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Clarifying the Assessment of Risk: VUCA (Volatility, Uncertainty, Complexity, and Ambiguity)

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Abstract

The acronym VUCA (Volatility, Uncertainty, Complexity, and Ambiguity) has been used to describe the risks that the military and corporate managers face when making decisions in a dynamic environment. A four-factor financial VUCA framework can generate a more nuanced discussion of investment risk, extending beyond the classic risk definition centered on market volatility. We adopt this framework to define the investment environment faced by traders, risk managers, and investment researchers. A finance-focused VUCA methodology for risk assessment provides deeper context for investment decisions, thereby strengthening the traditional subjective expected utility framework by incorporating richer descriptors. A VUCA analysis identifies and isolates impediments to risky investment decision-making that are not captured by a traditional quantitative framework. 1) Risk can be decomposed into a four-factor framework, VUCA—Volatility, Uncertainty, Ambiguity, and Complexity, which provides a richer description of the financial decision-making environment. 2) VUCA broadens the focus of risk management beyond countable metrics to issues that affect decision-making in environments that are not easily modeled or described by past events through traditional volatility and distribution analysis. 3) Both quantitative and discretionary analysts can use a VUCA framework to highlight the unique risks associated with a specific model or environment, thereby making decision-making more challenging.

Keywords

Risk, Risk Management, Uncertainty, Portfolio Management, Quantitative Finance, Decision-Making

1. An Introduction to VUCA Risk

Any market environment is defined by risk; however, this term is often imprecise.

This lack of clarity hinders decision-making. Most risk analysis focuses on quantitative, objective measures because it is easy to formulate numbers as representative of an environment; however, many environments or decision problems are not based on countable events. Classic finance defines risk in terms of market volatility, which can be further categorized as systematic, factor-based, or idiosyncratic. These tractable quantitative descriptions do not support an assessment of market conditions or problems in which decision-makers face changing environments that are not easily measurable or more nuanced than those captured by volatility measures.

A risk assessment is an information problem and is based on our knowledge or ignorance of the market environment. Thus, framing risk beyond what is "countable" and focusing on different types of knowledge can better support decisions for when to take or avoid risk. The fundamental risk problem is linked to our ability to gather, process, and evaluate information when making choices in a dynamic environment. When faced with a complex system or decision, investors may suffer from the pretense of knowledge (Hayek, 1989). Risk assessments must be tempered not only by what has occurred in the past and is counted, but also by what is possible in the future and has not yet occurred, as well as by the influences on risk. Many market-specific events or incidents are not captured by classic risk definitions, and our ability to form expectations is affected by the environmental context. A comprehensive risk framework should outline the information challenges and choices that investors face.

The often-cited Donald Rumsfeld risk description frames the problem, "… as we know, there are knowns; there are things we know. We also know there are known unknowns; that is, we know there are some things we do not know. However, there are also unknowns—the ones we don't know we don't know". Rumsfeld's risk characterization does not provide a framework to support financial decision-making, yet its description of the information problem is relevant to quantitative and discretionary portfolio managers, investment analysts, risk managers, and long-term investors.

There is a disconnect between the positive theory embedded in the SEU framework and the normative process by which actual decisions are made based on available information and knowledge (Bell, Raiffa, & Tversky, 1988). Where the set of alternative events comes from, how subjective probabilities are formed, or what the sources of confusion are for measuring risk are not addressed or assumed away. The solutions are assumed to fit the standard rational framework, yet risk requires a clarifying framework for describing events and probabilities, whether measurable or not.

To better train officers in formulating and improving decision-making, the US Army developed an acronym to describe a challenging risk environment: VUCA—Volatility, Uncertainty, Complexity, and Ambiguity. The VUCA framework has also been employed in management and strategic planning to enhance corporate decision-making; however, it has not been directly applied to investment management and finance, nor has it been given a precise definition within the context of risk management thinking. The VUCA framework can be a valuable tool for traders, portfolio managers, and researchers to structure and classify the impediments faced when making investment decisions.

A redefined financial VUCA framework or risk methodology, expressed in the language of investment decision-making, can serve as a guide by categorizing risks in a tractable manner, based on the operational precision required for the problems faced by investment and risk management professionals. This framework applies to both quantitative and discretionary decision-making, providing a comprehensive description of risk problems beyond volatility measurement and supporting better decisions by isolating and assessing the types of risks faced.

