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In This Issue:

Introduction BY JERRY WALLIS, IRUA EXECUTIVE DIRECTOR

Our third edition of the year - Volume 26, No. 3 – contains another selection of varied and interesting topical articles.

After six long years, the Florida Legislature has taken definitive action on the troubling issue of Assignment of Benefits. This topic was the subject of a 2017 article in this Journal by the same law firm and we are pleased for both policyholders and companies that the AOB genie has been put back in its bottle. Attorneys White and Volpe, of the Adams and Reese LLP law firm in Jacksonville, have written an excellent article titled: **The Florida Legislature Finally Enacts Assignment of Benefit Reform.** This explains the background to, and the measures taken, by the law makers to curb this abuse. With the return of natural catastrophe frequency to Florida, a surge in this practice of third-party providers having homeowners policy benefits signed over to them so that a claim may be made directly against the policy – usually in the form of a lawsuit – has resulted in a ballooning of both claims and claims costs to the detriment of the industry and, ultimately, the consumer policyholder through increased premiums.

For our second article, we stay on the property catastrophe theme and appropriately so as the North Atlantic hurricane season is in full swing and wildfire season is not far behind. A Partner Re Opinions and Research article entitled: **Rethinking California Wildfire Risk** is featured and contains interesting material. This is a very interesting and thought provoking read. The article was written by several members of the Catastrophe Research team lead by Dr. Della Marta who is based in Zurich, Switzerland. We are grateful to Partner Re for permission to reproduce this paper and which is available, along with other research papers, on their website.

Next, we have the second installment of Dr. Ivelin Zvezdov's, technical paper entitled: **An Essay on (Re)Insurance – Re(Insurance) Risk Metrics for Practitioners.** Dr. Zvezdov is AIR Worldwide's Director of Product Development. AIR Worldwide is part of the Verisk group of companies. Dr. Zvezdov's essay defines some dependencies and inter-operability between key portfolio risk metrics used in risk management and capital reserving functions. As noted in the first essay, Dr. Zvezdov is a past contributor to the *Journal* and we look forward to his future contributions with interest.

Our fourth and final article is the last of our 2018 Scholar winners. Sean McDermott interned at Transatlantic Re in New York, NY and continues his studies at Loyola University in Baltimore, Maryland where he is due to graduate in May 2020. His essay **Blockchain Technology: The Insurance Revolution** takes an extensive and in-depth look at this new technology that is being embraced throughout the world. The insurance and reinsurance industry are not lagging in the design and implementation of this game changing technology and as he states: *Why the Insurance/ Reinsurance Industry will Never be the Same.*

In the IRUA News

As we wind down our 2019 events, we can safely say that it was a successful series of seminars and a variety of Lunch & Learn events on relevant topics. This year we also were able to offer several of our short programs as webinars and, they too, were well supported.

On September 12, we had a "half-day plus" seminar entitled **De-Constructing Construction** that was both well attended and received excellent evaluation reviews. This covered the overview to the line of business; updates on current developments and the marketplace; a session on the legal aspects of New York Labor Law and, finally, a rousing presentation by a construction program manager.

We wind down 2019 with what promises to be a lively presentation on **November 5** with a Lunch & Learn in midtown Manhattan of the **Reinsurance Networking Group** which the IRUA jointly organizes and administers with a leading arbitrator. The topic of this luncheon is **"Everything You Wanted to Know About How Arbitrators Are Selected but Were Afraid to Ask."** The presenters are well-known Chicago based attorneys, Teresa Snider and Catherine Isely, from the Porter Wright Morris & Arthur LLP firm.

We start our 2020 program on **January 8** with another midtown Manhattan Lunch & Learn. The topic is **Reputational Risk: A Bigger Piece of Investor Legal Actions**. Peter Gerken of Steel City Re will be addressing the topic. This session will also be offered as a webinar.

Full details of these and all IRUA events can be found on our website at **www.irua.org.**

Looking ahead, our **2020 Annual Meeting & Conference** is set for **April 6-7** and again, we are pleased to say that the Conference will be held at the Marriott Harbor Beach Resort in Fort Lauderdale, Florida. The new format, introduced for 2019, was enthusiastically endorsed by our attendees and so we will continue with this format. Starting with our Golf Tournament before the educational sessions was preferred and condensing the sessions into one day was very popular. The Conference Committee is getting close to finalizing the program. Our 2020 theme is **"20/20 Vision –Looking to the Future"**.

For more information about the IRUA and the educational session we offer, please be sure to access our website at **www.irua.org**. Further, if you are not receiving our weekly e-mailed, and popular, **IRUA Newsletter** please let us know and we will add you for a free subscription *mailing list.*

As always, we remind you that all member company and individual members, as well as *Journal* subscribers, can access, free of charge, all articles published since 1993 on our website.

Best regards,

Jerry Wallis, IRUA Executive Director

UPDATE: The Florida Legislature Finally Enacts Assignment of Benefit Reform

BY: THOMAS WHITE, ESQ. & TIMOTHY VOLPE, ESQ.

About the Authors:

Tom White is an Associate in the Jacksonville, Florida office of Adams and Reese LLP. Practicing law since 2014, Tom's practice is centered on insurance law, business law and commercial litigation. During law school, Tom received several honors related to his advocacy skills, placing first in the Evan A. Evans Constitutional Law Moot Court Competition, and receiving a scholarship from the University of Miami School of Law's Litigation Skills faculty for his performance in that program. During law school Tom also interned for a federal district court judge, as well as a Florida appellate court judge.

Tim Volpe is a Partner in the Jacksonville, Florida office of Adams and Reese LLP. Practicing law since 1982, he focuses primarily in the areas of insurance law, business law and commercial litigation. He frequently represents clients in the insurance industry, including acting as outside general counsel to several companies. Florida Trend magazine has named him as one of Florida's "Legal Elite" each year since 2007, and Thomson Reuter's Super Lawyers publication has named him a Florida Super Lawyer in business litigation and insurance coverage law each year since 2007, a designation awarded to 5 percent of attorneys in each state. Tim's experience includes commercial litigation, bankruptcy matters, commercial arbitrations, insurance litigation, non-litigation insurance experience, and including the formation, reorganization, purchase and sale of insurance companies and agencies.

Abstract:

This article explains the assignment of benefit crisis that has impacted Florida's property and casualty industry for years. After many failed attempts, the Florida Legislature passed legislation this year designed to curb assignment of benefit abuse. This article further serves as a summary of that new legislation.

Two years ago, we authored an article published in this Journal explaining the assignment of benefits crisis that has plagued Florida's property and casualty market for years. For readers outside of Florida, the proliferation of contractors using "assignments of benefits" to obtain payments directly from homeowners' insurance carriers led to widespread abuse and, in turn, substantial rate increases year over year. Our article discussed insurers' efforts to stymy the impact of assignments of benefits but concluded that a true fix still needed to come from the Florida Legislature. In this update we are able to report that after six years of failed legislation, in the Spring of 2019 the Florida legislature finally passed meaningful assignment of benefits reform. [i]

For the uninitiated, an assignment of benefits ("AOB") is a legal document that, when signed by homeowners' insurance policyholders, allows third-party service providers to make home repairs and subsequently seek payment directly from policyholders' insurance carriers. Essentially, a contractor repairs first and then uses an AOB to stand in the shoes of the policyholder to assert a claim against the policyholder's insurer. Often insurers' first notice of the claim comes in the form of a lawsuit by the contractor, seeking to leverage Florida's consumer protection laws towards a larger settlement. AOB use in Florida became particularly rampant in water damage and roofing claims.

Published statistics demonstrate the impact of AOBs in Florida. In 2006, 405 assignment of benefit lawsuits were filed.[ii] Ten years later, a staggering 28,183 AOB lawsuits were filed in 2016 alone.[iii] The Florida Office of Insurance Regulation ("OIR") published a report in February 2016, analyzing

Continued on page 4

Essentially, a contractor repairs first and then uses an AOB to stand in the shoes of the policyholder to assert a claim against the policyholder's insurer.

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trends in water claims received by Florida's top 25 residential property and casualty insurers related to water and roof damage claims.[iv] OIR's Report noted that since 2010, the frequency of water claims has increased by 46%[v]. In that same period, the average severity of water claims increased by 28%.[vi] The combined impact of those upticks in frequency and severity produced an average 14.2% increase in losses each year.[vii] As a result of those losses attributable to water claims alone, OIR suggested that if there were no other perils covered under the policy and no changes in expenses from year to year, an insurer would need to increase its rates by 10% or more each year simply to break even.[viii] OIR further determined that claims with AOBs generally have higher severity than those claims without AOBs and generally cost 50% more on a per claim basis.[ix] AOBs also caused an increase in litigation. In 2012, 9.7% of litigated water claims involved an AOB.[x] Just 3 years later in 2015, claims involving AOBs exploded to 55% of all litigated water claims.[xi] Importantly, litigated water claims are approximately three times as costly as water claims that are not litigated.[xii] As a result of these loss trends, insurers had no choice but to increase premiums.

A one-way attorneys' fee statute, afforded to consumers litigating against their insurer, has long been recognized as the primary culprit behind the AOB crisis. Florida Statutes, Section 627.428 provides attorneys' fees to a policyholder who obtains a judgment for any amount against his or her insurance company, without exposing the policyholder to the countervailing burden of the insurers' attorneys' fees in the event the insurer prevails in litigation.[xiii] Contractors who obtained AOBs from policyholders were legally entitled to one-way attorneys' fees as if they were the policyholders.[xiv] After obtaining an AOB, unscrupulous businesses could make unnecessary repairs before insurers are able to investigate, and then file lawsuits to recoup any denied amount of their inflated bill, armed with one-way attorneys' fees against any insurer that might otherwise have fought the contractors' claims.

