Cambridge Centre for Risk Studies

Cambridge Case Study Series

RISK MANAGEMENT FOR THE CONSUMER SECTORS

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Risk Studies

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Judge Business School

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Developing risk professionals

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About the Institute of Risk Management (IRM)

The IRM is the leading professional body for Enterprise Risk Management (ERM). We drive excellence in managing risk to ensure organisations are ready for the opportunities and threats of the future. We do this by providing internationally recognised qualifications and training, publishing research and guidance and setting professional standards.

For over 30 years our qualifications have been the global choice of qualifications for risk professionals and their employers. We are an independent, not for profit body, with members working in all industries, in all risk disciplines and in all sectors around the world.

Foreword from the IRM

This latest guidance paper from the Cambridge Centre for Risk Studies focuses attention onto the consumer goods sector - an area of vital importance for economies in both the developed, and developing world. IRM is delighted to be supporting this work on behalf of our worldwide membership and the wider global risk community.

Understanding and managing the risks surrounding global supply chains has never been more important. In addition to the traditional operating and financial risks, organisations are also facing challenges in relation to sustainability, ethics, geo-politics and digital disruption of business models.

Most organisations can produce a list of these risks in a risk register. However moving on from this basic step requires a more sophisticated, consistent and rigorous analysis. The scenario based approach developed in this report will provide useful guidance to practitioners looking for robust and objective ways of evaluating and prioritising these risks in the context of the business balance sheet, linking directly into the concerns of the board.

We hope that the risk community will now take this work from Cambridge and 'road test' it to further develop new thinking in this area.

I would like to thank all the organisations and individuals who contributed to this project and also the Cambridge team for their focused and thorough approach, bringing some new thinking on concepts and techniques into the risk management space.

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Executive Summary

Consumer spending is a vital component of world economies, comprising in some cases up to 70 % of gross domestic product (GDP). The future business prospects of consumer sector companies range widely and depend on both internal and external forces. In this case study, we highlight the application of scenario stress tests as a systematic approach to viewing potential futures and for managing emerging risks from the perspective of a global consumer sector company.

Developing a Framework for Evaluating Business Risk

Companies are increasingly focusing on managing risks to their businesses. A number of reports and surveys suggest that modern international corporations may face more risk than those of a generation ago, driven by globalisation, interconnectivity of the economy, and a changing risk landscape. Regulatory pressures and shareholder scrutiny require businesses to be more explicit about the risks that they face. Organisations are exploring different approaches to identifying, quantifying, and managing risks to their operations and balance sheet. The Centre for Risk Studies (CRS), University of Cambridge Judge Business School is contributing to this evolution of management science by setting out a formal framework for quantifying risks to a company balance sheet. This report sets out an initial methodology and process for quantifying and comparing different risks to a business. It provides a framework for evaluating the impact on the key valuation metrics of a business of six potential classes of risk, as a worked example to demonstrate a proof-of-concept of this approach.

A Fictionalised Company as a Use Case

We take a fictionalised large company, Avocado plc, drawn from similar companies in the FTSE 100. Avocado is a global leader in food and beverages that is headquartered in the United Kingdom. The example chosen is from the Consumer Staples sector, although the approach is intended to be applicable to many other sectors and businesses. The profile of the case study business is drawn from publicly available sources, and uses information modelled from several real businesses, to represent the operations, organisational structure, geographical footprint, international markets, cashflows, and profit and loss accounts of similar corporations.

Risks Faced by Businesses

The business environment for companies is as challenging today as it has ever been. Traditional dimensions of inherent risk in consumer sectors include thin profit margins, global supply chain challenges regarding operations and sustainability, and economic fluctuations affecting both retail demand and cross-border supply costs. In the 21st millennium, these risks have been augmented by ecommerce combining with changing customer values which is manifest in a plethora of disruptive challengers and paralleled by the accelerating exposure to breakdowns and attacks in cyber space. More recently, a resurgence of nationalism and retreat from globalisation has re-introduced the threat of rising tariffs. These issues are of course relevant to many sectors.

We review the self-reported risk registers from annual reports and 10-Ks of global businesses. Risk registers vary greatly from one company to another. Although there are clearly idiosyncratic risks that may be unique to an individual company, we conclude that the heterogeneity of risk registers is more due to differences taken by corporations in their identification and communication of their risks than inherent differences in the risk landscape that they operate in. We propose a more formalised taxonomy of risks to business (see Figure 8), based on a review of self-reported risk registers, a catalogue of historical case studies of distressed corporations, and other sources.

A Scenario-Based Approach

A transparent and robust method of prioritizing and evaluating risks is to represent these risks by specific instances, namely scenarios, and then to estimate the consequences of each scenario on the business as a stress test. Scenarios are regularly exploited for planning and risk assessment in the oil and gas industry and the financial services; our aim is to build on that track record to benefit wider global corporations.

We propose a method for translating each of the major classes of risk in an organization's risk register into explicit scenarios, representing how that phenomenon could occur and the ways it might potentially impact the business, with variants to cover the uncertainties. The stress testing of these scenarios on the business provides an objective way of ranking them and exploring the most effective risk management actions. This report selects six illustrative stress tests, one scenario for each of the primary threat classes in the taxonomy of risks to business:

> Scenario A - Trade Dispute: United States vs European Union
> Scenario B - Geopolitical Conflict: Pakistan vs India
> Scenario C - Cyber Attack: Contagious Malware Infestation
> Scenario D - Natural Catastrophe: Floods Damage Key Facility
> Scenario E - Pandemic: Highly Infectious Influenza Virus
> Scenario F - Governance: Equal Pay Movement

Representing an Organization for Analysis

To apply scenarios to a business requires a standardized data structure for the representation of information about the contributions of different components of a business to its overall financial performance. These components can be affected by attributes of the scenarios. We represent a business as a 'Digital Twin': a representation of the balance sheet of an organization and its future five-year earnings, deconstructed to the markets, products, production processes, and supply chains of the company, with their representative 'enterprise value' to that balance sheet. Each scenario stress test is translated to shock each of these components and thus estimate the lost value that would result, if that scenario were to occur.

A Standardized Metric for Comparing Risks

Our approach provides a method for comparing scenarios from risks with widely different characteristics in a standardized way by evaluating how each scenario impacts the processes and assets of the organization to ultimately affect the fundamentals of the business expressed as a potential monetary loss metric. This provides a consistent risk metric that is meaningful to managers. Enterprise Value at Risk is a proxy for stock price instability, and can be derived for a wide range of different types of risk.

Discounted cashflow (DCF) models are well established methods of calculating valuations of businesses. We apply a five year discounted cashflow calculation, ignoring the terminal value, to derive comparative metrics for the business with and without the scenario occurring. The difference in enterprise value over five years is the valuation at risk from that scenario, which we call the 5yrEnterpriseValue@Risk, shortened to 5yrEV@Risk.

Conclusion & Future Perspectives

Despite the unpredictability of each the types of scenarios considered, we view all six types as foreseeable in that history provides some basis for estimating future impacts. The business impact of unpredictable events can be assessed by stress test scenarios that vary significantly in scale, severity, and type of impact – they can affect any business in contrasting ways. Quantifying these risks through a single metric, 5yrEV@Risk, allows for an assessment of the materiality of individual risks to an organisation as well as direct comparison between very different risks. This provides valuable insights into the dimensions of the company's operations or financial structure that are vulnerable to these threats.

There is a broader and continuing push for transparency in recognition and declaration of risk exposure within the private and public spheres. Quantifying risk appetite and building the data and analytics to monitor a firm's performance relative to its risk appetite thresholds is challenging but an aspiration for many organisations, even for highly unpredictable risk types. A clearer picture of the link between the structure of a public company, its risk exposures and its meaningful mitigations is an ambition. Financial and governance structures also play a role in risk exposures and in assessing and mitigating risks.

The Cambridge Business Risk Taxonomy (Figure 8) provides a starting list of risk types for an organisation which has not yet built its own comprehensive list of risk drivers. Second, business stress tests are needed for emerging risks as well as shock events. Third is quantify risk mitigation activities and investments. The goal is to develop standardised processes that allow comparison of business consequences across a comprehensive library of risk scenarios and thus a transparent cost-benefit approach to managing risk appetite and resilience.

This report focuses on a quantitative view of a company's balance sheet to six stress test scenarios that represent a wide range of disparate and differing types of risk. We illustrate an approach for creating an integrated view across all risks faced by an organization and that risks with widely different characteristics can be compared in a standardized way through our 5yrEV@Risk measurement. This is shown by examples from each of the major classes of risks that are commonly found in risk registers and serves as a foundation for comparative risk assessment and understanding cost-benefit tradeoffs in mitigations.

Section 1: Introduction

Consumer spending is a vital component of world economies, comprising in some cases up to 70% of gross domestic product (GDP). This includes expenditures such as food, clothing, housing (rent), energy, transport, durable goods (notably cars), health costs, leisure, and miscellaneous services[1]. Figure 1 shows household spending as a percentage of GDP for each G7 country. The future business prospects of consumer sector companies range widely and depend on both internal and external forces. In this case study, we highlight the application of scenario stress tests as a systematic approach to highlighting the potential futures and for managing emerging risks from the perspective of a global consumer sector company.

The consumer sectors face numerous challenges today as technology continues to displace traditional business models and structures. Consumers are using multichannel purchasing experiences for more of their consumption, even large ticket items like autos are available for online purchasing with pickup from car vending machines and home delivery.[2] Within a relatively short period of time, technology has enabled many consumer-centric services and products to elevate overall experience, convenience, choice, cost-efficiency, seamlessness, transparency, and selection. Similarly, expectations of consumers have normalised such that all businesses are now judged to the same efficiency standards set by leading e-commerce companies.

Global corporations face more risks than those of a generation ago because of complexities from globalisation, interconnectivity of the economy, and a changing risk landscape. Regulatory pressures and shareholder scrutiny require businesses to be more explicit about the risks that they face. Organisations are exploring different approaches to identifying, quantifying, and managing risks to their operations and balance sheet.

Most global companies have risk departments that are becoming increasingly accountable for the risks to their businesses. Risk maturity levels of sectors vary depending on their history and level of adoption of risk management practices. By some accounts, the consumer sector companies are considered to be less mature than other sectors that have high degree of regulatory oversight, significant natural resource exposure, human health and safety, and large levels of capital investment.[3] Risk mature companies across all sectors show positive correlations to stock price performance, materially lower stock price volatility, higher stock price to earnings (P/E) ratios, and lower premiums for Director's & Officer's (D&O) insurance.[4] Good practices in risk management serve to avoid or respond effectively to crises whether the risks are recognised or emerging.

Figure 1: Household Spending of G7 Countries (% of GDP).
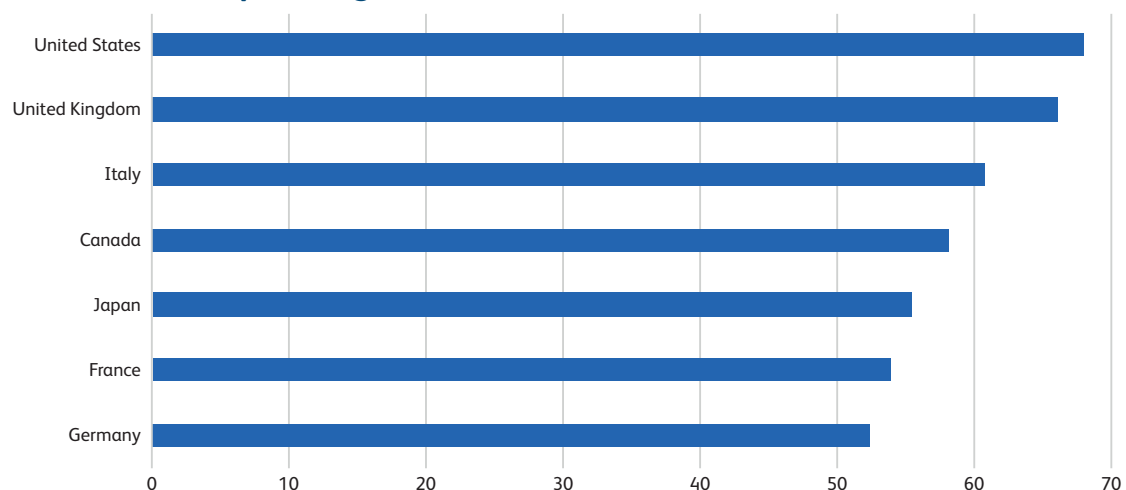
Source: Cambridge Centre for Risk Studies; Data from OECD National Accounts Statistics: National Accounts at a Glance

[1] (OECD 2019)
[2] (Kunz 2019)
[3] (Pergler, n.d.)
[4] ("Aon Risk Maturity Index" 2017)

Traditionally, risks such as recessions, reputation, consumer sentiment, business model disruptions, and supply chains have been key drivers of risk for the consumer sectors. While high severity shocks in those risk areas will always be relevant, trends such as changes in climate and social sentiment regarding environmental issues represent new classes of risks which have yet to fully manifest through company balance sheets. We argue that current risk management practices of global corporations may need to be rethought, or even reinvented to address tail risks - including processes for their identification, evaluation, mitigation, and monitoring.

This report sets out an initial methodology and process for quantifying and comparing different risks to a business. It provides a framework and proof-of-concept for evaluating the impact on the key valuation metrics of a business of six potential classes of risk through a worked example.

The research presented in this report is part of the Cambridge Centre for Risk Studies' research track on corporate risk profiling in collaboration with the Institute of Risk Management. It is informed by views from risk management specialists representing companies within the consumer sectors. The general objectives of our overall research programmes are to better understand current views, practices, and mitigations of risks at corporations and how they are adapting to meet future challenges and opportunities. While this report focusses on global corporations within the consumer sectors, we expect organisations from other sectors to find considerable overlaps on the definition and application of scenarios as part of their risk management processes.

A Fictionalised Company as a Use Case

This case study applies scenarios to a single company to highlight the potential quantitative impacts of the scenarios to its balance sheet. We take a fictionalised large company, Avocado plc, drawn as an amalgamation of a number of large consumer sector companies in the FTSE 100. Although Avocado plc is a notional firm in the Consumer Staples sector, the approach is intended to be applicable to many other sectors and businesses. The company profile is drawn from publicly available sources and information is modelled from several real businesses on their operations, organisational structure, geographical footprint, international markets, cashflows, and profit and loss accounts.

Companies within the Consumer Sectors

We refer to the Consumer Sectors as the collective for companies within the Consumer Discretionary and Consumer Staples sectors, using the terminology of the Global Industry Classification Standard (GICS).[5] Consumer discretionary is the term given to goods and services that are considered non-essential by consumers, but desirable if their available income is sufficient to purchase them.[6] Examples of consumer discretionary goods include durable goods, apparel, entertainment and leisure, and automobiles. Whereas consumer staples are essential products that consumers demand regardless of the economic conditions.[7] Examples of consumer staples include food, beverage, household goods, alcohol and tobacco.

The GICS structure consists of 11 sectors, 24 industry groups, 69 industries, and 158 sub-industries and applies to companies globally. Alternative classification standards for future consideration include the Standard Industrial Codes (SIC), and North America Industrial Coding System (NAICS).

This case study is part of the "Cambridge Case Study Series" – a collection of analyses of risk management practices of global corporations. There is more publicly available data on companies in the US and Europe than other regions and literature and media coverage of business activities and reporting in these regions tend to follow suit. Likewise, the data and analysis in this case study have greater focus on sectors and companies located in the US and Europe. Additionally, this case study covers topics relevant to publicly listed companies with traditional business models versus privately held companies.

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[5] (S&P Global & MSCI 2018)
[6] (Investopedia 2019a)
[7] (Investopedia 2019b)

Section 2: The Business Environment for Consumer Sector Companies

Consumer companies are well-positioned to benefit from an international and interconnected marketplace shaped by globalisation. On the other hand, technology continues to displace traditional business models and structures and the world faces renewed challenges to global business in the form of resurgent nationalism, protectionism, and reversals of international trade agreements - these factors certainly heighten risks to this industry. We summarise the current business environment and challenges for this sector to highlight the value of robust risk management practices for global companies.

Business Models

The growth of online activity and sales has been an on-going trend for the consumer sectors. Online shopping is growing significantly faster than brick-and-mortar stores. Online retailers brought in nearly half a trillion dollars in the U.S. over the past year, and online sales are growing between 15% and 17% per year, compared to about 5% for the overall retail industry[8]. Globally, the trend is even stronger. Figure 2 shows the dominant e-commerce companies ranked by gross merchandise value (GMV) transacted on their marketplaces. From a global perspective, Alibaba leads the pack with $768B (USD)[9] in GMV and Amazon leads the US markets with $239B in GMV.

Latest data shows that Amazon has 47% share of the total ecommerce sales in the US.[10] See Figure 3. "Amazonification" has most consumer companies feeling vulnerable to the scale, boundarylessness, and resourcefulness of Amazon. The fear of becoming just a wholesaler for Amazon looms large in the minds of many retailers. Amazon has set the standards upon which all retailers are measured with its highly responsive supply chains, competitive pricing, and product transparency.

Consumer companies have choices of either going it alone or partnering with Amazon in some capacity. High brand companies are more immune to the Amazon effect, but even they find middle ground in selling a subset of their products on Amazon while maintaining exclusivity of their higher end products. Forsaking Amazon altogether comes with the risk of being outsold by Amazon with a similar product. Partnership deals come with a heavy toll, professional sellers pay referral fees ranging from 6% to 25% with an average of 13% on each product sold via Amazon.[11] These rakes challenge their already thin profit margins.

Figure 2: E-commerce Company by Gross Merchandise Value (GMV).

Source: Cambridge Centre for Risk Studies; Data: Motley Fool, using data sources from Alibaba, Amazon, JD.Com, eBay, Rakuten, Walmart

[8] (Levy 2019)
[9] (Blazyte 2019)
[10] (EMarketer 2019)
[11] (Weinstein 2019)

Figure 3: Top 10 US Companies, Ranked by Retail Ecommerce Sales Share, 2019.
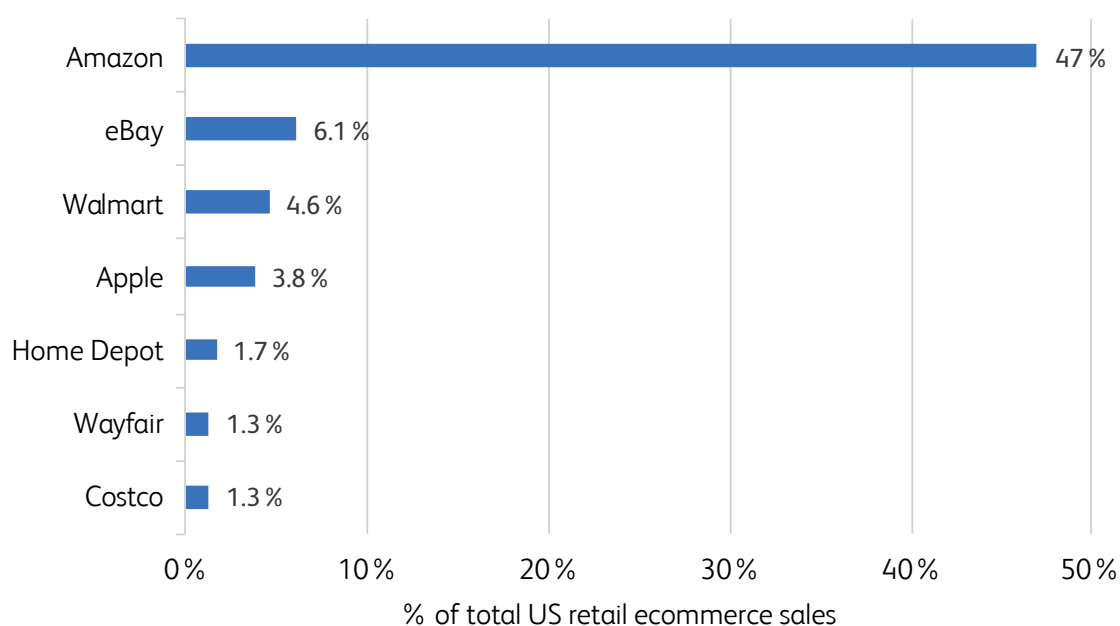
Source: Cambridge Centre for Risk Studies; Data from eMarketer, Feb 2019.[12] Note: data represents the gross value of products or services ordered via each company's website.