This paper introduces the VUCA framework to investment problems and is divided into three main sections. First, we present the classic management description of a VUCA environment. Second, we describe how the VUCA framework can be applied to investment management and finance problems, with an emphasis on the issues that influence quantitative analysis. Third, we present a method to support better financial decision-making, identify problems in a VUCA investment environment, and discuss how to employ the VUCA framework to address real-world risk problems.

Our financial VUCA framework provides operational definitions for volatility, uncertainty, complexity, and ambiguity, along with a methodological checklist for assessing market conditions and determining the information or analysis required to refine expectations and risk assessments. A VUCA checklist generates a repeatable assessment procedure that is useful beyond the usual quantitative or numerical investment applications and can be applied to a broad set of risk management problems. This framework provides practical structure and context for assessing knowledge gaps and enhances the usual SEU framework for assessing uncertainty. Forming a risk assessment framework enables improved, process-driven decision-making and can support credible confidence intervals for interpreting risks that are not normally measured.

2. VUCA as a Strategic Risk Framework

Discussion on how risk and probability assessments are generated, whether based on objective or subjective measures, is often limited. While Knight (1921) delineated the problem of measurable risk and non-measurable uncertainty, and Keynes (1936) described differences between objective and subjective risk, distinctions between risk and uncertainty are often downplayed and mitigated by assuming expected returns as the sum of subjective probabilities multiplied by the set of alternative events (Savage, 1954). While the subjective expected utility (SEU) framework simplifies the risk and uncertainty described by both Keynes and Knight, the axiomatic approach does not address the nature of uncertainty, the effect of context, the set of possible risk events, or any dependencies between probability and payoff that affect SEU formation.

An alternative conceptual risk framework (Diebold, Doherty, & Herring, 2010), called KuU, known, unknown, and unknowable risks, has been used to describe the broader risk problem; however, it centers on information problems and does not directly link to environmental problems. Within the KuU framework, known risks are those that can be identified and measured, reflecting risks that are explicitly countable. Measurable risk is the countable environment in which we like to work. Unknown risks may be identified but cannot be objectively counted and are often described as Knightian uncertainty. Finally, unknowable risks are neither predictable nor quantifiable ex ante. The KuU framework focuses on risk management as either a shortfall in knowledge measurement or theory. This approach has not been extensively utilized, and the formulation of risk beyond categorizing it as a knowledge issue has not been formally addressed. The KuU framework lacks specificity in framing issues related to risky investment decisions.

Beyond recognition and measurement, the key issue in repeated decision-making under risk and uncertainty is learning to act on past experiences and to draw correct causal inferences. Decision-making fails if there is no ability to infer from the past what may happen in the future. The learning environment faced by any decisionmaker is probabilistic. Hence, an environment can either be "kind" or "wicked" based on the quality of the inferences that can be made (Hogarth, Lejarraga, & Soyer, 2015). In a kind decision-making environment, the link between action and consequences is well defined, whereas in a wicked environment, the link between past, current, and future outcomes is not well defined. The complexity and ambiguity between action and outcomes, cause and effect, make risk situations difficult to learn from.

While useful and compact, the investment risk decision is often constrained to a limited number of risk measures, such as volatility or Value at Risk (VaR). There is a need for greater risk intelligence (Evans, 2012) to enhance decision-making in uncertain situations; however, the descriptive challenge lies in categorizing the market environment and classifying the risks financial decision-makers encounter.

VUCA (Barber, 1992; Mackay, 1992) has been used for decades by the U.S. Army War College to train military leaders. While developed for management leadership (Bennis & Nanus, 19985), from a military perspective, VUCA provides a framework for assessing Clausewitz's "fog of war" or the lack of clarity with evolving situations that creates stress for decision-makers. The VUCA framework is also used for strategic planning and leadership training to address challenges in decision-making in a risky business environment. By assessing the business environment through the VUCA framework, managers can improve their decision-making and choice selection. Generalized descriptions of VUCA thinking have been presented in the management and planning field (Bennet & Lemoine, 2014; Fletcher, Gaines, & Loney, 2023), yet it has not been applied to the risk management problem in finance or other institutional settings.