Despite calls for reform from OIR, Florida's CFO, Citizens Property Insurance Company (the quasi-governmental property and casualty insurer of last resort) ("Citizens"), and the property and casualty industry, it took seven years for the Legislature to pass meaningful AOB reform. However, on May 23, 2019, Governor Ron DeSantis signed House Bill 7065, which implements several measures to combat AOB abuse. The new law became effective as of July 1, 2019.

One of the new Florida Statutes sections that codify House Bill 7065, Section 627.7152(2)(a), sets forth a number of requirements for an AOB to be enforceable. An AOB must now:

- be in writing and executed between the assignor and the assignee;
- contain a provision that allows the assignor to rescind the assignment by agreement and without penalty within certain time-frames;
- contain a provision requiring the assignee to provide a copy of the executed assignment to the insurer within 3 business days;
- contain a written, itemized, per-unit cost estimate of the services to be performed; and
- relate only to work for services to "protect, repair, restore, or replace a dwelling or structure or to mitigate against further damage to such property."[xv]

Section 627.7152 also provides insurers advance notice of the assignee's claim and the opportunity to avoid litigation, which was not previously afforded. Under Section 627.7152(9)(a), an assignee must provide a written notice of intent to initiate litigation prior to filing suit, as well as a detailed invoice or estimate.[xvi] The insurer has 10 business days to respond by either making a pre-suit settlement offer, or requiring the assignee participate in pre-suit mediation or alternative dispute resolution, pursuant to the policy.[xvii] As a condition precedent to filing a lawsuit, an insurer may also require the assignee submit to examination under oath and recorded statements, as well as an appraisal.[xviii]

Assignees are incentivized to resolve claims through this presuit settlement opportunity, because the new law also levels the playing field with respect to attorneys' fees, providing that where an AOB has been utilized the insurer has the same opportunity to obtain an attorneys' fees award.[xix] Section 627.7152(10)(a) revises the attorneys' fees entitlement as follows:

- Where the judgment award is less than 25 percent of the disputed amount (defined under the statute as the difference between the insurer's pre-suit settlement offer and the assignee's pre-suit settlement demand), the insurer is entitled to award of its reasonable attorneys' fees.
- Where the judgment award is between 25 percent and 50 percent of the "disputed amount" neither party is entitled to an attorneys' fees award.
- Where the judgment award is at least 50 percent of the "disputed amount," the assignee is entitled to an award of its reasonable attorneys' fees.[xx]

However, if the insurer fails to inspect the property or authorize repairs within 7 days after the first notice of loss it waives its right to recover attorneys' fees, unless a state of emergency has been declared, the failure is beyond the insurer's control, or the insured has failed to permit or allow inspection of the property upon request by the insurer.[xxi]

Finally, the bill also included what is now Florida Statutes, Section 627.7153, which allows insurers to avoid AOBs altogether on some of its policies by including policy language that prohibits insureds from entering into AOBs.[xxii] However, to do so the insurer must ensure the following: (1) that the insurer makes another policy available that does not restrict the right to execute an AOB, (2) that the restricted policy is available at a lower cost than the unrestricted policy, (3) that policies prohibiting assignment in whole cost less than policies prohibiting in part, and (4) and that restricted policies contain an explicit notice, as set forth in the statute. Further, the insurer is required to notify the insured at least annually of the coverage options available, and the insured must reject a fully assignable policy in writing or electronically, on a form approved by the OIR.[xxiv]

Early returns suggest that the enactment of House Bill 7065 will have the desired effect of limiting the use and application of AOBs, and reducing future premium increases as a result. Prior to the passage of House Bill 7065, Citizens' President and CEO, Barry Gilway, remarked, "As written, this bill will result in lower 2019 rates for some of our policyholders and shorten the time it will take us to provide relief to all of our customers."[xxv] He further stated, "While not providing immediate premium reductions to all Citizens policyholders, the legislation would go a long way toward stabilizing and shortening the time it takes for Citizens to provide rate reductions to its policyholders."[xxvi] Following through on those comments after the bill was signed into law, Citizens' Board of Directors acted to incorporate the changes brought by the AOB reform by reducing the 8.2 percent recommended increase for homeowners multi-peril policyholders, which was previously approved by OIR, down to a 2.3 percent increase.[xxvii] Citizens

further commented that more than 67,000 policyholders will see decreases for 2019.[xxviii] At the beginning of this month, OIR approved of Citizens' rate changes, with homeowners multi-peril policyholders to see an increase of only 2.6%, effective December 1, 2019.[xxix]

OIR Commissioner David Altmaier commented, "We are pleased to see that AOB reforms passed by the legislature are already having a positive effect on rates. We will be closely monitoring new rate filings to ensure that costs savings are passed along to Florida consumers."[xxx] However, OIR has cautioned that it is still too early to determine the precise impact of the legislation, and that it will take time for the reforms to be reflected in losses and rate indications.[xxxi]

House Bill 7065 may be the cure to Florida's AOB crisis that has infected its property and casualty industry for years. Two months after enactment it is impossible to know for certain yet whether gaps in the legislation will need correction, or whether contractors and their attorneys will identify a method of circumventing the new reforms to continue their AOB practice. One thing is for certain: they will try. In the meantime, this legislation marks a milestone and the most significant effort by the Legislature to stop the undue losses experienced by insurers for the past number of years. With any luck, that effort will be rewarded and the early signs of premium stabilization will continue. ◀

i Amy O'Connor, *Will 7th Time Be the Charm? Industry Makes Big Push for AOB Reform in 2019*, *INSURANCE JOURNAL* (Feb. 28, 2019), https://www.insurancejournal.com/news/southeast/2019/02/28/518891.htm (last visited August 19, 2019).

ii *Assignment of Benefits*, FLORIDA OFFICE OF INSURANCE REGULATION, http://www.floir.com/Sections/PandC/AssignmentofBenefits.aspx (last visited August 19, 2019).

iii *Id*.

iv Kevin M. McCarty, *Report on Review of the 2015 Assignment of Benefits Data Call,* FLORIDA OFFICE OF INSURANCE REGULATION (Feb. 8, 2016), http://www.floir.com/siteDocuments/AssignmentBenefitsDataCallReport02082016.pdf (last visited August 19, 2019).

v *Id*. at 6.

vi *Id*.

vii *Id.*

viii *Id.* at 8.

ix *Id*. at 6 & 11.

x David Altmaier, *The Florida Property Insurance Market and Assignment of Benefits (AOB), Presented to the Financial Services Commission,* FLORIDA OFFICE OF INSURANCE REGULATION, at 5 (Feb. 7, 2017), http://www.floir.com/siteDocuments/FSCAOBPresentation02072017.pdf (last visited Aug. 19, 2019).

xi *Id*.

xii *Id*.

xiii Fla. Stat. § 627.428(1).

xiv *Cont'l Cas. Co. v. Ryan Inc. Eastern*, 974 So. 2d 368, 377 (Fla. 2008) (the Florida Supreme Court noting that an assignment transfers all of the insured's rights to a clam under the policy and renders the assignee entitled to an award of fees under Fla. Stat. § 627.428).

xv Fla. Stat. § 627.7152(2)(a).

xvi Fla. Stat. § 627.7152(9)(a).

xvii Fla. Stat. § 627.7152(9)(b).

xviii Fla. Stat. § 627.7152(4)(d) & (e).

xix Fla. Stat. § 627.7152(10).

xx Fla. Stat. § 627.7152(10)(a).

xxi Fla. Stat. § 627.7152(10)(b).

xxii Fla. Stat. § 627.7153.

xxiii Fla. Stat. § 627.7153(2).

xxiv Fla. Stat. § 627.7153(3) & (4).

xxv Amy O'Connor, *Assignment of Benefits Reform Moves Forward as Florida House Passes Measure*, *INSURANCE JOURNAL* (April 12, 2019), https://www.insurancejournal.com/news/southeast/2019/04/12/523549.htm (last visited August 19, 2019).

xxvi *Id*.

xxvii *Florida's Citizens Revises 2019 Rate Filing; Will Request 2.3% Statewide Rate Increase*, *INSURANCE JOURNAL* (June 20, 2019), https://www.insurancejournal.com/news/southeast/2019/06/20/529934.htm (last visited August 19, 2019).

xxviii *Id*.

xxix Amy O'Connor, *Florida Regulator Approves Post-AOB Reform Rates for Citizens Policyholders*, *INSURANCE JOURNAL* (July 30, 2019), https://www.insurancejournal.com/news/southeast/2019/07/30/534238.htm (last visited August 19, 2019).

xxx *Id*.

xxxi Mario Marroquin, *Insurance Office Foresees Difficult Road Ahead of New Assignment of Florida Benefits Law*, FLORIDA RECORD (July 20, 2019) https://flarecord.com/stories/512713451-insurance-office-foresees-difficult-road-ahead-of-new-assignment-of-florida-benefits-law (last visited August 19, 2019).

Rethinking California Wildfire Risk

BY LUCA WEBER, DR. NIKLAUS MERZ, DR. PAUL DELLA-MARTA

About the Authors

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Abstract :

Looking at historical losses, 2017 and 2018 were outlier events. Correct? Well "Yes and No"! The loss data says "Yes" – the industry hasn't seen such severe losses before. In contrast, our CatFocus® California Wildfire model says "No" – it shows that several similar wildfire events have occurred over the last half century.

