

# A Proposed Framework of CEO Risk Preference, Climate Change Risk and Opportunities with Firm Performance

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## Abstract

**Purpose:** The impact of climate change risk on firm and business performances resulted in several financial climate change authorities developing many frameworks. However, Chief Executive Officers (CEOs) risk preferences are somehow scarce among the dominant frameworks. Hence, this study is purposely designed to consider how CEOs risk preferences can respond to climate change risks and related opportunities to influence firms' performance.

**Design/methodology/approach:** Descriptive research design is the method adopted by this framework.

**Findings:** The framework conceptualizes how risk-seeking behaviour can lead CEOs to improve firms' performance by seeking climate change risk and framing probabilistic climate change opportunities. It also describes how risk-aversion behaviour can bound CEOs to influence firms' performance by avoiding climate change risk and framing certain climate change opportunities.

**Research limitations/implications:** This framework focuses on behavioural theories, especially Prospect theory. Hence, decision-makers need to obtain knowledge of Prospect theory elements such as reference point, value function, decision weights, framing, and choices.

**Practical implications:** This framework can benefit various decision-makers such as policymakers, investors, shareholders, scholars and other stakeholders globally. However, users should get relevant practical experience and valuable skills to apply CEOs' risk preferences.

**Originality/value:** The novelty of this framework can be linked to how CEOs' risk preferences bounds CEOs to seek or avoid climate change risk and frames climate change opportunities to influence firms' performance. CEOs can seek risk to continue with high carbon business or avoid risk due to mitigation of climate change risk.

**Keywords:** Climate change risk and related opportunities, firm performance, CEOs risk preferences, risk-seeking and risk-aversion behaviours

## Introduction

Firms' returns seem to be impacted by changes in climate conditions due to temperatures and another effort to mitigate the climate change risk, among others (Schroders, 2020). Climate

change risk is considered a risk that leads to increases in losses and damages to the financial sectors' assets (Reale, 2020). Besides, climate change risk seems to bring potential opportunities to firms and businesses. Task Force on Climate-related Financial Disclosures (TCFD) considers climate change opportunities as "the potential positive impacts of climate change on an organization" (TCFD, 2017). Opportunity is defined as the potential increase in the demand for financing and investment services (Connell et al., 2020). Perhaps, novel opportunities arise from climate change risk, such as investment in renewable energy (RE) and low emission energy (LEE) like biofuel, among others (Susskind et al., 2020), tend to improve firms' performance (Roman Pais Seles et al., 2018). Hence, investors and stakeholders demand strategic information to enhance firms' responses to climate change risks, gain opportunities (Financial Stability Board, 2021), and improve performance. Several authorities like Prudential Regulation Authority (PRA), among others, show how firms and businesses can respond to climate change risk and gain opportunities (Authority, 2019; Reale, 2020). Perhaps, these perceptions can be possible by integrating climate change risk strategies with prevailing risk management models, risk appetites of board members and proper regulations, among others. Perhaps, improving climate change risk management may support the transition to a low carbon economy (Reale, 2020). Besides the conflict of interest between shareholders and top-level executives (Hoskisson, Chirico, Zyung, & Gambeta, 2017), there is a scarcity of frameworks under the risk preferences of Chief Executive Officers (CEOs) in response to climate change risk and related opportunities. The upper echelons theory (UET) of bounded rationality (Barros, 2010) considers value as a psychological property that reflects CEO risk preferences, but it receives the slightest consideration (Hoskisson et al., 2017). Hence, the purpose of this framework is to conceptualize how CEOs' risk preferences can enhance corporate responses to climate change risk and increase potential opportunities arising from climate change risk to affect firm performance.