The four-letter VUCA framework characterizes risky or stressful environments and represents a continuum on which managers face varying levels of volatility, uncertainty, complexity, and ambiguity. A VUCA environment is dynamic and can move between high and low states, providing a more nuanced description than a risk-on/risk-off view expressed as a threshold or as a single number, such as a standard deviation. The framework breaks down any environment into four categories:

- Volatility refers to the rapid changes in the environment faced by decision-makers. Rapid environmental change makes it more challenging to identify a specific decision path, as the range of alternatives expands. Greater volatility, or volatility in volatility, requires a higher rate of adjustment and adaptability to a changing environment.
- Uncertainty is a lack of predictability associated with unexpected developments. High uncertainty reduces a decision-maker's ability to generate appropriate problem assessments and decreases the chance of generating correct predictions.
- Complexity arises when assessing market interconnections amid numerous market drivers. A complex environment makes it challenging to identify key risk drivers and distinguish between different events. It is unclear what the response to any action or stimulus will be. If events are not independent, it is more difficult to determine the likelihood of outcomes and to select the appropriate course of action.
- Ambiguity is the absence of clarity about the meaning of an event. Events unfold over time, but what they mean, represent, or how they respond to possible actions is unclear.

Based on an assessment of the VUCA environment, management allocates resources and takes controlled risk-taking actions. Practical applications (Grove, 2015) have discussed managing organizations that face complexity, uncertainty, and ambiguity (CUA), a shorthand term for VUCA. An environment with higher CUA requires greater management coordination and control for decision-making. The challenge for decision-makers in responding to a high VUCA environment is to clarify and assess the limited information they receive, compounded by the difficulty of interpreting its meaning. See **Table 1**.

Table 1. The VUCA environment for management.

	Volatility	Uncertainty	Complexity	Ambiguity
Definition	Speed and volume of change, disruptive dynamic environment so limited time to adapt or respond; a broad range of possibilities.	Lack of clarity and predictability from unexpected developments; unable to rely on past measured experiences to direct action.	Environment is difficult to understand based on the interconnection of events with cause and effect not always linear; multiple factors are conditional on the environment.	Difficult to separate or distinguish between similar events; events open to multiple interpretations and contradictory influences.

Continued

Knowledge/theory gap	Known knowns, but a rapidly changing measurement problem; risk from wide choice dispersion and changing outcomes.	Known unknowns; unclear measurement problem, cannot find objective measures of risk and requires subjective assessments.	Unknown or unclear response or reaction; unclear theory of response given high level of interconnectedness; difficulty with modeling and narrative.	Cannot fully distinguish between known and unknown possibilities; competing or conflicting explanations or beliefs; unclear cause and effect and measurement of causal relationships.

VUCA can frame where decision failure may occur and what additional information is needed to respond more effectively to a given situation. Unfortunately, these discussions are often given only superficial definitions and limited connections to work on decision theory or risk measures in economics and finance. Without situational awareness, a wicked or high VUCA environment will lead to less effective decision-making or decision avoidance. The VUCA framework, by decomposing the risk environment, supports the investment decision process by inferring different risk issues.

While developed as a management tool, VUCA can serve as a framework for both long and short-term investment decisions that face limited information problems. Limited information that affects the formation of probabilities and expectations is often overlooked in financial decisions; however, by leveraging the four key VUCA features, decision-makers can develop more effective ways to address ignorance arising from changes in environmental conditions. Decision management in a high-VUCA environment requires flexibility, openness to change, adaptability to new events, resilience in the face of unexpected challenges, and creativity in addressing problems from multiple perspectives.

3. The Application of VUCA to Investment and Financial Management

VUCA broadly describes the market environment challenges faced by any manager, yet it is not structured to address the specific problems investment professionals encounter. Investment problems face high uncertainty because the amount of variation explained by most formal regression models is relatively small. The unexplained portion of any regression is a measure of uncertainty and generates attempts to form new models to explain asset returns. For example, attempts to address financial uncertainty and complexity in asset pricing have led to a factor zoo of models (Harvey, 2017; Feng, Giglio, & Xiu, 2020) that may perform well during training but may not predict the future.

The four components of VUCA can be reoriented by giving each a precise meaning to address challenges in finance. A formalized approach to risk descriptions is helpful because simple stories, narratives, or analogies do not effectively convey the complexities of risk. A narrative (Mangee, 2021) attempts to simplify risk messaging but may lead to misleading analogies that create market mistakes.

Uncertainty is often challenging to describe, and volatility, as just a number, does not provide context. The VUCA components can be employed as a checklist for financial decisions.

Volatility: Volatility is the measurable assessment of the distribution of returns. It is generally well defined theoretically, ranging from simple measures such as standard deviation and VaR to more complex approaches that focus on downside or tail risk. Volatility and the link across assets, as measured by covariance, are critical inputs for portfolio construction, but can lead to misallocations if the covariance matrix is mis-specified. However, numerous models (variations of GARCH) have been developed as volatility predictors, but volatility measures constructed on past data limit their forecasting effectiveness and model success varies. The issues associated with forecasting tools have been extensively reviewed by Poon and Granger (2003).

