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From the Special Fintech Issue Editor

I was privileged to be invited as a guest editor of this special fintech issue by my colleagues and friends at St. John's University in New York about a year ago. I first want to sincerely thank the previous and current editors of the *Review of Business (RoB)*: Professor Nicos Scordis, my esteemed colleague and my coeditor in the *Palgrave Handbook of Unconventional Risk Transfer* (2017), and current *RoB* editor, Professor Yun Zhu, who gave his invaluable contribution to the forthcoming *Palgrave Handbook on Fintech and Blockchain,* in which I share the role of editor with Professor Roman Matousek, from Queen Mary London.

Nobody suspected at that time that the world, and the entire economy, was about to change because of a pandemic. We were already in the midst of revolutionary changes to banking, insurance, and all the other financial businesses disrupted by fintech and the implications of blockchain technology. Now, over these months of emergency, we are witnessing a disruption within a disruption. Both disruptive waves actively reshaping the global economy are far from done deploying all their effects. Nevertheless, something can be learned already from this recent experience, looking at the impact of these changes in terms of, (1) digital transformation, (2) new processes and business models, (3) distributed systems and decentralized finance, (4) Internet of Things and business intelligence, and finally, (5) COVID-19-related consequences in light of the tentative regulatory approaches the authorities are testing now, and the directions they should follow.

This special issue hosts four papers, covering crucial aspects of new technologies in the world of financial services, while exploring COVID-19 consequences.

The first contribution by Spencer Li, "How Does COVID-19 Speed the Digital Transformation of Business Processes and Customer Experiences?" tries to foreshadow how new normality will take place, looking at digital transformation, business process, and particularly customer experience. In other words, the paper explores how organizations speed up the digital transformation of business processes for a better customer experience while reducing exposure to COVID-19. Having outlined COVID-19 effects on digital transformation, Spencer focuses on customers' behavior, at the same time paying attention to a series of psychological effects and examining how "customer experience leaders" outperform their competitors. He provides an original theoretical model, the *after-COVID-19 "ABCDEF" effects model*, which is defined as an "architectural framework for the decision-making process" combining human factors and emerging technologies in order to manage in the next normal.

Will Cong and his colleagues, Beibei Li and Tony Zhang, with their article, "Internet of Things: Business Economics and Applications," aim to reveal the true extent of the innovations behind the Internet of Things (IoT). They explore how IoT is boosting the sector changes by surveying past and latest applications, and introducing some case studies (e.g., AirSage and Tencent). While reviewing some promising innovations, like combining IoT and insurtech (e.g., wearable electronics), the authors suggest that IoT-related research in business and eco-

nomics is just starting; there are many potentially important unexplored issues. In addition to providing a concise introduction to various applications, they cover the institutional background, and potential research directions, which could help future researchers in this emerging area.

Next, Andria van der Merwe (with her "A Taxonomy of Cryptocurrencies and Other Digital Assets"), defines *crypto-economy,* clarifies how blockchain is invariably behind a varied set of cryptocurrencies, and offers an exhaustive review of the salient features of cryptocurrencies (e.g., bitcoin, altcoin, and stablecoin), bitcoin futures, and decentralized finance. The paper develops a taxonomy of digital assets to show that while there are overarching common features—such as high volatility and the use of decentralized distributed ledgers—cryptocurrencies include a heterogeneous set of products, each with their own risk and return characteristics. Potential investors will benefit from the comprehensive overview of this taxonomy because it will enable them to identify potential investment opportunities. Regulators and policy makers should be able to develop more effective policies and regulations from a clear exposition of the cryptocurrency and decentralized finance universe.

The final paper, by Lorenzo Costantino and myself ("Fintech in Light of the 2020 Emergency: Excess Innovations to the Facts—From Securitization to Tokenomics, and More"), goes back to COVID-19 consequences, and the double disruption previously mentioned. The article points to past crises and present threats, and to the role of pandemic in revealing potential distortionary effects ahead of possible bubble bursts. Starting with the importance of being resilient, the article traces parallels between regulation of finance and the COVID-19 crisis and the policy and regulatory response to the pandemic. The *pandemization of the economy* calls for *controlled regulatory entropy* as a means for regulators to regain the center stage with more and better targeted regulation. Using international rankings and data from COVID-19 infection and death rates, the article corroborates the need for a robust infrastructure and system to tackle crises and emergencies. Yet, the analysis also concludes that the robustness of any system can be easily undermined by unclear or insufficient policy response and public sector intervention.

Scholars and fintech professionals will hopefully find this special issue of *RoB* a useful tool to stay tuned with the latest developments in fintech and COVID-19's impacts on it.

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How Does COVID-19 Speed the Digital Transformation of Business Processes and Customer Experiences?

Spencer Li

Abstract

Motivation: The paper examines how organizations speed up the digital transformation of business processes for better customer experience with less exposure to COVID-19.

Premise: COVID-19 radically reshaped the global economy and accelerated the pace of digital transformation to create unforgettable customer experiences (CX). It is interesting to discover that human behavior and culture is one of the critical factors such as good journey mapping, on-boarding, etc., in playing a crucial deciding factor in adopting anti-epidemic measures.

Approach: This paper summarizes the COVID19 and "next experience" initiatives from governments and business entities to solve the problems caused by COVID-19. The "next experience" is categorized into three subjects—digital transformation, business process, and customer experience—which kick-start business process re-engineering and management changes to improve the customer experience.

Results: This paper presents the study results objectively. It summarizes the anti-epidemic measures against COVID-19 infection. The paper advocates for the importance of digital transformation to generate a better customer experience in the "next normal."

Conclusion: This paper advocates the after-COVID-19 "ABCDEF" effects model which include the holistic interaction among **a**rtificial intelligence, **b**lockchain and big data, **c**ustomer experience, **d**igital transformation, **e**motion, and **f**intech. The after-COVID-19 "ABCDEF" effects model brings out the importance of three layers such as human factors, data analytics, and emerging technologies. The after-COVID-19 "ABCDEF" effects model lets stakeholders consider all impacting matters in the "next normal" era.

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Consistency: Current measures applied to the handling of new COVID-19 waves or other harmful diseases are conformed with the hypothetical after-COVID-19 "ABCDEF" effects model. Among most research, all predict digital transformation playing significant roles in "next normal."

Keywords: big data, blockchain, COVID-19, customer experience, fintech, next normal, robotics, smart living

JEL Classification Codes: L81, O32, O33

INTRODUCTION

"COVID-19 is a disease caused by a new coronavirus called SARS-CoV-2" (Prescott and Wiersinga 2020). The World Health Organization first learned of this new virus on December 31, 2019. COVID-19 is the disease with the most significant impact on earth in terms of the infected population, number of deaths, as well as economic and social impacts of the twenty-first century. The virus has evolved to easily infect humans to survive and spread.

"COVID-19 is, first and foremost, a global humanitarian challenge. Thousands of health professionals are heroically battling with the virus, putting their own lives at risk. Governments and industry are working together to understand and address the challenge, support victims and their families and communities, search for treatments, and a vaccine" (McKinsey & Company 2020, "COVID-19 and the Great Reset").

Throughout COVID-19's spread, anti-epidemic research and measurement, as well as altered living behaviors and working practices, have alleviated some impact of COVID-19. This paper collects various information, including problem-solving thinking, innovative ideas, and solutions to solve the COVID-19 disaster. The dominant anti-epidemic measures have come from many governments, public utilities, business entities large and small, schools, religious bodies, families, and individuals.

The writer is an expert focusing on fintech, smart cities, and blockchain. He has recently conducted thorough literature research on digital transformation, business process, and customer experience. This paper focuses on three areas of application: fintech, smart living, and customer journey globally. It explains the quick adoption of emerging technologies for government and business in the "next normal."

This article explores human psychological impacts during COVID-19. Various ways of delivering goods and services while avoiding human touch between service providers, intermediate agents, and end customers are examined. This paper consolidates and classifies the changing customer services into various categories of customer experience. It also envisages how COVID-19 will speed up businesses to adopt digital transformation strategies after COVID-19.

COVID-19 EFFECTS ON DIGITAL TRANSFORMATION

"Digital Transformation is the adoption of digital technology to transform services or businesses, through replacing non-digital or manual processes with digital processes or replacing older digital technology with newer digital technology.

Digital solutions may enable—in addition to efficiency via automation—new types of innovation and creativity, rather than simply enhancing and supporting traditional methods" (Wikipedia 2020).

COVID-19's hazard to health necessitated difficult country/city lockdowns, social distancing, and stoppage of most human and business activities. Recently, McKinsey experts pointed out how companies can adapt by investing in three areas. One of the most critical areas is digital.

"Digital engagement has accelerated tremendously, and leading companies have innovated quickly to replace or complement traditional, in-store experiences. Out of necessity or convenience, companies have created many new offerings. Indeed, 80 percent of companies believe that their core business model should be digitized to remain economically viable" (McKinsey & Company 2020, "Customer Experience").

Moreover, a report from the United Nations Industrial Development Organization (UNIDO) said that "COVID-19 is a catalyst for digital transformation. COVID-19 is becoming the unexpected accelerator of the digital transformation. The disruptions caused by the crisis are having a profound impact on the world's mindset, which is now more open to embracing change to curtail the effects of the pandemic and to return to normality. In fact, due to these disruptions, the world has arguably experienced the most astonishing digital transformation in a few months than we have seen in the last decade" (UNIDO 2020).

Based on increasing studies on COVID-19 "next normal," it is a right moment for us to consolidate global impacts accelerating digital transformation due to COVID-19. Currently, faster adoption of digital transformation by organizations re-define the new business process making global impacts.

Four areas—COVID-19 symptoms, preventive measures, global impact, and mitigation efforts (Marbouh et al. 2020)—are considered by corporations (see Table 1). These matters challenge us to tackle the daily problems of COVID-19.

TABLE 1. COVID-19 Impacts

Symptoms	Preventive Measures	Global Impact	Mitigation Efforts
Dry cough	Wear surgical mask	City/country lockdowns	Contract tracing
Fever	Wash hands for at least 20 seconds	Restrict human movements	National disinfection program
Tired	Social distancing—stay 1.6 m apart	Suspend business activities	Anti-pandemic testing centers
Breathing difficultly	Avoid touching face, mouth, and nose	Slow down global markets	Temporary hospitals/clinics

These measures will be considered by the digital transformation process as follows.

Isolation by Social Distancing

First, isolation and social distancing by self-discipline are among the most effective ways to prevent further dispersion of COVID-19. Social distancing is defined as keeping a safe space between yourself and people outside your house-

hold members. Isolation can be implemented by country/city lockdowns, isolated treatment of infected citizens, and the now-common practice of a 14-day quarantine for tourists, business visitors, etc.

It is recommended to "stay at least 6 feet (about 2 arms' length) from other people who are not from your household in both indoor and outdoor spaces. Social distancing should be practiced in combination with other everyday preventive actions to reduce the spread of COVID-19, including wearing masks, avoiding touching your face with unwashed hands, and frequently washing your hands with soap and water for at least 20 seconds" (CDC 2020).

Besides daily lives, most government bodies, corporations, schools, and places of worship have adopted remote tools like ZOOM, FaceTime, TEAM communication tools, online shopping, workflow, document management systems, etc.

Robotics Facilitate Social Distancing

Smart living and robots are efficient and effective ways to keep social distance. Our everyday living can be enjoyed by the deployment of robots and robotic process automation. A recent article, "The Covid-19 Pandemic Is a Crisis That Robots Were Built For," said that robots can help doctors perform distance diagnosis of patients while the machines are working in hospitals to fight COVID-19.

However medical treatment is tough to automate because actions like fine-motor skills, compassion, and quick life-and-death decision-making must be done by humans rather than machines.

The journal *Science Robotics* sees this pandemic as a catalyst to jumpstart medical robot technologies. During a press conference, founding editor of *Science Robotics* Guang-Zhong Yang said, "perhaps, people start to reflect that for situations such as this, how robots can be used not only to help with social distancing but also for increasing social interaction. Robots have the potential to be deployed for disinfection, delivering medications and food, measuring vital signs, and assisting border controls. As epidemics escalate, the potential roles of robotics are becoming increasingly clear" (Simon 2020).

In China, robots bring food and supplies to quarantined people's homes, preventing delivery workers from potentially infecting them. A recent "China Medical Robot Industry Report" said, "in 2019, China's medical robot market was worth $620 million. . . . In the Chinese medical robot market, the ever-deeper university-industry-research cooperation stimulates the industry. Companies of industrial robots and medical devices branch out to the intelligent medical robot field progressively with many years of technical expertise, and has collaborations with domestic research institutes at multiple levels; research institutes otherwise market their research results by incubating companies. Furthermore, COVID-19 pandemic props up demand for medical robots. During the time, hospitals as the battlefront used intelligent medical robots for guide, disinfection and sterilization" (Research in China 2020).

In a United Nations report, "Similarly, robotics has played an increasing role in monitoring and assisting patients, while wearables demonstrated to be effective in screening and tracing patients and medical staff" (Jia et al. 2020).

