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Luis A. Perez-Batres

Professor and Senior Presidential Fellow

Central Michigan University

Len J Treviño

SBA Communications Distinguished Professor of International Business and Director of International Business Programs

Florida Atlantic University

**Exposure, Black Swans, and Real Options**

Society has been susceptible to man-made and natural catastrophic events since the beginning of time. A few of the more notable natural disasters include the Antioch earthquake of AD 526, the 1881 Haiphong typhoon, and the more recent 2004 Indian Ocean earthquake and tsunami.[[1]](#endnote-1) Man-made disasters include the great depression, the great credit crisis of 2008, and of course climate change.[[2]](#endnote-2) Many scientists believe we have begun to surpass planetary boundaries on climate change (Hoffman and Jennings, 2019; Gillins & Hagan-Lawson, 2014; Rockstrom et al., 2009), which may lead to periodic flocks of black swan[[3]](#endnote-3) events represented by an increase in the number of natural disasters – e.g., fires, floods, tsunamis, pandemics, etc. Effective organizational responses to calamities with worldwide consequences are paramount. For events such as the COVID-19 pandemic, which have triggered isolation measures and taxed the efficacy of supply chains across countries, we recommend private and public organizations to engage in the real options[[4]](#endnote-4) exercise of building small webs of “essential” supply chain nodes on low population density areas to:

1. continually serve these low population density areas during regular times, while
2. ensuring sufficient slack capacity to maintain a state’s economy even if isolation measures are required.

**Collective Exposure**

Our recommendation’s premise rests on the concept of exposure and the extension of its implications from an individual level to a collective or aggregate level. Defined as being susceptible to an exogenous stressor,[[5]](#endnote-5) *exposure* is well understood at the individual level, although less so at the collective level. For instance, Taubenberger & Morens (2006)[[6]](#endnote-6) offer a historical account of the three waves of the Spanish Flu and their devastating consequences. However, their explanations imply a certain societal inability to understand how ecosystems play a role in increasing virus exposure during different timelines.

In extending the implications of exposure from an individual level to an aggregate level, first we identify two individual-level variables or recommendations provided by the US COVID-19 Task Force: a) enhancing social distance and b) avoiding visiting other households or hosting individuals at home. Next, we propose two collective level constructs, for comparison: i) state/country population density and ii) state/country annual visitors (see Table 1). If social distancing decreases individual exposure, then it follows that larger “natural” social distances, represented by states or countries with lower population densities, should also decrease exposure at the aggregate level. Likewise, if withholding visiting/hosting others decreases exposure at the individual level, then fewer annual visitors at a state or country level should also mitigate exposure.

Table 1. Exposure equivalents, from an individual to an aggregate level.

|  |  |
| --- | --- |
| Individual-level recommendation construct | Aggregate-level equivalent |
| a) Social Distance | i) Population Density (State/Country) |
| b) Visiting / Hosting | ii) # Int’l Visitors (State/Country) |

**Expected relationships**

We expected a positive relationship between COVID-19 number of deaths /confirmed cases and population density/international visitors. Table 2 shows that the top-10 most affected U.S. states had 10 times as many deaths (per 1 million pop.) and roughly six times the population densities compared to the least affected bottom-10 U.S. states. Table 3 illustrates a similar trend for European countries. The top-10 most affected European countries had 140 times as many deaths (per 1 million pop.) and approximately three times the population density compared to the least affected bottom-10 European countries. Both Tables illustrate median figures on four key variables: top-10 and bottom-10 (most/least) affected American states (out of all 50) and European nations (out of 40 countries with populations of 100K and above), pop. density, and annual international visitors.

Table 2. COVID-19 Exposure USA

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| States | Deaths  per 1 million pop., 2020 | Confirmed Cases per 1 million pop., 2020 | Population  Density (mi²) | Int’l Air Travelers  millions, 2017 |
| Top-10 (most affected) | 42.92 | 1,582.23 | 297 | 1.52 |
| Bottom -10 (least affected) | 4.07 | 287.81 | 46.9 | Fewer than 1K |

Sources: Worldmeters (04/06/2020); <https://state.1keydata.com/state-population-density.php>; <http://www.fi-aeroweb.com/Top-100-US-Airports.html>

Table 3. COVID-19 Exposure Europe

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Countries | Deaths  per 1 million pop., 2020 | Confirmed Cases per 1 million pop., 2020 | Population  Density (km²) | Annual Visitors  millions, 2018 |
| Top-10 (most affected) | 88.29 | 1,464.11 | 204 | 13.3 |
| Bottom -10 (least affected) | 0.63 | 90.45 | 68.5 | 8.8 |

Sources: Worldmeters (04/04/2020); indexmundi.com; ourworlddata.org/tourism

**Financial Hedging and Real Options Hedging**

In addition to the immeasurable cost in terms of human lives, the current black swan has already caused trillions of dollars in global economic losses . Negative effects from such events, however, are not rare. According to Hoffman,[[7]](#endnote-7) some insurance companies have modified their actuarial tables and increased premiums due to climate change patterns. While calculating and pricing risks is common practice in that industry, we argue that other organizations must learn from them; one way would be to include the cost of *financial hedging* against the possibility of being unable to operate due to black swan events. A timely example is that of the All-England Tennis Club (Wimbledon[[8]](#endnote-8)); for the past 17 years, Wimbledon paid for an insurance policy to safeguard against cancellation losses due to a worldwide pandemic. They now stand to receive £114 million amid the current contingency.