Risk preferences is a behaviour that "reflect the CEO's attitude towards risk and the company's operational philosophy in a situation of high risk and high return" (Zhao, Niu, & Chen, 2020). CEOs' risk preferences refer to decision-makers' psychological attitudes towards risk (Zhao et al., 2020). This study considers CEOs' risk preferences as behavioural strategies that bound CEOs to respond to climate change to seek or avoid risk and frame opportunities arising from climate change to choose either probabilistic gains or certain losses to achieve significant firms' performance. Several elements of behavioural theories especially prospect theory and other practices (such as sustainable reporting, professional skills and experiences) are assume to bound individual decision-makers like CEOs into risk preferences (Kahneman & Tversky, 1979; Wong, Jalaludin, & Phua, 2019). Certain outcomes may lead CEOs into risk aversion behaviour, while probabilistic outcomes lead to risk-seeking behaviour (Kahneman & Tversky, 1979). Risk-seeking behaviour is considered a strategy that allows CEOs to seek climate change risks to continue with regular business models under a high carbon position and choose probabilistic climate change opportunities to improve firms' performance. However, risk-aversion behaviour is a behavioural strategy that leads CEOs to avoid climate change risks by sustaining losses and choosing certain climate change opportunities to improve firms' performance. Organizations of the Treadway Commission (COSO) and World Business Council for Sustainable Development (WBCSD) presumed CEOs to display behavioural strategy as bound by internal and external factors (COSO-WBCSD, 2018; Zhao et al., 2020). Strategies in response to climate change risk may lead firms to share risk with customers and gain several opportunities such as financial support from banks (Connell et al., 2020), to name a few. Hence, these insights objectively strengthen this paper to conceptualize how CEOs can strategically respond to climate change to seek or avoid the risk and frame opportunities arising from climate change to achieve significant firm performance. These insights seem to open some questions, such as whether integrating CEOs' risk preferences into corporate firms'

strategies can lead CEOs to respond to climate change to seek or avoid the risk? Can framing opportunities arising from climate change improve firms' performance? This concept can benefit policymakers, potential investors, shareholders, scholars and other stakeholders globally. Policymakers can apply this concept to solve strategic climate change issues. Likewise, scholars, potential investors, shareholders, and stakeholders can use the framework in response to climate change risks and frames of its related opportunities. In addition, this concept contributes to the behavioural theories related to human cognition and psychology as they are somehow scarce in management studies (Daddi, Todaro, Giacomo, & Frey, 2018; Jofre, 2011).

Taking into account the above, the objective of this paper is to propose a framework that focuses on integrating CEOs' risk preferences in response to climate change risks and related opportunities which could influence firms' performance. The remainder of this paper is structured as follows. Section 2 presents literature reviews. Then section 3 contains the conceptual framework, while the implication of the concept follows in section 4 and the conclusion in section 5.

## **2 Review of literature**

### **2.1 Introduction**

This paper reviews literature related to climate change risk and its' related opportunities, CEOs' risk preferences, corporate firms' strategies and performance.

### **2.2 CEOs risk preferences, climate change risk and corporate firms' strategy.**

Climate change risk results from physical and transitional climate changes, impacting firms' operations, revenues, expenditures, assets, liabilities and capital (TCFD, 2017). TCFD consider two dimensions of climate change risk namely physical and transition risks. Physical climate change risk is a risk that adjusts climate patterns due to warming of the planet produced by GHG emissions (like Carbon Dioxide among others), which its outcomes resulted to losses and damages of physical assets, natural capital, products and other firm values (Battiston, Mandel & Monasterolo, 2019; Lord, Bullock, & Birt, 2019; NGFS, 2019; TCFD, 2017). A lot of empirical studies (Addoum, Ng, & Ortiz-bobea, 2020; Chenet & Ryan-collins, 2019; He & Ma, 2021; Tang, 2019) shows how uncertainty around physical climate change factors such as mean and extreme temperatures and other weather events to negatively affect firms performance (such as stock returns and prices of options). However, CEOs with a higher risk preference may likely improve firms' performance (Zhao et al., 2020). Perhaps, these perceptions lead Botzen, Duijndam, & van Beukering, (2021) to consider climate change factors such as recurrent natural disasters to have low probability–high consequence risks.