TRACKING OF COVID-19 BY BIG DATA

Hong Kong and China

According to recent research, "Analyzing mobile-phone data to track human contacts at different city venues offers a way to model infection risks and explain infection disparities" (Jia et al. 2020).

In China, central and municipal governments have adopted big data analysis to trace COVID-19's spread. A recent report, "Epidemiology: Predicting COVID-19 Spread in China Using Mobile Phone Data," advocated tracking anonymized mobile phone users' movement as the best way to reduce COVID-19 risk (Jia et al. 2020). The research team conducted a study, assisted by a major national carrier in China, on anonymized mobile phone data and collected and analyzed all movements of people who spent at least 2 hours in Wuhan between January 1 and January 24, 2020, just as the quarantine was imposed. The region's population is more than 11 million. Researchers linked these data to COVID-19 infection rates, until February 19, from 296 prefectures in 31 provinces and regions throughout China.

The authors concluded that "quarantine restrictions were highly effective at substantially reducing movement, with population outflows dropping by 52% from 22 January to 23 January, and by a further 94% on 24 January" (Jia et al. 2020). The report predicted the frequency and geographical locations of COVID-19 infections in China up to two weeks in advance based on population outflows. The authors highlighted the effectiveness of applying the model to assess future COVID-19 community transmission risk in targeted locations in the future.

"What is innovative about our approach is that we use misprediction to assess the level of community risk. Our model accurately tells us how many cases we should expect given travel data. We contrast this against the confirmed cases using the logic that what cannot be explained by imported cases and primary transmissions should be community spread" (Xinhua 2020).

This approach is advantageous because it requires no assumptions or knowledge of how or why the virus spreads, is robust to data-reporting inaccuracies, and only requires knowledge of the relative distribution of human movement. It can be used by policymakers in any nation with available data to make rapid and accurate risk assessments and to plan allocation of limited resources ahead of ongoing disease outbreaks.

Tracking of COVID-19 by Blockchain

The COVID-19 pandemic has exposed the limitations of modern health care systems to handle public health emergencies. Blockchain can help in effective planning operations and resource deployments, such as improving clinical trial data management by reducing regulatory approval delays and streamlining the supply chain communication.

Moreover, the spread of misinformation has intensely increased during the outbreak, and existing platforms cannot validate the authenticity of data, leading to public panic and irrational behavior. Thus, a blockchain-based tracking

system is vital to ensure that the information received by the public and government agencies is reliable and trustworthy.

An article, "Blockchain for COVID-19: Review, Opportunities, and a Trusted Tracking System," illustrates various blockchain applications in tracking systems to combat COVID-19. The co-authors "propose, implement, and evaluate a blockchain-based system using Ethereum smart contracts and oracles to track reported data related to the number of new cases, deaths, and recovered cases obtained from trusted sources"(Marbouh et al. 2020).

Blockchain can deliver holistic solutions to prevent COVID-19 from spreading, and it can be applied to clinical trial management, medical supply chain, privacy protection, contact tracing, outbreak tracking, etc.

In summary, COVID-19 drives social distancing and creates a big market for robotics to disinfect and deliver medications. The collection of data related to COVID-19 is useful for building a big data platform for analytics. At the same time, blockchain can ensure an authenticated COVID-19 news and outbreak data for big data analysis. Since COVID-19's inception, there are 11-month data observed that COVID-19 has already forever sped digital transformation in various daily applications.

CHALLENGES IN BUSINESS AND CUSTOMER BEHAVIORS

Business Recession Leads to Stress and Acceleration on Customer Experience

COVID-19 radically reshaped the global economy and accelerated the pace of digital transformation. That means significant challenges to marketers as to how to build unforgettable customer experiences (CX).

McKinsey & Company compared corporate stress for the period of Q2 2020 against the two-year financial crisis of 2007–2008 and concluded that, "in first two-quarters Q1/Q2 2020, the current recession has led to more stress than comparable to two years of the 2007–2009 Great Recession!" (McKinsey & Company 2020, "COVID-19 and the Great Reset"). Although the challenges and threats from COVID-19 still exist, business leaders are looking to make good decisions in the face of this uncertainty. "What do they need to do today to be resilient when then next growth cycle begins?" (McKinsey & Company 2020, "COVID-19 and the Great Reset").

McKinsey advises enterprises to take the following five steps: "Resolve, Resilience, Return, Reimagination, and Reform" (McKinsey & Company 2020, "COVID-19 and the Great Reset") to combat COVID-19 and get to the "next normal" stage. In the last stage, "Reform," the stakeholders should be clear about how the marco-/micro-environment in your countries and industries should evolve in the "next normal."

McKinsey also recommends a "nerve center" to speed up decision-making without sacrificing quality across these five dimensions. A nerve center is a right way of centralizing all planning, action, and review on business reform. By considering the five dimensions, we believe that corporations can take better care of psychological and financial matters during business reform. We predict that most deliverables can be achieved by digital transformation.

How Do Customer Experience Leaders Outperform Their Competitors?

According to many financial statistics and studies on COVID-19, the whole world encountered a significant impact on the global economy. However, it is an exciting fact that customer experience (CX) leaders can recover faster than laggards.

According to McKinsey, CX leaders delivered three times greater cumulative returns to shareholders from 2007 to 2010. "The corporate stress in Q2 2020 is the same point as 2009 tough, but in only months vs. two years" (McKinsey & Company 2020, "COVID-19 and the Great Reset"). McKinsey predicts CX leaders will outperform more than three times their competitors in the COVID-19 situation, as there is a more keen need for digital transformation to provide a better customer experience than before.

Data play an essential role in customer experience. "The key to optimizing your customer's journey is data. . . . Today's consumers expect personalized user experiences across many channels: email, mobile, social, advertising, and the web. But you have to collect and track the right information to deliver that" (Salesforce, n.d.).

". . . It's best to start with a map that reflects your specific business model. A customer journey map is a diagram showing each typical point of interaction during the six stages of customer engagement" (Salesforce, n.d.). Your map should be based on what happens, not on what should happen, to get maximum benefit.

"Mapping your customers' journeys helps to focus stakeholders on the big picture and remind them how their efforts affect each other. It can also help teams deliver consistent experiences throughout the customer journey. For example, if different departments support customers using different interfaces, it can be jarring for customers" (Salesforce, n.d.).

"Maps ultimately allow you to build logic into consumer interactions and automatically move customers down different paths based on their profiles, buying histories, locations, expressed preferences, or other indicators. Paths or branches on the map can show different experiences that might be triggered based on customer behavior" (Salesforce, n.d.).

"Customer journey maps should evolve. Journey analytics will show you what is and is not working so you can continually improve interactions and design a better user experience. The result will be satisfied customers who spend more money, are more willing to recommend the brand, and are less likely to drift away" (Salesforce, n.d.).

To allow more enterprises to recover faster, there are two significant steps for them to take.

1. Understand what drives the "next normal."
2. Accelerate thoughtful, targeted investments to adapt to the changing customer experience landscape.

Although health and hygiene safety are the primary concern for the people, enterprises are finding it difficult to sustain their existing business by pursuing these goals alone.

We observe the following behaviors from customers reacting to COVID-19:

- More digital engagement
- Work from home will become the norm soon (most of Generation Z love to work from home as they enjoy the cyber- and digital-working environment)
- More customers are engaging on digital platforms and online business
- Online ordering, entertainment, and media are a necessity for business and living
- Reliable, advanced streaming is no longer just a convenience, it is increasingly a necessity

Most CX leaders adopt the "fast accelerators" attitude. That means that "high-performing replacements for traditional in-person experiences will likely persist in the 'next normal'" (McKinsey & Company 2020, "COVID-19 and the Great Reset"). In fact, we observed high-performing digital customer experience like ZOOM meetings/lectures, signing of legal documents by video conference with multi-factor authentication, online shopping, food deliveries, digital payments, smart living initiatives like robotic process automation (RPA), etc., relieving human face-to-face interaction and touch.

Psychological Factors Encountered in COVID-19

Previous sections examined a lot of elements of digital transformation and customer experience. However, psychological factors are crucial for us to carry out digital transformation in due course. Future leaders in governments and business entities must improve their services and products by implementing more designs and touchpoints aimed at improving the psychological well-being of end users.

"The COVID-19 pandemic will inevitably have lasting psychological impacts, and consumer psychology is no exception. Business leaders should track these changes and understand the needs of the new customer in the new normal. Behavioral economics could be invaluable here. Companies in many sectors have already been bringing behavioral expertise into boardrooms and executive offices; in the post-COVID-19 new normal, such capabilities should be even more valuable" (EY 2020).

Recently, a survey on U.S. consumer sentiment during the coronavirus crisis said that "optimism in the United States has increased to levels not seen since March 2020. Most consumers remain mindful of 'discretionary' spending and plan to maintain or reduce spending during upcoming holidays" (McKinsey & Company 2020, "Survey"). "Even though 80 percent of consumers report still feeling somewhat unsafe, out-of-home activity is picking up with one-third of consumers resuming 'normal' out-of-home activities" (McKinsey & Company 2020, "Survey").

For customer experience in "next normal," we should study the effects of consumer sentiment driving customer behavior. Several significant changes in customer behavior have been discovered:

1. U.S. shopping behavior is changing.
2. Customer loyalty: There is a new generation.

3. U.S. consumer-packaged-goods (CPG) advertising is evolving in the next normal.

McKinsey's research shows how U.S. shopping behavior is changing due to COVID-19. Fundamental consumer shifts are:

- Flight to online
- Shock to loyalty
- Need for hygiene transparency
- Back to basics and value
- Rise of the homebody economy

Online shopping is a growing trend for customers. "Consumer intent to shop online continues to increase, especially in essentials and home-entertainment categories. More interestingly, these habits seem like they will stick as US consumers report an intent to shop online even after the COVID-19 crisis. Categories, where expected growth in online shoppers exceeds 35 percent, include over-the-counter (OTC) medicine, groceries, household supplies, and personal-care products. Even discretionary categories such as skin care and makeup, apparel, and jewelry and accessories show expected customer growth of more than 15 percent" (McKinsey & Company 2020, "The Great Consumer Shift").

"Consumers are switching brands at unprecedented rates. The crisis has prompted a surge of new activities, with an astonishing 75 percent of US consumers trying a new shopping behavior in response to economic pressures, store closings, and changing priorities. This general change in behavior has also been reflected in a shattering of brand loyalties, with 36 percent of consumers trying a new product brand and 25 percent incorporating a new private-label brand" (McKinsey & Company 2020, "The Great Consumer Shift").

McKinsey partner Jess Huang said, "changes in consumer behavior due to the surge in digital mean companies need to revamp their loyalty programs" (McKinsey & Company 2020, "Consumer Loyalty"). Besides the right digital channel, "predictive analytics also helps companies better understand what behaviors drive the high-value customers" (McKinsey & Company 2020, "Consumer Loyalty").

Lockdowns and caring for health and safety accelerated five years of e-commerce growth into three months, "dramatically reshaping both the consumer path to purchase and the actual points of purchase—patterns that are unlikely to revert to the pre-COVID-19 normal" (McKinsey & Company 2020, "US Consumer-Packaged-Goods").

Due to the uncertain consumer landscape in COVID-19, consumer-packaged-goods (CPG) companies can grasp the opportunity to revamp and redesign new advertising models based on facts such as, "this evolving and uncertain consumer landscape poses significant challenges for advertisers but also creates an opportunity for CPG companies . . . What was true in the past will no longer predict the future: companies must harness new sources of insight" (McKinsey & Company 2020, "US Consumer-Packaged-Goods"). McKinsey thoroughly studies psychological factors arising from COVID-19 that drive a faster digital transformation pace for a better customer experience.

"Next experiences" are the what-if scenarios for successful business reform after COVID-19. In brief, there are eight what-if scenarios on commerce, food, deliveries, socializing, travel, work, health care, and mobility. The eight what-if scenarios for CX leaders to design customer journeys by applying emerging technologies to fulfill useful anti-epidemic measures and customer satisfaction. Therefore, psychological factors affecting customer behavior will play important deciding factors in adopting anti-epidemic measures.

Consider how humans change their behavior to cope with "next experiences." If customers want to buy a meal, they can choose to have dinner in restaurants or buy fast foods in convenience stores. Nowadays, catering service providers can build their eCommerce store (i.e., "next commerce") and place social media advertisements on food deliveries portals like Uber Eats (i.e., "next deliveries"). The customers will enjoy all-in-one food ordering and delivery services at their earliest convenience.