Ergo, if your risk assessment is based only on industry loss data, you're not getting the full picture. It's time for a rethink. We explain the losses vs model discrepancy and recommend a more robust approach to assessing and managing portfolios exposed to California wildfire.

EXECUTIVE SUMMARY

The 2017 and 2018 industry losses were the most severe since 1950, but were in fact not that unexpected given the loss potential of other historical events.

The industry should be prepared for future losses of a similar magnitude to 2017 and 2018, and at return periods which will significantly impact property portfolios.

Our estimated return period of a USD 10 billion annual aggregate industry loss is 20 years.

Exposure growth, especially in areas close to wildland, is the main driver of the changing risk landscape for California wildfire. It explains why regions with no prior loss are now also at risk.

Other factors impacting wildfire risk include human activities, weather, climate variability, climate change and biosphere-climate interactions, some of which are changing over time.

Risk assessment based on historical loss records alone cannot therefore reliably quantify this risk. A catastrophe model is the only viable method. The CatFocus® model provides a reliable benchmark view of California wildfire risk.

The CatFocus® model shows clear differences between Northern and Southern California1:

- The annual aggregate losses of 2017 and 2018 were the most extreme years for Northern California. For Southern California, the losses from these years were not uncommon and were comparatively far less extreme.
- Compared to Southern California, severe losses in Northern California have a greater contribution to the annual aggregate expected loss of California as a whole.
- Susceptibility to wildfire is lower in the south than in the north, due to

different fuel types, fire spread and fire suppression aspects.

REPORTED AND MODELED LOSSES GIVE VERY DIFFERENT ESTIMATES OF RISK

Reported losses

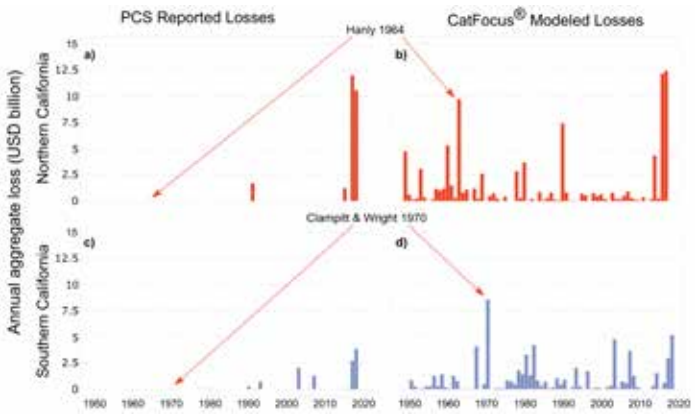
California wildfire risk assessment based on reported industry losses (see figure 1a & 1c, PCS recorded industry losses from 1950 to 2018[2]) indicates that the 2017 and 2018 losses were extreme, especially in Northern California. There are many years in the 1950 to 2018 time period when no losses exceeded the PCS's reporting threshold[3].

PartnerRe's catastrophe model

In contrast, results from PartnerRe's CatFocus® California Wildfire catastrophe model (see figure 1b & 1d) indicate that, using current industry exposure, many years in fact had the potential for losses greater than the PCS threshold. Previous historical events could have led to losses comparable to or exceeding the magnitude of loss observed in Northern and Southern California in 2017 and 2018 (figure 1a & 1c).

The difference is mainly due to changes in where people are living."

Figure 1: Annual aggregate reported industry losses in USD billion for



(a) Northern and (c) Southern California. Source: PCS[2]. Modeled annual aggregate losses for (b) Northern and (d) Southern California. Source: CatFocus®, PartnerRe. The difference between reported and modeled loss is significant – see also the disparate loss estimates for the Hanly (1964) and Clampitt & Wright (1970) wildfires – and strongly speaks to using robust catastrophe models to assess and evaluate current California wildfire risk. The PCS losses are only those that were reported and which caused an industry loss above the PCS loss threshold[3]. To ensure comparability with the reported losses, the same (current PCS) threshold is used for the modeled losses.

Why are these two estimates of risk so different?

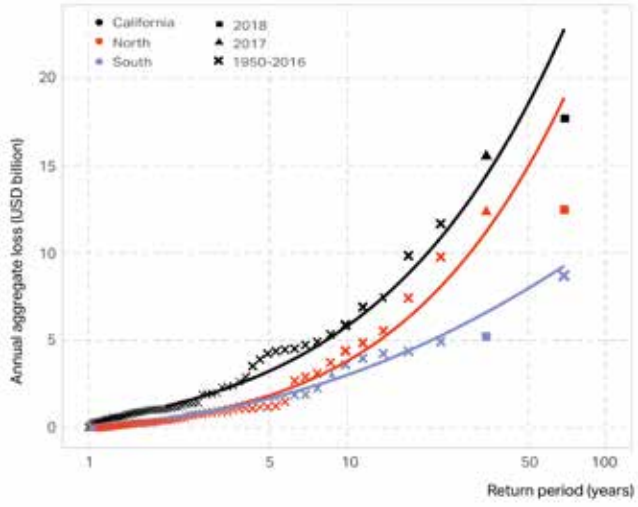
The difference is mainly due to exposure growth: changes in where people are living (e.g. from 1990 to 2010, the number of buildings in the Wildland-Urban Interface[4] increased from 3.3 to 4.4 million[5]), higher population density and increased property values. This exposure growth has a particularly strong positive and complex (non-linear) impact on risk evaluation.

Risk assessments informed by reported losses (which also often have the issue of incomplete loss record due to reporting biases) are challenged to adequately and reliably take exposure growth and other risk factor changes into account. In contrast, catastrophe models can do this well and therefore lead to a different estimation of the risk.

Modeled return periods of the 2017 and 2018 annual aggregate losses

Figure 2 shows the model's derived annual aggregate exceedance probability curves for California, and for the Northern and Southern California regions; to aid interpretation, we fitted smoothed curves to the individual annually aggregated modeled losses.

Figure 2: Modeled industry annual aggregate loss exceedance probability



curves for California as a whole, Northern California and Southern California. The 2017 (triangles) and 2018 (squares) annual aggregate losses for each region are also shown. Return periods of the modeled losses (crosses) are calculated using the empirical method, where the highest modeled loss has a return period of 69 years, equal to the length of the modeled time series shown in figure 1b & 1d. The smoothed colored lines are generalized extreme value distributions fitted to each regions' modeled losses. Source: CatFocus®, PartnerRe.

For California as a whole, CatFocus® indicates that:

- the estimated return period of a USD 10 billion annual aggregate industry loss is 20 years
- the estimated return period of a USD 15 billion annual aggregate industry loss, close to the reported PCS loss value for 2017, is 35 years.

For Northern California, CatFocus® indicates that 2017 and 2018 annual aggregate losses:

- are extreme with respect to the period 1950-2018
- are comparable in modeled loss magnitude to historical wildfire events in 1991 and 1964 *(see figure 1c)*
- have estimated return periods of 40 years.

Our estimated return period of a USD 10 billion annual aggregate industry loss is 20 years."

In addition, our own analysis points to a strong underlying positive trend in the hazard in this area over the last decade, which may be partly driven by other factors including climate change[6,7,8]. Modelled results require an adjustment to reflect this, and this adjustment further reduces the estimated return periods of the 2017 and 2018 losses.

Continued on page 8

For Southern California, CatFocus® indicates that:

- 2017 and 2018 losses have much shorter return periods than Northern California, of approximately 10 and 25 years respectively
- there are multiple years with the potential to have caused losses equal to or greater than the losses observed in 2017 and 2018 (e.g. 1970, 1982, 2003 and 2007, *see figure 1d),* given current exposures.

Notable variation between insurance portfolios

The model allows us to differentiate the risk between different insurance portfolios – to reflect their specific exposure concentrations – and to ascertain portfolio-specific return period ranges for the 2017 and 2018 events (see table 1). Importantly, since there are a large number of potential loss events based on historical footprints, the model is able to identify at-risk regions that have not recently been loss affected.

Portfolio	Northern California		Southern California	
	2017	2018	2017	2018
Industry exposure	40	40	10	25
A	50	40	4	15
B	30	5	10	30
C	30	15	8	15

Table 1: Modeled return period estimates (in years) for the annual aggregate losses from the 2017 and 2018 events split by region, for the industry exposure and for three sample insurance portfolios. Source: CatFocus®, PartnerRe.

THE CATFOCUS® CALIFORNIA WILDFIRE MODEL

Developed by PartnerRe's catastrophe research, modelling and underwriting experts, the CatFocus® California Wildfire model is a robust catastrophe model which captures the most important factors impacting wildfire risk; namely exposure change, hazard and the broad-scale vulnerability of typical insured residential and commercial property.

Model specifics

The hazard component is based on historical fire perimeters compiled by the Fire and Resource Assessment Program (FRAP)[9] from 1950-2018 for area burned exceeding 300 acres and conditioned with USDA wildfire hazard potential data[10]. See example footprint in *figure 3*. To estimate the ground-up loss, the model combines the hazard with high-resolution exposure information and an estimate of the damage ratio. The CatFocus® financial model then applies the re/insurance financial conditions to calculate the net loss.

Since historical losses show that the damage ratios in Northern California are in general higher than in Southern California, the model defines Northern and Southern California as two distinct vulnerability regions.

Figure 3: Example of a wildfire hazard footprint. Transect taken from the

There is uncertainty associated with using historical fire footprints overlaid on today's exposure, … Would the fire perimeter look the same given that there is now exposure within the footprint?

