MODELING THE ONE CONCERN **DOWNTIME STATISTIC** (1CDS™)

Executive summary of the One Concern white paper describing the data, approach, and supporting methodologies used to estimate a granular commercial property downtime resilience statistic.

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September 30, 2021

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Introduction

As climate change exacerbates the extent to which natural hazards adversely affect commercial property and more investors focus on environment (E), social (S), and governance (G)--ESG-related disclosure, corporate, asset-owner, government, and community stakeholders focused on commercial property are calling for disclosing resilience (R) assessments to identify exposure to natural hazards. As a result, ESG + R has become an increasingly important area for new risk analytics development. One Concern, a resilience technology company, has developed a new resilience analytic called the One Concern Downtime Statistic (1CDS™) to add a property-level resilience statistic to existing risk and valuation models in order to facilitate consistent comparisons of commercial properties' hazard resilience across properties and over time. In this way, analysts can quantify and benchmark resilience using a downtime lens. This downtime statistic relies on curated data at the property level (ranging from commercial to community/residential data), which are used to characterize components of infrastructure lifeline networks (e.g., power, transportation, etc.) to reflect these networks' interconnectivity at a hyperlocal level and 'at scale' (in order to achieve global deployment) to ensure robustness, comparability, and commercial usefulness. One Concern's researchers have written a white paper describing the technical details of the 1CDS™ calculation approach and supporting methodologies. This executive summary provides an overview of this white paper's content. While this summary highlights the innovative breakthroughs and algorithms behind these newly available resilience statistics, readers interested in the details should refer to the full white paper.

Executive Summary

One Concern provides curated data and derived analytics-- with an emphasis on the One Concern Downtime Statistic (1CDS™)-- that can materially improve understanding the degree to which a commercial property is at risk due to natural hazards. The data and analytics are combined to produce a suite of resilience statistics that lead to estimates of the following risk elements:

- Damage ratio of a property at a specified location
- Downtime of a property at a specified location arising from direct property damage and from damage to power networks, transportation infrastructure, and/or communities who use the property

Overview

The resilience statistics described in this white paper will be used as input for resilience metrics such as the One Concern Resilience Score (1CRS™), which reflects both the One Concern Exceedance Probability (1CEP™) and the 1CDS™ for a given property. These metrics and statistics can be used in a variety of valuation and risk assessment applications. For example, the comparability of these resilience statistics and metrics across geographies facilitates risk selection (e.g., building 'A' is significantly more at risk than building 'B'). With a little more analytical work, these metrics can be used to estimate the One Concern Expected Financial Loss (1CEL™) to explore comparable potential loss from resilience-related dependencies and to develop resilience-adjusted valuation models. These metrics can also be incorporated into simulation-based risk models to add resilience adjustments to estimates of conditional-value-at-risk (CVaR) or expected-tail-loss (ETL) (See One Concern's Umbrella Methodology white paper for details on the 1CRS™, 1CEP™, and 1CEL™ and possible methodological extensions.) This white paper focuses on the data and methodology underlying the 1CDS™.

A particularly useful innovation in this analytical framework incorporates climate change scenarios (as defined by Representative Concentration Pathways (RCPs)) in order to investigate the underlying interaction effects among climate change and drivers of property-related loss. Using this framework, analysts can systematically integrate climate transition risk into valuation and risk models. Another climate-change-oriented application of One Concern's framework relates to assessing the cost and resilience impact of changing the energy sources for a particular property.

Improving risk selection, pricing, management, and mitigation with the 1CDS™

Resilience statistics-- such as the 1CDS™ -- and relevant curated data add value in different ways, depending on how they are incorporated into decision-support workflows. In the "Case Study" and "Discussion" sections, we present several examples and potential applications of the resilience statistics data for supporting analyses related to risk selection, pricing, and risk management. With the 1CDS™ and related curated data, asset owners and asset managers can develop better resilience-adjusted valuation models. Banks can improve their commercial real estate mortgage models. Reinsurers can use these analytics to improve underwriting and risk management for a range of covers e.g., business interruption (BI), contingent business interruption (CBI), and non-damage business interruption (NDBI). The power of this methodology lies in providing sufficiently granular data to modify existing valuation and risk models to incorporate resilience with respect to climate change and other hazards that pose risks not typically incorporated into financial models. Note that the 1CDS™ reflects not just damage to a given building, but also how businesses may be impacted by network dependencies. This moves the resilience discussion from one narrowly focused on a specific property to one broadly focused on how businesses using a particular property generate value from that property.