Use of technology, social media, artificial intelligence, digital customer profiling, targeted advertising, and targeted product selection are enhancing reach for consumer-facing companies in a cost effective manner. Conversational commerce through chatbots and voice assistants such as Alexa and Siri are gaining traction with consumers for many retail-related tasks. In the US, 21% of consumers report using voice or text agents to shop, pay bills, bank online or send money.[13] Consumer expectations continue to grow with much priority placed on their overall experience during their purchasing journeys.

[12] (EMarketer 2019)
[13] (Taylor 2018)

Profit Margins of Consumer Sector Companies

Consumer sector companies generally subscribe to low-margin business models in comparison to other sectors. Their margins may be further challenged by higher costs, tariffs, and necessary investments in e-commerce. The companies rely on consistent and high sales volumes to generate profits. Technology is extending this business model by providing access to a larger customer base for many companies; however, it is also enabling greater competition and pricing transparency, and thus putting downward pressures on pricing. Figure 4 highlights average net profit margins of consumer companies compared to those in the S&P 500 Index.

Consumer companies broadly have lower net profit margins than those in the S&P 500. During economic downturns, the consumer staples sector maintains its profits margins while the consumer discretionary sector undergoes sharp declines in comparison to the companies in the S&P 500. Rising wages due to government mandated minimum wage increases and potential regulations for the gig economy model are sources of margin pressures across this sector.[14] There are certainly specialty markets that defy these general trends such as luxury goods, high-end retailers, and other exceptions.

Business disruptions have many sources and can have immediate consequences to profitability. The impacts to profits are usually more pronounced for low margin businesses. Whether disruptions are from catastrophes or economic cycles, some companies are more resilient, and fare better as measured by different metrics. One study concludes that corporate performance follows a power curve - a small number of companies gain the bulk of global profits while the rest return just above their cost of capital.[15] These more successful companies have resilience "playbooks" that help them navigate downturns ahead of their competitors.

Supply Chains

Given the tight profit margins in the consumer sectors, supply chain effectiveness is more critical than ever. Supply chains have been characterised as either responsive or efficient.[16] Responsive supply chains allow for companies to adapt quickly to market demand, but often at a higher unit cost. Conversely, efficient supply chains allow for larger batch sizes and therefore lower unit costs but often at the expense of market or operational responsiveness.

Global sourcing has been key to the growth and health of the world economy for eons. In the 20th century this was driven by declining costs of transportation.[17] After the Second World War, international supply chains grew largely between mature economies such as the United States and Canada in the automobile industry or intra-EU trade in machinery, but that changed in the 1990s when a revolution in information and communications technology

Figure 4: Net Profit Margins of Consumer Staples & Consumer Discretionary versus S&P 500 (1999-2018).
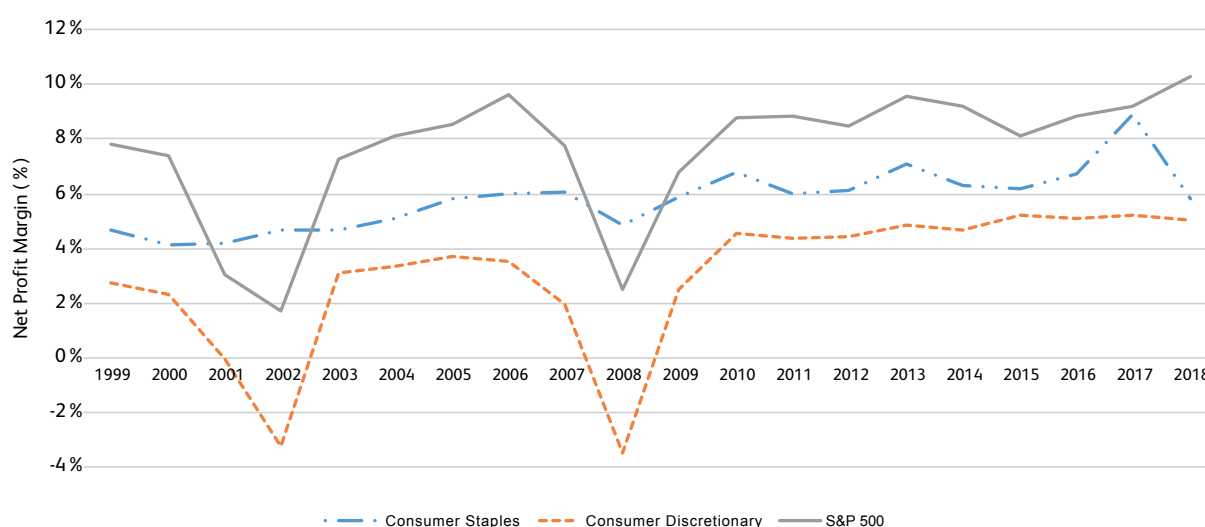
Source: Cambridge Centre for Risk Studies; Data of US companies from WRDS (sector data), S&P Capital IQ (company data)

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[14] (Morgan Stanley 2019)
[15] (Bradley, Hirt, and Smit 2018)
[16] (Randall, Morgan, and Morton 2003)
[17] (Glaeser and Kohlhase 2003)

made it possible to coordinate complexity at distance - fostering rapid growth of global sourcing from mature economies into Asia.[18] Thus, global supply chains became a keystone of world economic growth from the late 20th century into the new millennium.

With the 1990's blossoming of international and intra-regional supply chain networks came the recognition that supply chain management is not just a matter of cost reduction, but also exposure to new forms of risk.[19] Toyota's supply chain resilience strategy since the 2011 Tohuku earthquake is a prominent example of how industry adjusts its operations to manage robustness and resilience, with just-in-time processes augmented by multiple sourcing and flexible manufacturing.[20]

Strategic and reputational issues go beyond alignment of operations to balancing cost reduction against disruption risk. The 2013 Dhaka fire in the Rana Plaza tarnished the reputation of the global clothing industry and led to £6M in compensation costs to clothing retailer Primark.[21]

Legislation with extra-territorial reach such as the UK's Modern Slavery Act may be used to hold a company liable for malpractices in its supply chain anywhere in the world. These examples reflect growing transparency and regulation of supply chain practices. This trend, in synergy with the environment, social and governance (ESG) movement for responsible investment,[22] is part of a wider and ongoing conversation on role of firms in society.

At the same time, advances in technology have underpinned new channels to retail customers and offered cheaper and faster delivery. Amazon's business and operational model is the prototype of how big data and artificial intelligence combine in retail, from automated fulfilment centres to personalised advertising. The attraction of online shopping is underlined by willingness of two thirds of shoppers to pay extra for same-day delivery.[23] With consumers apparently tuned to ever more responsive retail services, fragility of supply chains to disruption will remain a top concern.

[18] (Elms and Low 2013)
[19] (Sheffi and Rice 2005)
[20] (Reuters 2016)
[21] (Butler 2014)
[22] (Kell 2018)
[23] (Small Business.Co.Uk 2017)

Risks of the Digital Economy

The exposure to cyber risks is growing most rapidly in the transformation of the retail and commerce space, where disruptive new online business models are challenging traditional business processes. Cyber risk for all businesses is changing rapidly due to explosive growth in digital attack surfaces as companies are taking advantage of digital efficiencies on consumer habits. The number of devices being operated by businesses, and number of commercial endpoints being connected to the internet are growing at rates of around 12 % annually; new active websites are increasing at over 26 % per year, and the volume of web traffic to commercial websites is typically seeing double-digit annual growth in many sectors.[24]

There is an increasing propensity for cyber-induced business interruption as companies are increasingly digitizing their supply chains. Services and assets that were once held in-house are transitioning to digitally outsourced vendors. Particularly for consumer-facing companies, physical and online financial payment systems are often provided by third-party vendors. Even the most secure organisation is vulnerable to attacks through its digital supply chain – third party vendors may compromise a large company in the process of doing business.

In a 2018 survey of 1,300 companies across the US, Canada, the UK, Mexico, Australia, Germany, Japan, and Singapore, two-thirds of companies said they have been targeted with a cyber attack costing an average of $1.1 M (USD) per attack, with 34 % of companies reporting that their operations had been disrupted.[25]

Cloud computing continues to be growing and widely adopted by companies in the consumer sectors. See Figure 5. This shared pool of resources hosted on the cloud gives companies rapid and efficient access to services; however, it also exposes companies to widespread outages and breaches. The public cloud market continues to be dominated by Amazon Web Services (AWS), closely followed by Microsoft, Google, and IBM. They operate highly secure environments, thus malicious attacks are rare; however, when outages do happen, it is usually due to operational errors or poor configuration by its users.

Highly capitalised corporations are especially vulnerable to state-sponsored cyber activities as these actors see economic opportunity and potential to gain advanced knowledge. Nation-state cyber actors can also cause systemic cyber events leading to business interruption, corruption of supply chains, theft of intellectual property, reputational damage, regulatory fines, and mitigation costs.[26]

Figure 5: Annual Growth Rates of the Big Four Cloud Service Providers.
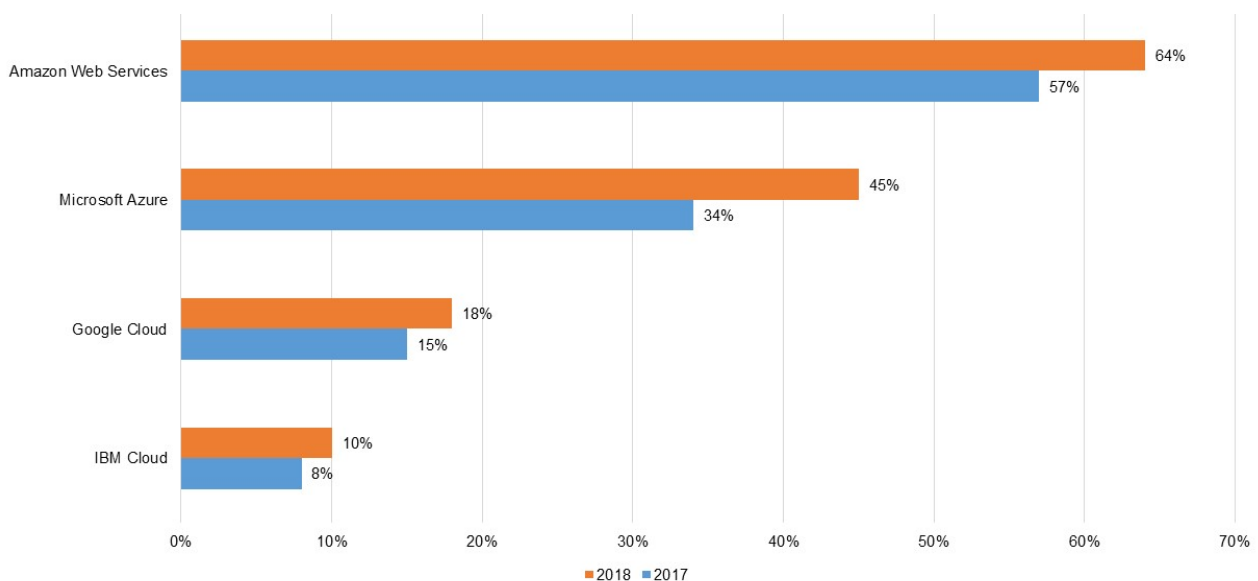
Source: Cambridge Centre for Risk Studies; Data from Rightscale, 2018

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[24] (Cambridge Centre for Risk Studies 2019b)
[25] (Cambridge Centre for Risk Studies 2019b)
[26] (Cambridge Centre for Risk Studies 2019b)

Changing Consumer Preferences

Branding is an essential aspect of a customer-facing business. Successful corporate branding portrays a company's business in line with the preferences and values of its customers. This requires aligning its true behaviours with internal and external communications, either direct or indirectly via visual associations of its business through its logo, website, images, public appearances, and third party associations. Changing societal views on consumption and consumerism are challenging existing beliefs on brand alignment of consumer products.

A corporate brand has been shown to account for five-to-seven percent of its market capitalization according to CoreBrand's Corporate Branding Index with strong brands surpassing weak brands across multiple performance measures.[27] However, brand loyalty is taking on new shades with millennial consumers. They tend to be distrustful of large corporate brand names and attracted to smaller "new" and "fun" brands.[28] This is causing established brands to rethink how to once again leverage their brands as an asset versus a liability.

The millennial generation is a rising consumer group who have distinct behaviours, attitudes, and expectation from previous generations. Millennials are by no means homogenous, but many of them share characteristics of idealism about a better world, being socially connected through technology platforms, trusting information from friends more than corporate statements, and expecting everything quickly.[29] They will profoundly impact the way companies position and market their products. Companies are gaining insights into future opportunities for their products and services by paying attention to early indicators of changes in consumer preferences.

Corporate Distress

Rising corporate debt is not necessarily worrying as borrowing is part of a healthy market economy unless repayment starts to become difficult.[30] Causes of corporate distress and bankruptcy vary widely and are the basis for much research on risk management. Descriptively, distress is associated with lost market value, inefficient production, high financial leverage, cash flow problems and high sensitivity to economic conditions.[31] Quantitatively, distress can happen when a firm's liquidation value is less than the total value of creditor claims.[32] Distance-to-default is another probabilistic indicator, measuring how close a firm is to bankruptcy.[33]

Topics on operations, supply chain, management structures, market analysis, credit and financial instruments, and other emerging risks are incorporated in most risk management plans. Precedent cases on defaults can provide insights into the failures of managing and implementing risk mitigation strategies. Clues of distress can be tracked in financial metrics, which are frequently used by risk managers as monitoring devices. Profitability, efficiency, liquidity, financial soundness, solvency, capital structure and valuation constitute the seven categories of financial metrics. Typical bankruptcy cases display worsening profitability and plummeting valuation in consecutive years before a company reaches insolvency and defaults.

Consumer sector companies can rapidly enter financial distress given their exposures to a large set of fast-moving risks. Rating agencies tend to use financial balance sheet metrics to derive probabilities of default of companies. However, sudden triggers such as trending consumer boycotts against a specific product, extreme weather during peak holiday periods, or cyber attack can cause unaccounted losses to become material to a company's balance sheet. Compounded with these exogenous risks are threats internal to businesses, such as management inertia and ineffective operation. These perils are typically unveiled with hindsight when companies become distressed or insolvent.

When trade tensions escalate, investors redeem their capital and bankruptcy filings can increase rapidly. Bankruptcies are also higher in countries such as Iceland and Denmark where there is more stringent creditor rights protection and higher judicial efficiency.[34] Explicit bankruptcy codes, existing deposit insurance together with favourable tax system encourage more borrowing, which may increase the risk of insolvency.[35] Many companies incorporate scenario analysis as part of their strategic analysis to provide insights into potential triggers of distress.

27 (Agency Inc 2016)
28 (McKinsey & Company 2019)
29 (The Boston Consulting Group 2012)
30 (Baruna and Buckley 2019)
31 (Campbell, Hilscher, and Szilagyi 2011)
32 (Chen, Weston, and Altman 1995; Hotchkiss et al. 2008)
33 (Koh et al. 2015)
34 (Claessens and Klapper 2005)
35 (Fan, Titman, and Twite 2012)

Section 3: Risks for Consumer Sector Companies

A risk lens can offer an objective business-relevant focus in considering the overall threats to a company's balance sheet. We begin by briefly reviewing the enterprise risks reported by global consumer sector companies.

Self-Reported Top Enterprise Risks by Companies in the Consumer Sectors

Self-reported risks in published regulatory accounts convey the perception of risk from at least the perspective of senior management or other responsible risk leaders within companies. Publicly listed corporations remain accountable to shareholders through their quarterly and annual reports. These reports are a corporate's main communication channel to investors and regulators, while potentially providing a backstop for securities class action litigation

contending that a corporate has not disclosed a risk. Companies listed in the US and based in the US must file a 10-K; those based abroad are considered a "foreign private issuer" and must complete a 20-F.

We also report top risks identified in Cambridge's 2018 Enterprise Risk Management report by business sector including the consumer sectors using the Global Industry Classification Standard (GICS)[36]. The top four enterprise risks are displayed by each GICS sector in the sector view. See Figure 6. Security, Reputation, Operational Performance, and Business Continuity are recognised as top risks for the consumer sectors.