Thomas 2017 event in Southern California. The blue line is the FRAP9 fire perimeter and the colors indicate the wildfire hazard potential[10] (red shaded areas have the highest potential). The property exposure can be seen in the background satellite imagery. Source: CatFocus®, PartnerRe[11].

The model is able to reproduce the 2017 and 2018 industry losses (see figure 1b and 1d) and has been validated on insurer specific losses, a further indication that it is a reliable tool for risk assessment.

Limitations and developments

The model considers the direct impact of fire within the fire perimeter and does not attempt to explicitly incorporate losses from indirect causes of damage, e.g. by smoke outside of the historical fire perimeters.

The model is limited to historical scenarios and does not include a "stochastic event set", which would allow the model to be used for less homogeneous exposures. However, given the complexity of factors influencing a fire perimeter footprint, a stochastic approach for generating other scenarios would not necessarily increase the accuracy of the risk assessment for the broad geographical scales of the industry and typical large insurance portfolios exposure used in this study.

There is uncertainty associated with using historical fire footprints overlaid on today's exposure, summarized by the following question: Would the fire perimeter look the same given that there is now exposure within the footprint? We would expect that in some cases the historical fire would now be fought with different capabilities, which could affect the loss potential of an individual event. However, as observed in 2017 and 2018, isolated conflagrations ignited by flying embers are extremely difficult to fire fight and have resulted in significant losses. Overall, this suggests that historical scenarios are suitable and reliable for assessing today's risk.

Additional analysis (not shown) of the 1950-2018 Californian wildfire activity (based on FRAP data) indicates a clear upward trend in burned surface area per year, primarily involving forest areas in Northern California. The trend is not as strong in Southern California, where wildfire more often occurs in shrubland. This implies that the model's "stationarity assumption" may require adjustment, and that the return period for 2017 and 2018 in Northern California is likely to be shorter than the model suggests. This, and other non-stationarity factors such as climate change[6], climate variability[7], forest health[8], and human interactions[12], will be investigated in subsequent research projects.

Disclaimer:

References

1 Northern and Southern California are separated by a line at 35 degrees north latitude.

2 PCS (Property Claims Service), a division of Verisk. Not for distribution without the permission of PCS. For more information, please contact Tom Johansmeyer, tjohansmeyer@verisk.com. Extraction date: April 29 2019.

3 The PCS loss reporting threshold is USD 25 million. Prior to 1997, lower reporting thresholds of USD 1 million (1949 – 1982) and USD 5 million (1983 – 1996) were used.

4 Wildland–Urban Interface (WUI): transition zone between wildland (unoccupied land) and populated areas. WUI areas are at risk of catastrophic wildfire as more than 75% of buildings destroyed in California wildfires are in WUI areas. Kramer et al., 2018. "Where wildfires destroy buildings in the US relative to the wildland–urban interface and national fire outreach programs", International Journal of Wildland Fire 27, 329-341.

5 Radeloff et al., 2018. "Rapid growth of the US wildland–urban interface increases wildfire risk", Proceedings of the National Academy of Sciences of the United States of America 115, 3314–3319. doi:10.1073/PNAS.1718850115.

6 Intergovernmental Panel on Climate Change (IPCC) drought index projections and regional climate change models show increases in wildfire risk during the summer and fall on the southeast Pacific coast, northern plains and in the Rocky Mountains. Intergovernmental Panel on Climate Change, 2014: Climate Change 2014 – Impacts, Adaptation and Vulnerability: Part B: Regional Aspects: Working Group II Contribution to the IPCC Fifth Assessment Report. Cambridge: Cambridge University Press. doi:10.1017/CBO9781107415386.

7 Climate variability is leading to significant inter-annual and inter-decadal fluctuation of wildfire hazard risk. Drought years have a higher likelihood of severe wildfires and wind conditions significantly alter the risk, especially of large fires.

8 Since 2010, an estimated 129 million trees have died in California's national forests due to climate change, unprecedented drought, bark beetle infestation and high tree densities. e.g. https://www.fs.fed.us/psw/topics/tree_mortality/california/index.shtml

9 Historical fire perimeters are compiled and maintained by the State of California Fire and Resource Assessment Program (FRAP). The FRAP fire perimeter database, updated to 2018, was downloaded from http://frap.fire.ca.gov/data/frapgisdata-sw-fireperimeters_download (accessed February 21, 2019). Due to data inhomogeneities, the analysis focused on the period of 1950-2018 and fires with an area burned exceeding 300 acres.

10 The wildfire hazard potential (WHP) map is produced by the USDA Forest Service and depicts the relative potential for wildfire. Areas with higher WHP values represent a higher probability of extreme fire behavior under conducive weather conditions. https://www.firelab.org/project/wildfire-hazard-potential.

11 Background satellite imagery tiles © Esri – Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, UPR-EGP, and the GIS User Community.

12 Population growth into wildfire-prone regions increases the exposure and impacts the hazard itself e.g. more infrastructure (downed power lines), more frequent campfires and arson. On the other hand, wildfire risk can be mitigated by human activities such as through active forest management (e.g. planned fires to reduce fuel accumulation) and improvements in firefighting practice.

(Re)Insurance Risk Metrics for Practitioners

BY IVELIN M. ZVEZDOV, M. PHIL.

About the Author:

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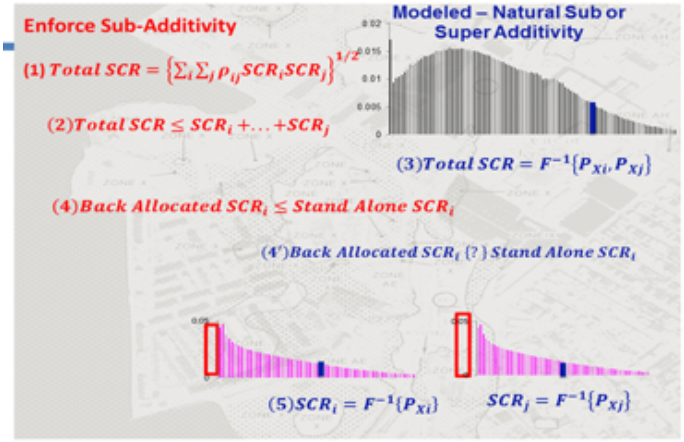
Abstract

This is the second essay of a two-part work in which Dr. Zvezdov recorded a series of discussions at conferences, seminars and presentations, which have taken place over the last few years. This record is of notes, conversations, sometimes critiques, and useful feedback from both industry academics and practitioners on two topics of interest in todays' reinsurance market place. In this essay we define some dependencies and inter-operability between key (re)insurance portfolio risk metrics, which are widely used by practitioners today in their risk management and capital reserving functions. We have chosen the format of the essay, rather than the academic paper, to compile and communicate the material, and have targeted the seasoned industry practitioner as our audience of choice. The first essay was published in the prior edition (Vol. 26 No. 2) of the JOR.

2.1 ENFORCED OR NATURAL ACCUMULATIONS OF SCR

Undoubtedly there is enforced or assumed sub-additivity in the standard solvency capital reserve formula (SCR) – *equation (1)* in *figure 8* below. The SCR metric by line of business, geo-admin unit, peril, and risk factors is in principles a value-at-risk metric. By definition value at risk metrics are not guaranteed to be sub-additive. They are not guaranteed to be super-additive either – a discussion we *provided in sections 1.3 and 1.4.*

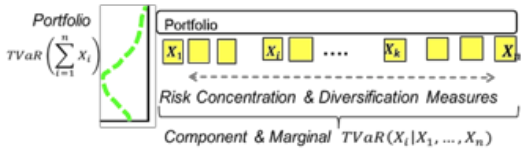
Figure 8: Relations of accumulation principles in SCR



The relationship between the accumulated portfolio total SCR and the sum of the portfolio component SCR(s) is empirical and theoretically unknown. Still the standard SCR formula guarantees, or rather enforces sub-additive accumulation, as defined in *equation (2)*. If the risk factors are guaranteed to be independent, or very well known and measured dependent in physical and economic laws such as geography, (in)dependence in catastrophe perils, financial diversification, this should be a safe and acceptable assumption. Still this practical practitioner view will not agree with the purist mathematician's view of the modeled world. The latter will require the construction of a multivariate probabilistic distribution or copula, as defined in *equation (3)* from the marginal distributions of all risk factors provided in *equations (5)*. Only from the combined aggregate distribution of all risk factors in the portfolio one could then coherently measure the portfolio SCR, and since it is a value-at-risk type metric, it is not guaranteed to be neither sub nor super-additive. It is a purely empirical and scenario based relationship. The standard formula also guarantees that a back-allocated single risk factor SCR (i.e. component SCR) is less than the same stand-alone SCR, as provided in *equation 4*. The economists will immediately see the benefits of diversification and market scale. However the true coherent back-allocated SCR from the joint distribution is not that easy to compute, and it is certainly not guaranteed to behave predictably versus the predictable and enforced stand-alone SCR.