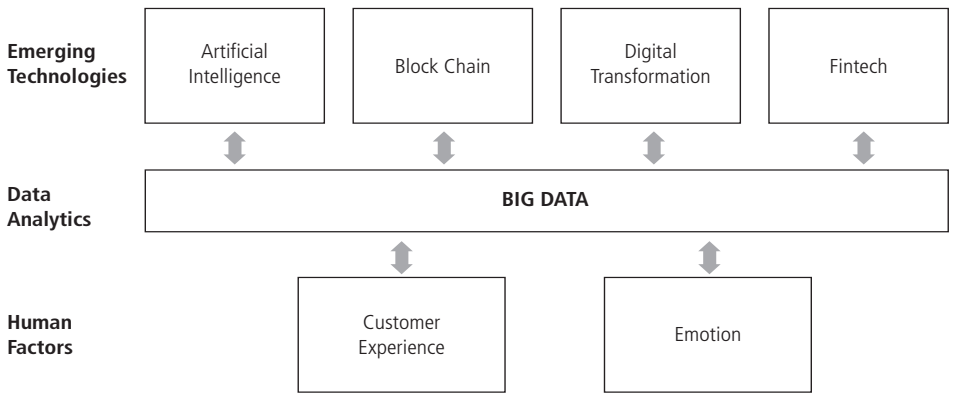
Emerging technologies like artificial intelligence, big data, blockchain, and fintech conduct the whole dining customer experience smoothly. Repetitive and upsell marketing can be done later for future promotional items.

AFTER-COVID-19 "ABCDEF" EFFECTS MODEL

Leaders should deploy the after-COVID-19 "ABCDEF" effects model on their businesses. The after-COVID-19 "ABCDEF" effects model acts as an architectural framework for the decision-making process, highlighting artificial intelligence, blockchain and big data, customer experience, digital transformation, emotion, and fintech (see Figure 1).

The digital transformation aside, important psychological "human factors" are always the first layer in the model. "Customer experience" examines how a better customer experience can be achieved by a better-designed customer journey. Social media also affects the emotional factors of the public, particularly Generation Z, and younger generations.

FIGURE 1. After-COVID-19 "ABCDEF" Effects Model—System Architecture



Decision-makers, like governors, scientists, and customer experience officers (CXOs), must pay attention to human factors using data analytics, bearing in mind international rules and regulations, like the General Data Protection

Regulation (GDPR) in the European Union (EU). The GDPR is the most stringent privacy and security law in the world. The regulation was put into effect on May 25, 2018. The GDPR levies harsh fines against those who violate its privacy and security standards, with penalties reaching tens of millions of euros.

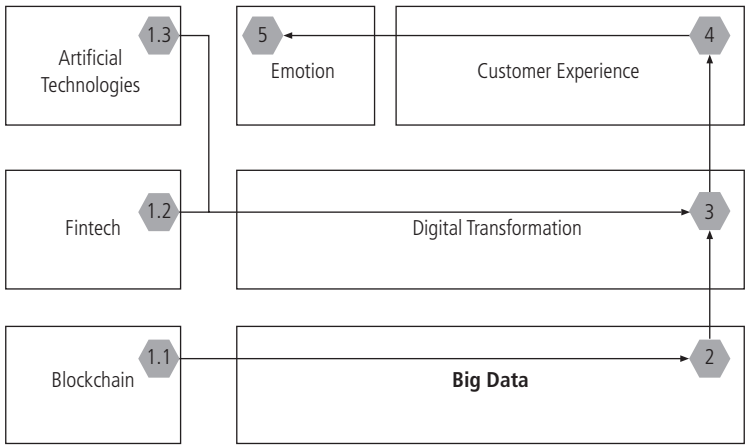
Advancements and breakthroughs in the "data analytics" layer include data security, big data analytics, 5G, faster and more extensive data storage media, and network/internet infrastructure. The UN highlights this layer: "For instance, migration to cyberspace and remote participation in social, educational and economic activities is allowing us to reduce the psychosocial impact of social distancing. Big data is increasingly being deployed in crisis management and predictive learning, allowing real-time data-based decision making and a faster and more efficient response. Similarly, the world has witnessed a shift to electronic commerce over physical retail and service provision.

"The necessity for crisis response has also undoubtedly spurred on innovation in some contexts. Artificial intelligence and Big Data have been used to assist virus research, vaccines development, and data analysis for supporting public policy decisions" (UNIDO 2020).

Similarly, blockchain, digital transformation, and fintech contribute to the after-COVID-19 "ABCDEF" effects model in the "emerging technologies" layer. Numerous emerging technologies, as well as many proven measures of adopting emerging technologies, can be examined and measured against the after-COVID-19 "ABCDEF" effects model.

Figure 2 presents the digital transformation flow illustrating how all the building blocks in the previous architectural diagram of the after-COVID-19 "ABCDEF" effects model interact to increase customer experience satisfaction for better business performance.

FIGURE 2. After-COVID-19 "ABCDEF" Effects Model—Digital Transformation Flow



The situation of the customer journey in Figure 2 is an example of the digital information flow. Due to persistent social distancing practice and the increasing adoption of online business, we expect online business to outperform offline business. The business initiative is driven by artificial intelligence like recurring

payment and repetitive sales, fintech transactions like eCommerce by digital payment, stock trading, and blockchain transactions, like the smart contract, and data verification, etc. In stages 1.1, 1.2, and 1.3, blockchain, fintech, and artificial intelligence trigger event transactions and also interact with each other to validate and authorize real transactions to create event details in centralized/private big data for two purposes.

The first purpose is to collect data of business transactions like transaction details, decision factors, and goods/product attributes, etc. We expect that more corporations are increasing investments to build companywide big data, while some government and public utilities are expanding their public services using program plug-ins and API to access their big data warehouses.

The second purpose is to perform data analytics for analyzing transaction requests. This paper forecasts more collaborated big data to provide holistic data analytics to achieve better business performance by delivering winning solutions and convenience to customers. Therefore, a super country-wide big data platform is being built by many countries under Smart Cities initiatives.

In stage 2, the deployment of big data analytics passes useful information to the digital transformation module to handle. For example, in the Bank 4.0 model, physical bank branches and ATMs are no longer crucial to deliver financial services, while more customized digital transformation services should be devised based on big data analysis.

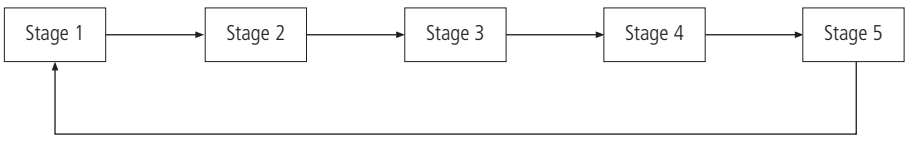
In stage 3, digital transformation achieves a better customer experience. More big data and artificial intelligence functions can help businesses transform in a better digital way. Intensive business process re-engineering and Digital Transformation 4.0 playing pivotal roles on government rulers and business decision-makers is anticipated.

In stage 4, a safe and contactless customer journey should be designed. For instance, a secure and contactless IDEA engagement can deliver a good customer journey to meet business objectives.

In stage 5, positive emotions and feelings are the consequences of enjoying the digital customer experience. In the past, front office staff were heavily relied upon to take care of sales and customer relationships. However, artificial intelligence and touchpoints are useful tools for customer relationship management. We expect that following the after-COVID-19 "ABCDEF" effects model will develop powerful tools to capture and analyze customer behavior without human touch.

The whole digital transform flow is an iterative one, as illustrated in Figure 3, which strives for better business excellence. We expect that most traditional business will vanish soon and be replaced by emerging digital business.

FIGURE 3. Digital Transformation Procedural Flow



CONCLUSION

Although the after-COVID19 "ABCDEF" effects model is a theoretical model for us to apply skills and techniques to survive in "next normal," we still need to plan the future development of the post-pandemic generation.

"For the generation coming up behind Gen Z, the post-pandemic 'next normal' will just be 'normal.' The impact of this generational shift will likely be profound. Think of the business transformations—corporate purpose, sustainability, ways of working, use of digital, new business models—sparked by the emergence of Millennials and Gen Z. The next such transformation is on the horizon. The companies that make sense of the post-pandemic generation fastest will enjoy a competitive advantage in areas such as recruiting, productivity, innovation, and customer [relations]" (EY 2020).

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Internet of Things: Business Economics and Applications

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Abstract

Motivation: Applications of the Internet of Things (IoT) have taken a central stage of consumer product innovation. While there is much discussion on wearable electronics, smart cities, etc., it is unclear whether the enthusiasm surrounding IoT is merely hype or interest in the underlying business economic models.

Premise: We introduce Internet of Things through its applications, which we categorize and relate to the recent advances in business intelligence and big data. We highlight unifying themes of Internet of Things and the methodologies for analyzing them, as well as elaborate on the promising developments in this field, including innovations combining Internet of Things and InsureTech and Artificial Intelligence.

Approach: To this end, we survey industry applications of the IoT and delve into several case studies.

Results: We find that the advance of IoT technology and Artificial Intelligence of Things (AIoT) empowers the retail, industrialization, and finance industries to accelerate the pace of digital transformation. Applications of the IoT have dramatically shifted strategies and structures of firms as they race toward the digitization.

Conclusion: Our framework for thinking about IoT and the cases we highlight can guide researchers interested in this area for further innovation or academic research.

Keywords: code system, geolocation, Global Positioning System (GPS), Internet of Things (IoT), IoT ecosystem, image sensors, point of sale (POS), Quick Response (QR) code

JEL Classification Codes: 014, 030, 031

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INTRODUCTION

One important source of alternative data is the Internet of Things (IoT), which has become prominent in tech innovations and generated a large amount of data across various industries (Minerva, Biru, and Rotondi 2015; Ray 2016). IoT refers to the nexus of physical devices that are connected through the Internet even though these items lack the capability of being connected physically.[1] It mainly consists of versatile devices that can sense and capture information in environments, with or without humans. IoT becomes relevant to finance and business due to availability of numerous smart devices and readily available connectivity that empowers businesses to conduct data-driven analytics and make informed decisions that were unseen before (Avasalcai, Tsigkanos, and Dustdar 2019; Mick, Tourani, and Misra 2018). This includes everything from smartphones, refrigerators, washing machines, lamps, video sensors, cameras, wearable devices, and components of machines (e.g., a jet engine of an airplane or the drill of an oil rig). It can be associated with almost anything in human society (Atzori, Iera, and Morabito 2010). However, the IoT devices are computational-light devices by design due to their resource constraints. Edge computing has been introduced as an ideal complementary solution for alleviating the resource limitation issues of IoT devices (Zhao et al. 2018). Edge computing allows a device to process data itself via a local computer or server, rather than by a remote data center.

In the age of digitalization, most businesses focus on tailored and personalized recommendations and services for their customers through apps or online portals. To identify innovative ways to better serve their customers, many financial institutions, including banks, asset managers, insurance companies, etc., have redesigned their processes with machine learning and other artificial intelligence technologies (Grivas, Schürch, and Giovanoli 2016; Kumari et al. 2020). These innovations provide seamless services, such as e-commerce, e-health, e-banking, etc., to the end users. The IoT and edge computing allow for virtually endless opportunities and connections to take place, many of which we cannot even think of or fully understand the impact of today. It is not hard to envision how and why the IoT opens the door to a lot of business opportunities and implies substantial financial applications. The financial service industry has long trafficked in the intangible, from counterparty risk and online bill payment to things that used to be tangible but increasingly are no longer due to the digital transformation. During this transformation, near- and long-term opportunities emerge for the financial services industry to see benefits from the IoT (Eckenrode 2020).

Widely regarded as a breakthrough in improving consumer lives and retail industry efficiency, the IoT is prevalent in business activities such as manufacturing, logistics, and personalized recommendation. Zhang, Li, and Krishnan (2020) conducted demand estimation for the taxi market and designed a new information-sharing strategy for taxi and ridesharing platforms by analyzing two million fine-grained location data from IoT sensors deployed in the cars. Soleymanian, Weinberg, and Zhu (2019) studied the new usage-based car insurance

[1]Lightbulbs, watches, glasses, or toys, when connected to the Internet, are all examples of IoTs (we use *IoTs* to refer to IoT devices). However, computers and smart phones are typically not referred to as IoT because they are built to have connection capabilities.

(UBI) policy based on IoT sensors, and found that after UBI adoption, UBI users improve the safety of their driving, providing a meaningful benefit for the individual driver, the insurer, and society as a whole. With its development comes data collected from decentralized crowds. IoTs can track customers' real-time location to better understand their behavior, generating micro-level information to better predict the future performance of corporations. New technological solutions developed based on the IoT for retailers enable the exploration of authentic customer behaviors and cheaper marketing opportunities across the world. Whether these innovations take the form of customer experience improvements or business process optimization, the possibilities for IoT are endless and not yet fully understood. We intend to provide some insights into IoT's huge potential by illustrating several examples of IoT-powered data applications.

The remainder of the article is organized as follows:

- "Applications of the IoT and IoT-Based Data" discusses a few applications of IoT-based alternative data, including use cases from the supply chain, customer experience management, and retail industries, as well as categories of data from IoT ecosystem.
- "Concluding Remarks and Future Directions" summarizes promising future directions for research and for industry development.