To assist with the development of a comprehensive taxonomy of business risks, the Centre of Risk Studies has also compiled an extensive selection of publicly disclosed business risk registers (Cambridge Risk Register Resource). In this we reviewed company disclosures (10-Ks, 20-Fs, annual reports and risk management reports for Latin

Figure 6: Sector View of Top Enterprise Risks for Companies.
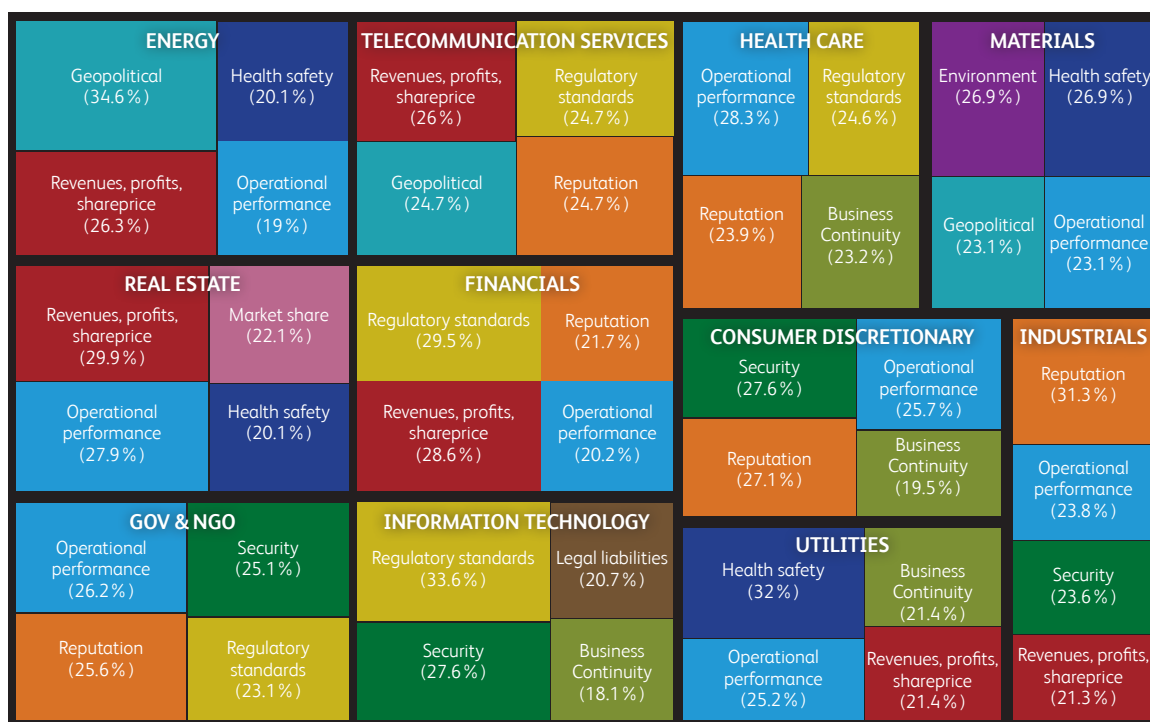
Source: Cambridge Centre for Risk Studies 2018 ERM Survey;[37] Sector classifications by GICS.

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[36] (S&P Global & MSCI 2018)
[37] (Cambridge Centre for Risk Studies 2018)

American companies) for 60 of the Forbes 100 largest public companies[38,39] based mainly in North America, Asia Pacific and European. In total, over a thousand risk factors have been identified and categorised into 20 risk categories from the 2018 ERM Survey. Figure 7 illustrates a summary of the findings by sector.

Overall, the top risk categories of concern are Revenues, profits, share price, regulatory, standards and reporting and macro-economic and trade factors. The consumer sectors' ranking is aligned to the overall top risks unlike some of the other sectors such as energy. Other commonly named risk factors include: capital project failure, climate change, cyber security and geopolitical risks.

The different vocabulary of risk factors present in annual reports highlights the need for a consistent risk taxonomy. The interchange of primary threats and consequences from threats as risk factors further emphasises this point. With the trend in risk reporting potentially migrating towards scenario based probabilistic assessment, it will be interesting to watch how companies - not just in the consumer sectors - transform their risk exposure communications.

Figure 7: Heatmap of Risk Factor Occurrence by Risk Category across GIC Sectors.

	Communication Services	Consumer Discretionary	Consumer Staples	Energy	Financials	Health Care	Industrials	Information Technology	Materials	Utilities	Grand Total
Financials - Revenues, profits, share price	7	18	11	29	84	10	10	5	8	5	187
Regulatory, standards and reporting	9	9	17	43	63	12	12	8	10	2	185
Macro-economic and trade factors	10	12	21	25	72	5	11	1	22	1	180
Market share	11	7	19	15	25	18	9	6	8	1	119
Other	8	5	14	2	17	8	5	10	6	1	76
Legal liabilities including taxation	10	7	8	4	17	3	5	7	2		63
Security of enterprise including cyber-security	3	3	10	8	15	3	3	3	3	1	52
Natural catastrophe and climate		3	5	20	11	2	1		5		47
Reputation/brand	3	3	8	2	12	2		3		1	34
Human capital	4	2	6	3	6		1	2	6	2	32
Environment and sustainability		3	4	13	1				5	1	27
Operational performance	3		3	2	7			8	4		27
Financials - Debt, pensions, and obligations	2	3			8		8	1	3		25
Business continuity and crisis management		1	3	4	1		2		1		12
Health and safety	1		6	1					2		10
Credit rating	1	1	1		2		1				6
Devaluation or damage of physical assets	1							1		1	3
Geo-political risks			1		1			1			3
Company viability											0
Gender and diversity											0
Grand Total	73	77	137	171	342	63	68	56	85	16	1088
Count of Companies Reviewed	4	4	7	11	19	3	4	2	5	1	60

Source: Cambridge Centre for Risk Studies; Sector classifications by GICS.

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[38] (Forbes n.d.)
[39] This is the preliminary results of the annual risk disclosure review.

Constructing a Comprehensive Risk Register

Many companies find value in referencing a comprehensive register of risks as part of their risk management processes. It may be created in an ad-hoc manner or more formally through committee participation. The register may include lists of the risks with which they are most familiar or external references to a wider spectrum of risks. Executives who are managing their organization are well-placed to evaluate the risks to their operations. However, it is clear from comparisons of different companies' publicly declared risk registers that businesses vary significantly in their perception of risks.

Our own surveys of executives' perception of business risk confirm those of many other benchmarking studies, that risk registers are far from being consistent, even in businesses in the same sector. For these reasons, businesses may find benefit from a more comprehensive checklist of a broader range of risks that could potentially pose strategic threats to their business plans. This could then form a framework for testing and prioritizing which risks are of importance to that individual company, as part of a systematic approach to risk evaluation.

Cambridge Taxonomy of Business Risks

When considering the business environment of any company, it is helpful to have a reference to a generalised structure representing different risk areas. For the purposes of discussion in this case study, we refer to the classes within the Cambridge Taxonomy of Business Risks in Figure 8 to guide our discussion.

The approach of the Cambridge Centre for Risks Studies is to develop a taxonomy of business risks that can span the range of threats that could potentially impact a business. We derive this from several areas of study: observations of actual examples of causes of corporate distress (Cambridge Corporate Distress Catalogue); reviews of the self-declared risk registers made public by companies in their regulatory filings (Cambridge Risk Register Resource); and extensive literature review and analysis of causes of economic and social disruption throughout a long period of history.

This taxonomy attempts to organize the universe of business risks into a typology. It is organized into six broad classes of risks: Financial; Geopolitical; Technology; Environmental; Social; and Governance. Each of these main classes has several families of risks, and a family of risks may contain many types of risk. The hierarchy of Class : Family : Type is commonly used in structures of taxonomies and provides a useful organizing principle.

We have organized risks by type into families using clustering principles of similarity and commonality. Many risk types could of course belong in several different families, and arguments could be made for individual risks to be allocated to different classes, but to avoid repetition we have assigned each risk type only once.

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[14] (Morgan Stanley 2019)
[15] (Bradley, Hirt, and Smit 2018)
[16] (Randall, Morgan, and Morton 2003)
[17] (Glaeser and Kohlhase 2003)

Figure 8: Cambridge Taxonomy of Business Risks

Financial

Economic Outlook
- Recession
- Stagnation
- Contraction
- Credit Crisis
- Steady Growth
- Expansion
- Acceleration
- Peak

Economic Variables
- Commodity Price Fluctuation
- Inflation
- Interest Rates

Market Crisis
- Asset Bubble
- Bank Run
- Sovereign Debt Crisis
- Flash Crash
- Fraudulent Market Manipulation
- Cryptocurrency Failure
- Reserve Currency Shift

Trading Environment
- Tariff Dispute
- Cartel Manipulates Market
- Organised Crime

Company Outlook
- Hostile Takeover
- Credit Rating Downgrade
- Investor Negative Outlook

Competition
- Disruptive Competitor
- Aggressive Competitor
- Fraudulent Competitor
- Intellectual Property Theft

Counterparty
- Supplier Failure
- Customer Failure
- Government Failure
- Creditor Failure
- Counterparty Fraud

Geopolitical

Business Environment (Country Risk)
- Talent Availability
- Industrial Action
- Minimum Wage Hike
- Sanctions
- Territorial Disputes
- Logistics Restrictions

Corruption & Crime
- Corruption Deterioration
- Crime Wave/Piracy Increase
- Slavery Practices

Government Business Policy
- Emerging Regulation
- Corporation Tax Rate Hike
- Diverted Profits Tax
- Nationalisation
- Confiscation of Assets
- Privatisation
- License Revocation

Change in Government
- Nationalism/Protectionism
- Left-Wing Radicalism
- Right-Wing Radicalism
- Populism
- Environmentalism

Political Violence
- Social Unrest
- Terrorism
- Subnational Conflict & Civil War
- Coup d'État

Interstate Conflict
- Conventional Military War
- Asymmetric War
- Nuclear War
- Cold War

Technology

Disruptive Technology
- E-Commerce
- Gig Economy
- Artificial Intelligence
- 5G Technology
- Blockchain
- Robotics & Automation
- Augmented/Virtual Reality
- Cryptocurrency
- Autonomous Vehicles
- Drones
- Medical Advances

Cyber
- Data Exfiltration
- Contagious Malware
- Cloud Outage
- Financial Theft
- Distributed Denial of Service
- Internet of Things
- Industrial Control Systems
- Internet Failure

Critical Infrastructure
- Power
- Transport
- Telecommunications
- Satellite Systems
- Water & Waste
- Fuel
- Gas

Industrial Accident
- Fire
- Explosion
- Pollution
- Structural Failure
- Nuclear

Environmental

Extreme Weather
- Flood
- Tropical Windstorm
- Temperate Windstorm
- Drought
- Freeze
- Heatwave
- Wildfire

Geophysical
- Earthquake
- Volcanic Eruption
- Tsunami

Space
- Solar Storm
- Astronomical Impact Event

Climate Change
- Physical
- Liability
- Transition
- Increase in Extreme Weather
- Sea Level Rise
- Ocean Acidification
- Lower Carbon Economy

Environmental Degradation
- Waste & Pollution
- Biodiversity Loss
- Ecosystem Collapse
- Deforestation
- Soil Degradation

Natural Resource Deficiency
- Fossil Fuels
- Biogeochemicals
- Raw Materials
- Water

Food Security
- Animal Epidemic
- Plant Epidemic
- Famine

Social

Socioeconomic Trends
- Ageing Population
- Gender Imbalance
- Wealth Inequality
- Poor Educational Standards
- Migration

Human Capital
- Failure To Attract Talent
- Gender & Diversity
- Labour Disputes & Strikes
- Loss of Key Personnel
- Employee Misconduct

Brand Perception
- Fake News
- Negative Media Coverage
- Key Influencer Disruption
- Negative Customer Experience

Sustainable Living
- Consumer Activism
- Sustainable Purchasing
- Supply Chain Provenance
- Diet

Health Trends
- Obesity
- Longevity
- Antimicrobial Resistance
- Medical Breakthroughs
- Healthcare
- Social Care

Infectious Disease
- Influenza Pandemics
- Coronavirus-like Epidemics
- Viral Hemorrhagic Fevers
- Preventable Disease Outbreaks
- Unknown Emergent Diseases

Governance

Non-Compliance
- Emerging Regulation
- Internal Corruption & Fraud
- Negligence
- Revised Accounting Standards
- Occupational Health & Safety

Litigation
- Private Lawsuit
- Mass Tort
- Class Action

Strategic Performance
- Divestitures
- Joint Ventures
- Mergers & Acquisitions
- Restructuring
- Poor Investment

Management Performance
- Executive Mismanagement
- Ineffective Board
- Management Execution Failure

Business Model Deficiencies
- Technology
- Customer Preference Change

Pension Management
- Contribution Management
- Fund Management

Products & Services
- Product Defect/Failure
- Innovation (R&D) Failure

Centre for **Risk Studies**

UNIVERSITY OF **CAMBRIDGE**
Judge Business School

Source: Cambridge Centre for Risk Studies, 2019 CTBR_V2.0

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Section 4: Exploration of Risks through Scenarios

Companies in the consumer sectors rely on the continued demand from their customers and therefore are particularly sensitive to the alignment of their strategies with business implementation and associated risk management planning. Given that the wider business, regulatory and societal environments are clouded by significant uncertainty emerging from a multitude of varying internal and external conditions, scenario analysis provides broad structures that are particularly conducive to the exploration of its risks.

Futures scenarios may range from a business-as-usual perspective without major disruptions to its production or consumption, or the extreme converse – massive fundamental shifts to the consumer sectors. This range of futures challenges strategic planning at companies, in particular, their risk management departments who have the added responsibilities for incorporating this wide array of futures into their standard risk frameworks.

Introduction to Scenario Stress Tests

Scenario analysis is a common approach used by managers to view organisations in an imagined state in order to assess risks and opportunities. In the 2018 Enterprise Risk Management survey,[40] 63 % of respondents said their company uses scenarios as part of their business risk analysis. Meanwhile respondents highlight that there is not a standard scenario library tool for companies to use for assessment and management of risk.

Scenarios are used to challenge the business-as-usual mentality in the context of risks, whether internal to the organisation or external/systemic, short or long term, or having the characteristic of a business disruption or a strategic shift. Perhaps the most common uses of scenarios are as stress tests, either as operational shocks or strategic challenges. This forms the basis for risk assessments and can be used to facilitate reporting, management, and mitigation of risks; and ultimately to rationalise investment in resilience. Scenarios are valued in management for developing and capturing creative thinking about plausible futures, rather than attempting to predict the timing or severity of particular events. Foreseeable risks which can be described and even quantified by scenarios are too often unpredictable regarding timing and other characteristics.

A critical distinction can be made between scenarios that examine emerging trends, which are of concern for long-term strategic planning, and those that consider catastrophes or shocks or tail risks, which represent acute threats that may trigger simultaneous impacts across an organisation and its supporting ecosystem. This report focusses on how catastrophic or shock scenarios can be used to assess risk to firms in the consumer sectors.

Since the 1970s, scenarios have been used extensively in the energy sector for exposing strategic threats to oil exploration and production associated with changing geopolitics and markets. Royal Dutch Shell brought scenario planning from the arena of national security into the corporate boardroom, foreseeing the emergence, but not the time of arrival, of the world's first global oil cartel which duly arrived in 1973 as the child of the Organization of the Petroleum Exporting Countries, OPEC. Scenario planning at Shell has also been credited with advance warning, not quite prediction but visibility of the future arrival, of the more severe price shock of 1979, the collapse of the oil market in 1986, the fall of the Soviet Union, the rise of Muslim radicalism, and increasing pressure on companies to address environmental and social problems.[41]

Catastrophe analysis has been a major factor in the success of the modern insurance industry. A modelling revolution was driven by the financial aftermath of Hurricane Andrew in the 1980s which saw the demise of many North American insurers. To clarify the goal of catastrophe risk analysis, we address two questions that are familiar when undertaking a scenario analysis. First, what is the scenario for?

We use shock scenarios to gain a better understanding of tail risk, starting with identification of a variety of extreme but low probability events, and then consider how severe their impacts might be. Second, how does examination of shock scenarios help to assess and manage risk? Workshopping scenario impacts is an effective way to improve qualitative understanding of risks which are present but not top of mind. This is a step toward quantitative assessment of risk exposures which is itself preparation for understanding the tradeoff between the value of resilience – reducing losses or capitalising on opportunities that are intrinsic to shocks - and the cost of investments in resilience capacity. The workshop approach is effective in undertaking a qualitative risk assessment on the basis of scenarios that are calibrated on real events from the historical catalogue of shocks.

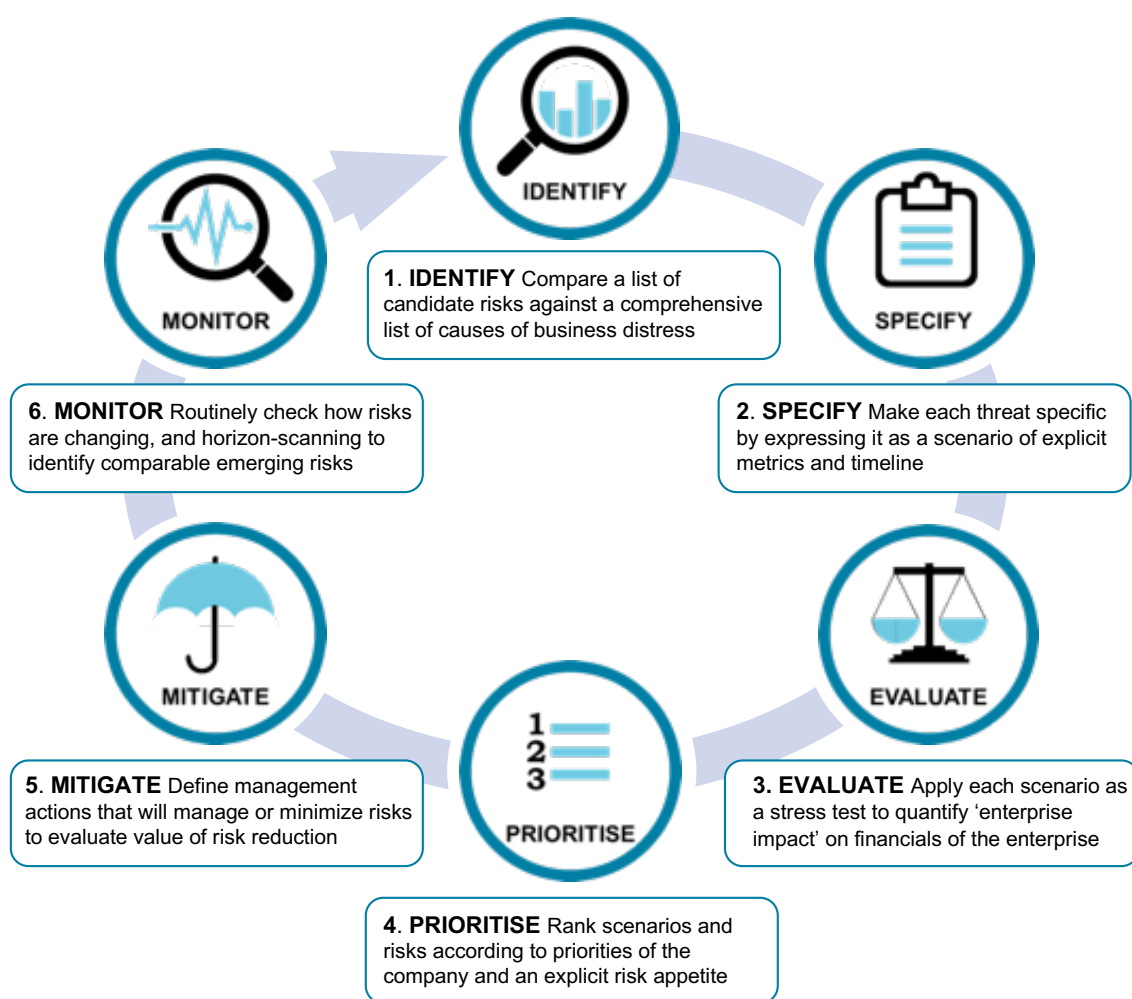[40] (Cambridge Centre for Risk Studies 2018)
[41] (Kleiner 2003)

Scenario Stress Tests to Assess Risk Exposure and the Value of Mitigations

A comprehensive risk study comprises the six steps shown in Figure 9.

Figure 9: Cambridge Risk Methodology - Risk Management Cycle.

