performs much the same function as a third truth value. As Susan Haack argues, the supervaluationist gap behaves, for most logical purposes, like an additional truth status rather than simply the absence of one (Haack 1996, p. 48). Supervaluationism must also explain how logical connectives operate when one or more of their components fall into the gap. To do this, it relies on a more complex semantic framework involving admissible precisifications, super-truth, and related concepts. This framework is considerably less straightforward than Łukasiewicz's approach of introducing a third truth value directly into the truth tables.

By comparison, Łukasiewicz's three-valued logic offers greater simplicity and formal clarity. It blocks the fatalistic argument by rejecting the assumption of universal bivalence, provides truth-functional definitions for all the logical connectives, and extends naturally to a modal logic of possibility and necessity, as discussed in Section 3. None of the bivalent or gap-based approaches examined in this paper achieves the same combination of simplicity, directness, and formal economy. Nevertheless, as argued in Section 5, these advantages come at the cost of abandoning some principles of classical logic.

Conclusion

The problem of future contingents is not a pseudo-problem or a simple fallacy as some philosophers have claimed, rather, it is a genuine tension between the classical principle of bivalence and the pre-theoretical sense that the future remains, in some respects, open. Łukasiewicz's three-valued logic resolves this tension by abandoning bivalence for future contingents and assigning them a third, indeterminate value. This study has shown that Łukasiewicz's approach is the safest and simplest when looked at side by side with other approaches. The objections considered here from Tomberlin, Quine, and Prior do not succeed in undermining this solution: they either misrepresent the fatalistic argument, beg the question in favour of an already-determinate future, or preserve bivalence only by relocating the very indeterminacy they claim to have eliminated. The contemporary alternatives examined in section 4.4, relativism about truth, branching-time semantics, and bivalentist compatibilism, fare no better: each either reproduces the substance of Łukasiewicz's solution under a different formal guise or purchases bivalence at the cost of the notion's ordinary inferential role.

Nevertheless, none of this shows that L_3 is unproblematic. Section 5 conceded a genuine cost: Łukasiewicz's logic validates substantially less than classical logic once a third value is admitted, and this concession should be taken seriously by anyone tempted to adopt L_3 merely because it is convenient. What the paper has argued, more modestly, is that this cost is one an indeterminist has independent reason to accept, since a logic that lets indeterminate premises license arbitrary conclusions would not really be treating them as indeterminate at all. Łukasiewicz's L_3 therefore remains, on balance, among the most direct and formally economical responses available to Aristotle's sea battle puzzle. Whether it is the correct response still depends on a metaphysical question this paper has not tried to settle outright, whether the future genuinely contains unsettled matters of fact, and it is to that question, rather than to further logical refinement alone, that future work on this problem should turn.

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