BACKGROUND AND CATEGORIES OF IOT ECOSYSTEMS

The term *Internet of Things (IoT)* was first introduced in 1999 by Kevin Ashton who described, "the IoT integrates the interconnectedness of human culture—our 'things'—with the interconnectedness of our digital information system—'the internet.' That's the IoT." IoTs have subsequently gone through two major developments, the first one being the introduction of radio frequency identification (RFID) tags that enabled real-time tracking of location and physical condition of connected objects. RFID aides the identification of objects by absorbing electromagnetic signals and broadcasting a simple, unique code through radio waves. The second development entailed Internet Protocol version 6 (IPv6), which improved remote access and management of large quantities of IoT devices. IPv6 uses IP addresses that have 128 bits comprising a routing prefix, subnet ID, and interface or device identifier. IP addresses endows every network-connected device with its identity. Today, there are more IoT devices in the world than people. Each of these physical devices can collect and share data without human intervention. The IoT architecture has three layers: the perception layer, network layer, and service layer. Data collection occurs within the perception layer, accessing the network happens between the perception and network layers, data management takes place between the network and service layers, and finally, applications manifest in the service layer in which consumers typically interact with IoT.

In general, data from the IoT can be categorized based on the properties of the sensing, including, but not limited to, geolocation data from the Global Positioning System (GPS), imaging data from video sensors, and data generated from other devices.

Geolocation-Based IoT Applications

Due to the wide adoption of smartphones in consumers throughout every country, the once seemingly impossible-to-acquire information on consumers' geolocation data can now be easily collected through either GPS, WiFi, or other wireless signals (Zhang, Li, and Krishnan 2020). Advanced techniques, including machine learning, are then applied to geolocation data to extract insights that may be valuable for businesses and investors. It is estimated that there are 2 billion smartphone users in the world. The smartphone that people carry everywhere is in fact a tracking device that knows more about where people go and their daily habits than they do. Tracking people's smartphone locations is just one way that companies can acquire analytical insights.

Many companies in this sector currently focus on tracking bundle traffic in and around store locations. There are direct and indirect ways of collecting this geolocation data. The direct way collects data by tracking the location of users' cellphones. This kind of data can typically be purchased from mobile service providers, e.g., T-Mobile or Verizon, China Mobile, etc. The indirect way involves placing mobile advertisements on goods, e.g., bar codes or Quick Response (QR) codes, so that a consumer's location can be instantly reported when they are triggered or scanned. Firms using the direct way include AirSage and Advan Research, while examples of the indirect method include Tencent and Walmart.

Case Study: AirSage

AirSage specializes in collecting and analyzing anonymous location data, such as mobile phone and GPS data, to identify patterns (Smith et al. 2005). It does so by tracking mobile phone data using patented technology to capture and analyze mobile phone signal tower data. It has secured location data from various sources, including smartphone software development kits (SDKs), fleet, and navigation systems. The data provided include both real-time and historical data.

AirSage distinguishes data based on transportation, travel and tourism, and commercial real estate. The company processes more than 15 billion mobile device locations every day with the widest coverage of any location-based service provider in the United States. Note that data features a group breakdown on anonymous origin/destination matrix with time stamps.

In travel and tourism applications, AirSage's data will help identify visitor demographics, behaviors, and build seasonality trends with historical data in destination markets. AirSage covers most of the metro areas in the United States, so that anonymous devices in almost every city can be retrieved.

The GPS coordinates of cell phones collected over the course of a week, a month, etc., allow analysts to get an estimate of the number of visitors in a certain season. Analysts can then improve the accuracy of predictions for top line revenue by combing the geolocation intelligence data as a proxy. Such cases include Six Flags, Disney, and Lululemon, all of which are publicly traded companies.

One firm outstanding in utilizing the indirect approach to collect consumer location and behavior profiling data is China's Tencent, via its code system. Unlike the direct way, in which the location information is directly retrieved from the apps on smart phones attached to users, the indirect approach

records the location of goods, through which the end-user profiles and locations can be acquired.

Case Study: Tencent Code Solution

With years of development in the consumer market of China, Tencent has evolved into one of the largest Internet-based value-added service providers in China. By adopting its latest cloud technology and IoT platform, Tencent has established large-scale, stable, and robust infrastructure and capabilities—complemented by online security, artificial intelligence, big data analytics, location-based services, and other proprietary technologies—to support ecosystem partners across various industries (Rong et al. 2015).

Like Amazon, Tencent has accumulated a presence in the consumer Internet ecosystem over the years, building its strength in developing the largest consumer market in the world. The massive Weixin and QQ user bases serve as the "digital gateway" for industries, while official accounts, mini programs, mobile payments, marketing solutions, and WeChat Work serve as the "digital tools" that connect developers and enterprises to potential customers. One such example is the implementation of code tracking systems in the retail industry.

Tencent Smart Retail introduced the full-code digital marketing package which helped the retail industry to "seek people by goods" and better connect users. Though seemingly simple at first look, it involves a very sophisticated system. The core concept is that Tencent's products are digitized at the core, so each product has a unique digital ID, which will then allow the merchants to track the life cycle of each individual good.

In marketing—despite the inability to establish direct connections with consumers, the difficulty in managing channel terminals, and the lack of long-term operation mechanisms for digital assets—the application of Tencent Optima in different scenarios will help brands build full-chain digital management and solve the above problems. Its no-field verification procedure provides a completely new solution: goods to connect people. Through Tencent, every bottle of select beverages is printed with a QR code. The code can be entered into the official code system to make coupons. In this way, the brand realizes the visualization of offline users, allowing target consumers to connect, acquire insight, and operate. At the same time, goods have also broken through the original single consumer goods' attributes, becoming a direct communication medium between brands and consumers. Regardless of whether consumers buy online or offline, they can use the products themselves to achieve further connection with the brand. This is also an important activity to reduce brand marketing activities' dependence on locations.

Image-Based IoT Applications

Other than geolocation data, image sensors have been widely used in collecting alternative data. In this section, distinct from the geospatial image data we discuss earlier, we focus on the image data from IoT devices typically used in home appliance and retail businesses.

The most popular motivation involved in creating such a dataset is the anticipation that information exploited from the dataset analytics will help to

make recommendations to consumers to drive revenue or to better understand customers. Almost every retailer has a website or mobile app that utilizes recommendation systems to suggest products to consumers. Most of these systems use text-based data to provide such recommendations. This data primarily includes customer details like their demographics (e.g., age, gender, address, etc.) and their purchase history. For these algorithms to work, each product has data tags for its category. Using the data from each consumer, scores are created for products, then products with the highest scores are recommended to each consumer. These values would only exist for products that a customer had already bought and were created using the consumer's information online. However, offline stores will not be able to monitor this type of traffic without image-based sensors. Can traditional retailers be empowered with a similar technology? Thanks to the advancement of IoT technology and deep learning neural networks, image-based sensing data can be captured and analyzed with relatively low costs and high efficiency. Some companies started investigating this domain. One retail analytics startup called Nomi developed their sensor platform that tracks customer behavior in traditional brick-and-mortar retail stores. Each arriving person in the store is assigned a tracking identifier using its advanced video camera. The cloud-based software analytic system then links the person's movements across Brickstream sensors, following the person wherever they go. The 3D sensors on the Nomi platform can see past overlapping objects to provide a truly accurate measurement of what people are doing in the store. With more than 140,000 sensors being used in stores located in more than 60 countries, Nomi's image data has a truly remarkable value proposition for retailers.

Other IoT Data Analytics

In the retail industry, one easily accessible category of data is point of sale (POS) or electronic point of sale (ePOS) data. Retailers today collaborate with suppliers and share sales and inventory information to increase profits. The most common source of shared data is driven from the universal product codes (UPCs) scanned at checkout registers. POS data is typically sent electronically from retailers and distributors in transactions known as EDI 852 and EDI 867, or through vendor portals in files generated from their internal data warehouses. By summing up the POS data of approximately 2,000 American supermarket stores from 2001 to 2012 for every company, Ishikawa, Fujimoto, and Mizuno (2016) compared the growth rate of the POS sales data with each company's actual sales. They discovered that the growth rates in quarterly sales for companies whose anchor products are daily necessities in the United States were strongly related to the POS data's growth rate, thus demonstrating that nowcast (real-time observation of company sales) is possible, at least for this type of business enterprise.

Recent progress in the retail industry includes autonomous shopping centers powered by advances in computer vision techniques. AmazonGo is a prime example of this. AmazonGo stores do not have any human staff or cash registers. Consumers enter these stores, pick up the groceries that they need, and leave. Many aspects of this seemingly simple operation require the use of computer vision:

1. Customers need to be identified using facial recognition as soon as they enter the store.
2. Every product that is removed from the shelf needs to be accounted for. This operation has two aspects: the customer picking up the product needs to be identified, and the correct amount needs to be added to the customer's bill.
3. The product removed from the shelf must be accounted for and replaced with an identical item from the inventory.

Data from the purchase can be used to recommend products to the consumer in the future. Identification and tracking of customers and products require computer vision algorithms and fusion sensors to work in perfect conjunction to achieve accurate results. Every time a product is picked up, sensors need to detect the reduction in weight and pressure on the shelf, and the vision algorithms at work need to identify which product has been taken from the shelf.

Other retailers also use images and videos to create better shopping experiences for use in stores. Candy retailer Lolli & Pops leverages facial recognition to identify loyalty program members as they enter the store and proceeds to provide them with personalized recommendations. Walmart uses video data to monitor missed scans during checkouts and potential thefts. Schnuck Markets uses robots to monitor shelves and take stock of inventory.

Since there are many retailers that operate on-ground stores, there are many variations of technology being used to simplify product tracking and checkout. Many retailers use barcode scanners at self-checkout counters. However, that still requires the consumer to individually scan each item. Redmon et al. (2016) proposes a method called YOLO (you only look once), which uses shape detection and categorization to identify all the products in a consumer's cart. This method consists of two convolutional neural networks (CNNs). The first CNN is a GoogleNet-inspired network that classifies products into 17 predefined shapes, and then a region-based convolutional neural network (R-CNN) is used to classify the shapes into categorized products. The time taken to detect and classify the objects is approximately 69.3 milliseconds per frame and is done with approximately 75% test accuracy.

IBM, partnering with Tesco, implemented a project that focused on monitoring products on shelves and using images to differentiate between similar products placed close to one another (Marder et al. 2015). The project focuses on addressing two common problems encountered while detecting objects on shelves:

1. Images used in training sets are usually high-quality studio photos in contrast to the real-time, lower-quality images that need to be classified in stores.
2. Many products of the same type look alike. Shape detection and categorization can be difficult for such products.

The model proposes a complex method that takes images from shelves and performs an initial classification on the products in the shelves. However, these classifications are not specific classifications, but similarity groups. Once prod-

ucts are grouped, features are extracted from the images and are used to classify the products more specifically.

APPLICATIONS OF THE IOT AND IOT-BASED DATA

Advances in the IoT have empowered almost every industry to become more efficient and smarter. Due to the large amount of alternative data produced, IoT adoption has opened a completely new landscape in many sectors, including finance. For example, Olsen and Tomlin (2020) describes the technologies inherent in Industry 4.0 and the opportunities and challenges for research in this area. Specific technologies discussed include additive manufacturing, the Internet of things, blockchain, advanced robotics, and artificial intelligence. Contemporary farming uses light detection and ranging (LIDAR) technology (a surveying method that measures distance to a target by illuminating the target with laser light and measuring the reflected light with a sensor), typically used in autonomous driving cars, to identify insects while robots pick weeds with the aid of computer vision. Videos, images, and voice capture technology can help farmers monitor the growing process of crops. Construction technology startups, using artificial intelligence and the IoT, have made construction work more like a manufacturing process. Versatile Natures, an Israeli company, offers a holistic view of a construction project by mounting IoT sensors under the hook of a crane (Versatile 2020). The sensors constantly collect and analyze data, with the goal of giving site managers actionable insights, such as information on materials, redundancies, construction progress, and crane utilization. Inspirit IoT, an IoT startup from Illinois, aims to reduce the impact of on-site environments on workers' safety and construction schedules by implementing an AI-based algorithm over a traditional monitoring system to detect safety concerns (Inspirit IoT 2020). Inspirit IoT makes sensors that measure environmental metrics, including temperature, humidity, carbon monoxide, etc. IoT's penetration into industries such as retail and wholesale, and hence a sustainable growing opportunity in finance, can be attributed to (1) improved customer experience and (2) optimized supply chain operations. These advantages are detailed next.

Improved Customer Experience

Today, many retailers have increased their interaction with customers, but the IoT will bring a more personalized and meaningful experience. As ordinary objects become smart devices, the customer experience becomes fully digital, creating a growing trend of personalization. Relying on this interconnected environment, companies can design and create products and services centered on each consumer with data rendered from the IoT.

Optimized Supply Chain Operations

Industrial Internet describes how companies can use cloud computing, mobile telecommunication, big data, and other technologies to closely integrate digital space with the real world, thereby improving operational efficiency and fostering innovation. It is expected that by 2030, the combination of industrial Internet and IoT devices will create an additional value of more than $14 trillion for the global economy.

In the face of increasingly complex supply chains, the growing importance of digital channels, and rising customer requirements, connected devices and products provide an opportunity for retailers to optimize operations. For example, wireless radio frequency (RF) technology can improve the accuracy of inventory tracking, while data visualization technology makes it easier for employees to track the location of products in the supply chain. Merchants can even offer this service to customers, for example, to support customers in reviewing the progress of orders in the production and distribution process.