2.2 CAPITAL BACK-ALLOCATION BY THE COVARIANCE PRINCIPLE

For portfolios of risks with high degree of clustering and concentration, risk and capital metric back-allocation is best accomplished and most widely done in industry by the covariance principle, describe in *figure 9* with four equations. Less well used is the second attribute of this principle, which actually accounts for dispersion and diversification. The critical technical task for application of this principle is to decompose the total (re)insurance portfolio covariance into single risk-to-total components, and define the back-allocation ratio, which we provide in *equations (1) and (2) on figure 9.*



$$\sum_{i=1}^{n}\sum_{k=1}^{n} Cov(X_i, X_k) = Cov\left(\sum_{i=1}^{n} X_i, \sum_{k=1}^{n} X_k\right) = \sum_{k=1}^{n} Cov(X_1, X_k) + \cdots + \sum_{k=1}^{n} Cov(X_n, X_k), \quad i < k \qquad eq(1)$$

$$\frac{Cov(X_i, \sum_{k=1}^{n} X_k)}{\sum_{k=1}^{n} Cov(X_1, X_k) + \cdots + \sum_{k=1}^{n} Cov(X_n, X_k)} = w_i, \quad i = 1 \text{ to } n, \quad i < k \qquad eq(2)$$

$$TVaR(X_i|X_1, \ldots, X_n) = \frac{Cov(X_i, \sum_{k=1}^{n} X_k)}{\sum_{i=1}^{n}\sum_{k=1}^{n} Cov(X_i, X_k)} * TVaR\left(\sum_{k=1}^{n} X_k\right), \qquad eq(3)$$

$$TVaR(X_i|X_1, \ldots, X_n) = w_i * TVaR\left(\sum_{k=1}^{n} X_k\right), \qquad eq(4)$$

Figure 9: Mechanics of back-allocation by the covariance principle

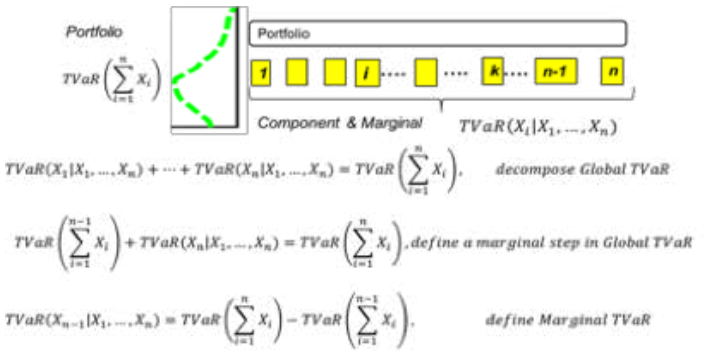
Then deriving the expression for back-allocation becomes quite trivial and it is formalized in *equations (3) and (4)*. The mechanics are written in context of TVaR, and the same will apply to VaR and SCR.

2.3 COMPONENT AND MARGINAL TVAR CONVERGE

Estimating component and marginal TVaR(s) is one of the most computationally intensive tasks in the capital allocation process. These two risk metrics are actually convergent, which we show with a four equations proof in *figure 10*. We define standalone TVaR, as a risk metric computed for each risk factor or portfolio component independently from the rest of the book

of business. We define component TVaR as the metric statistically from the total portfolio TVaR. With a well-known and widely used back-allocation methodology it contains covariance risk, since the Portfolio TVaR takes into account inter-risk dependencies.

Figure 10: Proof for convergence of component and marginal TVaR



In *equation (1)* we back-allocate the total portfolio metric using a stand-alone TVaR ratio to the portfolio risk components - i.e. this gives us our component TVaR(s). These are cumulative and sub-additive as provided in *equation (2).* Then in *equation (3)* we show that the sum of the marginal risk metrics leads to the total portfolio metric. Rearranging in *equation (4)*, we derive the marginal TVaR, which is also our component TVaR. Effectively we have two metrics converging to each other, and derived with only a single computation. To put it differently, once we have our stand-alone metrics and total portfolio TVaR, the marginal metric becomes purely analytical.

2.4 PRACTICE IN THE SCIENCE OF RISK RANKING

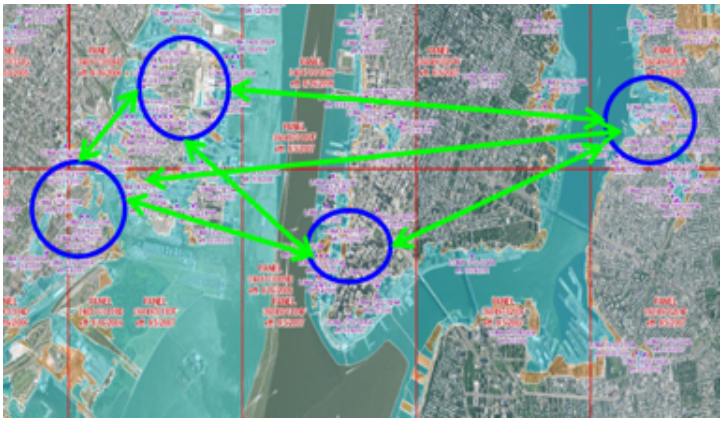
All practitioners involved with the (re)insurance chain of business practice risk ranking, including the insured(s). The methodologies vary from theoretical to empirical and to numerical simulations, to historical best practices, and such that are reliant on expert knowledge. Regardless of the underlying theory one still needs a robust ranking metric. In this section we attempt to show that choosing a ranking metric can actually be done in a systematic manner. We look at three metrics - pure technical premium, variance, and tail-value-at-risk (TVaR) and their goodness for purpose as a preferred risk ranking metric.

Firstly all three metrics allow the ability to back-allocate from the top portfolio metric to its risk components such as lines of business and single risks and reversely accumulate single and component risk metrics to lines and business units. All three metrics satisfy these criteria. They are either additive or sub-additive which is sufficiently good for the practitioner. Secondly comes the appreciation of ruin scenarios in addition to appreciation of volatility. Pure technical premium and variance, the latter being contained in the former, emphasize knowledge of volatility. While TVaR emphasizes information of worst-case scenarios, which may lead to severe downside or even to 'utter ruin' of the firm. A third requirement may be to be able to perform risk ranking at business unit (BU) level. The relative riskiness of a business unit or a single line is already implied in the accumulated total premium of the unit. The risk of the expected outcome and its variance is already priced into the total accumulated business unit premium. Premium and variance become unsuited as risk ranking measures because the insurer already prices their relativity. On the other had the relative riskiness of TVaR by BU is not accounted in premium pricing. Practically it is not accounted in capital allocation in most or in many cases, as the preferred metric for capital allocation is value-at-risk (VaR). A last forth requirement is for the metric to provide stability and robustness. All three metrics are affected by marginal impact to the book of business, because of dependences among risks. A change to the profile of one risk factor affects the change of the risk profile of the whole portfolio both in terms of most likely outcomes and tail outcomes. Lastly and in conclusion TVaR meets in best and most robust manner these four criteria for a practical risk ranking metric. The relative riskiness of other metrics is already implied in the price of insurance risk, thereby they become risk neutral and by using them for ranking purposes, such analytics do not bring additional informational value to the underwriter or risk manager. TVaR being outside of the definition of the price of (re)insurance risk brings new information value to the ranking process.

2.5 THE EPIDEMIOLOGY OF RISK ACCUMULATION

The global financial system defined as including the insurance and reinsurance firms, can be viewed as one large organism. Where firms of various sizes are inter-connected and inter-dependent. The larger the firm, in terms of assets and risk exposure, the more complex connections it bears to other firms and to the system as a whole.

Figure 11: Systemic interconnectedness among institutions of the wider financial system



Larger scale means disproportionately larger risk. This is a thesis, inspired by biological sciences, in opposition of the traditional financial theory of diversification and economies of scale, which states that with size and distributed exposures come the benefits of stability and durability. Biological theory however, from its first principles, states that the larger the unit in a biological system or organism the more inter-connected and inter-dependent it becomes on other units and on its living environment as a whole. This makes it more complex and harder to survive a systemic shock. Simple organisms adapt and survive crisis and shock better than large and complex ones. Should these principles apply to the financial system and its firms and if they do, then it would be scale and not diversification that defines risk management and capital reserving. Large scale requires disproportionately larger reserves and disproportionately more intense precautions by all executive management. Mathematicians call this effect super-additivity. However diversification, de-concentration and sub-additivity remain proved principles of classical financial theory. Still on a systemic level, it is critical to continuously re-appreciate and revisit which principles dominates and defines risk management and capital reserving practices. ◀

Blockchain Technology: The Insurance Revolution

Why the Insurance / Reinsurance Industry will Never be the Same

BY SEAN MCDERMOTT

ABOUT THE AUTHOR

Sean McDermott received an award for this paper that was submitted as part of the 2018 IRUA Intern Scholarship Essay Contest. He interned at Transatlantic Re in New York, NY and attends Loyola University Maryland in Baltimore, Maryland with planned graduation in May 2020.

ABSTRACT

The Insurance Revolution has arrived and it goes by the name Blockchain. Blockchain Technology is turning the business world upside down, and is here to stay as more and more companies begin utilizing this technology. The insurance industry is perfect for blockchain technology. This essay discusses why this is the case and how this technology will affect and revolutionize insurance in its entirety. With so much change on the horizon is the Insurance world ready to embrace unprecedented change?

"**Blockchain is coming! Blockchain is coming! Blockchain is coming!"** is being screamed by business people in every industry across the globe. This warning functions in the same manner as Paul Revere's Midnight Ride, right before the American Revolution. Paul Revere announced to Americans the imminent arrival of British soldiers and the American Revolution as whole. The world was never the same after the American Revolution. Similarly, the world will never be the same after the implementation of blockchain technology. People have realized the revolutionary power and impact of the technology, and they are warning the world of the pending revolution. The revolution has begun as major companies spend hundreds of billions of dollars to research and implement the technology. In the past, the largest companies turned a blind eye and ignored the blockchain technology, but recently, these companies, including Apple, JP Morgan, Walmart, and Microsoft to name a few, have realized the power of the blockchain and now have a bull's eye on the technology (*forbes.com*). Interest and research in blockchain is not reserved to typical financial powerhouses; insurance companies are investing heavily in the technology with Ping An Insurance as the largest ranking as the tenth largest researcher in the world across all industries.