1. **IDENTIFY** Compare a list of candidate risks against a comprehensive list of causes of business distress

2. **SPECIFY** Make each threat specific by expressing it as a scenario of explicit metrics and timeline

3. **EVALUATE** Apply each scenario as a stress test to quantify 'enterprise impact' on financials of the enterprise

4. **PRIORITISE** Rank scenarios and risks according to priorities of the company and an explicit risk appetite

5. **MITIGATE** Define management actions that will manage or minimize risks to evaluate value of risk reduction

6. **MONITOR** Routinely check how risks are changing, and horizon-scanning to identify comparable emerging risks

Source: Cambridge Centre for Risk Studies

This case study reviews the qualitative assessment of six shock scenarios. This is associated with the third stage in the cycle - Evaluate. It is worth a few details here on the prior stages of the Risk Management Cycle, which are to identify and specify scenarios. Identify, the first stage of the cycle, can be undertaken by elicitation from sample groups of staff members, who represent the breadth and depth of the organisation, and external experts; and also by reviewing the literature for threats identified or explored there. In the context of both top risks and emerging risks, this basket of activities may be called horizon scanning, and is usually undertaken in an annual process that maintains and adjusts a short list of high priority threat areas.

Cambridge Centre for Risk Studies prescribes additional structure to the identification or scanning process by producing a long and relatively static list or taxonomy of risk classes. The goal of the taxonomy is to provide a boundary for the subsequent risk discussion, not the details of particular threats that can be placed within the taxonomy

The second stage of the cycle is to specify a subset of risks from the taxonomy, to be later assessed or evaluated for business impact. Rather than consider risk types in the abstract, we prepare a long list of scenarios each of which illustrates a different threat type. Stakeholders are convened or polled to compare those scenarios. Iterating with stakeholders allows scenarios to be revised, or new scenarios to be added. Examples of scenarios selected for use in this case study are shown in Figure 10.

A preliminary, usually qualitative evaluation of scenarios by their impact is undertaken by stakeholders. The output of this is a selection of scenarios and their corresponding threat types. That is, the specify stage typically involves a preliminary assessment, with the main evaluation in the third stage to follow. A qualitative Evaluate stage may iterate in a facilitated process between expert judgement, translational work from the empirical and other research literatures, and stakeholder validation.

Beyond qualitatively evaluating risk impacts of a given scenario, a deeper study that is beyond the scope of this report would produce a set of empirical or modelled quantitative outputs, to Evaluate:
- Maximal loss for each scenario
- Probabilistic assessment leading to estimation of average loss such as annualised average loss
- Value of existing and potentially new resilience measures

The goal is a set of evaluation processes that, by consistency of methodology, allow comparison between different scenarios, and thus aggregation across all scenarios, to:
- Put a value on existing resilience capacity and to give a cost-benefit analysis of changing or investing in resilience measures
- Identify the potential for risks to scale or cascade and the paths by which that happens

Such a quantification framework requires a comprehensive library of scenario stress tests and methodology for translating scenario severity into metrics for business impact. It is beyond the scope of this case study to expand on the remaining stages in the cycle, which are to Prioritise, Mitigate and Monitor risks. Very briefly, prioritisation is in terms of threat impact, as generated by the Evaluate stage, and may also reflect mitigations: a scenario with higher impact, or mitigations that are less costly or more effective, will tend to be highlighted for management attention. Monitoring is natural in dual checking the expected effect of mitigation, and also useful in updating certain scenarios whose characteristics, such as probability of occurrence, vary over time.

Figure 10: Selected Stress Test Scenarios.

Financial
Trade Dispute
United States vs European Union
Trade tariffs imposed on imports between US and Europe
- L1 10% tariff on products
- L2 20% tariff on products
- L3 40% tariff on products
- L4 140% tariff on products

Geopolitical
Geopolitical Conflict
Pakistan vs India
Military conflict in India subcontinent causes market depression and loss of assets in India subsidiary
- L1 Regional war
- L2 National conflict
- L3 High casualty nuclear

Technology
Cyber Attack
Contagious Malware Infestation
Ransomware payload infects many endpoints in the company's network and central ERP system
- L1 Infection disables ERP 4 days
- L2 All systems down 10 days
- L3 System rebuild 3 weeks

Environmental
Natural Catastrophe
Floods Damage Key Facility
Key distribution and production facility for major lines of products are made unserviceable by floods
- L1 0.8 m depth, 2 weeks, clean
- L2 1.3 m, 3 mths, mod contam
- L3 >1.5 m, 12 mths, high contam

Social
Pandemic
Highly Infectious Influenza Virus
Extended staff absenteeism from illness and fear, with economic demand shock
- L1 2 weeks of 30% absenteeism
- L2 4 weeks, 40% absenteeism, and mortalities in staff
- L3 6 weeks, 50% absenteeism, Multiple waves over 2 years

Governance
Governance
Equal Pay Movement
Company's pay disparity between genders gives rise to employee action and to reputational loss
- L1 Class action and protests
- L2 Strikes affect production
- L3 Consumer demand reduces

Source: Cambridge Centre for Risk Studies 2019

Section 5: Application of Scenarios for Corporate Risk Profiling

Defining a Corporate Loss Model

We have been able to use evidence-based modelling approaches to successfully estimate how each of these scenarios will impact the economic environment in which the business operates, and the potential impacts on the revenues, capital stocks, and profits and losses of the case study business. Some of these estimates have significant uncertainties, and these can undoubtedly be improved through improving the analytics in the future. Nonetheless, this worked example demonstrates that it is possible to model a wide variety of risk classes through a standardised framework of corporate finance.

Corporate Loss Modelling Methodology

The loss modelling methodology is derived from deconstructing the corporate balance sheet to identify the principal components of revenues, operating costs, capital stocks, supply chain, and other factors, by each significant product line, and by each significant geographical market by region or country. It incorporates schedules of locations of key facilities, that are critical hubs of production, administration, or distribution, and how these nodes influence the flow of revenues in the value chain network of the organisation. We have developed a data structure for mapping this information onto which we can apply scenarios of various types. We use analyst reports and historical trends to construct a five-year projection of future cash flow and enterprise value.

Five Year Enterprise Value at Risk (5yrEV@Risk)

Corporate financial analysts use a variety of methods to assess the value of a business, including peer benchmarking to stock market share price, expert opinion, and formal calculation methods. We have selected a variant of a formal valuation calculation method for enterprise value to use as our primary method of estimating the impact of a scenario on a business. Enterprise value calculation entails assessing

the net present value of the future cashflows of the business, by applying discount conventions. To estimate the impact of a scenario, we take as our metric the change in the projected future cashflows for the next five years, expressed as five-year enterprise value at risk, or 5yrEV@Risk. In order to align with business planning time horizons and investor perception we ignore terminal valuation residues beyond the five-year outlook. This 5yrEV@Risk metric aligns with technical share price – an event that causes a 5yrEV@Risk of 10% means that the fundamentals of the business have reduced by this amount, and a rational investor would apply this discount to the share price, although market sentiment could drive significant variations around this in real-world examples of scenarios occurring.

Using 5yrEV@Risk in Decision-Making

5yrEV@Risk is quantified for each of the eighteen examples (six classes of risk scenario and three variants), as shown in Figure 13. Expressing the consequences of a range of different potential threats and scenario events through a single risk metric, 5yrEV@Risk, which relates to valuation fundamentals, appears to be a useful addition to the tools available to business managers. We demonstrate that it can be used in ranking risk scenarios and diagnosing the drivers of risk to a business. We are also confident that it can be employed to support risk mitigation decisions and to guide the management science of creating a resilient organisation.

Section 6: Overview of a Fictionalised Company – Avocado plc

Description

We explore the impacts of risk scenarios on a fictionalised company by applying shocks to its cashflow and business value. Avocado plc is a fictional global food and drinks company that produces and distributes internationally-recognised brands. The company product portfolio spans a varied range of major categories of food and drinks products, which are marketed under more than 200 brands sold to international or local markets at a range of price points to meet diverse global demands. Six of Avocado's largest global brands are responsible for 40% of net sales, while local brands tailored to individual markets, and luxury brands at premium price points, each represent 30% and 20% of Avocado's sales respectively. Avocado is headquartered in the UK, listed on the FTSE-100, and operates in most countries around the world.

Value Chain

Avocado has over 30,000 employees globally, and operates about 200 major production facilities, which include: ingredient processing, packaging, warehousing, distribution, and various types of production facilities, see Figure 11.

Avocado's value chain comprises the procurement and processing of raw materials; production of food and beverage products through various manufacturing processes; maturation of certain products (such as scotch whisky that requires aging for at least three years); packaging of products; and distribution to global markets. To serve its European and North American markets, which together account for 60% of net sales, the company distributes its brands through a network of wholly-owned and operated distribution centres in the UK and US. In other global regions, products are distributed through various third parties.

Each step in Avocado's value chain can be mapped to the company's geographical footprint. Therefore, to capture and understand the company's operations, it is useful to first locate its physical assets and facilities, from which the value chain can be derived in detail. While Avocado sources raw materials and manufactures products locally to its markets where possible, the appeal of many of its key global brands depends on where they are produced, and certain products have protected designation of origin status (or similar geographical indicators) whereby production is limited to specific regions or countries.

Figure 11: Global Distribution of Avocado's Facilities and Their Categorisation of Regional Markets.
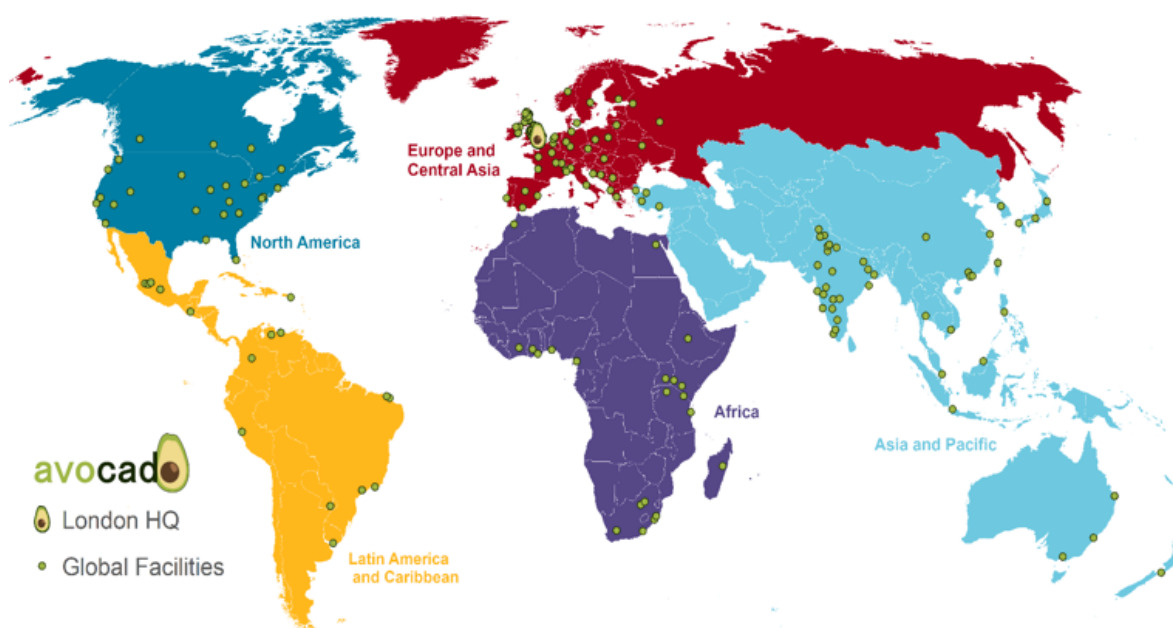
Source: Cambridge Centre for Risk Studies; Data from simulation of consumer sector companies in the FTSE 100.

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[42] (Cambridge Centre for Risk Studies 2019a)

Therefore, a small number of production sites, primarily located in the UK, US, and India, are responsible for a large proportion of Avocado's total supply. Through the process of identifying and assessing the function of each facility, we have identified the sites that are most critical to Avocado's global operations and serve as bottlenecks in the value chain.

Financial Performance

Avocado's total revenue totalled $12 billion in 2018, with an earnings before interest and tax (EBIT) of $4 billion and a net income of $3 bn. See Table 1 for a summary of Avocado's key financial measures. The company primarily reports sales by individual brands and geographical markets displayed in Figure 12. The distribution of global net sales - Avocado's most widely reported performance metric, defined as "sales less excise duty" – is also shown in Figure 12. Most brands are targeted at a single region, and often to individual countries within a region, although global brands are each sold widely in all geographic regions and are among the world's largest brands within certain food and drink categories. Net sales growth has been volatile in

recent years, with a four-year average growth rate of 4.6 % between year-end 2015 and 2018. This value is used to calculate Avocado's five-year future net sales projection for use in the following scenario modelling.

At the headquarters level, Avocado earns, on average, a 50-60 % gross margin on its product sales, a further half of which contributes to the operating profits. At a mature stage of business development, it has maintained a firm hold to positive net incomes for many years. Financial markets perceive Avocado as a value stock, with a price-to-earnings (PE) ratio smaller than the industry average and a systemic risk beta measure of 0.35, benchmarked against the overall market (where beta is one). Financial metrics reveal that Avocado holds substantial investments in intangible assets while possessing less property, plants and equipment in comparison to its self-identified competitors. A high proportion of the company's current assets, such as accounts receivables and inventory, plus a corresponding low turnover, suggest that Avocado is susceptible to demand shock. Despite these concerns, the company has relatively low financial leverage that shields it from insolvency issues and renders a credit grade of A among its industry peers.

Figure 12: Avocado plc's Distribution of Net Sales by Brand Category, Brand, and Regional Market.
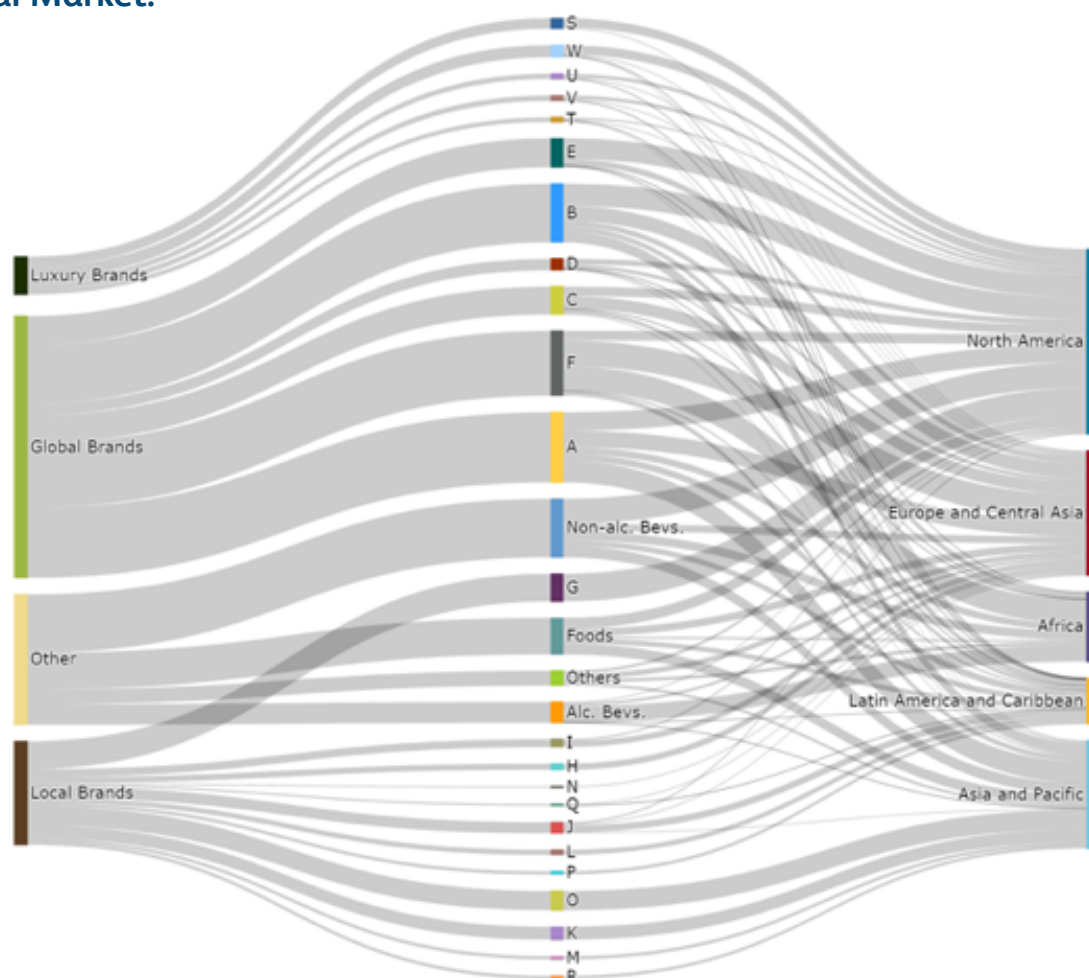
Source: Cambridge Centre for Risk Studies; Data from simulation of consumer sector companies in the FTSE 100.

Table 1: Financial Summary of Case Study Company

Multinational Food and Drinks
GICS – Consumer Staples
30,000 employees $
12 billion Annual Revenue

Top Level Company	Value or Metric	Trend	Rank	Avocado	Industry Average	All Company Average
Income Statements & Balance Sheet Items	Revenue (in $m)	▲		12,000		
	EBIT (in $m)	▲		4,000		
	Net Income (in $m)	▲		3,000		
	Earnings per Share (EPS)	▲		1.50		
	Dividend per Share	◼		0.75		
	Assets per Employee (in $m)	▼		1.00		
	Book Value (Equity) (in $m)	▲		11,000		
Valuation	Share Price/Earnings (PE Ratio)	▲		22.35	27.24	27.50
	Share Price/Earnings to Growth (PEG Ratio)			#N/A	#N/A	#N/A
	Share Price/Cash Flow	▲		36.45	42.56	18.01
	Share Price/Sales	▲		5.59	5.66	0.74
	Share Price/Book Value (PB Ratio)	▲		7.01	7.09	8.02
	Dividend Payout Ratio	◼		50.00%	40.32%	35.51%
	Dvidend Yield	▼		2.24%	2.01%	2.25%
Profitability	Gross Profit Margin	◼		55.12%	47.23%	48.22%
	Operating Profit Margin After Depreciation	▲		33.33%	28.78%	21.31%
	Net Profit Margin	▼		25.00%	19.06%	13.57%
	Return on Assets	▼		10.00%	8.79%	7.73%
	Return on Capital Employed	▼		14.81%	13.67%	12.33%
	Return on Equity	▲		27.27%	19.87%	15.21%
Growth	Revenue Growth	▼		4.60%	4.21%	5.98%
	Net Income Growth	▼		8.33%	7.43%	13.23%
	Earnings per Share Growth	▲		8.60%	10.33%	17.07%
	Net Working Capital Growth	▼		11.01%	20.26%	20.00%
Financial Soundness/Solvency	Cash Balance/Total Liabilities	▲		0.05	0.07	0.10
	Total Liabilities/Total Tangible Assets	▼		1.06	1.53	0.87
	Long-Term Debt/Book Equity	▲		0.71	1.10	1.51
	Total Debt/Capital	▲		0.46	0.56	0.55
	Total Debt/Equity (DE Ratio)	▲		0.87	1.23	1.65
	Interest Coverage Ratio	▼		8.29	7.07	6.64
Luquidity	Quick Ratio	▲		0.50	0.45	0.36
	Current Ratio	▲		1.42	1.02	1.02
Efficiency	Asset Turnover	▼		0.45	0.57	0.68
	Inventory Turnover	▲		0.91	1.26	1.43

Source: Cambridge Centre for Risk Studies; Data from simulation of consumer sector companies in the FTSE 100.