Store managers can also use online smart price tags to adjust pricing in real time, such as lowering the price of a promotional product or a poorly selling product, or increasing the price of a sought-after product. A fully integrated pricing system will help retailers better achieve price synchronization between shelves, checkouts, and various channels, ensuring that online stores and physical stores are priced consistently.

In addition, merchants can integrate other IoT devices in the supply chain to further improve store operations and reduce costs. For example, sensors based on IoT technology can help store managers monitor and adjust lighting brightness and temperature to achieve energy savings and cost reductions while improving customer comfort.

Sensors can automate many of the tasks that currently need to be done manually, such as tracking inventory of individual items or adjusting prices, which will give salespeople more time to communicate with customers and further enhance in-store services.

As we have shown, IoT technology helps firms to better understand once fragmented scenarios, leading to an improvement of business as a whole. From a FinTech perspective, the broad applications of the IoT remain in the retail industry in which firms have the direct desire and incentives to push forward. The IoT has been maturing such that there are currently enough IoT sensors and devices that firms can start experimenting at a scale showing what the technology is truly capable of in various industries. As such, an enormous scale of alternative data is produced, intentionally or unintentionally, offering opportunities to study corporate business from multiple angles. This was utilized in the post-crisis period that was characterized by a low interest rate environment where investors spent large amounts of resources and capital to identify anomalies through the alternative data of the IoT and rapid fund their new discoveries.

We next discuss how IoT-based data is created and utilized in multiple business settings.

The Advance of the IoT-Driven Retail Industry

The retail industry caters to hundreds of millions of people each year. It also gathers and maintains multitudes of data—point of sales transactions, customer details—such as addresses, reviews on e-commerce websites, and browsing history—vendor details, product details, etc. Given the proven effectiveness of the use of data to create sophisticated and accurate systems that learn through experience, it makes sense that retailers, with all the data in their possession, make use of this data and current technology to create vastly personalized buying experiences for customers, more efficient inventory and delivery processes, and increasingly secure environments for purchasing products.

E-commerce dramatically shifts the strategy and structure of firms that are active in domestic and international markets as companies race toward the digitization of their business processes (Koh, Kim, and Kim 2006). These shifts create new opportunities for small- and medium-sized enterprises (SMEs) that want to compete with the major incumbent players in markets. Most of them heavily rely on the technical assistance from large high-tech firms or marketplaces, e.g., Google or Amazon, where customer relationships are nourished and supported by digital tools. Retailers may have a lot of issues——ranging from inventory to location to customer service——but one of the largest challenges arises from unnecessary marketing failures that are fully self-inflicted. For instance, the brand is often "lost" the moment that a product enters its sales channel.

In the four key aspects of the retail business—product, efficiency, store, and sales—online brand promotion and e-commerce have gradually visualized the effective marketing of products and their impacts. In online stores and marketing, due to the complex and diverse sources of store traffic, it is often difficult to effectively precipitate user assets, while the effect of offline promotion is hard to track, resulting in the separation of online and offline data information. From a financial planning and marketing budgeting perspective, the question, Who are the consumers at the other end of the product? often becomes a blind spot to the brand. Failing to perceive the user makes it extremely challenging to convert sales into non-switching, or long-term, consumers. That, coupled with the problems of fraud, low-quality replicas, and interference from certain unlicensed middlemen, make the marketing cost of brand investment out of the real value of the target end users and service providers. Researchers (e.g., Peng 2012) have classified the factors tied to marketing failures into three major groups, including competition-specific, institution-specific, and resource-specific factors. Though retail involves unlimited exogenous factors and multiple issues, these failures stand out as problems that arise from a failure to construct a clear and aligned story, strategy, and system, as well as an inability to embrace the desire of customers.

Success in the retail industry has always been tough, but the current battleground in globalization, or deglobalization, presents new challenges and opportunities in a faster manner to all the participants. Advertisements have become "smart" as the Internet with wide-bandwidth communication powers up the fast customization and deployment of ads with precision targeting of customers given their preferences and behaviors, learned from historical personal data or personal network research. Every company in every sector, including retail, is essentially advertising their dependence on big data. When constructing any transaction there are several steps that must be taken, either in a specific order, or in parallel, so a snag in one step tends to snowball into more problems down the line. Merchants, manufacturers, advertising agencies, logistics companies, and IT innovators hope that by adopting IoT solutions to cut costs, trace transportation, and use limited sales and marketing resources more efficiently, they can turn the capricious, fragmented, and spatially distributed world of e-commerce and retail into something more closely resembling what it is supposed to be—a service process for individuals. The focus is not only on how to sell goods or deliver faster, but also on turning retail and e-commerce into a regimented process that can be better understood and optimized. Amazon, for example, has

a reputation for operating on a large scale of online presence and it has facilitated such a presence through emphasis on offline merchants and supply chain optimization with reinforcement from IoT solutions since 2014.

Like other industries which have undergone a digital revolution, thanks to the fast advance of IoT technology and blockchain, many aspects of the retail industry are also being revolutionized. Today, home appliances, home security and comfort products, and even health care products are becoming part of the IoT ecosystem. Retailers in home décor or consumer electronics can not only increase the sales of these connected devices, such as Home Depot, which has more than 600 "smart" products, but also leverage the data provided by these devices to extend the business scope to consumers' homes.

Some retailers are taking advantage of various interconnected products by becoming an integrated platform. The basic idea of these platforms is to make it easier for customers to communicate to each other's home devices. For example, Lowe's launched the Smart Home Hub, the Iris platform, which can communicate with any device via networking technologies such as WiFi, ZigBee, or Z-Wave. The platform also has an open interface so manufacturers can interface with their products. Iris has enabled Lowe's to compete directly with telecom providers such as AT&T and Verizon, while also creating new opportunities for the company—working with manufacturers to integrate products into the Iris platform. In addition, Home Depot's Wink and Staples' Connect, as well as other platforms, are being released.

Other types of retailers, such as grocery stores, can build or collaborate with such platforms. Connected platform provides retailers with another channel for direct interaction with customers, opening a hidden treasure trove of customer data. This information covers almost every aspect of home life—from electricity use to consumption trends.

Under this context, the rest of this paper will focus on how IoT data is used by retailers and wholesalers, utilizing machine learning and deep learning algorithms to identify potential business locations, the creation of personalized recommendations on e-commerce websites and mobile applications, and how the data are used to identify and track both products and customers.

This practice of leveraging existing models (and/or creating newer ones) and algorithms to explore data to learn from experience has manifested in many ways in finance applications. The applications of machine learning, and more recently deep learning, have come a long way from using predictive analytics in 2002 to targeting customers with emails about products it believed they would want next (Coussement and Van den Poel 2009), to Amazon using computer vision to create a friction-less grocery-buying experience for its customers (Grewal, Roggeveen, and Nordfält 2017).

IoT and InsureTech

Another important application of the IoT is in InsureTech because IoTs enable real-time collection of data from customers to monitor their conditions or assets (health, home, car, etc.) in order to update insurance coverage and premium accordingly. Such a legacy challenge is costly to insurers and is traditionally a nuisance for customers.

With advances in IoTs, such as connected devices, smart sensors, and wearable electronics, this space is now ripe for disruption. Solutions in this space usually enjoy easy adoption and retention because they benefit most parties involved: insurers get better data and customers have a chance to lower their premiums. Zendrive auto insurance is one example. Zendrive's app, in addition to showing safety measures and reminders for driving, collects driving behavior data for auto insurers to more accurately price insurance policies and reward safe driving with discounts. CapeAnalytics home insurance is another example using technology to monitor "home intelligence" and perform remote property inspections to set premiums. A third example is Oscar health insurance, an alternative tech-enabled health insurance provider that rewards healthy actions (such as exercise) based on data from fitness trackers (e.g., FitBits, Apple Watches, etc.) to discount premiums.

ARTIFICIAL INTELLIGENCE OF THINGS AND EDGE COMPUTATION

One especially important development in IoT is its combination with AI and edge computing. Lately, industry leaders and researchers have been adding machine learning capabilities to the connectivity, signaling, and data-exchange capabilities of the IoT. The resulting Artificial Intelligence of Things (AIoT) allows for more powerful and flexible data-analytics solutions at the device level that will help optimize operations and create value from alternative data.

At present, AIoT innovations focus on consumer retail products and industrial applications. One promising application of AIoT is smart retail. Smart cameras with computer vision and facial-recognition capabilities identify customers as they walk in and out the door. The system can gather customer demographics and shopping preferences in order to predict consumer behavior. The smart sensors on the product shelves allow consumers to collect their preferred products, place them in their cart, and walk directly out of the store. Another area where AIoT has made an impact is construction and real estate. As in smart retail, smart office buildings use sensors to detect when employees have entered the building and then automatically adjust lighting and temperatures to improve productivity. Transportation has also been disrupted with AIoT that can monitor vehicular fleets, delivery robots, and autonomous vehicles to analyze data on fuel levels and costs, vehicle maintenance, and driver behavior. AIoT sensors, along with inputted data, allow delivery robots to gather information about their surroundings and make decisions on how to navigate the terrain around them to safely and efficiently deliver a product and return to their bases. Autonomous vehicles also use sensors and inputted data, as well as radar, sonar, GPS, and cameras to gather data on driving conditions and make decisions on how to respond. AIoT devices, once combined with edge computation, can further optimize these variables to better fleet management and protection of company assets.

AIoT requires artificial intelligence, fast networks, and big data to operate. Hence, as the number of IoT-connected devices grows, the amount of data collected by them grows as well. As a result, the way consumers, and society as a

whole, interact with devices at home, work, and in transit continues to evolve. While AIoT has been put into practice at the consumer level as discussed, the presence of AIoT across all industries, whether via industrial or municipal implementation, necessitates all businesses to prepare for AIoT integration into daily practices. AIoT's ability to increasingly individualize interactive experiences, procedures, products, and services to improve revenue building and cost saving will allow companies to progress into a smarter future.

Of course, AIoT is a larger driver of increased automation. Forbes even declared that AIoT will usher in Industry 4.0, a new revolution carried by the likes of edge computing, voice AI, and vision AI. At present smart appliances have these capabilities, but home robots and autonomous vehicles are poised to be the next generation of edge computing AIoT devices. Voice AI, today in the form of smart speakers and voice activated displays, allows users to talk to an application or program to instruct it to retrieve information or perform tasks. Natural language processing and ePayment voice authentication are future innovations to Voice AI that will be facilitated by AIoT. Vision AI, a technological capability where computers are trained to replicate the human vision system, allows digital devices to identify and process objects, images, and videos in real-time like humans do. Object detection and 4k resolution are current features of Vision AI, but video analytics and super 8k resolution are two innovations expected in the future.

Smart cities is one more avenue that will incorporate AIoT. Traffic control is one important way in which AIoT can be implemented with smart traffic signals able to process data from cameras, drones, and radars and the capability to detect congestion and accidents to decide on how to update traffic signals in the area to prevent further backup. Developing markets, like New Delhi, where traffic is the worst in the world, are promising places for early movers in this space to enter. Furthermore, pedestrian traffic monitoring will also be enhanced by vision and voice AI capabilities that will proceed from further development of natural language processing and video analytics. More intricate ideas like identifying criminals or missing children would still be challenging, but the concept is gradually implemented and realized. In fact, it is generally believed that over 80% of enterprise IoT projects will incorporate AIoT by 2022.

CONCLUDING REMARKS AND FUTURE DIRECTIONS

To conclude, we summarize the key applications and developments of the IoT in economics and business-adjacent fields. Academic research on the topic is still emerging and we highlight that IoT-based data retrieval, AIoT, and financial applications of the IoT all constitute promising directions for further research and industry innovations.

Specifically, IoT, as one of the breakthrough techniques in retail and wholesale industries, has been a powerful venue for financial analytics. The geolocation, image, and transaction data streams from over 400 retailers and distributors have only been part of the alternative data that have been utilized. Within five years, the consensus is that IoT data will have the largest volume of alternative data for finance analytics. Both new challenges and opportunities will emerge as more dynamic and advanced IoT devices are developed.

AI, a powerful new technology, can potentially transform the next era of industrial and technological enhancements once combined with the IoT to create AIoT. Companies may have the opportunities to boost revenue through individualized marketing tactics and decrease costs through autonomous IoT devices. AIoT presents a promising direction for both academic and industrial research, and the opportunities are limitless opportunities for improvement to cities, healthcare, and services. Companies should explore how to integrate these AIoT-enabled devices in their everyday practices in order to capitalize on the increased access to data IoTs provide.

It remains open how regulators and institutions can best address data privacy issues. More generally, it is a holy grail in data science to have multi-party usage of data while preserving privacy. Related are tools for merging traditional data with alternative data.

This article by no means illustrates all possibilities provided by the potential and large scale of IoT-based alternative data. Given the pace of development in blockchain technology, deep learning techniques, and IoT technology, we expect research in this area would also evolve quickly. That said, the general trend and utility of using alternative data are here to stay and are likely to significantly impact the world of FinTech and business intelligence.