In addition to researching the technology, insurance companies have already begun implementing the technology. Insurance partners such as Willis Towers and XL Catlin (now AXA XL) have implemented a blockchain platform called Insurwave for marine insurance which will transform how the insurance world manages risk according to the founders (*Insurance Journal*). This application already has the insurance world discussing the possibility of an all-blockchain insurer across all lines of business, not just marine as evidenced by a paper by Boston Consulting Group (*Bosisio*). Clearly, blockchain technology interests the insurance industry immensely, but why? How does this technology work? How will it change the industry? This essay answers these questions and showcases how the insurance/reinsurance industry will never be the same.

Contrary to its new public status, blockchain technology is not new; it has existed for 10 years which means we have some data on how the technology works in the real world. The blockchain technology has its origins with Bitcoin, the online cryptocurrency. Blockchain is the underlying technology that allows Bitcoin to function and exist in the manner that it does today. It was formed by an unknown person under the pseudonym Satoshi Nakamoto in 2008 following the financial crisis. Satoshi invented the technology in order to serve as a ledger that is completely open to every person. Satoshi attributed the cause of the financial crisis to people having too much trust in companies that did not warrant that level of trust. Through the use of clever accounting, bookkeeping and reporting tactics, companies were able to hide or conceal the truth, and thus appeared to be in better financial standing than they actually were.

A prominent example of these accounting tricks is Lehman Brothers. Lehman Brothers used accounting tricks to mask the precarious financial state. As a result, investors had no knowledge of the true state of Lehman Brothers and made investments based on the fabricated reports generated by Lehman Brothers themselves. In other words, companies take the actual financial transactions adjust them to help them appear in better standing, and then people are left to trust them strictly on their word and reputation that these are accurate financial records. People are completely dependent on third party information to inform their decisions which is problematic in and of itself, especially when that third party has a vested interest like Lehman Brothers and Enron with their financial records. The United States government forced increased regulation of companies in an attempt to curtail these issues and allow people to have access to accurate and complete data. These regulations have not proven to be completely effective, the data still must go through another third party (the government) which is prone to the same issues detailed earlier, before it reaches the people.

Third party reporting of crucial information extends across every industry of the world, and they are usually handled by the federal government. For example, citizenship verification, property rights, credit ratings, and really any integral aspect to a person in the United States is held and confirmed by the government. If someone needs to prove to another person or entity that they are who they say that they are, that person would present their social security card, birth certificate, driver's license, warranty deed or what-

ever document needed, but all of these documents only have value if they are approved by the United States government and deemed to be truthful by the government and its records. Avoiding this third party trust seemed impossible for so many years, but those years are numbered as a result of Blockchain technology. Blockchain can act as a truth ledger that can verify these important aspects for every person or company without relying on third party verification. People will have the means to verify the information themselves.

So what exactly is a "blockchain"? A blockchain is a distributed ledger, meaning a database (structured, organized, and accessible data) that tracks and verifies transactions. These transactions can be any transferring of one thing from person to person and are therefore not restricted to financial or business transactions. Currently, the most important areas utilizing the technology are the transfers of assets, specifically stocks and bonds, and the storing of records (medical, property, citizen). The blockchain forms a complete historical record of all verified transactions that occurred in that area of interest which automatically updates immediately after the verification of the transactions. The transactions are verified by a process titled "mining". "Miners" use extremely high powered and efficient computers to find/solve a complex mathematical algorithm. The transaction is verified through "proof of work" due to the extremely complex nature of the algorithm and the computational power needed to solve it. These "miners" are issued payment for their efforts and are thus incentivized to continue mining. For example, the bitcoin miners that solve the algorithm and verify a transaction first are awarded one bitcoin, with other blockchain platforms issuing similar incentives to miners.

All newly verified transactions are combined together to form a new "block" in the ledger. This new block is attached to the already existing verified blocks in the network to create a "chain" of connecting, verified transactions. At this point, the transaction is completed and immutably recorded without the verification of truthfulness or authenticity by any third party. Everyone can view the "chain" of verified transactions to trace its history which creates absolute transparency. Additionally, a blockchain is distributed which means that there is no single copy of it. Nobody has special access or owns the blockchain; everyone has access to the same information or record of events. Noteworthy, there is not a single blockchain to serve all interests; each blockchain serves a different purpose or interest. A blockchain that tracks the transfer of assets is different than a blockchain that tracks an exchange of information, and so on.

The important aspect of the "chain" is that since every transaction is connected, even the smallest transaction change alters the state of the entire chain and then entire ledger. Updating the ledger with a recent transaction ensures that ownership of some good has shifted from the old owner to the new owner. Once this transaction is added to the blockchain, the blockchain updates its records by now attributing ownership to the new owner and removing ownership from the old owner. This solves the double-spend problem that desolated internet transactions in the past since the internet specializes in copying and distributing information. Blockchain technology prevents one person from owning something, copying it, and sending to everyone else. With rapid verification of transactions, ownership of goods can transfer within minutes and there is still plenty of room to grow. For example, on the Bitcoin blockchain, it takes only ten minutes for a transaction to be verified, so it takes only ten minutes for ownership of a good to change hands. Additionally, the rapid verification of transactions and updating of the blockchain network allows for transactions to occur in basically real-time. This is a monumental increase in efficiency considering it currently takes days and sometimes weeks for certain changes in ownership to settle. For example, remittances take as long as a week to settle; stock trades usually settle in two to three days, and bank loaned trades can take over three weeks to settle! These transaction can be speed up exponentially with a blockchain ledger, which will have a dramatic effect any industry that deals with transfers of money. This impact will be discussed in much more detail later.

One component of blockchain that makes the technology revolutionary and valuable is its top notch security to ensure protection of data. Every transaction is encrypted through an advanced method of *cryptography* called public-key *cryptography*. This method of *cryptography* involves using separate keys for encryption and decryption which differs from the standard, single key for both encryption and decryption. Public-key *cryptography* involves the use of public and private keys where the public key can be transferred or shared with anyone, and the private key can only be viewed by the person to whom it belongs.

Public-key *cryptography* begins with a piece of plain text, like the details of a transaction, being encrypted by both a sender's public and private key. The recipient of the text (buyer) decrypts the data through the combination of his or her private key and the sender's public key. It is impossible to access someone's private key from their public key which allows for people to send their public key to anyone without fear of losing private or personal information. In short, the sender can encrypt files that can and will only be accessed by the intended recipient. At the end of the transaction, a digital signature, which functions the same way as a physical signature does today, is produced by combining the user's private key with the data representing the details of a transaction through a mathematical algorithm (Lisk). Bitcoin uses the Standard Hash Algorithm 256, and its network has yet to be hacked in its 10 year existence. This digital signature ensures the integrity of the data because the data itself is ingrained in the digital signature. This means that if even the slightest bit of data is altered in any way, the blockchain will not recognize the transaction as valid due to the complete alteration of the digital signature. The immutability of the data creates a true record of transactions by preventing alteration of events, thus ensuring truly accurate and reliable data. This *cryptography* and encryption ensures data security and integrity.

Public-key *cryptography* puts private data in the hands of the individual and not at the mercy of approval by a third party such as the government. A secure private key stores all the important, private information, and only relevant information is provided for a transaction. The private key acts as a digital repository of all important information that replaces the outdated, physical copies. This digital repository will drastically reduce identity theft which has affected over 16 million *Americans* and resulted in the theft of over 16.8 billion dollars in 2017 alone *(Warren)*. Today, third parties such as the government, credit card companies, banks, department stores, etc. contain crucial private details regarding a person's identities. The government itself holds all of the records that "prove" someone's identity (social security number, passport, birth certificate, etc.) and ownership of a product (land title, job, etc.), and it is commonplace for other third-parties to ask for copies of these materials as well. With all of this important information on file, these third-parties act as giant targets for hackers; they act as a one-stop hacker heaven to reap astronomical financial rewards. If

Continued on page 14

a hacker can hack into the systems of one of these places, then the hacker has access to perhaps millions of people's personal details that can be used for identity theft plus standard credit card information.

Hacking private keys in a blockchain is inefficient and thus ineffective because they are secure, and even if the hacker did manage to hack into a private key then they only get the details of a single person as opposed to the hundreds of thousands that are affected by the hack of a single, major third-party. Additionally, the digitization of the documents used as "proof" of identity and ownership would speed up any transaction because people do not need to provide physical copies of identities while avoiding physical theft of these documents altogether. This also minimize human errors such as losing these important documents (social security number, driver's license, passport, land titles, etc.) which allows everyone access to information to prove their identities.

As soon as identity is proved, insurance companies can feel comfortable issuing insurance policies because they can trace that person's transaction history and properly assess the risk, and create an appropriate policy for that individual. Proof of identity will give millions of people access to personal insurance such as life insurance, changing the landscape of the insurance industry. Moreover, if someone can prove their identity and ownership of important properties (house, job, etc.), then that person has a much higher chance of ensuring a loan. With a loan, a person now has the capital to start their own business or invest in the financial markets which can both increase funds. Starting a business is a risky operation which means that this person will want insurance for many different lines. This insurance will include property (for their location of operations), health (for employees), professional and product liability, auto insurance just to name a few, expanding the insurance industry even more. With more capital in the world, the more insurance people will want because the risk of loss is exponentially greater. The insurance world will open up to hundreds of millions or billions of previously uninsured people.