Another important application of these statistics focuses on developing more robust evaluations of resilience mitigation/intervention efforts. In this way, companies and regulators can better assess efforts to meet climate change-related mitigation and adaptation goals. Once the resilience adjustments are added to risk and valuation models, an analyst can explore how a proposed mitigation project quantifiably changes a property's resilience. This estimate can provide the basis for a more reliable return-on-investment estimate for a proposed mitigation, given that different stakeholders involved in commercial property can more objectively discuss changes in values, debt service costs, and insurance premiums.

Understanding different resilience modeling approaches

Resilience scores are not new as a class of useful analytics. Several broad frameworks have been developed that not only aim to measure potential risk, but also take into account the ability for leaders to take action during emergencies, such as the City Resilience Index (CRI) (Silva and Morera 2014) and the United Nations Office for Disaster Risk Reduction (UNDRR) framework (United Nations Office for Disaster Risk Reduction 2015). These frameworks use matrix approaches that require subjective assessment (often relying on self-assessments). This type of methodological approach can be more comprehensive; however, assessment subjectivity and the lack of comparable scores limit usability in property portfolios. A different approach explored by other researchers identifies proxy indicators to represent specific vulnerabilities such as the Social Vulnerability Index (SoVI) (Cutter et al. 2003) and COPEWELL (Links et al. 2018). While these scores are easier to calculate based on available data, these scores tend to be narrowly focused and are not easily incorporated into larger scenario analyses and return on investment (RoI) calculations for mitigation efforts. A third methodological approach uses tools such as IN-CORE (Colorado State University 2021) and HAZUS (Plasencia et al. 2020) to measure and estimate impacts from future shocks directly. These tools facilitate better understanding of vulnerabilities and how mitigation efforts will improve resilience. This said, these tools have been developed for use by researchers, which makes them impractical for widespread commercial application given the required extensive use of experts and access to the necessary data for practical implementation.

One Concern's approach relies on a mix of physics-based (e.g., fragility functions) and machine-learning models to generate resilience analytics at the building level in a way that facilitates comparisons across buildings, across geographies, and over time. One Concern has defined resilience as the ability of individuals, businesses, and communities (linked to a property) to resume their normal function in the face of acute shocks and long term stresses by minimizing the impact before, during, and after plausible shocks and stresses, adapting to impact as disaster events occur, and recovering from these events. By measuring direct disaster impact, the time to recovery, and the indirect impact of cascading network failures, One Concern's approach provides a holistic view of disaster risks to a specific property and how that impairment affects entities dependent on a particular property.

One Concern's methodological advantages

One Concern's methodologies and its implemented end-to-end calculation processes have the following advantages:

- Provide access to curated and formatted resilience-related data that have been ingested from a wide range of messy, disparate data sources.
- Deliver comprehensive resilience statistics and metrics that are comparable across properties and over time. These statistics and metrics create a suite of analytics well suited for risk assessment, valuation, scenario analyses, and simulations.
- Incorporate a holistic estimation of a property's functional downtime due to a hazard's direct impact as well as its indirect impact via impairment to networks, such as power, transportation, and community, upon which a property's normal functioning depends.
- Provide resilience statistics over different planning horizons that can help institutions understand cumulative risk over a planning duration of choice.

- Integrate climate-change scenarios in a robust and objective manner in order to assess climate transition risk that facilitates consistent and comparable analyses across individual properties and property portfolios.
- Leverage machine-learning to develop best-in-class resilience models. For example, One Concern has developed an innovative machine-learning model for predicting different degrees of earthquake damage to buildings. Note that often relevant model acceptance criteria lead to including a more conventional physics-based model (e.g., fragility-function based) for making damage predictions. In such cases, machine learning models used in conjunction with conventional physics-based models generate the most robust damage predictions.
- Incorporate physics-based, statistics-based, and machine-learning models to create granular (i.e., at the building or property level) statistics and metrics. Preferably machine-learning models are developed when reliable data to support model development are available. For cases where development of suitable machine learning models is not possible, appropriate physics-based or statistics-based models are implemented to make the best use of available information. An important feature of One Concern's approach relates to choosing from a menu of possible models to implement methodologies that not only perform well from a strictly modeling perforamnce perspective, but are also commercially viable in the sense that a chosen model can suitably scale and deliver useful output given data, compute, compliance, and robustness constraints.
- Apply machine learning to impute missing data and improve data coverage related to drivers of property downtime. A particularly innovative application of this synthetic data generation capability fills in components of network data (e.g., related to power, transportation, and communities) that reflect the relevant dependencies of a property's value on external networks.

- Generate an analytical framework that can easily integrate into commonly used valuation and risk models in a way that seamlessly adds resilience adjustments at relevant planning horizons. In particular, this framework facilitates comprehensive simulation-based analyses, extensive scenario analyses, and widespread sensitivity analyses.