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A Taxonomy of Cryptocurrencies and Other Digital Assets

Andria van der Merwe

Abstract

Motivation: Cryptocurrencies and decentralized assets comprise a heterogeneous set of products. These products exhibit rather divergent features but are all either directly or indirectly linked to the blockchain, distributed ledger technology.

Premise: We assume that the real innovation behind cryptocurrency is the blockchain, which enables user-to-user trading among decentralized participants and settlement and recordkeeping of such transactions without a trusted, centralized authority. The current generation of digital assets are not fiat money, but rather are functioning as a medium of exchange while some are starting to achieve success as part of alternative investment strategies.

Approach: The paper reviews the salient features of cryptocurrencies, bitcoin, altcoins and stablecoins, bitcoin futures, and decentralized finance.

Results: This study develops a taxonomy of cryptocurrencies from an economic perspective that will be useful to investors and regulators. The taxonomy shows that while there are overarching features, such as high volatility and the use of decentralized distributed ledgers, cryptocurrencies include a heterogeneous set of products, each with their own risk and return characteristics.

Consistency: Potential investors will benefit from a comprehensive overview of the taxonomy of decentralized assets to identify potential investment opportunities. Regulators and policymakers should be able to develop more effective policies and regulations from a clear exposition of the cryptocurrencies and decentralized finance universe.

Keywords: altcoin, bitcoin, blockchain, cryptocurrency, Dai, decentralized finance (DeFi), stablecoin

JEL Classification Code: A19

INTRODUCTION

Cryptocurrencies and decentralized finance products have comprised a diverse set of innovations since bitcoin was introduced in 2009. The real innovation behind bitcoin was the blockchain, the introduction of decentralized consensus

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methodology which enables peer-to-peer trading, settlement, and recordkeeping of transactions without a trusted, central authority. The bitcoin blockchain paved the way for new, innovative types of digital assets, including cryptocurrencies and decentralized financial products.

The consensus view is that the current generation of cryptocurrencies, while serving as a means of payment in the crypto-economy, do not have the typical characteristics of fiat money outside the confines of the crypto-economy (G7 Working Group on Stablecoins 2019; Ron and Shamir 2013). Research by Yermack (2013) and Glaser et al. (2014) reached a similar conclusion, further observing that cryptocurrencies behave more like speculative investments. Cryptocurrencies can be a good alternative investment, especially in terms of bringing diversification to portfolios (Trimborn, Li, and Härdie 2017), but in choosing the appropriate product, investors first need to undertake the daunting task of dissecting the diverse set of available products.

This paper develops a taxonomy or classification of cryptocurrencies and other decentralized products focusing on the salient features of each of these innovations. Research in this area typically focuses on the technological aspects (Glaser and Bezzenberger 2015). Few if any academic papers have been written that classify cryptocurrencies and other digital products from an economic perspective.[1]

This paper is an initial step in filling that void. The treatment here is not comprehensive, but rather focused on representative products in each category.

The first section below gives an overview of the crypto-economy and lays the foundation for the rest of the discussion. The next five sections introduce representative products in each of cryptocurrencies, altcoins, stablecoins, bitcoin futures, and DeFi products. Thereafter, a discussion on the main observations on the taxonomy, followed by a conclusion.

THE BASIC COMPONENTS OF THE CRYPTO-ECONOMY

A particular blockchain is a public ledger of digitized information, such as the record of the cumulative purchases and sales among bitcoin participants. A cryptocurrency such as bitcoin is the "digital asset" transacted among participants in the crypto-economy. Whereas every cryptocurrency must have an associated blockchain, certain types of blockchains may have value on their own even without the explicit trading of digital assets, for example, to store medical records (Halamka, Lippman, and Ekblaw 2017) or to facilitate the clearing of repurchase agreements (Smith 2017). The application of blockchain technology beyond cryptocurrency typically involves private or permissioned blockchains that are controlled by a centralized entity or consortium of entities that governs the exchange of information among a particular group of participants, such as the entity's clients.

The crypto-economy typically consists of four, interrelated components: (1) the distributed ledger or blockchain, (2) the digital assets, such as bitcoin, (3) the

[1]There are some examples of industry publications in this area. See for example, "General Taxonomy For Cryptographic Assets," https://bravenewcoin.com/general-taxonomy-forcryptographic-assets.

active participants or "miners," and (4) the passive participants or users. A particular blockchain is composed of blocks or groups of cryptocurrency transactions. A particular transaction represents the purchase or sale of cryptocurrency between two participants. The number of transactions per block varies—for example, the original bitcoin protocol allowed up to 2,000 transactions per block. Only settled transactions are included in a block appended to the blockchain so that the speed with which new blocks are created effectively determines the time it would take to settle a particular transaction.

An important feature of the bitcoin protocol is that it is designed to create a deliberate, fixed maximum supply of digital assets in a deterministic and controlled fashion. The blockchain protocol associated with bitcoin controls, among other things, the number of new coins created per block, and the frequency with which new blocks are added to the blockchain. The supply of bitcoin is therefore not a direct function of the price of or demand for bitcoin. For example, the total aggregate supply of bitcoin is capped at 21 million, and the amount of new coins created with every new block decrease deterministically, according to a formula in the protocol. According to some calculations, 99 percent of all new bitcoins will have been created by 2032 (Burniske and Tatar 2018). The amount of time needed to reach the total supply is somewhat misleading because the number of newly minted bitcoins per block can be adjusted. Because of its digital nature, bitcoin is infinitely divisible so that even a fractional number of coins per block is feasible.[2] The technical details of the bitcoin protocol are beyond the scope of this paper, but it is important to recognize that new bitcoins are being created in an orderly, predictable way. Yet the demand for cryptocurrency is theoretically unlimited, resulting in a perceived scarcity that adds value to bitcoin.

The third component of the crypto-economy is the active participants, in the case of bitcoin, the miners, that are responsible for "building" the particular blockchain. The challenge of the blockchain design is to devise a protocol that will establish consensus among geographically dispersed miners (active nodes) with competing incentives in the absence of a contracting or central authority to resolve disputes among miners.[3] Agreeing on the group of transactions to be included in a block and therefore appended to the blockchain is not as simple as ordering cryptocurrency purchases and sales according to their timestamps. Transacting participants broadcast transactions and/or requests to buy or sell cryptocurrency to all nodes on a particular blockchain; but because of the geographically distributed nature of blockchain participants, the latency, or time delay, between the submission of a transaction and its receipt by other nodes can differ widely depending on their physical locations. Latency differences render transaction timestamps an ineffective means for ordering transactions (Narayanan et al. 2016). Moreover, the ordering of purchases and sales should obey certain rules, for example, transactions that double spend the same bitcoins or any other type of malicious transactions should not be confirmed and added to the blockchain.

[2]A potential area for future research is whether the infinite divisibility of bitcoin would be viable without devaluation of the currency.

[3]By contrast, only certain, permissioned entities are allowed access to the typical private or permissioned blockchain. See Burnside and Takar (2018).

The bitcoin blockchain relies on a cryptographic principle referred to as "proof-of-work" to facilitate trust and coordination among miners and ensure that only a legitimate transaction is confirmed (Nakamoto 2018). The bitcoin proof-of-work algorithm requires miners to expend considerable computational capacity to solve a complex, mathematical puzzle. This puzzle is not necessarily difficult to solve, but the solution requires a significant amount of costly computational power that requires the miners to purchase special hardware systems. Bitcoin miners compete with each other to receive the transaction fees and any newly minted coins associated with a particular block of transactions. An increase in the number of competing miners could further increase the computational power required by the proof-of-work protocol.

The fourth component of the crypto-economy is the individual participants. These participants are linked to the crypto-economy though a wallet.[4] Each wallet is identified by a number similar to a digital bank account number, referred to as the public key. The public key is further uniquely linked to a private key. While the public key is shared and visible to other participants, the private key is not public and not shared, but it is necessary to approve any transfer of bitcoin out of the wallet. Wallets have a dual purpose; first, wallets can be used to securely store, send, and receive cryptocurrencies. Similar to a bank account, a wallet is essentially a record of unspent bitcoins. Wallets also provide a user interface to track the balance of cryptocurrency holdings and automate certain functions, such as estimating what fee to pay to achieve a desired transaction confirmation time. Table 1 shows the contents of a particular bitcoin wallet identified by its public key, 12ib7dApVFvg82TXKycWBNpN8kFyiAN1dr.[5] The private key for this wallet is stored by the owner and is not publicly available. This wallet was created on May 13, 2010. Bitcoins were last received by this wallet on February 20, 2018, and last sent out from this wallet on July 24, 2010. As of August 19, 2020, most coins in this wallet remain unspent—namely, out of 52,700 bitcoins received, only 21,700 were sent/sold.

A participant can have multiple wallets for the same or different cryptocurrencies. Some participants use centralized wallets on an exchange or payment platform that pool funds together into a limited number of large wallets or addresses. Linking wallets to individuals or even determining estimates of the exact number of cryptocurrency users from the number of created wallets therefore presents a number of challenges without additional non-public information.

TABLE 1. Example of the Contents of a Bitcoin Wallet

Wallet 967	Number of Bitcoin	First Transaction	Last Transaction
Balance	31.0K BTC		
Received	52.7K BTC	5/13/10	2/20/18
Sent	21.7K BTC	6/2/10	7/24/10

[4]The first step to trading cryptocurrency is the creation of a wallet, which simply entails downloading software to your digital device.

[5]https://www.blockchain.com/btc/address/12ib7dApVFvg82TXKycWBNpN8kFyiAN1dr.

CRYPTOCURRENCY COINS—BITCOIN VERSUS ALTCOIN

The investment landscape for cryptocurrencies (or coins specifically) has expanded well beyond the bitcoin that Satoshi Nakamoto, the pseudonymous developer, conceptualized in his 2009 white paper. Cryptocurrency coins have grown into multi-billion-dollar market with thousands of listed cryptocurrencies (Coinmarketcap, n.d.). Cryptocurrency coins include simple variations of bitcoin, such as most altcoins. For example, the altcoin litecoin is recorded on a variation of the bitcoin blockchain. Other coins represent more substantive variations, including new innovations of blockchain such as ethereum and the native coin ether. The ethereum blockchain uses different cryptographic principles than bitcoin's blockchain and further permits programmable "smart contracts" that in turn enabled the growth in initial coin offering (ICO) tokens. While the nomenclature is not yet standardized, there are often technological and other differences between coins and tokens. Coins typically have their own blockchains or exist as forks of existing blockchains whereas tokens are issued on a blockchain that enables smart contracts such as ethereum.

This evolution in coins can be attributed to a few factors. Bitcoin is not perfect—new cryptocurrencies are developed to address specific limitations of bitcoin, such as the high computation cost of the proof-of-work protocol, the relatively small number of transactions per second, or the limit on the number of transactions per block. Furthermore, bitcoin is based on open-source software, which means that the source code is publicly available and that it can be studied, changed, and improved by anyone with the necessary technical skills. The crypto-economy is also relatively unregulated when compared to the traditional financial markets, further leading to low barriers to entry. The first step in creating a new cryptocurrency is typically the publication of a white paper that establishes the rules about the creation of new blocks, the procedure for supplying new cryptocurrency, and the mechanism for reaching consensus among active participants.

A challenge in introducing a successful, new cryptocurrency, and its associated blockchain, is to attract a sufficient demand from participants using the cryptocurrency and active participants (e.g., miners) willing to expend resources to generate and maintain the blockchain. Despite the large number of cryptocurrencies being introduced, there are only a relatively small number of successful currencies. Table 2 shows the market capitalization and share for the top ten coins as of June 30, 2019. The combined market share of the top five coins was 91 percent as of July 31, 2020, with bitcoin's share still much larger than that of the other coins.

The discussion that follows focuses on a sample of cryptocurrencies that has some unique features not shared by bitcoin.

Litecoin (LTC)

Litecoin borrowed the main concepts from bitcoin but improved some features of the blockchain protocol to enable faster transaction confirmations.[6] The time

[6]Litecoin uses a different hashing algorithm that improves on the time-power efficiency of bitcoin's mining. https://arstechnica.com/information-technology/2013/05/wary-of-bitcoin-a-guide-to-some-other-cryptocurrencies/, last accessed on August 20, 2020.

TABLE 2. Market Share of Bitcoin and other Altcoins as of July 31, 2020

Cryptocurrency	Market Capitalization	Market Share[a]
Bitcoin	$208,301,738,184	70.90%
Ethereum	$38,461,983,022	13.10%
XRP	$11,293,810,672	3.80%
Bitcoin Cash	$5,562,323,569	1.90%
Bitcoin SV	$4,230,697,934	1.40%
Litecoin	$3,776,500,072	1.30%
Cardano	$3,592,104,122	1.20%
Binance Coin	$2,960,333,142	1.00%
EOS	$2,885,995,745	1.00%
Tezos	$2,095,922,196	0.70%

[a]Denominator is the aggregate market of the top 20 cryptocurrency coins.