How is the technology used? A user accesses a good (asset, information, record, etc.) on the open ledger through the user's public key (accessible to all) that is linked to the user's private key (accessible only to user). These keys are cryptographically generated by an algorithm to ensure privacy; all transactions are anonymous. Once a user uses their private key to unlock their assets or information that are assigned to that user's public key, then that user is free to transfer or exchange those goods to another user. As soon as a user transfers these goods in a transaction, then the original transaction is altered and updated on the blockchain. Users can add information to the ledger and attribute that information to their public key.

The user has the choice whether to make information public for all to see, available only to that one person, or available only to those people with the certain private key/public key combination detailed earlier in regards to the public-key *cryptography*. Users are in control of the information that they choose to share, and only absolutely essential information to the transaction is shared. This sharing of only essential information along with anonymous public keys eliminate bias and discrimination that still tragically plague our world today. People are no longer forced to release nonessential, personal information such as age, race, gender, religion, etc. when doing a transaction. People will be judged exclusively on whether or not they own what they say they own and whether they can perform the agreed task. People will know as much or as little about another user as they want. Additionally, there is a reputation system incorporated in the blockchain which is similar to rating systems on platforms such as Uber or Yelp. After a ride, a customer rates an Uber driver from 1 to 5 stars based on the quality of the ride. The drivers with the highest ratings get the most business. Blockchain users have the same rating system in which users are rated by other users based on many different aspects. Users are incentivized to be honest because the users with the highest scores get the most business and a single negative score will drastically affect future business.

Insurance companies will benefit immensely from the rating systems already implemented on the blockchain. After a transaction, the members of the transaction rate each other based on their experiences. For example, a company can rate an insurance company based on its expertise in various different lines of coverage. If an insurance company provides great auto insurance, then a person or company will rate that insurer 5 stars, and this logic will be applied to all lines of business. With this information, customers will be able to search for insurance policies for their desired line of coverage and then be provided with the companies that meet all of their criteria and have the highest rating. Likewise, insurance companies can rate customers on their behavior in a transaction underlying the risk that is associated with that customer which is provided by the information on the blockchain and additional feedback. From there, insurance companies will have a very good idea of the quality of customer with whom they will be doing business, and they will charge higher prices for higher risk people and vice versa for low risk. Insurance companies can create truthful and accurate assessments of the underlying risk which allow for more knowledgeable risk selection with essentially zero guesswork due to the verified information existing on the blockchain.

This rating system also cuts out the need for intermediary agents that are far too commonplace in the insurance industry. Right now insurance brokers represent the buyers of insurance, and they obtain insurance quotes and guide their clients in choosing the best policy. With blockchain, customers can sort through insurance companies based on their desired policies and the best company or policy that they desire will appear. This is similar to how customers no longer need someone in a department store to show them the best product; customers on Amazon can look up a product and find the best product for their specified desires with the best rating and have no need for an intermediary. Through blockchain, customers can find the perfect insurance policy or insurance provider through the internet, so brokers or insurance agents are no longer needed to intermediate, and will have to change their role. This lack of intermediaries will reduce costs for insurance companies which reduces the prices for customers and this allows more people to buy insurance policy therefore increasing revenue.

The blockchains discussed so far are open, decentralized, and permissionless, but it is also possible to have permissioned distributed ledgers as well. These permissioned distributed ledgers appear to be the more likely outcome for the foreseeable future, so it is worth noting the differences. Permissioned distributed ledgers exist on a blockchain network to fit a specific business desires. There is a different blockchain network to fit each different business need. These networks vary by type of market, business relationships, and other necessary or important parameters. In these networks, a registration authority is responsible for issuing access to the blockchain exclusively to participating companies. Only participating companies know the identity of the other participating companies; the identities are not known by unauthorized or non-participating companies. Crucially, the content is kept confidential through a similar encryption to permission-less blockchain where only participating companies have the

key in order to decrypt the information and execute a transaction. This type of blockchain is very effective at tracking company or business assets and complex transactions.

In these permissioned blockchains, companies share their data on a shared ledger. If insurance companies participated in this type of blockchain, then all the companies share their data which increases the amount of data that each company can use to evaluate risk. According to the law of large numbers, as a sample grows in size the closer the sample reflects the actual population. This means the more data insurance companies can access, the more accurate their risk assessments will be which increases profits.

In a blockchain, all data is managed in a single repository which connects all the data for every constituent part of an industry in a single location drastically speeding up the process of issuing an insurance policy. Improvement in efficiency benefits every sector of the insurance industry with health insurance providing a clear example. Currently, insurance companies rely on separate data surrounding the healthcare facilities insurance program (machines, property, etc.), the patients that attend the healthcare facility, the doctors, nurses, and all staff employed by the facility to construct the appropriate program. The evaluation of all this data can take days to collect and validate its accuracy. With a blockchain, all of this information will be already verified for accuracy as well as accessible in a single location that can be updated in real time. In time, it seems possible that adjustable insurance policies can be updated in real-time alongside the real time updating data. Increased efficiency reduces transaction costs which leads to a decrease in the price. The savings achieved allow healthcare companies the opportunity to purchase expanded limits or coverage on their healthcare coverage increasing risk protection for the healthcare provider and higher premiums for insurance companies.

Now, that both types of distributed ledgers are understood, it is time to discuss smart contracts. Smart contracts are the fuel of transactions on a distributed transaction; without smart contracts, there would be no transactions on the blockchain network, and the technology would simply be an advanced bookkeeper. Smart contracts are self-executing contracts that implement the terms of an agreement written in code. In other words, two parties write and agree to a smart contract, and as soon as the terms of the agreement have been completed, the smart contract is executed, and the other party receives its payment. All information is uploaded and subsequently verified for truthfulness on the blockchain, ensuring that the terms of the contract are only paid when something actually occurs; no lies, pretending or manipulation of the truth. Smart contracts function on the same public-key *cryptography* as the blockchain and as such produce a digital signature, which functions in the same manner as a traditional, physical signature, for each party once the terms of the contract are agreed to signal both acknowledgment and acceptance of the terms.

To assure trust in the fulfillment of important actions of a smart contract that exist outside of the blockchain, smart contracts use the help of disinterested third-party arbiters in a multi-sig approach. With this approach, principal parties use multiple authenticating digital signatures (private keys) though the use of third-party arbiters in order to complete the transaction. In this case, two people or companies agree to use the help of a neutral, unbiased third party arbiter(s), who is/are micro-monetized in the transaction. The total fee of the arbiters is much less than the fees charged by lawyers. The third party arbiter(s) acts as a judge determining the rightful owner of the funds and if the contract was violated. Crucially, the arbiter never has access to the funds; the arbiter simply acts as a mechanism to shift the funds from one party to the other. Participants in a contract can agree to include as many third-party arbiters as they want, but each arbiter will need to be compensated. Each principal participant is issued a private key and the third-party arbiter is issued one collective private key that is distributed based on the majority of arbiters.

Each entity in the transaction has a private key and the goods of the transaction need two private keys in order to be accessed. If a disagreement between the two principal parties arises in which one party accuses the other party of invalidating or not living up to the terms of the contract that are not explicitly written in the smart contract, the two parties turn to the arbiter. At this point the funds or goods of the transaction are moved to a public address that can be seen by all yet accessed by none. At this point, the third-party arbiter (if more than one arbiter is used then the majority decision of all the arbiter decisions serves as the deciding factor) solves the dispute and uses his private key to settle the dispute and provide access to the public address to the rightful side within minutes. The two principal parties only require the need of the arbiter if there is a dispute, otherwise the transaction does not involve the arbiter at all. This multi-sig approach allows for security and trust to anonyms transactions. A start-up company called Hedgy has already begun to use multi-sig technology on contracts that depend on future events.

As soon as all the agreed-upon terms are met, the contract executes the payment or reward for the contract with no delays. No longer do people have to wait days, months, or even years to receive payment, and all details for a transaction are open for both parties to see creating complete transparency. Additionally, these smart contracts can come in all different forms. Smart contracts can be written exclusively in computer code, be a combination of computer code and some traditional written agreements which reflect the same terms as the computer code, or even be a direct split in governance between code and writing. Smart contracts have applicability to many types of transactions that occur in the insurance industry. Smart contracts can revolutionize the claims department of insurance and reinsurance industry. Reinsurance companies and their ceding company work together to create a smart contract that outlines the specific terms of a reinsurance treaty, notably the exact conditions when a claim will be paid.

For example, a reinsurance company agrees to a smart contract with a ceding company that assumes property losses resulting from a hurricane that exceed $200 million in the state of Florida occurring in the contract period in a standard excess of loss reinsurance agreement. This cover is triggered by very specific circumstances; there is little to no room for the companies to try to manipulate each other for their benefit. The companies can also agree to use a third-party arbiter to settle disputes if they arise. This contract functions as an "if-then statement"; if the insured loss is greater than $200 million for a hurricane in Florida, then the reinsurer pays the rest. The two companies sign the contract through their digital signatures generated by the blockchain *cryptography*. The smart contract will execute itself once all essential inputs (when/if the hurricane occurred, where the hurricane hit, the amount of insured losses) are uploaded to the blockchain, and the claims payment will be made instantaneously since the conditions for coverage were triggered. On the rare chance that there is a dispute surrounding the contract between the two companies, the funds transferred between the two companies will be transferred to a public address. If there is a dispute in the contract, the two companies turn to the

Continued on page 16

decision of the third-party arbiter so there is no need for lawyers, lawsuits, and courts which reduces contractual costs. Disputes will be settled in a much faster manner with arbiters issuing decisions quickly as opposed to days in a court room that are spent today.