Materiality of Risks

As a UK-based company, Avocado is required to include a consideration of the principal risks and uncertainties facing the company in their annual report. Each of Avocado's annual publications describes the principal risks that would threaten Avocado's business model, future performance, solvency, or liquidity, and strategies employed to manage or mitigate these risks are also reported. Avocado reports the top 10 risks that it has identified as material to the business, as summarised in Table 2. This is significantly lower than the average number of risk factors included in the public risk registers of other comparably sized organizations, where our survey of 60 annual reports of large companies showed an average of 22 risk factors identified. Avocado states that none of its top ten risks individually threaten the viability of the company.

In response to global, social, political, and economic changes, as well as other idiosyncratic developments, the company's principal risks evolve over time. These changes can be tracked through subsequent annual reports to assess how Avocado reacts to emerging and increasing or reducing risks. For example, in the past five years the cost and supply of raw materials, failure to recruit and retain talented employees, and unprofitable business acquisitions have each been removed from Avocado's list of principal risks. In contrast, cyber risk and data privacy, political instability, and product quality have become principal risks in this period.

As is the case for many of the assessed companies, the reported risks are generic, referencing a combination of threats, consequences, and management measures while lacking detail on specific scenarios through which these risks might manifest. We interpret these risks as more specific scenarios in Table 2.

Table 2: Reported Principal Risk Factors in Annual Report of Case Study Company

	Risk Factor	Potential scenarios these may represent
1	Market restrictions & Indirect tax	Growth in negative sentiment towards unhealthy food and drinks Regulations restricting marketing and availability of products
2	Economic change	Local market volatility drvien by political unrest or upheaval
3	Critical industry developments	Consumers choose more attractive and more profitable product offered by a competitor
4	Non-compliance regulations	Non-compliant actions of representatives in operating countries
5	Sustainability & responsibility	Climate change and water stress
6	Cyber	Contagious malware, cloud outages, industrial control system attacks leading to physical damage and other cyber events that cause business disruption
7	Political instability & terrorism	Security threats to Avocado's supply chain
8	Data privacy	Data breach (cyber threat), and non-compliance with GDPR
9	International tax	Protectionism and tariff wars Corporation tax regulation change
10	Product quality	Supply of contaminated or counterfiet products

Source: Cambridge Centre for Risk Studies; Data from simulation of consumer sector companies in the FTSE 100.

Evaluating the Materiality of Risks

As previously discussed, Avocado, like many other companies, lack a comprehensive and holistic assessment of all threats. Risk assessments are often either internally-focussed and undervalued or lack awareness of exogeneous shocks. The Cambridge Scenario Suite provides an extensive list of scenarios that have been mapped to Avocado according to their relevance. The scenarios deemed relevant to Avocado include those with significant global-scale disruption to finance, economics, and trade, as well as threats to regional or local geographical regions in which Avocado operates. Modelling of the most relevant scenarios can expose the materiality of individual risks, which can then be compared and integrated into a holistic risk profile.

Section 7: Stress Test Scenarios

Overview and Selection of Scenarios

A wide variety of scenarios is needed to comprehensively represent risks in the consumer sectors. To prioritise risk categories of relevance, we turn to our 2018 Enterprise Risk Management report[43] which surveys a variety of business sectors on their principal risks, including consumer sectors. The top four risk classes identified by the Consumer Discretionary and Staples sector respondents (see Figure 6) are:

> Security;
> Operational performance;
> Reputation; and
> Business Continuity.

The challenge of proposing a scenario-based methodology lies in applying loss modelling to a business from a wide variety of disparate causes of risk. In this report we demonstrate that it is possible to model the business loss and the resulting impact on the enterprise value of an organization in the consumer sector from each of the classes of risk in the Cambridge Taxonomy of Business Risk. These scenarios are described as one-page profiles in Appendix A.

Scenario A - Trade Dispute: United States vs European Union

Businesses manage a wide range of financial risks and it is common practice to do financial stress tests on a balance sheet. Typical exercises apply univariate shocks – testing what will happen if one variable, like interest rate changes, or a different single variable such as movement in the exchange rate between two key currencies. There is a growing recognition that 'coherence' in financial stress testing is more useful – to understand how multiple macroeconomic variables move from a common underlying cause.[44] These can be explored using realistic scenarios of financially significant events in which multiple factors change in a correlated way.

We represent the class of financially significant events by a scenario of a trade war between two trading blocs, resulting in tariffs being imposed by both sides. In this case study, the business is European (headquartered in UK) and has a major component of its revenues coming from United States, so we evaluate the impact on the organization of a trade war between US and Europe. Many international businesses cite in their risk registers, concerns that they could face losses from trade wars and disruption to cross-

border business flows through the imposition of tariffs. We evaluate four levels of severity of the scenario, with different levels of tariff being applied, ranging from 10% to 140%.

Scenario B - Geopolitical Conflict: Pakistan vs India

Global businesses face many geopolitical risks, where territories where they have business interests are affected by national change or political violence. We represent this range of risks with a scenario of military conflict between two nations where the case study organization has important business interests. The scenario results in regional markets becoming depressed, international supply chains being disrupted, and a set of global consequences from the disruption of peace for business operations. There are many potential future flashpoints for conflicts, but as our case study business has a significant revenue stream from the Indian subcontinent, we selected a militarized conflict between India and Pakistan, with three levels of severity of the conflict.

Scenario C - Cyber Attack: Contagious Malware Infestation

Technology risks form a major part of the risk landscape of any modern business. The technology landscape is changing dramatically, and many businesses are investing in the digitization of their processes, and facing disruptive new technologies in their sectors. Cyber risks – the potential for malicious attacks or IT failures – are a growing concern for business executives. No longer confined to be an operational risk within the IT department, the potential impact of cyber attacks has become so significant that they register as a strategic risk, capable of impacting the earnings and viability of a business. Technology risks are represented by a scenario of a cyber attack infiltrating contagious malware into the company's information technology networks affecting business-critical systems. This scenario has three levels of severity characterizing the extent of potential infection through the network of the business, and the number and importance of computers disabled.

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[43] (Cambridge Centre for Risk Studies 2018)
[44] (Rebonato 2010)

Scenario D - Natural Catastrophe: Floods Damage Key Facility

International businesses face many environmental risks in the many sites and locations where they have operations, and also they are increasingly having to confront their responsibilities for maintaining the sustainability of the environment. Threats from natural hazards have the potential to cause damage to major facilities that are vital to the functioning of a business. These are relatively conventional risks, and are highly dependent on the geographical location and site conditions of the facilities. Businesses typically have hazard assessments and engineering safety evaluations for their major manufacturing, processing, distributions hubs, data centres, office locations and other major facilities that they rely on.

We identified a realistic example for this case study business of one of their major facilities: a large processing plant, warehousing complex, and distribution hub that has high 'enterprise value' in being critical to the production of a major product line responsible for a sizeable component of business revenue. It is sited in a coastal region of flat land with potential for flooding in extreme storm surges, of the type that could become more likely as a result of climate change.

In this scenario we explore the potential for the destruction of capital assets and inventory into the analysis of a business balance sheet, and to compare the physical losses with the consequences of loss of revenue that could result. We apply three variants of the scenario with increasing severities of damage and business disruption.

Scenario E - Pandemic: Highly Infectious Influenza Virus

Businesses face a wide variety of social risks of behavioural change and human activity. These include changes in consumer preferences for their products and services, and changing trends in the ways that consumers purchase their goods, and perceive their brands. We represent these risks with a scenario of a pandemic of infectious disease that spreads through the population and results in behavioural change in the consumer base and in the employees of the consumer business. This results in demand side shock – the reduction in consumer purchasing – combined with supply side shock – the inability of the organization to staff its stores and to suffer a capacity reduction in its operational capabilities. We apply three levels of severity of pandemic, representing increasing levels of infection rates in the general population, and virulence, increasing the fear factor that changes people's behaviour.

Scenario F - Governance: Equal Pay Movement

Governance risks are the class of business risks that arise from issues of corporate control of ethical behaviour and regulatory compliance. We represent this class of risks by a scenario of a pay dispute that arises over gender inequality in compensation rates in the workforce. This results in strikes and disruption of operational continuity over a period of time, and a class action law suit that is brought against the company, before the dispute is settled. The scenario results in various types of costs, and an overall increase in the cost of labour, combined with damage to reputation that results in customer loss. This is represented by three levels of severity of the scenario, with increasingly disruptive and costly outcomes for the business.

Section 8: Developing Scenarios and Analysing their Impacts

The scenarios are carefully specified and developed by a team that researches the specialist areas of each topic, incorporating subject matter expertise, data science, and more detailed analysis where required. Each scenario is constructed in a standardized framework, incorporating a narrative, geography, and timeline, and identifying a key objective metric that can be used to assess the severity of the phenomenon independently of the cost of it to an organization that is affected by it. This makes the scenario independent of the organization that is being analyzed, so it can be regarded as an externality to the performance of the business. The same technique can be applied to idiosyncratic scenarios that are unique to one particular business, or to scenarios that might arise from the functional or management decisions of the business itself, which may be considered endogenous risks within the control of the management team.

Likelihood of Scenario Occurrence

Assessing the likelihood of a scenario occurring is important for management decisions. More severe levels of scenarios are generally less likely than milder occurrences. For management purposes it is also important to be able to compare the likelihood of one type of scenario occurring relative to another, and to be able to assess this objectively, in an evidence-based approach. The metric of severity of a scenario is defined and used to help assess the likelihood of the occurrence of the scenario.

We assess likelihood as an annual probability – i.e. the chances that an event of this type and severity could occur within a twelve month period. Where we characterize a trend risk, we estimate the likelihood of the rate of change occurring in a year. The annual probability can be translated into the likelihood of one of more events of this type occurring during the five year cashflow projection of a business. We have introduced a standardized categorization for assessing scenario occurrence likelihood, with colour-coded probability ranges, to aid senior managers in understanding, comparing, and using objective likelihood assessments in their decision-making.

Where possible, the likelihood of a phenomenon happening is benchmarked against its historical occurrence from past observations. We can assess the likelihood of some of these scenarios by observations from the past: how often pandemics have occurred in the past century, how frequently floods of different depths have been experienced in the locations of concern, how many incidents of contagious malware have been reported infecting similar organizations in recent years, the number of times that geopolitical conflicts have arisen in the theatres of interest,

and so on. These historical baselines are adjusted to take into account different conditions that prevail today, relative to the historical period of observation. For example pandemics would occur today within a very different public health environment including better medical treatments; flood likelihoods could be increasing due to climate change; contagious malware infections are increasing as cyber attackers discover new ways to evade cyber security measures; potential conflicts may be diffused more easily than in the past because of international peacekeeping institutions.

Some risks are less amenable to historical observation analysis to assess their likelihood. They may never have occurred in the past, or they may be so different to similar events in history that past incidence is not a helpful guide. There have been many trade disputes in history, and between many nations, as documented in World Trade Organization records, but the chances of large tariffs being levied between US and Europe in the next twelve months has to be assessed more subjectively, using latest news on negotiations and whatever comparative references and geopolitical outlooks can be incorporated. The relative likelihoods of severity levels of the tariffs that might be levied can be assessed by the distribution of tariffs that are operated by different inter-country trading systems around the world. Similarly there have been many pay disputes historically about pay inequalities, but gender inequality may be qualitatively different, so data about recent gender-pay related court cases and precedents in countries elsewhere are more useful for assessing how likely these scenarios are.
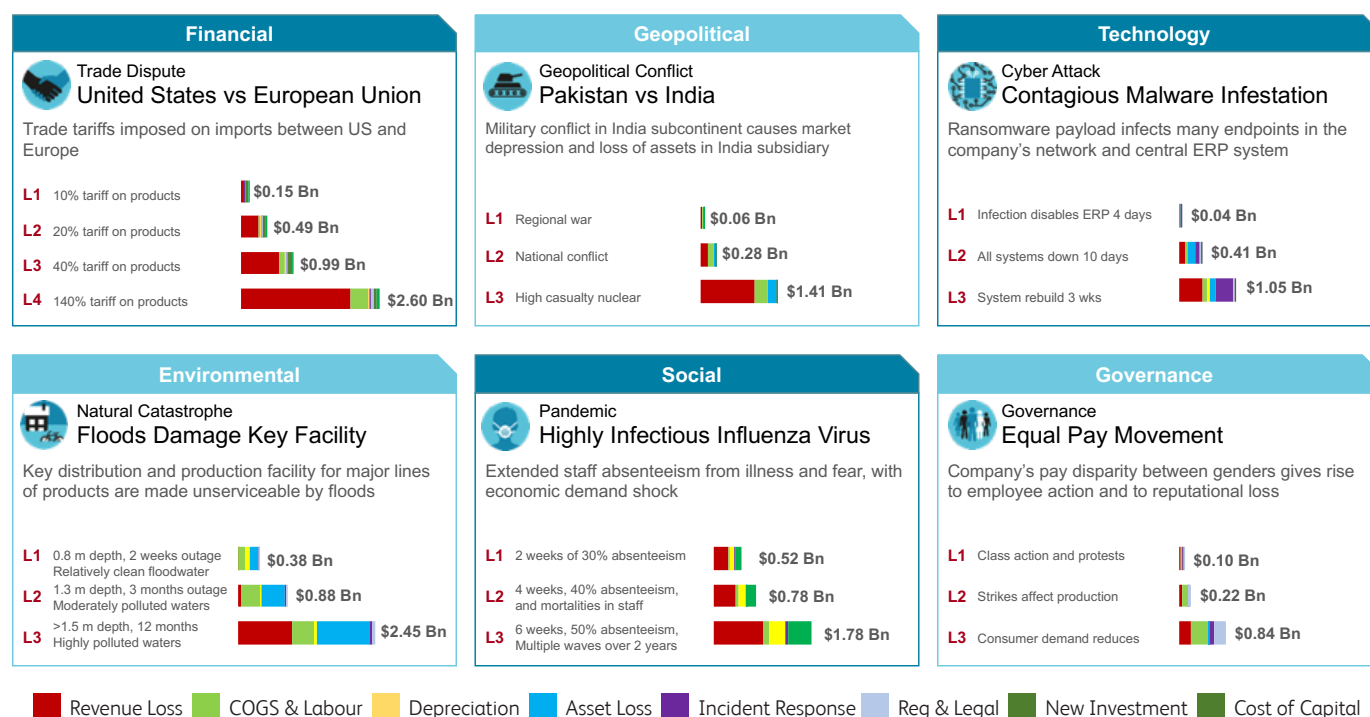
There is no doubt however that likelihood assessments have higher uncertainties associated with them than the assessment of potential impact.

Scenario Impact Assessment

The scenario analysis team assesses the impact of a given scenario on the balance sheet of the case study company by following a 'loss trigger pathway', a logic-tree approach to assessing how causal processes triggered by the scenario will affect key components of the financial balance sheet of the company. A baseline view of the balance sheet, without any scenario, is compared with the estimate of how the balance sheet performs when the scenario occurs. The difference between the two represents the impact of the scenario. To be consistent we compare a five year outlook, even when scenario impacts may only affect a single year's performance. We ignore termination value of the enterprise at the end of the five years.

Figure 13: Scenarios Analysis Results on Case Study Company

Financial
Trade Dispute
United States vs European Union

Trade tariffs imposed on imports between US and Europe

L1	10% tariff on products	$0.15 Bn
L2	20% tariff on products	$0.49 Bn
L3	40% tariff on products	$0.99 Bn
L4	140% tariff on products	$2.60 Bn

Geopolitical
Geopolitical Conflict
Pakistan vs India

Military conflict in India subcontinent causes market depression and loss of assets in India subsidiary

L1	Regional war	$0.06 Bn
L2	National conflict	$0.28 Bn
L3	High casualty nuclear	$1.41 Bn

Technology
Cyber Attack
Contagious Malware Infestation

Ransomware payload infects many endpoints in the company's network and central ERP system

L1	Infection disables ERP 4 days	$0.04 Bn
L2	All systems down 10 days	$0.41 Bn
L3	System rebuild 3 wks	$1.05 Bn

Environmental
Natural Catastrophe
Floods Damage Key Facility

Key distribution and production facility for major lines of products are made unserviceable by floods

L1	0.8 m depth, 2 weeks outage Relatively clean floodwater	$0.38 Bn
L2	1.3 m depth, 3 months outage Moderately polluted waters	$0.88 Bn
L3	>1.5 m depth, 12 months Highly polluted waters	$2.45 Bn

Social
Pandemic
Highly Infectious Influenza Virus

Extended staff absenteeism from illness and fear, with economic demand shock

L1	2 weeks of 30% absenteeism	$0.52 Bn
L2	4 weeks, 40% absenteeism, and mortalities in staff	$0.78 Bn
L3	6 weeks, 50% absenteeism, Multiple waves over 2 years	$1.78 Bn

Governance
Governance
Equal Pay Movement

Company's pay disparity between genders gives rise to employee action and to reputational loss

L1	Class action and protests	$0.10 Bn
L2	Strikes affect production	$0.22 Bn
L3	Consumer demand reduces	$0.84 Bn

Legend: ■ Revenue Loss ■ COGS & Labour ■ Depreciation ■ Asset Loss ■ Incident Response ■ Reg & Legal ■ New Investment ■ Cost of Capital

Source: Cambridge Centre for Risk Studies; Data from simulation of consumer sector companies in the FTSE 100.

We consider time-series projections of some 18 key financial metrics of the balance sheet, including revenue projections; cost-drivers of goods sold; repair, damage, and write-down value of physical infrastructure and fixed assets; unbudgeted costs such as incident response and emergency provisions; regulatory charges and litigation settlement costs; and changes in depreciation and costs of capital that could be realistically expected to occur as a result of the scenario. These in turn are informed by underlying estimates of how the company's customers react in each market; how the company's production processes and supply chain integrity affect the flow of goods to market; and how reputation and qualitative aspects of management response translate into measures of goodwill and sentiment for the business. Changes in demand for goods with price hikes, for example, are estimated using well-documented demand elasticity relationships that respect differences between essential and discretionary classes of goods.