Transition climate change risks (TCCR) are risks factors "arising from society's response to adapt to physical changes and to mitigate further change" (Benedetti, Biffis, Chatzimichalakis, Fedele, & Simm, 2019). TCCR contains carbon risk factors that normally pose "non-physical climate change risk" such as policies risk, stranded assets risks, Credit risks, technology risk, market changes, reputational risks and shifts in consumer preferences, among others (Chenet, Thomä, & Janci, 2015). Carbon risks are risks associated with the transition to a low-carbon economy. The market risk stems from asset depreciation on financial markets, leading to balance-sheet losses (Bolton et al., 2020). Credit risk is an outcome of nonpayment probability and challenges of high leverages. Stranded assets can be considered assets that have suffered unanticipated or premature write-downs, devaluations, or conversions to liabilities (Ansar, Caldecott, & Tilbury, 2013; Caldecott, Howarth, & Mcsharry, 2013). Policy risks are risks associated with changes in policies related to climate change. In contrast, stranded asset risk is a risk that leads to assets' deferment due to lower prices, higher production costs and carbon taxes, among others (Caldecott, 2015; Krueger, Sautner, & Starks, 2019; Pearce, 2015). Some indications show how several firms hold their assets at high risk of climate change, while most exposures and resilience are poorly understood (Lord, Bullock, & Birt, 2019). Perhaps, these circumstances confirm how the impact of climate change risk can influence the future growth of firms' risk management, business strategies, and financial performance over time (TCFD, 2017; Rashid, Ali, & Hossain, 2020). Hence, these risk factors seem to stress the need to integrate climate change risk, especially CEOs' risk preference into corporate firms' strategies. Integration of climate change risk into corporate firms' strategy may lead risk preferences of CEOs to improve responses to climate change risk. Integration of climate change risk (ICCR) is considered a feature of organizational capabilities that lead corporate firms to incorporate climate change issues into their strategic planning process (Lee & Ahn, 2019). Integration of climate change risk into firms' strategies may lead to understanding and connecting organizational capabilities with managerial perceptions of environment-related risks and opportunities (Lee & Klassen, 2016). Numerous authorities (Authority, 2019; Reale, 2020; TCFD, 2017) presented some frameworks to support corporate firms to integrate climate change risk with firms' strategies, prevailing risk management models and risk appetites of firms' board members. Likewise, many scholars (Daddi et al., 2018; Lee & Ahn, 2019) deliberated on a broader range of corporate firms' risk management strategies related to climate change issues. For example, the work of Lee & Ahn, (2019) confirms how an organization can sense the potential impacts of climate change and seek its related opportunities under the context of climate entrepreneurship. Theoretical review by Daddi et al., (2018) shows how firms consider climate change as a strategic issue rather than a societal or ethical issue under strategic management. So far, the above perceptions may lead corporate firms to direct CEOs to respond to climate change to seek or avoid risk and gain related opportunities to improve firms' performance.

CEO risk preferences are considered risk-seeking and risk-aversion behaviours that strategically lead CEOs to respond to climate change to seek or avoid risk and frame opportunities arising from climate change to improve firms' performance. Risk-aversion behaviours are behaviours that appear to persuade decision-makers to choose certain outcome against probabilistic outcome (Olmastroni, Guidi, Martini, & Isernia, 2021). Decision-makers under the risk-aversion domain, end off in avoiding risk and choosing exposures to losses such as insurance cost among others (Kahneman & Tversky, 1979; Osberghaus, 2016; Tversky, 1992). Under climate change risk, Botzen & van den Bergh, (2012) contended how risk-aversion cause individuals that demand for flood insurance to pay higher than the expected value of the flood risk. So far, these evidences seem to validate how risk-aversion behaviours (RAB) claimed to lead decision-makers to overweight small probabilities which consider as

"certainty effects" under prospect theory (Kahneman & Tversky, 1979). Evidences show sizable aversion to debt financing persuade CEOs not investing internal generated funds (Guenzel & Malmendier, 2020; Trumpp & Guenther, 2017). To some extent, CEO risk-aversion became a significant economic factor among firms with a high probability of risky debtor defaults (Milidonis & Stathopoulos, 2012), as it led to avoid possible failures from risky projects and other defaults. So far, the significance of CEO risk-aversion behaviour may persuade corporate firms to integrate CEOs' risk preferences into their strategies to avoid climate change risk by choosing certain losses to improve firms' performance. Risk-seeking behaviour encourages CEOs to choose probabilistic outcomes to make gains and avoid losses (Kahneman & Tversky, 1979; Olmastroni et al., 2021). Under the context of climate change risk, RSB may lead CEOs to end off in underweighting (moderate and high) probabilities as hypothesized by Osberghaus, (2016) and depicted in figure 1. Kahneman & Tversky (1979) described decision-makers under the risk-seeking domain (RSD) as risk seekers who avoid losses and make gains. Several decision makers disposed into RSB under negative (harm) environments, which is considered the "reflection effect" (Baucells & Villasís, 2009; Tversky & Kahneman, 1981). Empirical studies show how RSB can support CEOs to influence corporate decisions. CEOs can undervalue firms' shares, decrease shareholders' wealth (by investing cash in risky projects) to capitalize on wealth (Anilov & Ivashkovskaya, 2020; Burns & Roszkowska, 2016; Geiler & Renneboog, 2016; Zolotoy, O'Sullivan, Martin, & Veeraraghavan, 2019). Likewise, CEOs with a high level of risk preferences were found willing to accept a higher value of goodwill (Zhao et al., 2020). So far, these perceptions seem to permit this study to conceptualize how CEOs can respond to climate change to seek risk and frame to choose probabilistic opportunities that arise from climate change to improve firm performance. Several scholars (Baucells & Villasís, 2009; Osberghaus, 2016; Vandenbroucke, 2016; Zhao et al., 2020) motivated this study to conceptualize CEOs' risk preferences under the context of Prospect theory.