However, financial hedging, such as that offered by insurance products and financial derivatives (calls, puts, forwards, etc.) is not the only choice; other hedging alternatives include *real options*. Real options provide their holders with an actual physical choice to switch⁴ should a given scenario materialize – e.g., oil companies sometimes shut down plants when prices are low and resume operations when prices increase. Real options, however, are not only available to very large corporations. At the individual level, there is a growing worldwide market of consumers utilizing home standby gensets to facilitate continuing their daily life amid grid failures.[[9]](#endnote-9) Indeed, gensets provide them with a real option (physical options to switch or expand) that they can exercise during such contingencies. Thus, similar to what individuals do during a grid failure contingency, we argue that private and publics organizations should utilize real options at the aggregate level amid contingency failures derived from regular “supply chain *power* *grid*” malfunctions.

**Conclusion**

Building small webs of essential supply chain nodes would act as a contingency strategy to power a state’s economy during catastrophic contingencies. In addition, we believe that creating webs of “essential” supply chain nodes on low population density areas have two direct extra benefits, namely promoting: 1) fuller participation of smaller communities in the life and well-being of a state and country, especially during similar exigent circumstances, and 2) an enhanced sense of community self-reliance during normal times.

Some good can emerge from this calamity. Our contribution is a feasible measure to mitigate against the negative effects of black swans arriving during major climate or public health crises, forcing isolation practices on most of us. However, we must also try to prevent[[10]](#endnote-10) them and anticipate other possible repercussions.

In the meantime, it has been refreshing to see a world putting the lives of its citizenry first.

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**Endnotes**

1. <https://www.livescience.com/33316-top-10-deadliest-natural-disasters.html> [↑](#endnote-ref-1)
2. <https://journals.ametsoc.org/doi/pdf/10.1175/2010BAMS3092.1> [↑](#endnote-ref-2)
3. https://en.wikipedia.org/wiki/Black\_swan\_theory [↑](#endnote-ref-3)
4. <https://corporatefinanceinstitute.com/resources/knowledge/valuation/real-options/>. Real options include the physical choice of expanding and switching – i.e., temporarily abandoning projects. [↑](#endnote-ref-4)
5. Exposure definition adapted from [Lee, Oh, and Eden (2010, p.2](https://link.springer.com/article/10.1007/s11575-010-0057-9)) [↑](#endnote-ref-5)
6. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3291398/> [↑](#endnote-ref-6)
7. <https://www.youtube.com/watch?v=IlRGU0TvPSA&feature=youtu.be> [↑](#endnote-ref-7)
8. <https://www.insurancejournal.com/news/international/2020/04/13/564598.htm> [↑](#endnote-ref-8)
9. <https://www.globenewswire.com/news-release/2019/05/15/1824372/0/en/Home-Standby-Gensets-Market-value-to-hit-5-billion-by-2025-Global-Market-Insights-Inc.html> [↑](#endnote-ref-9)
10. <https://www.ft.com/content/74e5f04a-7df1-11ea-82f6-150830b3b99a>;

    <https://www.researchgate.net/publication/10859579_Predictable_Surprises_The_Disasters_You_Should_Have_Seen_Coming>

    **Bio**

    Luis is a graduate of Texas A&M University (PhD), the University of Illinois at Urbana-Champaign (MS), and Monterrey Tech (BS). He is a Professor of Strategy, two-term Department Chair, and Senior Presidential Fellow at Central Michigan University. He served as a Faculty Affiliate of the Erb Institute at the University of Michigan, where he was a Visiting Scholar during his sabbatical, in Fall/2013. His research rests at the interplay of international strategy and sustainability and has been funded by the U.S. Department of Education. He is on the editorial board of *Journal of World Business* and recently earned the Management Development Program (MDP) certificate at Harvard’s Graduate School of Education (2018).

    **Bio**

    Len Treviño is a graduate of Indiana University (PhD; MBA), and the University of Notre Dame (BBA). He is the SBA Communications Distinguished Professor of International Business and Director of International Business Programs at Florida Atlantic University. He is the President of Iberoamerican Academy of Management and sits on the editorial board of *Journal of World Business.* His research focuses on the antecedents and consequences of foreign direct investment and the internationalization strategies of multinational enterprises. He has published in *Journal of International Business Studies, Journal of Management, Journal of World Business* and other top management and international business journals. [↑](#endnote-ref-10)