The investment risk challenge is twofold: volatility is time-varying and does not always follow a normal distribution. Volatility risk measurement is a threefold investment problem: minimizing the volatility measurement error arising from both sampling and the technique employed, selecting the appropriate distribution (normal, skewed, fat-tailed) to describe volatility, and developing the best predictor of future volatility. There is an ongoing problem of assuming normality as an expedient solution when actual risk is more complex. For example, the tails of an asset's distribution increase when an asset's risk is a mixed distribution. Risk is likely undermeasured when the distribution is nonnormal, and using historical volatility data has inherent predictive limitations. Hence, any predictive error estimate must be considered when discussing risk.

Uncertainty: Uncertainty focuses on risks not captured by a volatility measure and reflects the incompleteness of the event set as known to the financial decisionmaker. If volatility is a measurement and counting problem, uncertainty is a problem associated with noncountable risks. This is the realm of Knightian uncertainty and subjective risk measures. For investments in private equity or venture capital, where payoffs are more difficult to measure and may not fit within the standard financial framework, managers are more challenged by uncertainty than by volatility. Uncertainty, the realm of the unknown, has a real economic impact on macro behavior, prices, and investment decisions (Jurado, Ludvigson, & Ng, 2015). Bloom (2009) shows that shocks to uncertainty will lead to lower investments. When faced with high market uncertainty, investors often seek to manage or contain it by avoiding action.

Complexity: Complexity risk arises from the choice of model features and interdependence structure. It occurs when essential theoretical features are not properly accounted for in an asset valuation. Most financial models explain only a small portion of the variation in returns. Even if a given model identifies significant factors or a risk premium, there may be other factors that have not yet been modeled or that emerge conditionally. Investors must decide whether to increase complexity to minimize prediction error or maintain simplicity based on a theoretical foundation. Hence, there is a risk associated with the inappropriate modeling of market drivers; another way of describing model overfitting and training problems. Identifying the appropriate set of risk factors has been a persistent problem in finance.

As more risk premium models are developed and tested, the complexity of return drivers also increases, not only through greater choice but also through potential overfitting. For known factors, linear models are employed as the workhorses of finance, yet nonlinear relationships between asset and risk factors have not been fully exploited. There are ongoing questions about how to measure systematic risks and which factors are most appropriate for explaining returns. Time-varying factor risk premia further complicate the measurement and identification of their effects. While principal component analysis (PCA) has been used to reduce dimensionality, the number of risk premiums is not only increasing but also dynamic. Given the rise of machine learning, there is an ongoing debate about the required level of complexity in modeling expected returns (Kelly, Malamud, & Zhou, 2023; Kelly & Malamud, 2025).

Ambiguity: Decision-makers face ambiguity when different models yield multiple plausible narratives. It is unclear which model or narrative to choose, as all the alternatives seem reasonable. Models or narrative descriptions are vague and indistinguishable from other alternatives. A model that may have been effective in the past may not work in the future, or a model that has been rejected over a past training or test period may now prove to be effective. Returns can be explained by alternative hypotheses (measurement and theory) that compete for the best fit to a given data set. While ambiguity has often focused on the framing of uncertainty, as in the Ellsberg paradox, there are also practical issues when choosing which model to employ. Conflicting theories that attempt to explain a specific financial phenomenon impact financial decision-making. Decision-makers exhibit ambiguity aversion (Camerer & Weber, 1992; Machina, 2014); consequently, the definition and response to ambiguity remain ongoing problems. Ambiguity is associated with the probability of asset gains and losses, and its increase negatively affects asset prices (Epstein & Schneider, 2008; Baillon & Bleichrodt, 2015). Ambiguity in the business cycle and macroeconomic environment distorts asset-specific finance decisions (Ilut & Schneider, 2014).

Making causal inferences is difficult and a significant, growing research concern in finance (Lopez de Prado, 2023). The relationships between cause and effect are often unclear, leading to poor causal inferences regarding return drivers. Theoretical and measurement ambiguity compromise our ability to learn. Competing rational beliefs or models offer plausible narratives; however, Kurz (1996) shows that a belief's success or failure is revealed only over time. Rational beliefs can be mistaken and require revision. Ambiguity exists because the relationships between past actions and current outcomes are vague, as characterized by "wicked" and "kind" learning environments.