Prospect theory is a behavioural model that determines the expected utility of decision-maker to a reference point of current wealth position by framing of the outcome, editing and choosing a probabilistic gain or certain loss from risky and uncertain decisions (Kahneman & Tversky, 1979; Kliger, Tsur, Kliger, & Tsur, 2011; Tversky, 1992; Tversky & Kahneman, 1981, 1986; Vandenbroucke, 2016). As shown in Figure 1, a reference point is a "status quo wealth" that permits gains and losses to be relatively weighed in a different way (Starmer, 2000). However, the value function is a "nonlinear transformation of the probability scale" that overweight small-probabilities and underweights moderate and high probabilities (Tversky, 1992). Value function ( $v$ ) presumes to be concave for gains, convex and steeper for losses and able to change the monetary value of the outcomes to reflect the decision-makers risk preferences on the level of wealth (Vandenbroucke, 2016). Summation of value and probability transformations perhaps determines individual risk attitudes (Kahneman & Tversky, 1979). Probability transformations reflect the weight an individual decision-maker assign on specific probabilities to protect themselves from a particular risk. Value function and probability-weighting function are hypothetically depicted in figure 1 (Osberghaus, 2016).

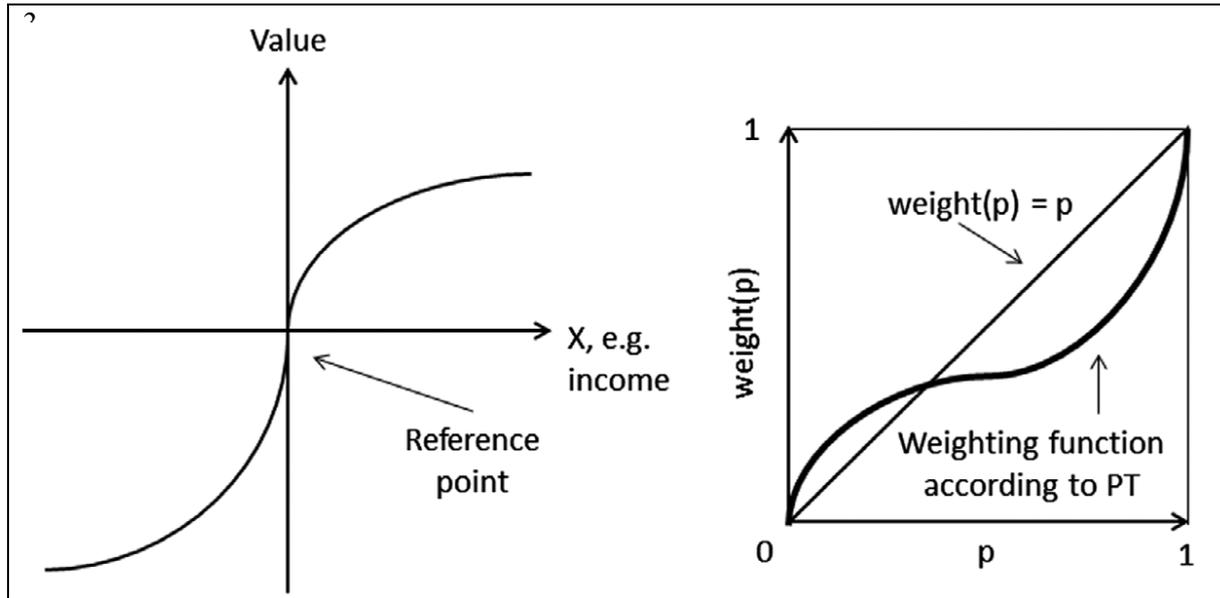


Figure:1 Hypothetical value function at the left panel, while probability weighting function on the right panel (Osberghaus, 2016).