Some of the scenarios affect the macroeconomic climate: trade disputes, geopolitical conflict, and pandemic scenarios are severe enough to affect markets and economic conditions in North America, Europe, and Asia. For these scenarios, we use industry-leading macroeconomic models, including the Oxford Economics Global Economic Model, to assess how major financial and geopolitical events would impact national economic outputs, consumption, and related economic variables of the global economy, such as interest rates, unemployment level, import and export trade balances, and exchange rates across the markets where the business operates. These macroeconomic variables are then translated into the impacts on the balance sheet of the business being analyzed.

Figure 13 shows the results of the analysis of the six scenarios, with the three levels of severity for five of the scenarios and four levels of severity for the first scenario (Financial), making 19 analysis results in total. Results are indicated by their impact on six categories of variables of the balance sheet, aggregating the 18 financial metrics of the modelling.

Table 3: Scenario Impacts on the Case Study Company

	Risk Categories		Scenario	Scenario	Loss 5yrEV@Risk ($Bn)	Likelihood (Annual Prob)
A	Financial	A.1	Trade Dispute: US vs EU	10% tariffs imposed on company's products	0.15	0.02
A	Financial	A.2	Trade Dispute: US vs EU	20% tariffs imposed on company's products	0.49	0.0.15
A	Financial	A.3	Trade Dispute: US vs EU	30% tariffs imposed on company's products	0.99	0.01
A	Financial	A.4	Trade Dispute: US vs EU	140% tariffs imposed on products	2.60	0.005
B	Geopolitical	B.1	Geopolitical Conflict: Pakistan vs India	Countries on war footing, minor skirmishes	0.06	0.025
B	Geopolitical	B.2	Geopolitical Conflict: Pakistan vs India	Military conflict, low consumer confidence	0.28	0.013
B	Geopolitical	B.3	Geopolitical Conflict: Pakistan vs India	Loss of all Indian subsidiary business	1.41	0.004
C	Technology	C.1	Cyber Attack: Contagious Malware Infestation	Malware disables ERP for 4 days	0.04	0.02
C	Technology	C.2	Cyber Attack: Contagious Malware Infestation	All IT systems for 10 days	0.41	0.01
C	Technology	C.3	Cyber Attack: Contagious Malware Infestation	System rebuild with 3 week outage	1.05	0.003
D	Environmental	D.1	Natural Catastrophe: Floods Damage Key Facility	0.8 depth, 2 weeks, clean	0.38	0.004
D	Environmental	D.2	Natural Catastrophe: Floods Damage Key Facility	1.3m depth, 3 months, moderately polluted	0.88	0.002
D	Environmental	D.3	Natural Catastrophe: Floods Damage Key Facility	>1.5m depth, 12 months, heavily polluted	2.45	0.0007
E	Social	E.1	Pandemic: Highly Infectious Influenza Virus	2 weeks of 30% absenteeism	0.52	0.024
E	Social	E.2	Pandemic: Highly Infectious Influenza Virus	4 weeks and mortalities	0.78	0.012
E	Social	E.3	Pandemic: Highly Infectious Influenza Virus	Multiple waves over 2 years	1.78	0.004
F	Governance	F.1	Governance: Equal Pay Movement	Class action and protests	0.10	0.03
F	Governance	F.2	Governance: Equal Pay Movement	Strikes affect production	0.22	0.015
F	Governance	F.3	Governance: Equal Pay Movement	Consumer demand reduces	0.84	0.005

Table 3 provides the results of the analysis for each scenario, together with the definitions and estimated likelihoods of the scenario occurrence at that level of severity.

The losses are provided in monetary value, summing the losses over 5 years in terms of depletion of the enterprise value of the organization – 5yrEV@Risk. They range from $60 million ($0.06 Billion) to $2.6 Billion. Five events cause a loss of over $1 Billion to the organization. The annual net income to the organization is $3 Billion, so these are very material scenarios.

For this particular organization, the baseline 5 year Enterprise Value is $14.7 Billion, if no scenarios were to occur, and the projected business plan were to be achieved of consistent growth and successful improvement of margins. Four of the events out of the 19 cause losses of over 10% of the value of the enterprise.

Section 9: Informing Risk Decisions

The Company's Risk Matrix

Figure 14 shows the scenario results plotted on a chart, showing the impact of the scenario (along the bottom x axis) against the estimated likelihood of the scenario occurrence (vertical y axis). Both are plotted on logarithmic axes – each interval is a multiple of 10 on the scale.

Companies typically refer to a plot of this type as 'risk matrix'. Many organizations produce their own risk matrix, generally a qualitative estimation involving subjective judgements and often divided into quadrants of high-impact low-likelihood combinations. Figure 14 is an extension of the typical risk matrix: each type of event or risk is shown as a series of connected dots to indicate that it can occur at different severities with different probabilities. Figure 14 also has the merit of being more objectively derived than a typical firm's risk matrix because it uses detailed analysis and domain-specific research. Graphs of events that cause loss relative to their likelihood are common in the financial services sector, and we have maintained their convention of presenting loss severity along the bottom 'x- axis' and likelihood diminishing towards the bottom of the vertical 'y- axis'.

In this diagram, each scenario can be seen as a range of levels of severity, each with their own impact and likelihood. We have joined the levels of severity L1 to L3 (or L4) for

each scenario with lines to show that the outcome of a scenario is actually a distribution of potential outcomes, rather than a single point. The distribution of outcomes represents a curve on a log-log graph of this type: the more extreme outcomes are increasingly unlikely. The levels of severity of outcome from a scenario that were selected for the analysis are not necessarily the complete range of potential outcomes – there could be even more extreme variants of the scenario that cause more loss than those captured by the highest level, and there could be ways that the scenario could occur and cause less loss that the lowest level of severity specified. The curve however provides an indicative distribution, and can even be extrapolated to conjecture even more extreme outcomes in the tail of the distribution.

For many scenarios the severity may even be curtailed at a maximum loss outcome from the very worst case outcome that could occur, and so the scenario loss distribution curves downwards, and may become asymptotic to a maximum possible loss value with decreasing likelihood.

The risk matrix shows each scenario as a curve of loss against likelihood. It plots how likely the case study business is to have losses of a given severity from scenarios with different characteristics and likelihoods of occurrence. It illustrates the range of different threats against the business and the relativities between them.

Figure 14: Impact vs Likelihood of Scenarios on Case Study Company
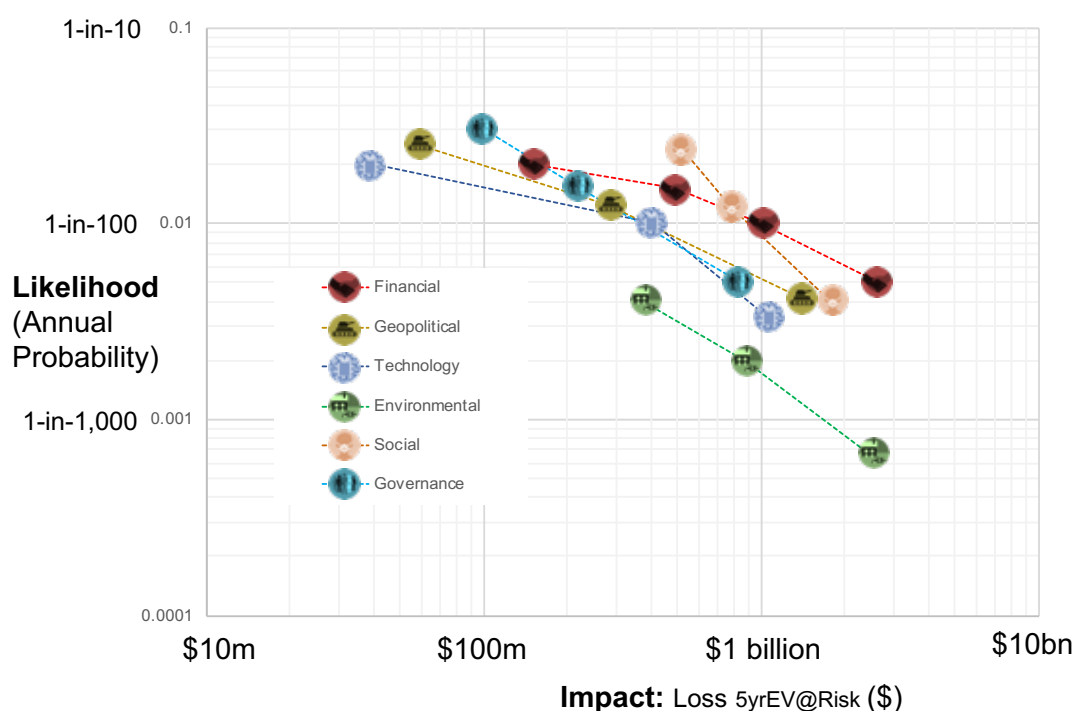
Source: Cambridge Centre for Risk Studies; Data from simulation of consumer sector companies in the FTSE 100.

Breaching Explicit Risk Tolerance Levels

The management of the company consider the potential impact on their business of these scenarios and the levels of loss they represent. Smaller impacts which are unlikely are of less concern than large impacts that are likely. Defining the level of risk that is acceptable determines the 'risk appetite' of an organization, or 'risk tolerance'. We can use the quantitative scale of the company risk matrix to identify that risk appetite explicitly. Risk appetite is defined by the level of loss, relative to the likelihood of it occurring.

Figure 15 illustrates the risk appetite defined by the management of our fictional case study company, Avocado. They have identified three levels of risk:

> 'Catastrophic' - that would have viability implications, a major share price mark-down, or the potential for a credit downgrade, with wide ranging consequences for the company and its leadership
> 'Strategic' - that would impact quarterly earning notifications, or derail the business plan, with consequences for share price devaluation and for senior management
> 'Risks of Concern' – potential risks that could become strategic risks by increasing in likelihood or severity, and that need monitoring

The scenarios that breach each of these are highlighted in Figure 15 with colour-coding – red for the scenarios that represent Catastrophic Risks (extreme trading dispute outcomes and the most severe pandemic), orange for those that represent Strategic Risks, and yellow for Risks of Concern.

The company decides that it will invest in risk mitigation actions to reduce the risks that it faces from Catastrophic and Strategic Risks. It decides that it will carefully monitor, on a quarterly review basis, the scenarios that fall into the category of 'Risks of Concern'.

Defining the Company's Risk Tolerance

In deciding where to define the risk tolerance levels, the absolute level of loss is the most important factor – many companies will simply identify thresholds of financial loss irrespective of how likely it is to occur. In reality, there is a trade-off between level of loss and likelihood: many managers (and people in general) are willing to accept the potential for higher levels of loss at lower levels of likelihood.

The criteria for risk tolerance are not purely financial. Some types of risks may be more acceptable than others qualitatively. Risks that are associated with potential rewards to a company – operating in a high risk country that generates high margin business for example – may have a higher risk tolerance. Risks that are likely to systemically affect the whole sector and will affect competitors equally as badly, can be tolerated more than idiosyncratic risks that will only affect this particular business. Risks that have health and safety implications, sustainability or environmental liabilities, or reputation connotations may receive management stipulation for lower risk tolerance.

Figure 15: Risk tolerance levels for case study company
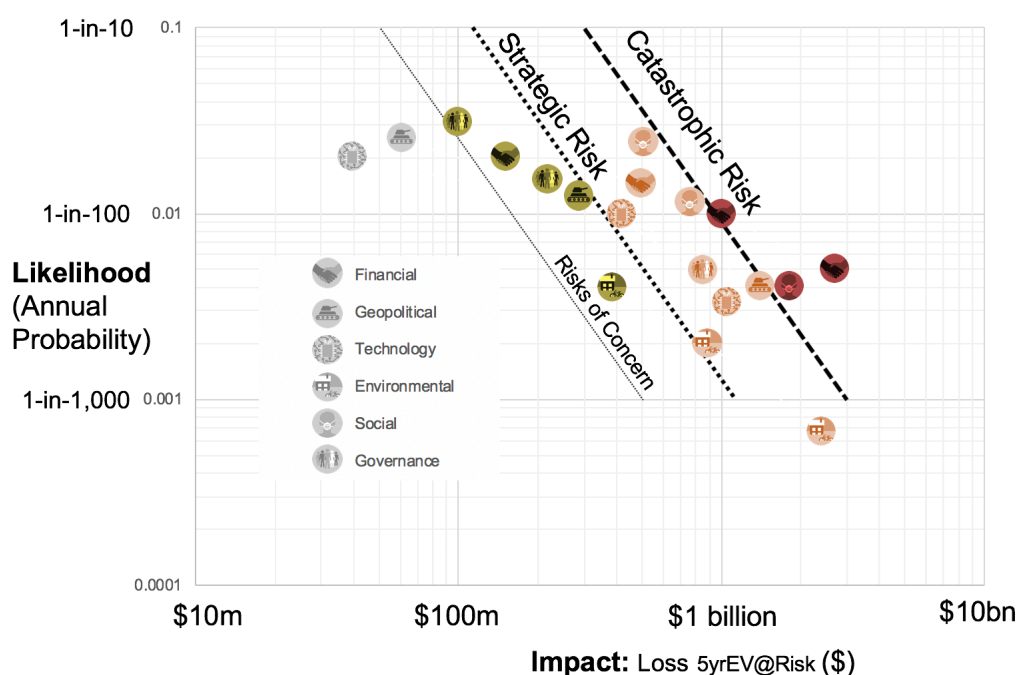
Source: Cambridge Centre for Risk Studies; Data from simulation of consumer sector companies in the FTSE 100.

Likelihood of Crisis

Each of these scenarios that have been analyzed, even those with the lower impact outcomes, would cause some level of crisis for the company. As individual risks for the business, they are unlikely events to occur. They have relatively remote likelihoods. For example, the collective chances of the specified trade dispute with any of the four levels of severity in this example are estimated to be around 1-in-20 in a year. The chances of a cyber attack with any of these severities is estimated at 1-in-30 a year. The chances of a damaging flood hitting the key facility is considered to be 1-in-150. Individually each of these scenarios is improbable and it would be understandable if senior management did not become overly concerned about any individual risk on the list. However, they are indicative of the fact that the organization faces many risks with relatively low likelihoods. The six presented here are significant for the company, but by no means represent the entire universe of significant risks that the company faces.

The six scenarios are each individually of low likelihood, but collectively they pose a significant likelihood of the company experiencing a crisis of one sort or another. The scenarios that we have selected are broadly independent – the chance of having to deal with a pandemic outbreak is unrelated to the likelihood of being hit by a cyber attack. There is some chance that some of the scenarios could occur together because of a common background causal factor – for example a trade dispute could lead to financial hardship which might make a pay dispute more likely – but these are weak potential correlations. It is reasonable to expect them to be independent. More than one event could occur in a given year, but that would probably be a coincidence.

The collective annual likelihood of all of the scenarios together is around 1-in-5: there is a 20 % chance each year that the company would have to deal with some level of loss from one of these six causes. In the five year projection of the business plan, there is a 71 % chance – or roughly two chances out of three, of experiencing a crisis from one of these causes at some time during the five years. There is a small chance that the company could experience multiple crises during the five years and may have even have to deal with several crises in a single year.

So although each individual risk may seem unlikely, the fact that there are many of them means that some type of risk event occurrence can be expected during short term business planning cycles.

Company Loss Exceedance Probability

The outcomes from the loss analysis can be considered together by considering how often and how severely the company would be expected to experience a loss. Figure 16 shows the same loss outcome information presented as a loss exceedance probability (EP) distribution. This is the cumulative likelihood of the company experiencing a loss of that level or greater from the scenarios considered. The scenarios are ranked from the most severe level of loss to the least, and their likelihoods are considered cumulatively, from worst to least.

Figure 16 is presented with the loss (non-logarithmic for better visualization) along the horizontal x axis, and probability on a log scale, vertically on the y axis as in the previous chart but represents the probability of a loss of that value or greater than, from all the scenarios combined.

This shows that there is a 1-in-10 (10%) chance each year of the company experiencing an event which will cause a loss of $0.4 billion or greater, and a 1% chance (1-in-100) of experiencing a loss of $1.75 billion or greater, more than half of the annual net income of the company.

If the losses from all the scenarios are probability-weighted, the annual average loss from these events would be expected to be around $100 million.

Figure 16: Cumulative likelihood of the company experiencing a level of loss from the suite of scenarios considered
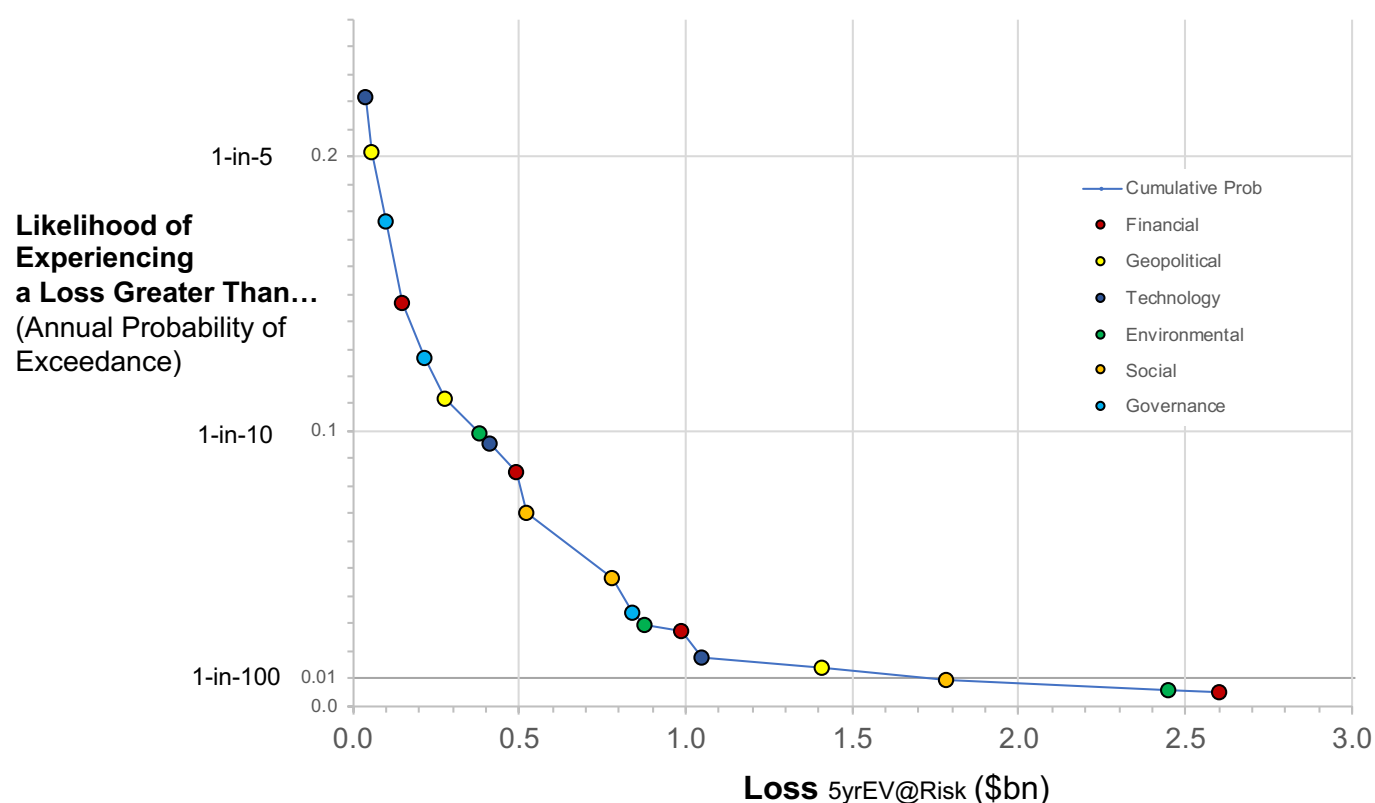
Source: Cambridge Centre for Risk Studies; Data from simulation of consumer sector companies in the FTSE 100.