Source: CoinMarketCap.

lapse between litecoin blocks is 2.5 minutes, approximately four times faster, than bitcoin blocks. Because blocks are issued four times as fast, this means that litecoin can handle a higher transaction volume. The total amount of litecoin released will be therefore be four times greater than that of bitcoin in the same time period. Litecoin will converge upon a fixed 84 million units, whereas bitcoin will converge upon 21 million units. Burniske and Tatar remarked in their comparison of bitcoin (BTC) and litecoin (LTC), "a unit of litecoin will be one-fourth as valuable as a unit of bitcoin because there are four times as many units outstanding. This is important, because all cryptocurrencies differ in their supply schedules, [so that] the direct price of each crypto-asset should not be compared if trying to ascertain the appreciation potential of an asset. Litecoin is nimbler than bitcoin because it stores a fraction of the monetary value" (Burniske and Tatar 2018).

Ripple

Ripple is an open-source, permissionless, and decentralized blockchain technology that can settle transactions in 3 to 5 seconds. The Ripple network also provides an enterprise solution for banks and digital asset exchanges that allows payment settlement, money transfer, and currency exchange services. Ripple also has its own native cryptocurrency, XRP, that can be exchanged for other cryptocurrencies or fiat currency. While bitcoin is deterministically created over time, all XRPs were created instantly during a genesis event.

Ethereum

Ethereum is a decentralized computing platform based on an innovative proof-of-stake consensus mechanism. The ethereum blockchain also hosts the ERC-20 tokens that enable developers to create digital applications or "smart contracts." Ethereum is considered the platform leader because these smart contracts are

programmable and form the basis of ICOs and decentralized finance products discussed in the next sections. The native cryptocurrency of ethereum is called ether (ETH). Ether can be exchanged for other cryptocurrency coins or fiat currency, but it is also the "digital oil," or unit of payment, for the fees related to smart contracts.

STABLECOINS BACKED BY FIAT CURRENCY

Stablecoins are a type of cryptocurrency that, as the name suggests, seek to stabilize the price by linking the value to an underlying basket of assets. In some regards, stablecoins are the digital equivalent of stable value funds, but their design is rather complex and typically involves the broader crypto-economy. Stablecoin issuance, redemption, stabilizing mechanisms, type and design of the user interface, and transfer of stablecoins to the broader crypto-economy involve a governing body, exchanges, wallet providers, payment system operators, smart contracts, and a blockchain (G7 Working Group on Stablecoins 2019).

Table 3 shows a list of stablecoins backed by U.S. dollar deposits. (Stablecoins could also be backed by crypto-collateral, for example the Dai coin discussed at the end of this section.)

Stablecoins differ in how the underlying basket of assets are secured. The basket of assets could be backed by a central entity, such as the Tether Treasury for tether (USDT), a decentralized system of governance (multiple users can issue stablecoins), such as USD coin (USDC) or backed by Federal Deposit Insurance Corporation (FDIC)-insured banks (Paxos Standard [PAX] and Binance [BUSD]), or escrow accounts TrueUSD (TUSD). An escrow account reduces settlement risk for both the purchaser and seller of the stablecoins. Suppose an investor wants to buy one stablecoin, they would deposit a dollar (the assumed stablecoin price) in an escrow account. The issuer would deposit a TUSD coin in the account, which is sent to the purchaser and upon verification of the receipt, and the dollar is transferred to the issuer (Lyons and Viswanath-Natraj 2020).

Another technical difference among stablecoins is the governing body's choice in stabilizing mechanism. In theory, the price of stablecoins backed by fiat currency is exactly one; in practice, however, intraday price could show minuscule deviations from one due to market frictions, including settlement delays and rebalancing the collateral basket, which could introduce some price volatility in stablecoins.

TABLE 3. Properties of Top Stablecoins

Stablecoin	Symbol	Basket of Assets
Tether	USDT	100% USD deposits held in centralized Tether Treasury
USD Coin	USDC	100% USD deposits in decentralized (private) accounts
Paxos Standard	PAX	100% USD deposits held by FDIC-insured banks
Binance USD Coin	BUSD	100% USD deposits held by FDIC-insured banks
True USD	TUSD	100% USD deposits held in escrow accounts

Stablecoins—Backed by Cryptocurrency

A particular example of a cryptocurrency-backed product is the stablecoin Dai. Like other stablecoins, Dai seeks to reduce price volatility against a reference basket of assets with only a soft peg to the U.S. dollar. Most stablecoins are backed by fiat currency such as the U.S. dollar or a basket of fiat currencies, but Dai is collateralized by the cryptocurrency ether. The name Dai is a transliteration of the Chinese character meaning to "lend or to provide capital for a loan" (u/Rune4444, n.d.). The stablecoin Dai can be traded and exchanged for other cryptocurrencies, but it can also be used to generate interest on cryptocurrency through lending.

The Dai stablecoin is decentralized and based on a set of smart contracts referred to as *Maker Vaults* supported on the ethereum blockchain (MakerDAO, n.d., "Vaults"). Dai can be generated by anyone by depositing ether collateral into Maker Vaults. The cryptocurrency becomes the collateral for a Dai loan to the user. The interest rate on this loan is known as the *stability fee*. This mechanism of Dai creation effectively means that the user effectively borrows Dai using cryptocurrency collateral to establish a collateralized debt position (CDP). Once created, Dai can be traded or exchanged for other cryptocurrencies or fiat currency. Initially, Maker Vaults only accepted the native cryptocurrency of the ethereum blockchain, ether, but toward the end of 2019 introduced the idea of allowing other types of collateral also. The amount of collateral deposited is greater than the amount of Dai generated. For example, the loan-to-collateral value is currently 50 percent, which means that the user needs to deposit $150 worth of ether for $100 worth of Dai. If the collateral falls below 150 percent, the collateralized debt position is automatically liquidated.

The Maker protocol has several built-in mechanisms to guarantee that Dai remains stable against the dollar, such as the target rate feedback mechanism (TRFM). For example, "if the Target Price of Dai is below $1, the TRFM increases so that it can push the price of Dai back up. This causes the price of Dai to increase, which then causes the generation of Dai through CDPs to become more expensive" (MakerDAO, n.d., "MakerDAO MCD FAQs"). The feedback mechanisms require the smart contract to know the price of ether at any point. The Dai stability mechanisms have performed well, with Dai reaching an all-time high price of $1.11 on March 13, 2020, during the peak of the COVID-19 global market uncertainty.[7]

Several use cases of Dai have emerged. For example, investors who want to reduce the risk and volatility of their cryptocurrency portfolio could exchange ether for Dai on a cryptocurrency exchange. Users could also deposit ether in a Dai smart contract and receive a Dai. Dai lending, whereby the Dai holders lock their Dai into a Dai savings rate smart contract, is an alternative way to use Dai by earning interest. The interest accrues at a variable rate referred to as the Dai savings rate (DSR) and set by the Maker (MakerDAO, n.d., "Dai Savings Rate"). The Maker protocol uses the level of the DSR as a means to influence the demand for Dai. When the DSR is high, it creates demand for Dai but when DSR is low it stimulates supply (DeFi Rate, n.d.). Historically, DSR varied between a

[7]CoinMarketCap, https://coinmarketcap.com/currencies/multi-collateral-dai/historical-data/?start=20130428&end=20200920.

high of 8.75 percent on February 4, 2020, to a low of zero percent on March 17, 2020, when the demand for Dai exceeded the supply.

CRYPTOCURRENCY DERIVATIVES—BITCOIN FUTURES

The Chicago Mercantile Exchange (CME) and the Chicago Board of Trade (CBOT) were some of the first regulated exchanges to enter the digital asset market with the launch of cash-settled bitcoin futures in 2017. Bitcoin futures opened the market to broader institutional involvement—increasing from 45 funds with over $7 billion in assets in 2016 to over two thousand funds in 2018 (Faucette, Graseck, and Shah 2018).

Bitcoin futures serve two functions. Futures facilitate the efficient transfer of risk from participants wanting protection against the risk of price movements to speculators wanting to bear price risk. The cash-settled futures provide a means for participants to short bitcoin (Hale et al. 2018). The Federal Reserve Bank of San Francisco suggests that the launch of CME's bitcoin futures in December 2017 improved the efficiency of the bitcoin spot market.

The CME lists monthly contracts for six consecutive months and two additional December contract months. If the six consecutive months includes December, it lists only one additional December contract month. The contract trades on CME Globex from 18:00 Eastern time to 17:00 Eastern time Friday with an hour break every trading day. Individual contracts equal five bitcoin per contract. CME bitcoin futures are cash settled to the CME CF Bitcoin Reference Rate (BRR) that is calculated using a volume-weighted median price of trades collected from approved exchanges including Coinbase Pro, Bitstamp, Kraken, and itBit and Kraken between 15:00 and 16:00.[8] The CME also provides a real-time index for bitcoin, the CME CF Bitcoin Real-Time Index (BRTI) that is updated every second. (Lakhani 2019; Moran, Richardson, and Letson 2017).

On September 22, 2019, the Intercontinental Exchange (ICE), launched the Bakkt futures, which unlike the CME's cash-settled futures, are physically settled. The other contract features of the Bakkt futures are also different than the CME version. ICE lists monthly contracts for 12 consecutive contract months. The Bakkt bitcoin futures contract size equals one bitcoin and upon the final settlement date, bitcoin are delivered to the Bakkt Warehouse.[9]

Figure 1 shows the growth in bitcoin futures open interest at the CME over time. Trading volumes in CME bitcoin futures currently exceeds Bakkt futures volumes; the consensus view is that the CME still dominates in terms of price discovery (Aleti and Mizrach 2020).

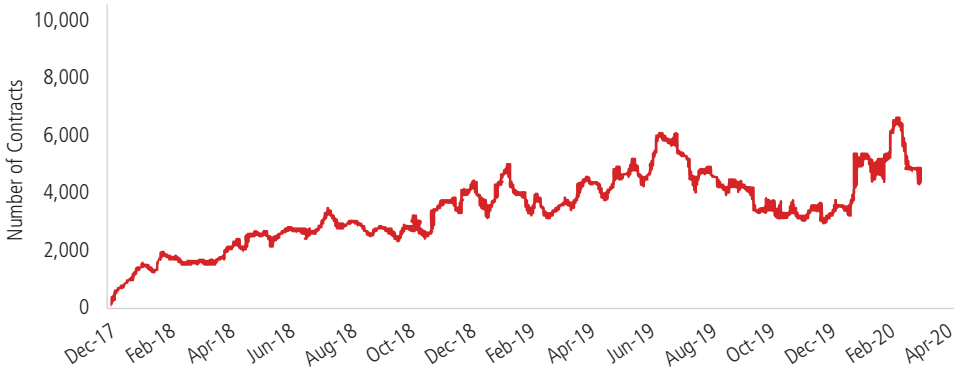
DECENTRALIZED FINANCE—LENDING AND BORROWING

Decentralized finance, or DeFi, refers to the offering of traditional financial services using decentralized technology. The basic idea behind many of these developments is that ethereum smart contracts are used to automate enforce-

[8]https://www.cmegroup.com/trading/equity-index/us-index/bitcoin_contract_specifications.html, See also, https://www.cmegroup.com/confluence/display/EPICSANDBOX/Bitcoin.

[9]https://www.theice.com/products/72035464/Bakkt-Bitcoin-USD-Monthly-Futures-Contact.

FIGURE 1. Open Interest of CME Bitcoin Futures

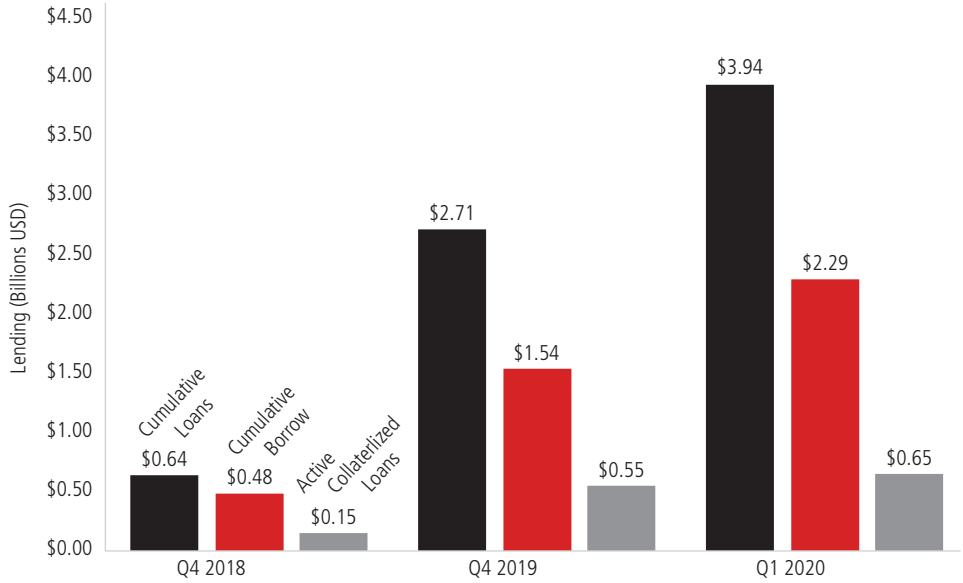


able agreements without the need for bank oversight and intermediation, using blockchain technology instead. These types of products present examples of how innovation can be used to facilitate alternatives to traditional financial services. An example of decentralized borrowing and lending follows.