Building credible commercializable resilience analytics

One Concern's methodologies and calculation process workflows are regularly subjected to validation exercises with advice from Technical Working Groups (TWGs) comprised of experts in relevant research areas. The validation efforts reflect application of historical data as well as comparison against published research to ensure a high level of accuracy and robustness. One Concern is also active in the broader research community focused on resilience modeling.

An important feature of One Concern's implementation of relevant methodologies (worth reiterating) relates to choosing calculation components that meet more than just model performance criteria (e.g., scalability, processing speed, robustness, diagnosability, etc.). One Concern relies heavily on its network of researchers inside the firm, within the TWGs, and more broadly, in the personal networks of this community. These interactions, in the context of the expanded range of criteria used to determine an appropriate calculation approach, provide an important benefit of using One Concern's resilience statistics and metrics. A strictly academic approach produces narrowly-focused calculation components that may not work in the context of commercial applications. A strictly commercial approach does not benefit from the innovations continually developed in the academic research community. One Concern's methodologies and calculation process workflows reflect the best of both worlds. This means that sometimes the latest and greatest machine-learning algorithm is not incorporated. This said, future developments may lead to choosing a new machine-learning algorithm for a calculation component when it makes sense. Over time, hardware capabilities, algorithmic understanding, client feedback, and academic feedback support a dynamic development approach that results in a slowly changing, but always robust, end-to-end approach to generate relevant statistics and metrics. Thus, this methodology paper may change over time; so please be sure to read the most recent version.

Glossary

1CDS™: One Concern Downtime Statistic, which provides an estimate of the amount of time a commercial property may not support normal business operations and can be a function of both direct physical damage to a property and/or indirect impairment arising from damage to supporting lifeline networks (e.g., power, transportation, and communities, etc.)

1CEL™: One Concern Expected Financial Loss, which provides an estimate of the financial losses a company may suffer as a function of the downtime for a property as estimated by the 1CDS™.

1CEP™: One Concern Exceedance Probability, which provides an estimate of the probability that a hazard (e.g., typhoon/hurricane, earthquake, wind, fire, etc.) exceeds a threshold that defines when a commercial property and/or supporting lifeline networks are damaged or impaired to the extent that the property cannot support normal operations. The 1CDS™ and 1CEL™ are conditional on exceeding the threshold reflected in the 1CEP™.

1CRS™: One Concern Resilience Score, which provides a probability-adjusted property downtime estimate and can be straightforwardly calculated as 1CEP™ x 1CDS™. A low score indicates higher resilience while a high score indicates less resilience. The 1CRS™ can be grouped into resilience ratings.

BI: Business interruption (BI) insurance provides cover for the risk of disruptions to a company's normal functioning dependent on commercial properties (e.g., offices, warehouses, factories, etc.) essential to a company's operations. This insurance covers disruption from direct physical damage to a company's commercial properties.

CBI: Contingent Business Interruption (CBI) insurance provides cover for the risk of disruptions to suppliers and customers. That is, this insurance covers disruption from problems at suppliers and customers, which adversely impacts the company even though an event may not directly damage the company buying the insurance policy. Typically, CBI is an insurance policy added to other commercial policies and not sold on a stand-alone basis.

CVAR: Conditional-Value-at-Risk measures the average extreme losses in an asset portfolio where a specific threshold is determined as the point at which extreme losses occur. Also called expected tail loss (ETL).

ESG: Non-financial factors not typically incorporated into company financial statements that become financially relevant over longer time horizons and cover categories of Environment, Social, and Governance. ESG factors focus on ethical and sustainability issues. Adding Resilience, R, to ESG extends into ethical and sustainability areas not covered by standard ESG factors.

ETL: Expected-Tail-Loss measures the average losses in the tail area of a portfolio loss distribution with the tail area determined by a specific threshold.

NDBI: Non-Damage Business Interruption (NDBI) insurance provides cover for the risk of disruptions to a company's normal functioning where commercial properties are not damaged; however, an event impairs networks (e.g., power, water, transportation, cyber, etc.) essential to normal functioning of commercial properties thereby causing business interruption.

RCP: Representative Concentration Pathways measure concentrations of greenhouse gases and are used by the Intergovernmental Panel on Climate Change (IPCC) to indicate climate-change scenarios. An RCP scenario is labeled by the positive radiative forcing (i.e., net energy increase leading to earth's warming) assumed by the year 2100 that is generated by greenhouse gas concentrations and measured in terms of watts per square meter of space on earth. An intermediate scenario is RCP 4.5, which likely results in 2 to 3 degrees celsius global warming by 2100. A more extreme scenario is RCP 8.5, which likely results in 3 to 5 degrees celsius global warming by 2100.

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