Ambiguity is embedded in the very language we use to describe risks, as discretionary decision-makers often employ imprecise language. Ambiguity in language is embedded in our communication and interpretation of words. Words, such as "likely" or "unlikely", do not have precise meanings, so there is ambiguity between what a sender may mean and how a listener may interpret. Discretionary language problems are likely to arise in decisions made by investment committees, where language and storytelling are often the primary means of communication. Words create a form of risk that is often underappreciated and requires assigning verbal descriptors an estimative probability (WEP), first addressed by Sherman Kent in his work on improving analysis at the CIA (Friedman, Lerner, & Zeckhauser, 2016; Mauboussin & Mauboussin, 2018).

The VUCA framework can be employed to categorize risks and serve as a checklist to identify potential critical risks, even if it does not provide specific solutions to address them. It serves as a framework for categorizing and exploring the specific challenges involved in making effective financial decisions. See Table 2. VUCA, as a set of states of the world, can support explanations of risk associated with a mismeasurement of volatility, increased uncertainty through non-countable events, greater complexity due to potential non-linearities and missing features, and ambiguity in the model that cannot effectively explain the environment.

Table 2. The VUCA market environment for investment and risk management.

	Volatility	Uncertainty	Complexity	Ambiguity
Management Challenge	Assessing the distribution of returns. The time-varying nature and speed of changes in prices and return; vol-of-vol issue.	Assessing the incompleteness of the event set. The lack of knowledge or high unpredictability; forecast or phenomena that cannot be measured.	Assessing model structure. Difficult to understand relationships or make causal inferences; limitation of simple models.	Assessing the multiplicity of plausible alternatives. A lack of model clarity; cannot distinguish between models; model input uncertainty.
Quantitative and Discretionary Challenge	Countable or measurable objective risk; sampling problem and dynamic sensitivity subjective to forecasting error.	Unforecastable risk: noncountable or subjective risk that cannot be modeled; the issue of ignorance.	Many factors necessary to explain; low explanatory power for any model because of feature or factor limitations.	Conflicting models or unstable coefficients of an existing model; more than one explanation can be applied to the same data.
Risk Problem	Changing volatility and covariances lead to forecast errors; and problems with risk measurement.	Imperfect knowledge and ignorance; Unforecastable volatility; Small sample problem or unique problem/rare event issue.	Modeling nonlinear relationships with unknown parameters that are dynamic.	Rational beliefs: Multiple reasonable narratives exist and can explain the environment, yet all cannot be true.
Management Response	Increase diversification with dynamic adjustments to changing covariance matrix; map causes of volatility.	Reduce ignorance (information shortfall) through research; Focus on tail protection; use scenario analysis for expected return; if a choice, walk away.	Develop alternative models; add more features for any model; use alternative modeling techniques; map causal relationships.	Ensemble models to offset ambiguity with any one model; if a choice, a heuristic is to walk away and avoid ambiguity.

A high VUCA environment increases reliance on the precautionary principle in risk management. Investors should increase cash liquidity, reduce leverage, decrease exposure to less liquid investments, and avoid exposure to irreversible or costly decisions. A review of the four VUCA components identifies the type of risk faced and provides possible solutions. For example, ambiguity aversion, as highlighted by the Ellsberg paradox, is the tendency to prefer known risks to unknown risks and thus to avoid decisions with incomplete or conflicting information. Within the VUCA risk environment, ambiguity aversion is framed in a context not typically observed in controlled experiments. If the ambiguity is resolved or given context, risk exposure, all else equal, can increase.

A high VUCA environment can be addressed through focused portfolio management analysis, complemented with enhanced statistical tools. For example, a highly volatile environment can be managed through increased diversification, reduced risk position size, or reduced leverage. An environment with greater uncertainty, or a higher likelihood of extreme events that cannot be directly quantified, should prioritize downside or tail risk management. A complex environment should adopt new models that incorporate additional factors to accurately describe the market, which may require more sophisticated measurement or prediction techniques. Ambiguity, given potential conflicts across models, may necessitate ensemble modeling to account for competing approaches to address the same risk.

Financial decisions should adapt to VUCA conditions. The VUCA problem for a private, long-term, illiquid investment is different from that of a short-term trader in public markets. The decision faced when there is an effective valuation model will differ from that when there is a poor or limited valuation model. The common VUCA theme is that there is a different knowledge shortfall or ignorance for a given asset environment and decision. The investor should manage ignorance and minimize exposure to different forms of risk.

4. Decision-Making Solutions in a VUCA Environment

Effective decision-making requires an environmental risk analysis, and the VUCA framework can serve as a checklist for assessing the environment and supporting more effective framing of the risk problem. Risk cannot be adequately assessed without identifying the uncertainties that extend beyond the estimated volatility. Implementation can take the form of reviewing the level of knowledge or ignorance of each VUCA component, then assessing how each VUCA factor can be mitigated.