Prospect theory assists (individual) decision-makers to solve choice problems through choosing prospect(s) that dominate others, removal of common components among prospects and comparing of values (Tversky & Kahneman, 1986). The choice process has two phases, the framing and editing phase, followed by the evaluation phase (Kahneman and Tversky 1979). The framing and editing phase consist of all the preliminary analysis of the decision problem, such as frames of the influential acts, contingencies and outcomes. The framing effect is considered a cognitive bias that affects the degree to which individuals are preferred to make risk-seeking or risk-averse choices based on how a scenario is presented (Tversky & Kahneman, 1981). In comparison, the evaluation phase deal with the evaluation of choice with the highest value. Empirical studies (Hameleers, 2021) in the United States (US) and the Netherlands under Coronavirus (Covid, 19) determine how frames lead to a slight risk-aversion intervention such as lockdown, while loss frame effect risk-seeking behaviours like frustration and powerlessness. Likewise, Doerfler et al., (2021), who tested the effects of message framing and personality (Dark Triad traits) among US adults, found both gain and loss framing influenced risk choice in response to COVID-19. However, their result shows how individuals were more risk-averse in the loss condition compared to the benchmark established by Tversky and Kahneman (1981).

**2.3 CEOs risk preferences, climate change opportunities and firms' performance.**

Empirical evidence (Malmendier, Tate, & Yan, 2011; Roman Pais Seles et al., 2018; Zhao et al., 2020) connected CEOs' risk preferences, climate change opportunities and firms' performance. CEOs with a higher risk preference are more likely to improve firms' performance through the asset-liability ratio of enterprises (Malmendier et al., 2011) and by accepting a higher value of goodwill (Zhao et al., 2020), among others. Prospect theory established how outcomes can be perceived as probabilistic gains (positive) or certain losses (negative) in line with the way reference outcomes are presented (Kahneman & Tversky, 1979; Tversky & Kahneman, 1981, 1986). Probabilistic gains arise when the prospects impact wealth positively, while certain losses are incurred when prospects impact wealth negatively. However, the discrepancies of the reference point may likely result in an outcome becoming

gain or as a loss. At the same time, shifts of reference transform the value difference between outcomes and thus reverse the individual preference order between options (outcomes). Under the context of climate change, Osberghaus, (2016) observed current climate change as the reference point, its impact as losses, while adaptation or mitigation measures as a medium to reduce its losses. This position may give opportunities (option) to decision-makers to choose either climate adaptation or mitigation or between technical and financial adaptation measures. In the same direction, climate change opportunities may improve firms' environmental, financial, and operational performance (Connell et al., 2020; Roman Pais Seles et al., 2018) such as finance or investment in biofuel, heating and cooling among others (Agency, 2015; Connell et al., 2018; Susskind et al., 2020). A lot of firms and business CEOs, gains financial opportunities through investment in new products (like electric vehicles and RE storage), accessing new markets, resource efficiency and adopting other technological innovations (Krueger et al., 2019; Paisley & Nelson, 2020; TCFD, 2017). For example, Tesla and Toyota grow their revenue of electric (hybrid) vehicles and make some market gains (Lee & Ahn, 2019) through climate change-related opportunities. However, some opportunities (such as new investment, new product/services) may lead to changes in operational costs (Gasbarro, Iraldo, & Daddi, 2017) due to changes in climatic risk factors such as regulations, market forces and reputation among others. Perhaps, these sensitivities can motivate investors, financial authorities and other stakeholders to look for strategic information on how to enhance climate change opportunities (Financial Stability Board, 2021). So far, this perception strength this study to assume CEOs to frame opportunities arising from climate change to improve firms' performance.

#### **2.4 Boundaries to CEOs' risk preferences.**

Several elements of prospect theory (such as risk-seeking and risk-aversion behaviours, reference point, value function, decision weights, frame and choice, to name a few) and other practices are assumed to bind CEOs to respond to climate change and frames its related opportunities to improve firms performance. Framing and evaluation (Kahneman and Tversky 1979) are considered the main phases of the choice process and as elements of cognitive bias (Tversky & Kahneman, 1981). As such, they may lead decision-makers to shift their risk preferences, predict compelling performances, contingencies and outcomes of risky decisions (Doerfler et al., 2021; Hameleers, 2021; Kahneman & Tversky, 1979; Olmastroni et al., 2021). In addition to norms, habits, and expectations of individual decision-makers, the evaluation phase of the choice process may bind CEOs into risk preferences in line with how the problem is presented (Tversky & Kahneman, 1986). Other factors like value function and decision weights (Botzen et al., 2013; Kahneman & Tversky, 1979; Tversky, 1992; Vandenbroucke, 2016) may also bound CEOs to change the monetary value and probabilities for outcomes to reflect their risk preferences. Hence, CEOs may begin to overweight small probabilities due to "certainty effects" and underweights moderate and high probabilities due to the "reflection effect."