The question of enforceability arises when discussing smart contracts. Luckily, smart contracts are fundamentally the same as traditional, written contracts which are validated with digital signatures as opposed to written signatures. The increased adoption of click-wrap agreements, the online contracts that require a user to agree to a company's terms and conditions, show that online contracts are the way of the future. Additionally, court systems have enforced and validated digital signatures and click wrap agreements and through the Electronic Signatures in Global and National Commerce Act (E-Sign) and the Uniform Electronic Transactions Act (UETA) which essentially allow digital signatures to have an equal effect as a physical, written signature (*Findlaw*). Unfortunately, the digital signatures that are involved in blockchain technology have yet to be tested; however, the E-Sign and UETA provide applicability to blockchain technology. Smart contracts require the digital signatures (formed by the public-key *cryptography*) of both parties which should ensure that the smart contract is legally binding as long as both parties intended to sign the contract because digital signatures are equal to physical signatures under E-sign and UETA (*georgetownlawtechreview.org*). In fact, smart contract digital signatures appear to be more reliable than physical signatures because they are linked to all the private information needed to establish one's identity. With this information and previous precedents, the courts will accept the legality of smart contracts thus establishing their enforceability.

The wide use of smart contracts will lead to the widespread use of distributed applications (DApp). Distributed applications are a set of smart contracts that store data on a specific industry. Insurance companies can create an insurance DApp consisting of all the insurance companies for a particular line of business. Each insurance company participating in the DApp will perform company-specific calculations to price for an individual person for a particular line of business based on the inputs provided. These calculations can happen in real-time through the help of autonomous agents developed through machine learning algorithms which is not far away. Companies providing a service for an individual person will use this insurance DApp to get the insurance cost specific to that customer, instead of charging a class rate to all customers that punishes the many, good customers for the mistakes of the few, bad customers. Good customers will be rated based through a reputation system similar to the ones mentioned previously.

The concept of decentralized applications can best be described using an example. Airbnb is an aggregator of unused real estate, and people use the service to lease or rent short term living spaces. Airbnb offer real estate providers a flat insurance coverage of up to $1 million dollars and will additionally compensate them in the case of theft and damage. This insurance charge is paid by an increase price for every customer. Here, every customer is paying a higher price in order to finance an insurance policy that is only utilized by the very few. With a decentralized application, host providers can provide an individually priced insurance policy to each customer thus reducing the price. In this case, good renters are rewarded for their good behavior with much lower insurance rates and bad renters are punished (good and bad renters are determined by reputation systems similar to Uber or through the house itself through sensors explained later).

Once a customer makes a request to rent a living place that customer's public key is sent to the insurance DApp in order to get the insurance policy. The insurance DApp alerts the various insurance companies that participate in the application network about the individual person, and each insurer releases their own rate for customer. Each insurer performs the rate calculations based on the essential input provided by the renter's public key, which is all true verified information running on the blockchain network, and information provided by the host provider surrounding the property through traditional practices in the present and autonomous agents in the future. Examples of essential input include desired coverage amount, market value of home, the host provider's reputation, the renter's reputation, etc. Once the calculations are made, the homeowner will then choose the most applicable insurance policy for the renter creating more accurate insurance policies which lead to lessened risk and greater premium. The host provider and the renter both rate each other on a reputational system after their experiences to ensure the reputational systems are updated.

Blockchain technology makes the "Internet of Things" a true possibility with many technology companies acknowledging blockchain's crucial role in the Internet of Things with IBM referring to it as the "framework" (IBM, slide 11). The "Internet of Things" is where any device connected to the internet senses, responds, and exchanges data with other connected devices creating a network of machine to machine communication. The devices evolve over time due to machine learning algorithms to reach optimal and autonomous decision making based on the constant flow of new data. For example, house and automobile keys can be connected to a person's smart phone, and that person can unlock either through the use of their smartphone. Also, a world filled with connected "smart" sensors will make real time-monitoring of anything possible. An example would be sensors attached to water pipes in a building that send a signal to the repair crew requesting repair once a pipe becomes even a little leaky. These sensors can be applied to any device connected to the internet, and all of the data is uploaded and verified on the blockchain. This allows for real-time and true updates which greater increase risk assessment for insurers and reinsurers since people can trace or follow how someone acts. For example, insurance companies can now trace exactly how drivers drive which will allow insurers to issue much more accurate rates. A few examples of smart devices are smart pills that monitor bodily activity to improve healthcare, smart sensors on land that more accurately monitor weather or traffic patterns, and infinite other possibilities where all information will be immediately sent to those who need it.

The connecting of millions of devices allows for more communication, almost infinite, constantly, updating data, and better predictions. All of which reduce risk leading to accurately priced insurance policies and avoidance of catastrophic loss. All information and data generated from these connected devices is both true and secure, making it valuable for sharing information and automating actions. Blockchain technology allows people to program any specific smart device to act under specified circumstances without fear of hacking or exploitation. People can be sure that the information their devices are receiving is correct and accurate due to the verified history on the blockchain. Without this verified truth, devices could be susceptible to hacking or at the mercy of inaccurate data. Additionally, running these devices on a distributed ledger reduces costs drastically because devices do not need to pay to consult many different resources to find the pertinent data; all the data is located in the same location. Likewise, the single

repository for all data reduces the time needed to communicate or implement transactions.

Not to mention, people will also be able to rent out products that they aren't using to create a real sharing economy unlike the aggregate economy that masquerades as a sharing economy that exists today. People can agree to a smart contract where one party agrees to rent a smart product from someone else. The smart contract will specify the allotted time for the rental, and the insurance policy specific to the renter (discussed earlier). The product will stop working for the renter once the time allotted has been reached and will alert the owner to retrieve the product. Moreover, a renter can rent a product, and the exact amount of time that the renter has used that product will be recorded on the device ensuring that the renter only pays for their exact usage, nothing more and nothing less. With this effect, people will be able to rent out any unused product which can be an unused physical product or excess energy, computing power, cell minutes, and many other nontangible assets. This creates a need for more insurance policies on products because these products can serve as a source of revenue for people when not in use which means the risk of loss is much greater. Also, there will be an increased amount of insurance policies demanded because each time someone rents something the owner will want to be insured against losses.

An example would be renting a car. People could choose to rent out their "smart" autonomous, vehicle to other people while it is not in use automatically, meaning the car rents itself out as soon as it is not in use. Renter and owner are matched using the rating systems discussed earlier. The renter and the owner of the car agree to a smart contract with all the important conditions. Once the contract is agreed, the owner issues its car to complete the terms of the smart contract. The car could also search for the best renter that satisfies criteria through rating systems since it is connected to the internet as well. The car drives itself to the location of the renter (tracked through GPS on the user's smartphone), and then proceeds to drive the renter to his or her desired location, and then returns to the owner. As soon as the renter arrives at the destination, the smart contract enforces itself and the owner is paid.

With everything connected to everything else, the desire for insurance policies will be huge because a breach into an authorized device will yield catastrophic losses. Unfortunately, the potential gains incentives thieves. All information on the blockchain is secure, so cyber hacks are ineffective as discussed earlier in the paper. On the other hand, physical theft or manipulation to acquire private keys could prove catastrophic for victims and fruitful for burglars. For example, if someone's smartphone is stolen and the thief gains entry access to the smartphone then the criminal has access to everything that person owns. A robber has access to home keys, car keys, and everything else because everything is connected. The potential ramifications of theft and loss will be catastrophic, which will compel people to buy insurance, so that people are covered against these losses. Due to the potential losses, insurance companies will not want to hold all that risk themselves, so they will buy reinsurance, and reinsurance companies will buy retrocessional coverage, establishing a domino effect on all constituents in the industry. Fortunately, the insurance industry will have access to all possible data, so they should be able to create the best possible insurance policies, thus minimizing the risk exposure on behalf of the insurance industry.

The topics discussed in this paper only scratch the surface of the revolutionary capabilities of blockchain technology and its impact on the insurance industry with many topics left undiscussed and with many more to be discovered. Digital technology, like any general-purpose technology (GPT) has huge impacts on productivity which creates seismic increases in economic progress. Only stem power, electricity and now digital technology are classified as GPTs due to their impact, pervasiveness, and ability to improve and spawn innovation over time. These technologies take some time to be implemented and for crucial innovations to spawn, but in time productivity spikes exponentially especially in industries that are technologically behind other industries. Look to electricity's impact on production once it replaced steam power for an example of this productivity spike. Luckily, the insurance industry has been maligned for its lack of innovation and lethargic approach to change which means it will reap incredible benefits from technological innovation. After years of waiting, the insurance industry has found its revolutionary innovation.

Blockchain technology will give billions of people access to the financial industry, verify billions of people's identities, create enforceable online contracts, the possibility of the internet of things, and much more all due to verified true information, without the use of third parties. Real time pricing, ensured privacy and security, updated data, and everything else in between will turn the industry on its head, but it does not stop there. The insurance industry's antiquated practices and previous resistance to change make the industry ripe for great change just like Great Britain before the American Revolution. The current insurance/reinsurance industry will be unrecognizable after the catastrophic storm of unparalleled change and innovation resulting from Blockchain technology, and like with any catastrophic storm, I hope they bought insurance. ◀

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