Figure 1 provides a simple checklist for reviewing and decomposing a VUCA environment. This process can be used as an operational workflow framework. The framework is flexible enough to address portfolio problems, investment decisions, or situational trade assessments. Each VUCA component can have a separate review for inputs and assumptions that can affect the overall risk analysis for a decision. Each component should identify model inputs, missing knowledge, missing input features, alternative models, and model conflicts. From these inputs, the decision-maker will assess potential errors, the impact of missing information or knowledge, model alternatives, and the likelihood of confusion. From these assessments, downside risk, potential changes in ignorance, the amount of unexplained variation, and the range of possibilities can be clarified. After reviewing the components, an overall assessment of the risk environment can be made. The response choice will be the set of actions that can mitigate the identified risks. If the risk assessment and solution do not seem viable, the process can be repeated for further analysis. The financial decision can be calibrated or adjusted based on the VUCA assessment.

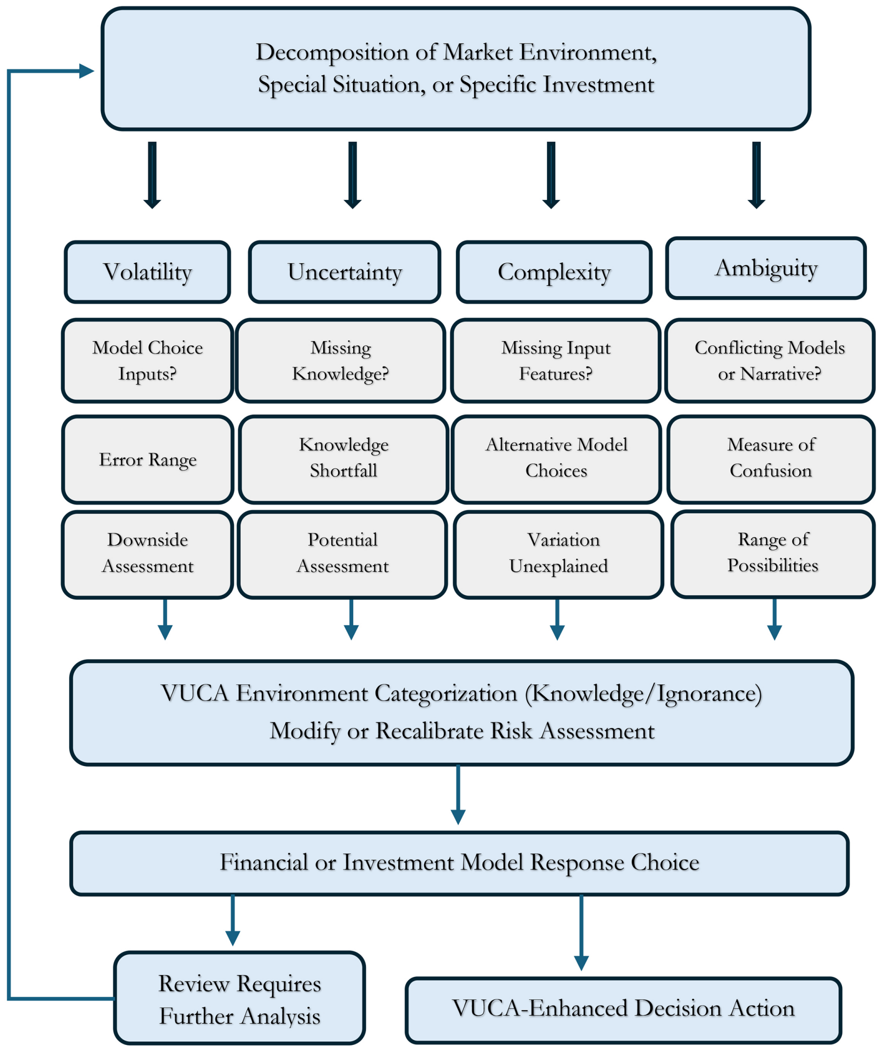

Figure 1. Checklist framework for investment VUCA decomposition.

The response to VUCA components will vary based on the problem faced. Private equity valuation may require more scenario analysis to account for the high uncertainty associated with long-term illiquid investments. Portfolio management may require accounting for higher risk and alternative asset pricing models that account for the complexities of risk premiums. Trade assessment with conflicting narratives may require ensemble modeling. The VUCA framework can address the knowledge and theory problem across the spectrum of volatility, uncertainty, complexity, and ambiguity through a series of questions.