Various practices such as professional skills and experiences related to sustainability reporting, climate change policies, shareholders' value, risk appetites of the board of directors and stakeholders' interest may bound CEOs into risk preferences. Risk appetite is a preference for compliance with a sequence of interrelated uncertainties towards achieving organizational strategic goals (Allan, Cante, Godfrey, & Yin, 2013). The risk appetites of board members may bound CEOs into risk preferences due to awareness of firms' risk management and accountability for the firms' long-term success (COSO-WBCSD, 2018; Williamson, Satre-Meloy, Velasco, & Green, 2018). Shareholders, for instance, may bound CEOs to seek risky

projects even if it means pushing the firm at high climate change risk (Cossin & Lu, 2021). Perhaps, some shareholders grant equity-based incentives to CEOs to lower their risk aversion behaviours and increase risk-seeking ("taking") to satisfy their value and reduce agency costs (Hoskisson et al., 2017). In addition, future policy outcomes may lead CEOs as individual decision-makers into risk-aversion or risk-seeking behaviours (Olmastroni et al., 2021). In addition, sustainability reporting seems to bound CEOs into preference for climate change risk and emission of carbon dioxide. A lot of countries such as Malaysia for instance mandated all its public limited companies (Plc) since 2016 to prepare and present their sustainability reporting (Wong et al., 2019). In fact, listing requirements (Practice Note 9) of Bursa Malaysia required annual report to comprise sustainability statement related to economic, social and economic risks and opportunities of the firms. Perhaps, this policy may influence firms' CEOs to seek or avoid climate change risk and choose opportunities arising from climate change to improve firm' performance. These perceptions portray how a mixture of theoretical and other practices may likely bind CEOs to prefer to respond to climate change to seek or avoid risk and frame to choose opportunity arising from climate change risks to improve firm performance.

### **3. Conceptual framework**

This paper attempts to conceptualize how CEOs' risk preferences can respond to climate change risk and how to frame and choose opportunities arising from climate change risk to affect firms' performance.

#### **3.1 CEOs risk preferences and climate change risk**

CEOs are assumed to respond to climate change to seek or avoid risk. Perhaps, risk-seeking and risk-aversion behaviours believe in supporting CEOs to achieve this objective. Risk-seeking behaviour is expected to support CEOs to seek climate change risk, while risk-aversion behaviour is expected to sustain CEOs to avoid climate change risk. Hence, this study divides climate change risk into seek-able climate change risk and avoidable climate change risk.

##### **3.1.1 Avoidable climate change risk and risk-aversion behaviour**

Avoidable climate change risk is considered an outcome of the variations in climatic conditions that decision-makers can avoid it by incurring certain losses with a low probability of occurrence and high expected value. This insight seems to corroborate with the work of Botzen et al., (2021), who consider the impact of climate change to have low probability–high consequence. Perhaps, avoidable climate change risk (ACR) factors can result from changes in policies, firm strategies, market forces, investor preferences and technological innovations, to name a few (Bolton et al., 2020; Caldecott, 2015; Chenet et al., 2015; Krueger et al., 2019; Pearce, 2015). Perhaps, relationships between ACR and risk-aversion behaviour may likely bound CEOs to prefer to incur liabilities (such as legal fees, carbon taxes and interest on default loans, among others) and additional expenditures (like investments in RE and LEE) as certain losses (negative prospect). Certain losses are somehow incurred when prospects impact wealth negatively (Kahneman & Tversky, 1979; Tversky & Kahneman, 1981, 1986). This assumption is equivalent to Botzen & van den Bergh's work (2012), which shows how individuals demand to pay higher insurance over the expected value of the flood risk. Likewise, this position seems to adapt the way negative climate beta ( $\beta$ ) increases the risk aversion of an agent (Dietz, Gollier, & Kessler, 2018; Dietz & Stern, 2015).