Section 10: Risk Mitigation Actions

The case study company has identified risks that are potentially catastrophic to their business, and a set of risks that could be strategic in compromising its five-year business plan.

Their decisions are to implement management actions to mitigate those categorized as both catastrophic risks and strategic risks, with catastrophic risks taking priority for investment and urgency.

Mitigation actions take two types:
a. Threat-specific: Efforts to diffuse the company's vulnerability to an identified risk
b. Resilience-strengthening: Generic measures to improve the ability of the company to withstand shocks from any source

Both need to be deployed to mitigate the risk, and the optimal balance between the two can be assessed using tools of this type.

Threat-specific Mitigation for Catastrophic Risks

For the case study company, the risks that have been identified as potentially catastrophic include the prospects of tariff wars with countries supplying critical raw materials, and the potential for severe pandemics to suppress consumer demand while failing to provide service and goods during depleted staffing levels. These are outlined to managers in the departments responsible for procurement, contingency planning, human resources, and others, and plans and costings requested for reducing the impact of these scenarios, if they were to occur.

Proposed management plans to reduce the potential impact of the trade dispute risk include replacement sourcing of supplies that would incur tariffs from alternative countries, acknowledging that there would be additional costs and reduced margins incurred by switching supplier. Pandemic contingency plans include creating larger staffing pools in an emergency and provisions for stockpiling larger inventories of products. Each of these has associated cost implications. The costs of these plans are compared with the risk reduction benefits.

Threat-specific Mitigation for Strategic Risks

Additional risks that have been identified as strategic risks include cyber threats, flood risk, pay disputes, and the potential for severe levels of conflict in a key region of business. Similar operational plans to address these risks are requested from a range of different departments. Their plans include investment in cyber security technology and network reconfiguration, increased flood insurance cover, pay scale reviews, and contingency plans for implementation with any escalation of political tension in the conflict theatres. The costs of these measures are similarly optimized against the risk reduction goals.

Resilience-strengthening

The scenario analysis exercise identified that several of the scenarios required unbudgeted expenditure that would need to be funded through short-term borrowings and budgetary adjustments, creating debt obligations and having collateral impacts on other business operations. If the business were to carry a larger cash account in its reserves, many of the scenarios would be reduced in overall impact, improving the general resilience of the overall business. The downside for this is shareholder pressure on the inefficiencies of holding unallocated reserves. Analysis of the risk reduction benefits gained against the penalties of holding unallocated reserves allows the management team to assess the right balance of increased reserves.

Monitoring Other Risks

The other risks that have been identified as 'Risks of Concern' are put on a monitor watch, to be reassessed every three months. The likelihood of each of these scenarios is reviewed on a routine basis. If the assessment suggests that either the likelihood of these risks occurring has increased, or the consequences if they were to occur would be more severe than originally assessed, and these changes are sufficiently large to put them over the defined tolerance level to constitute a 'strategic risk', then these risks are flagged for mitigation action and management are asked to review the options for intervention.

Figure 17 illustrates how the effects of management action are estimated to be able to reduce the strategic and catastrophic risks identified by the analysis, and bring them down below the risk tolerance thresholds mandated by senior management.

Figure 17: Effects of risk mitigation measures in reducing the loss levels and likelihoods of scenarios of concern
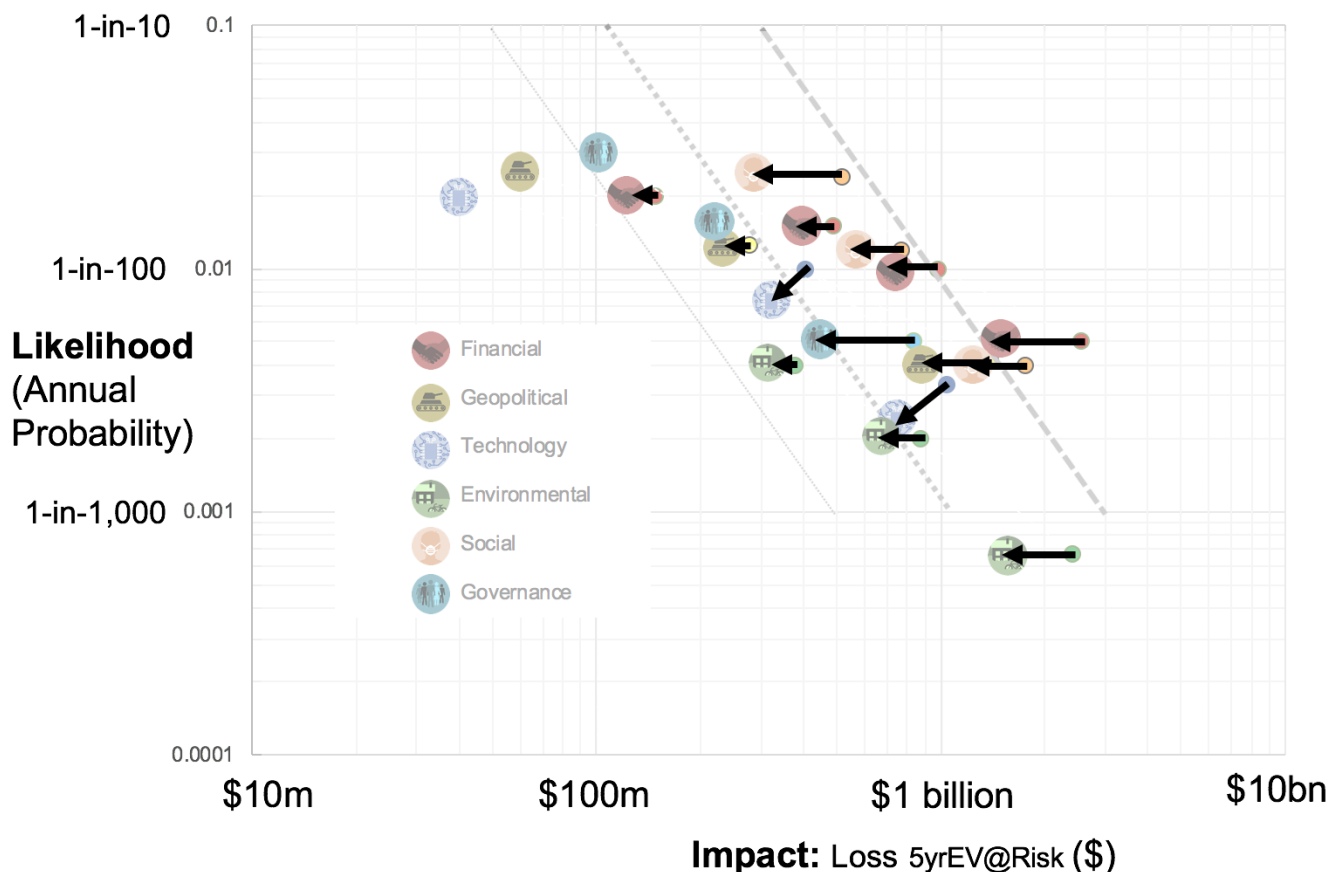
Source: Cambridge Centre for Risk Studies; Data from simulation of consumer sector companies in the FTSE 100.

Section 11: Conclusions

This case study uses quantitative analysis to illustrate the balance sheet impact of six specific scenarios on a fictional but realistic company, Avocado, in the consumer staples sector. Financial tools including insurance offer protection against damage to capital assets and inventory, yet are not a substitute for emergency response and business continuity capabilities for responding to catastrophic events. Maintenance of brand value, including confidence in operational performance, is important for the future health of any business.

Despite the unpredictability and low likelihood of each of the types of scenarios considered, the Cambridge Centre for Risk Studies views these types of risk as part of the operating landscape that this company, and others like it have to accommodate into their business contingency planning. Unpredictability is not an excuse for lack of preparation. There is genuine uncertainty in evaluating these risks but providing best estimation and using evidence-based assessments enables a consistent and objective approach to be taken to managing these risks.

Looking more broadly, there is increasing pressure for information transparency of firms in declaring and sizing their risk exposures. An early milestone facing a firm on the road to greater transparency is articulation of its risk appetite, in the context of the business activities that deliver its value proposition to its customers. Quantifying risk appetite, and building the data and analytics to monitor a firm's performance relative to its risk appetite thresholds, is challenging but should be considered as a goal even for risk types where events of significance are highly unpredictable. Financial and governance structures play a role in both risk exposure and in assessing and mitigating risks. A clearer picture of the link between the structure of a public company, its risk exposures and its meaningful mitigations is an ambition.

This report focuses on a quantitative view of a company's balance sheet to a number of stress test scenarios that represent a wide range of disparate and differing types of risks. We have demonstrated that it is possible to compare and rationalize across these differences. We illustrate an approach for creating an integrated view across all risks faced by an organization.

A deeper study would expand the analysis in three directions. The first would be to dramatically increase the number and type of risk scenarios, given the unpredictability of catastrophic events which a global organisation experiences – recurring impacts from apparently unrelated events. The Cambridge Business Risk Taxonomy in Figure 8 has six major risk classes and around 100 risk types, which are a starting point for an organisation which has not yet built its own comprehensive list of risk drivers. The second direction, a refinement of the first, is to identify emerging risks and construct business stress tests around these. The third would be to classify and model risk mitigation strategies.

The Cambridge vision is to produce standardised evaluation processes that, by consistency of methodology, allows comparison of business consequences across a comprehensive library of risk scenarios. Aggregation across all scenarios is the foundation for a transparent cost-benefit analysis to managing risk appetite and resilience.

Bibliography

Agency Inc. 2016. "Corporate Branding. Why Is It so Important to a Business?," October 2016. https://www.agencyinc.co.uk/corporate-branding-important-business/.

"Aon Risk Maturity Index." 2017. Insight Report. Aon Risk Solutions. https://www.aon.com/attachments/risk-services/2017-RMI-InsightReport-Web.pdf.

Baruna, Akrur, and Patricia Buckley. 2019. "Rising Corporate Debt: Should We Worry?" Deloitte Insights. Deloitte. https://www2.deloitte.com/content/dam/insights/us/articles/5042_ibtn-april-2019/DI_IbtN-April-2019.pdf.

Blazyte, Agne. 2019. "Annual Gross Merchandise Volume (GMV) Transacted on Alibaba's Retail Marketplaces in China from FY 2014 to FY 2019 (in Billion Yuan)," September 23, 2019. https://www.statista.com/statistics/959573/china-alibaba-gmv/.

Bradley, Chris, Martin Hirt, and Sven Smit. 2018. Strategy Beyond the Hockey Stick: People, Probabilities, and Big Moves to Beat the Odds. McKInsey & Company. https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/strategy-beyond-the-hockey-stick.

Butler, Sarah. 2014. "Primark to Pay £6m More to Victims of Rana Plaza Factory in Bangladesh." The Guardian, March 16, 2014. https://www.theguardian.com/world/2014/mar/16/primark-payout-victims-rana-plaza-bangladesh.

Cambridge Centre for Risk Studies. 2018. "Risk Management Perspectives of Global Corporations." Cambridge Centre for Risk Studies at the University of Cambridge Judge Business School, in collaboration with Institute of Risk Management. https://www.jbs.cam.ac.uk/faculty-research/centres/risk/publications/finance-economics-and-trade/risk-management-perspectives-of-global-corporations/.

———. 2019a. "Quantifying Corporate Risk from External Shocks: A Worked Example, Corporate Risk Profiling." Cambridge Centre for Risk Studies at the University of Cambridge Judge Business School, in collaboration with Willis Towers Watson.

———. 2019b. "Cyber Risk Outlook." Cambridge Centre for Risk Studies at the University of Cambridge Judge Business School, in collaboration with Risk Management Solutions. https://www.jbs.cam.ac.uk/faculty-research/centres/risk/publications/space-and-technology/cyber-risk-outlook-2019/.

Campbell, John Y., Jens Dietrich Hilscher, and Jan Szilagyi. 2011. "Predicting Financial Distress and the Performance of Distressed Stocks." Journal of Investment Management. https://dash.harvard.edu/handle/1/9887619.

Chen, Yehning, J. Fred Weston, and Edward I. Altman. 1995. "Financial Distress and Restructuring Models." Financial Management 24 (2): 57–75. https://doi.org/10.2307/3665535.

Claessens, Stijn, and Leora F. Klapper. 2005. "Bankruptcy around the World: Explanations of Its Relative Use." American Law and Economics Review 7 (1): 253–83. https://doi.org/10.1093/aler/ahi004.

Elms, Deborah K, and Patrick Low. 2013. "Global Value Chains in a Changing World." WTO Publications.

EMarketer. 2019. "Top 10 US Companies, Ranked by Retail Ecommerce Sales Share, 2019," February 2019. https://www.emarketer.com/chart/226335/top-10-us-companies-ranked-by-retail-ecommerce-sales-share-2019-of-total-us-retail-ecommerce-sales.

Fan, Joseph P. H., Sheridan Titman, and Garry Twite. 2012. "An International Comparison of Capital Structure and Debt Maturity Choices." Journal of Financial and Quantitative Analysis 47 (1): 23–56. https://doi.org/10.1017/S0022109011000597.

Forbes. n.d. "The World's Largest Public Companies." Forbes. Accessed December 10, 2018. https://www.forbes.com/global2000/list/.

Glaeser, Edward L, and Janet E Kohlhase. 2003. "Cities, Regions and the Decline of Transport Costs." Papers in Regional Science, no. 8: 197–228.

Hotchkiss, Edith S., Kose John, Karin S. Thorburn, and Robert M. Mooradian. 2008. "Bankruptcy and the Resolution of Financial Distress." SSRN Scholarly Paper ID 1086942. Rochester, NY: Social Science Research Network. https://papers.ssrn.com/abstract=1086942.

Investopedia. 2019a. "Consumer Discretionary." March 2019. https://www.investopedia.com/terms/c/consumer-discretionary.asp.

———. 2019b. "Consumer Staples." April 2019. https://www.investopedia.com/terms/c/consumerstaples.asp.

Kell, Georg. 2018. "The Remarkable Risk of ESG." Forbes, July 11, 2018. https://www.forbes.com/sites/georgkell/2018/07/11/the-remarkable-rise-of-esg/#18cc9de91695.

Kleiner, Art. 2003. "The Man Who Saw the Future." Strategy+business, Spring 2003. https://www.strategy-business.com/article/8220?gko=4447f.

Koh, SzeKee, Robert B. Durand, Lele Dai, and Millicent Chang. 2015. "Financial Distress: Lifecycle and Corporate Restructuring." Journal of Corporate Finance 33 (August): 19–33. https://doi.org/10.1016/j.jcorpfin.2015.04.004.

Kunz, Dave. 2019. "Used Car 'vending Machines' Popping up along Southland Freeways." ABC7, September 2019. https://abc7.com/automotive/used-car-vending-machines-popping-up-along-socal-freeways/5521446/.

Levy, Adam. 2019. "The 7 Largest E-Commerce Companies in the World." Motley Fool, August 2019. https://www.fool.com/investing/the-7-largest-e-commerce-companies-in-the-world.aspx.

McKinsey & Company. 2019. "Perspectives on Retail and Consumer Goods."

Morgan Stanley. 2019. "What Drives Outperformance as Profitable Growth Becomes More Elusive?" North America Insight.

OECD. 2019. "Household Spending (Indicator)." doi: 10.1787/b5f46047-en. https://data.oecd.org/hha/household-spending.htm.

Pergler, Martin. n.d. "Enterprise Risk Management: What's Different in the Corporate World and Why." 40. McKinsey Working Papers on Risk. McKinsey & Company. https://www.mckinsey.com/~/media/mckinsey/dotcom/client_service/risk/working%20papers/40_whats%20different%20in%20the%20corporate%20world.ashx.

Randall, Taylor, Ruskin Morgan, and Alysse Morton. 2003. "Efficient versus Responsive Supply Chain Choice: An Empirical Examination of Influential Factors." The Journal of Product Innovation Management 20: 430–43.

Rebonato, Riccardo. 2010. Coherent Stress Testing: A Bayesian Approach. John Wiley & Sons.

Reuters. 2016. "Toyota, Other Major Japanese Firms Hit by Quake Damage, Supply Disruptions,." https://fortune.com/2016/04/17/toyota-earthquake-disruptions/].

Sheffi, Y, and JB Jr Rice. 2005. "A Supply Chain View of the Resilient Enterprise." MIT Sloan Management Review.

Small Business.Co.Uk. 2017. "Online Shoppers Would Spend More to Get Same-Day Delivery," June 15, 2017. https://smallbusiness.co.uk/online-shoppers-spend-get-day-delivery-2539110.

S&P Global & MSCI. 2018. "Global Industry Classification Standard." S&P Global & MSCI. https://www.spglobal.com/marketintelligence/en/documents/112727-gics-mapbook_2018_v3_letter_digitalspreads.pdf.

Taylor, Glenn. 2018. "Retail's Big Opportunity: 87 % of US Consumers Grasp the Power of Conversational Commerce." Retail Touchpoints, March 2018. https://www.retailtouchpoints.com/topics/omnichannel-cross-channel-strategies/retail-s-big-opportunity-87-of-u-s-consumers-grasp-the-power-of-conversational-commerce.

The Boston Consulting Group. 2012. "The Millennial Consumer: Debunking Stereotypes." https://www.bcg.com/documents/file103894.pdf.

Weinstein, Mary. 2019. "How to Sell on Amazon: Everything You Need to Know for 2019." Tinuiti, April 2019. https://cpcstrategy.com/blog/2019/04/sell-on-amazon/.

Appendix A: Science in Scenarios

Scenario A - Trade Dispute: United States vs European Union

Science in Scenarios™

Trade Dispute: United States vs Europe Union

Business Risk Overview

Trade disputes arise from political differences between market jurisdictions, and involve raising barriers for a country to sell their goods in a specific market. Barriers include quotas, tariffs, subsidies, anti-dumping duties, regulatory barriers and voluntary export restraints, with differential constraining power.

Scenario Narrative

Transatlantic trade negotiations break down, citing inequities in trade. Historical points of friction include genetically-modified soybeans into Europe, car imports from Europe damaging US motor industry, and steel tariffs. US and Europe Union Customs Union impose tariffs on classes of goods imported from each other's markets. Variants of the scenario include the magnitude of the tariff applied, classes of goods that it is levied on, and duration to resolution.

Timeline

Tariffs are applied in Year 1 Q1 and sustained, unchanged, for five years.