- Measurement of change (volatility): Volatility measurement and assessment are subject to error. How do you measure risk? What is the amount of data necessary for measurement? What are countable and noncountable risks? How do you distinguish between objective and subjective probabilities for an event, and the difference between risk and Knightian uncertainty?

The response to volatility-related risks is to measure error to determine the risk of being wrong, thereby minimizing the maximum error.

- Measurement of risks that are not well known (uncertainty): The uncertainty from what is not countable or rare is an ignorance problem. What information or knowledge is missing? What risks are based on subjective assessment? What risk events are missing, and what are the likelihoods associated with any set of events?

The response to uncertainty risk may focus on scenario analysis to account for unexpected events that do not appear in historical data.

- Measurement of factors not included in current models (complexity): Markets are complex, and models can explain only a small portion of the variation. What factors are not included in the model? How do you account for nonlinearities or conditional market behavior? How do you identify, reduce, or control complexity and provide useful simplification? How can model prediction errors be minimized? Is there an issue of overfitting?

Complexity requires testing alternative models to address potential feature changes and time-varying coefficients.

- Measurement of conflicting explanations (ambiguity): Ambiguity is associated with conflicting models or narratives, leading to ineffective assessment of cause and effect. Is there a clear understanding of causal drivers in the markets? Are the underlying models used to describe markets well understood and independent? How dynamic are the coefficients within a model? Can you distinguish between competing models and isolate vagueness in risk predictions? Can you distinguish between competing narratives?

With ambiguity, the decision-maker faces conflicting answers from plausible models, suggesting that an ensemble approach will be helpful. The final assessment will be a weighted average of the ensemble of choices.

When a potential investment is decomposed into VUCA risk categories, it becomes clearer where the actual risks lie and how to mitigate any ignorance and identify potential decision-making errors. By differentiating investment-environment problems using VUCA, the investment manager clarifies what is known and unknown, what needs to be measured, what is problematic, which issues or features require clarification to support predictive judgment, and where theoretical problems make measurement difficult.

Table 3 presents the measurement issues for each VUCA category, the potential for error, an example of the issue faced, and possible solutions for that type of category risk. For example, volatility risks can be addressed through additional diversification; uncertainty may require scenario analysis; complexity may require a review of the feature set and the time-varying nature of the coefficients; and problems of ambiguity can be addressed through ensemble modeling to cover possible alternatives. The range of solutions will depend on the type of problem, but a VUCA assessment will usually indicate that the credible risk range is higher than that suggested by confidence regions from quantitative models. Note that VUCA is a holistic framework, meaning there may be multiple solutions to apply in a given environment, and not just one answer.

Table 3. Solutions to a VUCA financial environment.

	Measurement	Potential for Error	Example Issue	Potential Solutions
Volatility	Rolling averages; GARCH modeling.	Range of calculations for covariance measure.	Different volatility models or sample generate range of forecasts.	Increase diversification and lower position risk to offset covariance error.
Uncertainty	Form subjective expectations; adjustments for probabilities and scenarios that are hard to measure or not encountered in past data.	Misidentified environment and missed events; high error exists if high ignorance, lack of knowledge.	Unique events impact financial outcomes: Pandemic effects; discounting AI productivity gains.	Employ scenario analysis; Tail risk measurement; Regime measurement; Increase knowledge research; avoid active choices.
Complexity	Feature selection and modeling types that increase model alternatives.	Choosing the wrong features or modeling techniques; misspecification.	Different risk premium models can explain excess returns in asset pricing; the "factor zoo" problem.	Adding feature selection and/or adaptive modeling like Kalman filtering; Machine learning techniques.
Ambiguity	Model and theory comparisons that may be in conflict and produce different narratives.	Issue of competing theory, models, and features that are rationale but in conflict.	Different measures for valuation will generate conflicting signal (P/E, P/B, profitability); conflicting risk premia.	Ensemble modeling for comparative approaches: avoid active choices that cannot be differentiated.

The application of a VUCA checklist is evident in a review of typical cases. The checklist is organized around questions for each VUCA component. As a systematic approach, VUCA provides a reliable, repeatable assessment of the risks in financial decision-making. Any decision can use the checklist to review the risk environment. For each of our three case examples, the investment decision-maker can ask a series of questions for each VUCA category, then assess the risks, identify missing information, examine a model or narrative limitations, and note any points of ambiguity.