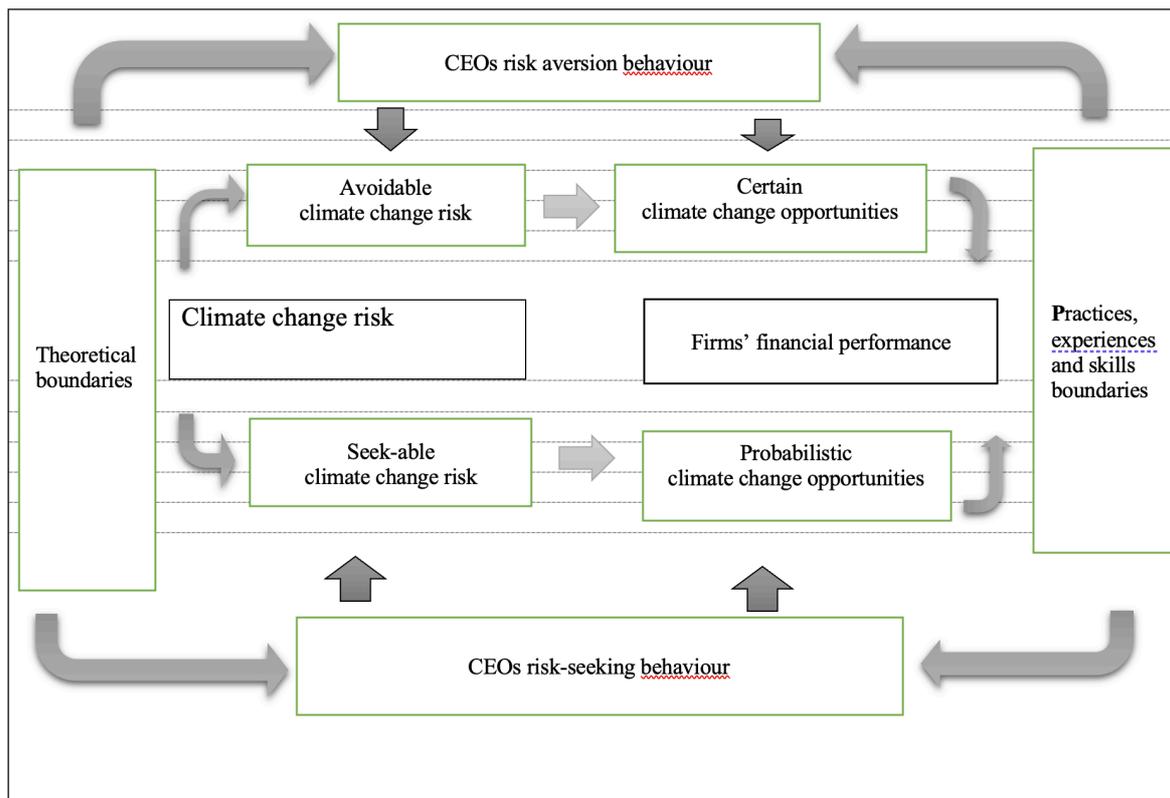


Figure 2: A conceptual framework on CEOs' risk preferences in response to climate change risk and choice of its potential opportunities. Source: Author.

### 3.1.2 Seek-able climate change risk and risk-seeking behaviour

This risk emanates from climatic changes that lead decision-makers to seek the risk even at a high probability with the low expected value to achieve their objectives. This insight seems to replicate the "reflection effect" of prospect theory that described how decision-makers seek risk and avoid losses to make gains under negative environments (Baucells & Villasís, 2009; Kahneman & Tversky, 1979; Tversky & Kahneman, 1981) like that of climate change risk. Hence, this study assumes risk-seeking behaviour to bound CEOs to seek additional climate change risk, perhaps by continuing with the usual business model under negative environments such as high carbon positions.

### 3.2 CEOs risk preferences, climate change opportunities and firms' performance

Climate change opportunities refer to opportunities arising from climate change which can be obtained by frames **and** choice of probabilistic gain or certain loss to improve firms' performance. CEOs as individual decision-makers can achieve this objective with the support of risk-seeking and risk-aversion behaviours and the tradeoff (between one another) to improve firms' performance. Risk-seeking behaviour is expected to support CEOs to frame climate change opportunities to choose probabilistic gains. In contrast, risk-aversion behaviour is expected to support CEOs to frame climate change opportunities to choose certain losses. However, CEOs can tradeoff between risk-seeking and risk-aversion behaviours to improve firms' performance, in line with how choices are presented (Kahneman & Tversky, 1979; Tversky & Kahneman, 1981, 1986). In addition, the board of directors can predetermine the

tradeoffs under their risk-appetite statements to encourage superior performance related to exposure to risks (News, 2021). Hence, these sensitivities let this study consider two types of climate change opportunities, namely probabilistic and certain climate change opportunities.