Tariff in place

0 Year 1 2 3 4 5

Metrics of Severity

Ad Valorem Tariff % price increase levied (agricultural and non-agricultural), accounting for X $Billion of value on trade between the two blocs, in both directions.

Scenario Severity Levels

| L	Agr	Non-Agr	Duration	Chance
L1	10%	10%	3 Years	Possible Chance
L2	20%	20%	5 Years	Low Chance
L3	40%	40%	5 Years	Unlikely
L4	140%	140%	5+ Years	Very Unlikely

Likelihood Trend: Increasing ▲

Geography
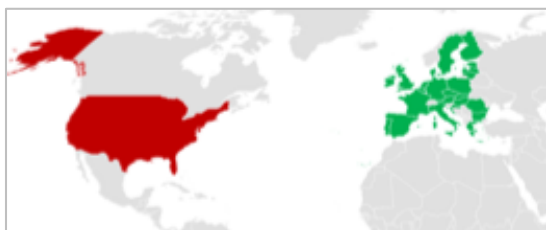
How the Scenario Impacts Your Business

Products and services that you sell into these markets from the other territory become more expensive, increasing your costs of goods sold. If you pass on these costs to your customers, they face increased prices, which reduces demand according to price elasticity economics. There are additional spillover effects on unconstrained brands and discount rate changes.

Threat Analysis

Tariffs Applied Historically in WTO
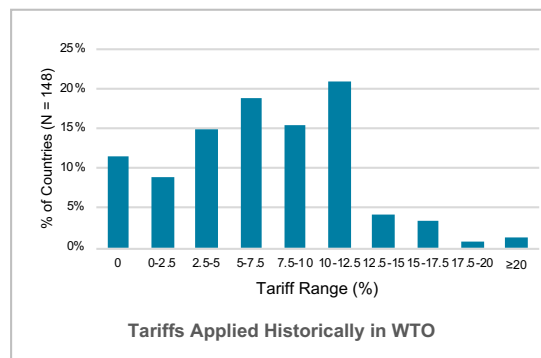
Precedent Evidence Base

US-China trade war 2018 saw tariffs of up to 25% being imposed on $250 billion of China imports. Scenario analysis is based on World Trade Organization (WTO) statistics. For Agriculture Agreement market access in agricultural products is tariff only; non-tariff barriers like quotas are viable for non-agricultural products under Non-Agricultural Market Access (NAMA). Tariff negotiations can take a long time to conclude, so there may be lengthy periods of uncertainty while discussions continue.

Further Information

📧 **Trade War US-Europe** Scenario Presentation

📖 **Trade War US-Europe** Scenario Report

🎬 **Financial Risk** Video

Financial: International Trade Dispute
Scenario TW 001-01

Scenario Type:
Regional Macroeconomic

Scenario B - Geopolitical Conflict: Pakistan vs India

Geopolitical Conflict: Pakistan vs India

Business Risk Overview

International conflicts are highly disruptive to trade and economic activity, despite causing short term stimuli for domestic industrial and military production. In addition to the destruction incurred in the theatre of hostilities, wars have impact on many other countries, and typically result in inflation, increased national debt, and economic consequences for many parts of the world.

Scenario Narrative

The long-standing tensions between Pakistan and India over disputed territory in Kashmir escalates to military conflict between the two nations. Three levels of severity of conflict are explored in the scenario, from regional guerrilla warfare, through conventional military targeting of each others cities for bombing and invasion by land forces, through to all out nuclear conflict. Allies and superpowers finally broker a peace between the protagonists.

Timeline

A disruptive build up of tension is envisioned before a period of hostilities, followed by a lengthy reconciliation.

	Build Up	Conflict	Post-conflict trade disruption		
0	1	2	3	4	5

Year

Metrics of Severity

Magnitude of conflict is determined by the military firepower deployed. Conflict protagonists are defined by their military power index. Duration of hostilities is a key metric.

Scenario Severity Levels

L	Scenario Variant	Magnitude	Duration	Chance
L1	Kargil Redux – Localized guerrilla war in Kashmir Region	Medium	6 Months	Possible Chance
L2	1965 War Redux Military invasions and extensive city bombing	Major	1 Year	Unlikely
L3	All Out Conflict Nuclear strikes on major cities in both countries	Nuclear	2 Years	Very Unlikely

Likelihood Trend: Increasing   ▲

Threat Analysis

Global Fire Power	Military World Ranking	Defence Budget	Military Personnel	Air Power	Naval Power	Land Power
India	4	$47 Bn	1.4 M	2,185 aircraft	295 assets	4,426 tanks
Pakistan	17	$7 Bn	0.3 M	1,281 aircraft	197 assets	2,182 tanks

How the Scenario Impacts Your Business

Business operations in territories involved in conflict are jeopardized, with potential disruption to those markets and to facilities, personnel, and activities in affected areas. Security of staff is a concern. Facilities may be affected in zones of hostilities. War also affects confidence and investment market volatility worldwide, and affects suppliers and trading partners with belligerent countries.

Geography

Event Source Country
- India
- Pakistan

Violent Event Severity
- Non-military conflict & bombing
- Military force
- Fight with light weapons
- Fight with artillery & tanks
- Employ aerial weapons
- Mass killing & ethnic cleansing

Precedent Evidence Base

India and Pakistan have been to war over Kashmir three times since partition in 1947: 1965 war over Jammu and Kashmir involved India ground forces penetrating almost to Lahore, and resulted in around 17,000 fatalities; In 1971 a guerrilla war supported by India to assist East Pakistan become Bangladesh resulted in Pakistan air attacks on India and full retaliation by India, resulting in over 11,000 deaths and 37,000 wounded. In 1999, with both states now nuclear forces, Pakistan engaged in a limited firefight with India in mountainous Kargil, with over 1,000 fatalities.

Further Information

📧 **International Conflict** Scenario Presentation

📖 **International Conflict** Scenario Report

▶ **Geopolitical Risk** Video

Geopolitical: Interstate Conflict
Scenario IC 045-01

Scenario Type:
Regional Macroeconomic

Scenario C - Cyber Attack: Contagious Malware Infestation

Cyber Attack: Contagious Malware Infestation

Business Risk Overview

Computer malware – a virus, worm, or trojan – that can replicate and spread through IT networks is a long-standing cyber threat. Latest generations of malware can penetrate even the most secure of corporate networks and paralyse IT systems by exploiting little-known vulnerabilities in security systems. Hackers may demand ransoms to unlock the systems. Restoring infected computer systems might take many days, and the disruption can be very costly.

Scenario Narrative

The IT networks of many companies are penetrated by a rapidly replicating ransomware virus that encrypts large numbers of computers, servers, and industrial control systems, disabling business activities that rely on them. Demands are made for ransom payments in cryptocurrency to decrypt, but even paying may not guarantee restoration. Many other businesses are similarly affected, including suppliers and customers.

Timeline

Computer systems are initially disabled for a number of days. Other consequences take months to resolve.

Metrics of Severity

The proportion of computers (endpoints) infected within the network of the organisation. Number of infected organizations indicates counterparty risk.

Scenario Severity Levels

L	% of computers	Payload type	Days outage	Chance (one company)
L1	10%	Ransomware	3	Possible Chance
L2	25%	Ransomware	5	Unlikely
L3	50%	Ransomware	10	Highly Unlikely

Likelihood Trend: Increasing ▲

Geography

Example Footprint of Malware Infection (WannaCry 2017)

How the Scenario Impacts Your Business

Your organization's IT network is compromised by the malware through a previously unknown ('Zero Day') vulnerability in your security system. It spreads through your network before activating and encrypting many servers and computers. Business activities that depend on IT are disrupted for the time it takes to repair and restore the computer systems. Restoration time is a major variable in the business impact. Counterparty organisations are also paralysed for similar periods.

Threat Analysis

Ransomware Incidence by Country

Country	%
United States	17.2%
Great Britain	11.1%
Belgium	8.6%
Singapore	6.5%
Indonesia	5.3%
India	4.8%
Germany	2.9%
Netherlands	2.8%
Malaysia	2.7%
Taiwan	2.4%
Australia	2.4%
Italy	2.3%
France	2.2%
Philippines	1.9%
Chile	1.9%
Canada	1.6%

Precedent Evidence Base

The 2017 NotPetya virus infected the networks of 8,000 organizations, including several that issued profits warnings due to the disruption to revenues that resulted, and direct costs of over $10 bn. WannaCry, a similar virus infected 30,000 computers and caused costs of over $3 bn. Many other incidents of malware have been recorded over the past 30 years. Toolkits for sale on the black market make it easier for hackers to perpetrate new variants of malware.

Further Information

📧 **Cyber Contagious Malware** Scenario Presentation

📖 **Cyber Risk Landscape** Scenario Report

🎬 **Technology Risk** Video

Technology: Cyber Attack
Scenario CA 001-01

Scenario Type:
Operational: Company Specific

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Science in Scenarios™

Environmental: Floods Damage Key Facilities

Business Risk Overview

Natural hazards can pose a threat to individual facilities, damaging them and putting them out of action for lengthy periods. Events are rare so it may not be obvious that sites are hazard-prone without detailed analysis. Damage to key facilities and high value assets can be costly, particularly if they are a critical element of business operations.

Scenario Narrative

A major storm with winds, heavy rain, and a high sea surge along the coast, causes extensive flooding along coastal regions and river plains. Major plants and facilities of the business that are located on coastal and river plains are flooded. The flood affects distribution hubs and major manufacturing and processing plants of the business. In severe levels of the scenario floods are more extensive and deeper than expected historically, due to climate change.

Timeline

Flood Event — Function loss from the facility

Year 0 1 2 3 4 5

Metrics of Severity

Flood severity is measured by depth of flood water at the affected site. The velocity of the flood water flow, and pollution in flood waters, can significantly increase damage.
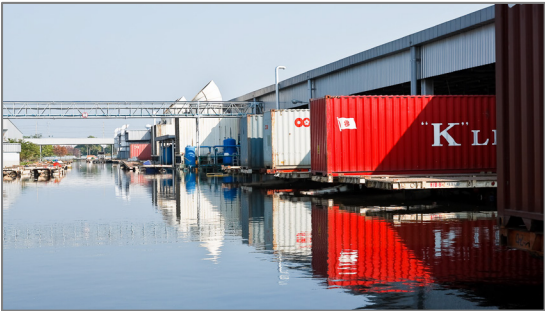
Scenario Severity Levels

L	Depth	Pollution	Contents Loss (%) & Outage	Chances
L1	0.8m	Light	25% 2 weeks	Very Unlikely
L2	1.3m	Medium	30% 3 months	Highly Unlikely
L3	1.5-3m	Heavy	40% 12 months	Extremely Unlikely

Likelihood Trend: Slowly increasing ▲

Geography

Potential Flood Footprint from Extreme North Sea Storm Surge

How the Scenario Impacts Your Business

Flooding of a major facility causes damage, loss of contents and inventory, and business disruption, which can be a major financial loss and cause extensive operational disruption. A major flood can hit many sites simultaneously, affect suppliers and customers' assets, and cause widespread power outages and infrastructure failure. It can disrupt supply chains and cause business disruption at places that rely on services from the damaged facility.

Threat Analysis

Flood Areas Affecting Key Processing and Distribution Facility

Precedent Evidence Base

Floods have caused business losses periodically at locations all around the world. The North Sea flood of 1953 hit Netherlands, Belgium, England and Scotland, overwhelming sea defences, killing 2,500 people, and flooding large areas up to 5.6 metres deep. Floods are one of the most common types of natural hazard, and affect many cities, coastal areas, and river plains. Climate change is likely to increase the occurrence and severity of floods.

Further Information

- **Flood Risk Scenario** Presentation
- **Natural Catastrophes and Financial Markets**
- **Climate Change as a Business Risk** Video

Environment: Flood Damage
Scenario CC 001-01

Scenario Type:
Global Macroeconomic

Scenario E - Pandemic: Highly Infectious Influenza Virus

Pandemic: Highly Infectious Influenza Virus

Business Risk Overview

Pandemics are the spread of a disease through the population across international borders. Several diseases can cause pandemics, each has its own characteristics of infectiousness, virulence, and method of spread. Influenza is one of the most infectious, capable of causing high absenteeism and death. One of the most rapidly mutating viruses is influenza, with potential for major societal impact.

Scenario Narrative

A new strain of influenza virus emerges that is highly infectious, with many deaths recorded, even among the young and healthy. It rapidly spreads from one country to another, over several months, making people sick for weeks. Some die. Countries instigate national emergency measures, close schools, and ration antiviral drugs. Heath care resources are overwhelmed. Businesses are forced to close. Markets are affected. It takes months until a vaccine is available to suppress the further spread of disease.

Timeline

The infection wave passes around the world in 9-12 months, followed by a secondary wave in second year.
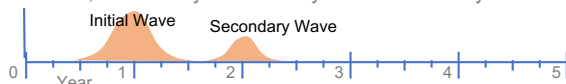
Metrics of Severity

Infection rate in the general population, and virulence, represented by Case Fatality Rate (CFR). The resultant levels of absenteeism in the workforce and duration are the metrics of operational impact. Consumer demand loss.
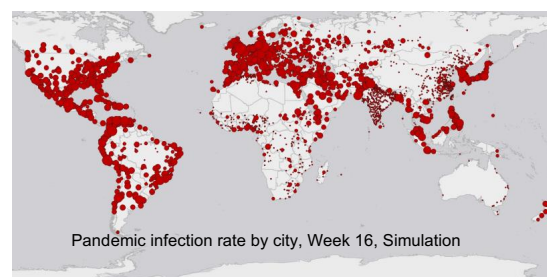
Scenario Severity Levels

L	Variant	Absentee Rate	Duration	Chance
L1	New Strain - Infectious	30%	2 wks	Possible Chance
L2	New Strain - Severe	40%	4 wks	Unlikely
L3	New Strain - Deadly	50%	6 wks	Very Unlikely

Likelihood Trend: Decreasing ▼

Geography

Pandemic infection rate by city, Week 16, Simulation

How the Scenario Impacts Your Business

Your workforce suffers high levels of absenteeism during the infection wave, not just from those who are ill, but also from caring for someone who is ill or from fear. Your suppliers and counterparties also have high absenteeism. Consumers reduce their purchasing and the economy slows. Markets fall, and investment portfolios suffer devaluation.

Threat Analysis
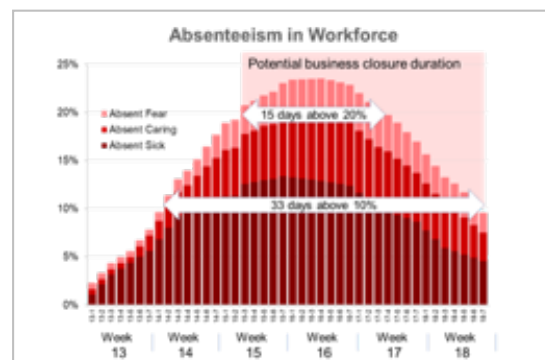
Precedent Evidence Base

1918 Spanish Flu pandemic is estimated to have infected about a third of the world's population and killed 50 to 100 million people, including healthy adults. New strains of influenza caused milder pandemics in 1957, 1968, 1977, and 2009. Pandemics from new strains of influenza and other emerging infectious diseases pose a constant threat. Historically there have been around 4 or 5 pandemics a century from the evolution of new pathogens for which medical science has no vaccine. Risk is reduced by good disease surveillance and improving healthcare.

Further Information

📰 **Pandemic** Scenario Presentation

📖 **Pandemic** Scenario Report

▶ **Social Risk** Video

Social & Humanitarian: Human Epidemic
Scenario HE 005-02

Scenario Type:
Global Macroeconomic

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# Science in Scenarios™

Governance: Equal Pay Dispute

Business Risk Overview

Gender pay gap is the difference in renumeration of men and women. Large differences between highest and lowest pay grades in a company are also increasingly controversial. Regulation in several countries requires businesses to report on pay grades by gender or level. Pressure for pay equality can cause disruptive disputes and large increases in labour costs.

Scenario Narrative

Reporting of gender pay gaps and senior management pay inequality results in workforce demands for pay increases. Labour disputes lead to industrial action, protests, strikes, and negative publicity for the company. Consumer boycotts and shareholder activism add to the pressure. Brand reputation of the organization suffers. The company suffers a lengthy period of reduced productivity and is also faced with a class action lawsuit. The pay dispute is settled, leading to an increase in labour costs for the company.

Timeline
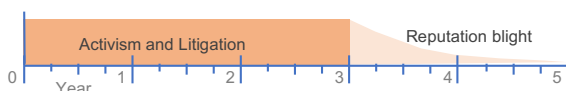
Metrics of Severity

The average % difference between pay rates at equivalent pay grades between men and women in the company being analyzed.

Scenario Severity Levels

L	Activism	Litigation	Chance
L1	Protests and publicity	Lawsuit (Win)	Possible Chance
L2	Strikes and Violence	Major Lawsuit (Settle)	Low Chance
L3	Customer Boycott	Mass Tort Lawsuit (Lose)	Very Unlikely

Likelihood Trend: Significantly Increasing ▲

Geography
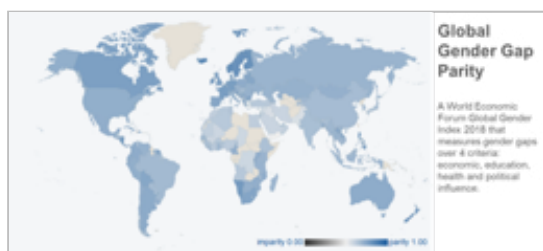
Social: Gender & Diversity
Scenario SH-CP-TI

How the Scenario Impacts Your Business

Corporates will likely experience an increase in labour costs to equalize pay for workers of lower pay and those with grievances. Productivity is hampered as employee morale is reduced. Public relation costs are spent to help mitigate the reputational damage. Money is spent to litigate a class action lawsuit and the share price is impacted as the company is seen as performing worse than their peers on gender pay.

Threat Analysis
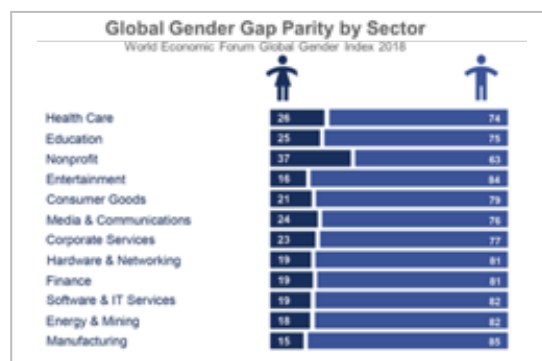
Precedent Evidence Base

Google, Dell, HP, Humana, JP Morgan, Walmart, and others have experienced gender pay related activism and litigation. Google pay issues involved an investigation by the US Department of Labor, a class action lawsuit and a mass walkout over sexual misconduct internal policies. Many large employers of both manual and highly-skilled workers are facing activism and litigation over gender pay.

Further Information

📇 **Equal Pay Dispute Scenario** Presentation

📖 **Corporate Risk** Report

Scenario Type:
Company Specific: Labour

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