Case 1: *Defining Portfolio Risk Through VUCA*

A portfolio's risk can be filtered through the VUCA framework. What is a portfolio's volatility, and can it be effectively forecast? What is the portfolio's uncertainty based on noncountable events or subjective risks? Are there risk factors that have not been included or properly measured that are related to complex relationships between assets and market events? Is there ambiguity concerning beliefs about the portfolio drivers, or are there conflicting views concerning the models used to describe risk?

In this case, the portfolio manager may choose to reduce the size of positions or active shares within a portfolio, given that correlation risk is under-identified, and volatility may be higher than indicated by past standard deviations.

Case 2: *Defining Inflation Risk Through VUCA*

The VUCA framework can be employed to describe a more specific macro event, such as the inflationary environment, using a simple checklist. What is the volatility of inflation? Is it clear how to measure the change in inflation? Is there an understanding of inflation uncertainty beyond time series volatility? Is there something about inflation that we cannot count and will have to be subjectively evaluated? What is the relationship between inflation and asset returns, oil price shocks, and wage growth? Is the current inflation environment like past inflation episodes? What is the relationship between monetary policy and inflation? Where is there ambiguity about inflation forecasts (conflicting models)?

In this trading decision case, the VUCA analysis suggests extrapolation or time series analysis of inflation may under-represent the true measurement risk. This assessment may lead to the avoidance of trades until there is added knowledge about the inflation process and link with asset prices.

Case 3: *Unique Regime Change Event Through VUCA*

The VUCA framework can be beneficial for unique events that have not been captured in past data. For example, the COVID pandemic, the tariff wars, and geopolitical events are all events that impact volatility, which may not be adequately measured, are uncertain because they are non-countable events, complex given the inability to see connections across markets, and ambiguous because there may be competing models that are rational but may not prove to be correct. Unique regimes can be categorized using the VUCA framework.

For regime changes that are unique events with no historical precedent, a solution may include broader scenario analysis of possible outcomes or ensemble modeling to account for different approaches to uncertainty and ambiguity.

The VUCA analysis may provide more credible (Bayesian) bounds on possible risks. Nevertheless, a financial VUCA framework does not eliminate the need to assign probabilities and expected outcomes, as in the classic SEU framework, nor can it generate an optimal portfolio or provide a downside measure such as VaR. The framework can support better risk decision-making by revealing potential errors or why a formal, process-driven decision may be misleading. VUCA thinking can support risk assessments that may otherwise be given more precision than is appropriate; consequently, the use of VUCA is an adjunct or complement to existing frameworks, not a substitute.

Responding to VUCA is a problem of bounded rationality (Simon, 2013), which focuses not only on the cognitive limitations of decision-making, the purview of behavioral economics, but also on the time available to make decisions, and whether there is sufficient reliable information for informed decision-making. VUCA assumes that information limitations make decision-making difficult; therefore, "rules of thumb" should be developed to support decision-making under time, information, and processing constraints. Assessments using a broader methodological framework support decision-making in the face of bounded rationality and serve as a methodological check on existing risk assessment frameworks.

5. Conclusion

Clarifying the risk environment is more than just measuring volatility, and to be useful operationally, needs to define the risks faced and not just generate subjective expectations; however, the investment decision domain differs from a business strategy problem and requires a different decision-making approach, whether it involves forecasting daily price movements or deciding on long-term financing for investment projects. A useful risk assessment must not only address what is measurable and knowable, but also clarify what is unknown, what cannot be counted, and what may be hard to assess. A structured risk assessment framework based on volatility, uncertainty, complexity, and ambiguity (VUCA) provides a means to assess the risk environment. VUCA defines the types of risk faced, identifies what is unknown, measures what is known, and assesses complexity and the vagueness between models, supporting better decisions and addressing the critical trade-off between knowledge and ignorance. Risk assessment through volatility is a counting measurement problem. Uncertainty is a noncountable problem and often an issue of ignorance management. Complexity arises from the challenge of identifying the correct factors for causal inference, and ambiguity must be addressed to balance the trade-off between competing rational explanations, which may not all be accurate.

This paper provides a specific VUCA framework that can be used as a repeatable process for financial risk assessment for investment decisions. Decisions based on these factors require trade-offs; more importantly, these risk categorizations frame how to structure better decisions beyond the standard expected utility framework. Financial and investment managers can prepare for risky environments and situations that the four key VUCA factors may characterize through a structured decision process. The type of decision preparation required, given these four factors, is determined by the environment that must be navigated. By addressing VUCA through a structured categorization framework and checklists, risk can be assessed and managed more effectively, even if it cannot be eliminated.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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