### **3.2.1 Probabilistic climate change opportunities, risk-seeking behaviour and firm performance:**

Probabilistic climate change opportunities are considered positive gains arising from climate change risk that may lead decision-makers to improve firms' performance under existing business models (EBM) or carbon-intensive business (CIB). PCOs are assumed to have a high probability of occurrence and low expected financial value. Perhaps, high probability can be related to finance or investments factors (that may increase shares and additional loans), nonfinance/investments factors such as social expenditures like Emission Trading System, and other liabilities like carbon taxes and fines. The high probability of PCO may be an outcome (replica) of the underweight effect of Prospect theory (Osberghaus, 2016; Tversky, 1992), which may lead firms to gain low expected value in the capital market. The low expected value may stem from an increase in operational costs (Gasbarro et al., 2017) due to changes in climate change risk factors like regulations, market forces and reputation, among others.

### **3.2.2 Certain climate change opportunities, risk-aversion behaviour and firm performance:**

Certain climate change opportunities are considered opportunities arising from climate change risk that can negatively lead decision-makers to choose certain losses to improve firms' performance. Certain climate change opportunities (CCO) are assumed to have a low (small) probability of occurrence and high expected value. This insight seems to align with the overweight and "certainty effects" of Prospect theory (Kahneman & Tversky, 1979; Tversky, 1992). Several pieces of evidence show how decision-makers can gain opportunities through finance or investments in RE, LEE, carbon capture and storage, among others (Agency, 2015; Connell et al., 2018; Krueger et al., 2019; Lee & Ahn, 2019; Paisley & Nelson, 2020; Susskind et al., 2020; TCFD, 2017). Perhaps, changes in climatic conditions may bound CEOs to overweight finances or investments in long-term expenditures to mitigate climate change risk to gain (such as resource efficiency and high expected value in the capital market, among others) and improve firm performance.

## **4. Discussion and Conclusion**

This paper has attempted to propose a framework that focuses on integrating CEOs' risk preferences in response to climate change risks and related opportunities that could influence firm performance. Firms' financial performance, such as return on investment, among others, are somehow affected by seek-able and avoidable climate change risks. However, various frameworks show how integration of climate change risk into corporate firms' strategy may improve responses to climate change risk and firms' performance. This concept as an extension to various frameworks related to financial climate change, describes how CEOs' risk preferences, especially risk-seeking and risk-aversion behaviours, can bound CEOs to seek or avoid climate change risks. Likewise, the study reflected how CEOs can frame opportunities arising from climate change risk to choose probabilistic gain or certain loss to affect firms' performance. So far, informative contents of this framework lead to concluded that CEOs' risk preferences can bound CEOs to respond to climate change risks and frames opportunities arising from climate change risk to affect firms' performance.

## 5. Theoretical Implications

This framework deliberated on CEOs' risks preferences under the context of behavioural theories, especially that of prospect theory, among others. Preservation of behavioural theories elements such as risk-seeking and risk-aversion, reference point, value function, decision weights, framing and choice may lead CEOs to respond to climate change risk and its related opportunities to improve firm performance.

## 6. Practical and Social Implications

This framework is an extension of several frameworks related to financial climate change authorities (Authority, 2019; Connell et al., 2020; Financial Stability Board, 2021; Reale, 2020; TCFD, 2017). So far, policymakers, potential investors, shareholders, scholars and other stakeholders as users of this framework need to consider international positions of institutions, ownership structure, the life cycle of the firms, industry-specific and environmental factors due to diversities in compensation systems and firms' performance across countries (Hoskisson et al., 2017). Likewise, the user of this framework should coordinate, learn and rethink how to transform CEOs' risk preferences strategy into different contexts of global practice. These suggestions seem to be in line with the work of Stoknes, (2014) on rethinking climate communications and the 'psychological climate paradox.

## 7. Limitations and Suggestions for Future Research

This study is limited to description of CEOs risk preference, namely risk-seeking and risk-aversion behaviour under behavioural theories especially that of prospect theory. This concept is described under the context of firms' performance in relation to climate change risk and its' opportunities. Further research can replicate this study by means of empirical or experimental studies in the same field or other context globally.

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