Genesis Global Capital ("Genesis Capital"), a registered broker-dealer, started digital asset lending to institutional investors on March 1, 2018 (Genesis Global Capital 2018) followed by fiat currency lending toward the end of 2018, whereby institutional investors can borrow cash against their cryptocurrency holdings. Genesis Capital lending grew from cumulative originations of $1.11 billion on December 31, 2018, to over $6 billion on March 31, 2020.

Genesis Capital allows institutional investors, such as hedge funds and trading firms, the opportunity to borrow or lend bitcoin, ether, and other digital assets in large quantities over fixed terms. Figure 2 shows a breakdown of their cumulative loan originations between borrowing and lending of digital

FIGURE 2. Lending in Billions USD



assets. The amount of lending in digital assets continues to exceed the amount of borrowing. This figure also shows the number of active cash loans against institutional cryptocurrency holdings, which is still smaller than the digital asset lending.

The salient features of cryptocurrency-backed loans are compared to other asset-backed loans in Table 3. The interest rates on cryptocurrency-backed loans, represented here by loans against bitcoin, are typically on the higher end when compared to loans against more traditional collateral such as future sales, fixed company assets, or equity and debt securities. The lender directly controls the cryptocurrency collateral in contrast to the traditional collateral, which is not transferred, but only pledged, to the lender. The lender can therefore generate an additional return on the cryptocurrency collateral over the lifetime of the loan. The amount of collateral often exceeds the loan amount. As shown in Table 4, the loan-to-value of bitcoin-backed lending was between 50 and 80 percent, which creates a leverage effect further enhancing the return.

Digital asset loans are comparable to more traditional types of asset-backed loans, but the underlying cryptocurrency assets have relatively high volatility. The high loan-to-value of bitcoin-backed loans is commensurate with the relatively high volatility of bitcoin (and other cryptocurrencies). The loans are also subject to margin calls in the event the loan-to-value ratio decreases below the required levels. As explained by Genesis Capital, "[t]he attractiveness of bitcoin as collateral relies heavily on the lender's competency with both holding bitcoin and managing margin calls and forced liquidations. If the price of bitcoin decreases rapidly, the lender needs to ensure the borrower adds more bitcoin collateral to back the loan or have a systematic selling solution in place if the price continues to fall" (Genesis Global Capital 2019). Cryptocurrency has characteristically high volatility, which raises questions about the sufficiency of using it as collateral. One way to protect against high volatility is to require over-collateralization, which is what Genesis Capital did in their structure by requiring a high loan-to-value ratio of between 50 and 80 percent. For example, borrowing $100 against bitcoin, at a loan-to-value ratio of 70 percent would require a deposit of $170 worth of bitcoin collateral. But, using over-collateralization as a means to counter high volatility, implicitly relies on a liquid market for cryptocurrency so

TABLE 4. Comparison of Asset-Backed Securities and Digital Asset Loans

	Asset-Backed Cash Loans Against			
Description	**Bitcoin**	**Future Cashflows from Sales**	**Fixed Assets (Property, Equipment, and Inventory)**	**Securities (Equity or Debt)**
Return on Cash (Spread to LIBOR)	5% to 8%	3% to 6%	7% to 9%	2% to 4%
Usability of the Collateral Assets	Usable	Unusable	Unusable	Usable
Return on Collateral	3% to 5%	N/A	N/A	LIBOR + spread of between 2% and 4%
Loan-to-Value Ratio	50% to 80%	75% to 85%	50% to 75%	50% to 95%
Volatility of Collateral	High	Low to medium	Low	Medium to high
Liquidity of Collateral	Highly liquid	Generally illiquidy	Generally illiquidy	Highly liquid
Duration	0 to 2 years	1 to 5 years	1 to 5 years	0 to 5 years

Source: Genesis Global Capital. 2019, Q3. "Digital Asset Lending Snapshot," *Genesis Quarterly Insights*.

that lenders and borrowers can freely trade should margin calls arise. Should the price of bitcoin decrease to the point where loan-to-value is below the required ratio, the borrower would have to add more bitcoin collateral, or the lender would need to have a systematic solution in place to sell the collateral.

The 2020 COVID-19 pandemic presented a natural stress test for digital lending. In March 2020 the global market conditions were uncertain, and volatility, including volatility for cryptocurrencies, spiked. Digital asset lending however, continued to grow during the first quarter of 2020; Genesis Capital had over $1 billion in active loans outstanding while experiencing no defaults, capital losses, or delinquencies at any point over the period. (Genesis Global Capital 2020). Short-term lending would allow arbitrageurs to capitalize on short-term price dislocations in the cryptocurrency markets, but as the cryptocurrency-backed lending matures the potential use cases are also expanding.

DISCUSSION

The blockchain is a fundamental building block of the products previously discussed. Investors in cryptocurrency should therefore be cognizant of the salient risks associated with cryptocurrency. In addition to the relatively high price volatility discussed, cryptocurrency is also exposed to inherent risks of the protocol. For example, a bitcoin transaction is not final until the transaction has been confirmed by at least six miners and does not settle until it has been included in a block and appended to the blockchain, which can take up to 10 minutes per block (Böhme, Christin, Edelman, and Moore 2015).

Cryptocurrency shares the scarcity of non-renewable commodities—in the case of cryptocurrency the limited supply is rather artificial because scarcity is embedded in the protocol design—this perceived scarcity does contribute to the investment value of cryptocurrencies. Cryptocurrencies can be a good alternative investment, especially in terms of bringing diversification to portfolios (Trimborn, Li, and Härdie 2017). Other evidence suggests that some interest in cryptocurrencies is also driven by speculative or "excitement-seeking" traders wanting to increase their overall levels of risk in their search for higher returns (Pelster, Breitmayer, and Hasso 2019). The cryptocurrency markets have historically been dominated by individuals, but several institutions have entered or expressed an interest in entering this market. Fidelity Digital Assets is the digital asset arm of Fidelity, the $7.2 trillion asset-management giant, offers custody, trading, and service for digital asset investments, including bitcoin. TD Ameritrade (Fuscaldo 2018) and DRW Trading are also avid public supporters of cryptocurrency (Del Castillo 2018).

A pervasive risk of cryptocurrencies is the high price volatility. The first generation of decentralized borrowing and lending previously discussed relies on high levels of over-collateralization against the high volatility in cryptocurrency prices. Stablecoins may be the one exception since these are not plagued by the high price volatility of other cryptocurrencies and may indeed be used as a vehicle currency in the cryptocurrency markets and potentially also in the economy more generally (Lyons et al. 2020). The interest in using stablecoins to facilitate cross-border payments in the broader economy are growing. France and Germany both have initiatives looking at a special type of stablecoin referred to as central bank digital currency (Renaudin 2020).

Considering cryptocurrencies only, potential investors should be cognizant of the fact that most altcoin returns are highly correlated with bitcoin return but not with more traditional assets such as gold and stocks (Hu, Parlour, and Rajan 2019). As explained by Hu, "many altcoins do not trade directly against fiat currencies, but against bitcoin itself. Purchasing any of these altcoins thus may require purchases in bitcoin, which may drive the common price movement." On average, the aggregate high correlations between bitcoin with the other altcoins in the Hu study implies that returns of altcoins and bitcoin reflects a common systematic risk. This has important implications for portfolio diversification and risk assessment. The persistent low correlations of the return of cryptocurrency and more traditional assets suggest that cryptocurrencies are attractive alternative investments, but it would also expose investors to the novel risks embedded in crypto-economy that are not captured by a ratio analysis.

CONCLUSION

Cryptocurrency may add diversity to an investment portfolio because of its low correlation with more traditional assets. However, a potential investor should recognize the qualitative and quantitative risks typically associated with an investment in cryptocurrency, such as the high price volatility. This paper discusses a taxonomy of cryptocurrencies and decentralized financial products. A heterogeneous set of products comprises the universe of availability products, but the blockchain technology, the backbone of these products, exposes investors to a unique set of risks.

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Fintech in Light of the 2020 Emergency: Excess Innovations to the Facts—From Securitization to Tokenomics, and More

Lorenzo Costantino

Maurizio Pompella

Abstract

Motivation: Extrapolating from COVID-19's impact on society and economy, this article establishes innovative correlations between shocks, firms' behavior and reactions, regulatory response and approaches.

Premise: The research objective of this article is to gauge the regulatory resilience in the fintech space, drawing examples from the recent global pandemic. With due credit to technology's considerable innovations in finance and banking, this paper warns about distortions that may trigger bubbles and crises caused, for instance, by the phenomenon of *tokenomics*. The article points to how the COVID-19 pandemic revealed potential distortionary effects ahead of possible bubble bursts. Starting with the importance of resilience, the article traces parallels with the COVID-19 global health crisis and the policy and regulatory response to the pandemic, coining the terms *pandemization of the economy* and calling for *controlled regulatory entropy* as a means for regulators to regain center stage with more and better-targeted regulation.

Approach: Using international rankings and rates of COVID-19 infection and death, the article corroborates the need for a robust infrastructure and systems to tackle crises.

Results: The comparison of global health emergencies and international financial crises leads to the general conclusion that regulatory response needs to be granular and targeted. The analysis also confirms that the robustness of any system can be easily undermined by unclear or insufficient policy response and public sector intervention.

Conclusion: Notwithstanding the considerable socioeconomic impact, the pandemic represents a reset of assumptions and narratives that drove the policy debate and practice, including in finance, about the role of private investors,

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financial engineering, and innovation. This reset provides unique opportunities for regulators and policy makers to shed light on the hitherto grey area between financial innovations and speculations that benefit only a few.

Consistency: The article also builds on the experience of securitization and calls for revision of the push to make liquid and tradeable any event while disregarding the cost to the general public. The article also outlines lessons for businesses and entrepreneurs stemming from the response to the pandemic based on concepts of resilience, mitigation measures, and vaccination. Both professionals and scholars will benefit from the approach followed.

Keywords: blockchain, COVID-19, fintech, nothing-baked-securities, pandemization, regulatory entropy, tokenomics

JEL Classification Codes: G01, G21, O33

INTRODUCTION

Blockchain and fintech have impacted the finance and banking industries and are expected to further affect them in the future. While promising, such innovation may have ramifications that can potentially affect financial stability, transparency, and protection of investors. This requires a renewed role for regulators and policy makers to safeguard financial systems and prevent bubbles and crises that may emerge from potential threats stemming from financial innovations such as *tokenomics,* based on *nothing-backed securities* (NBSs).

The new social and economic models emerging from the outbreak of COVID-19 inspired the authors to coin the term *pandemization of the economy* (PoE). Following this logic, a series of similarities between the field of medicine and the dynamics of the financial sector may be outlined, with innovations and evolutions that may require more careful oversight and intervention from regulators and policy makers. Using the parallel of a virus that impacts individuals and the economy (here meant as the combination of both legal entities, economic actors, as well as economies as a whole), it is possible to elaborate on the "entropic element" of regulation.

Building on the concepts of *pandemization of the economy* and *controlled regulatory entropy,* the article scales back the disruptive impact of latest technologies, in fact, and using a combined inductive bottom-up/deductive approach paves the way for the concept that COVID-19 is creating room for regulators to regain their central role in providing certainty in the market while supporting industry innovation. The authors' starting point is that the pandemic is corroborating the return of precise and targeted regulations, with a proactive and commanding role of regulators and authorities, to manage crises, restore certainty, and build confidence.

The article draws parallels between the impact of the pandemic and the evolutions recently characterizing the financial sector to confirm the disruptive features of fintech and blockchain in finance and banking. Apart from analyzing the role of start-ups in bringing innovation in the finance domain, the paper confirms the pivotal role of traditional banks in providing safeguards and robustness to the system as a whole.

We expect that the results of this analysis are coherent with the working assumptions that regulatory authorities and policy makers may adopt a more

proactive role and behavior toward transparency and consumer protection than in the past.

THE ENTROPY OF REGULATORY SYSTEMS AND THE METAPHOR OF DISEASE

Having defined *entropy* according to information theory (Shannon and Weaver 1949), and assuming that policy makers' measures may be assigned a certain degree of entropy, the *entropy level* is a function of the scope of the regulation: the wider the scope the lower the entropy; the more focused and precise the regulation, the higher the entropy. As such, there is a correlation between the entropy of a norm and its ability to govern a specific situation. Yet, the lower the entropy the lower the impact of the norm: norms and regulations that are generic, not customized to the specific features of the intended recipients, may not produce the intended impact. This is exactly as it happens in the case of a pharmaceutical therapy administered at a systemic level to treat a very localized condition, such as a bone fracture. The higher the entropy, the higher the perception of "disorder" due to the higher degree of detail and complexity. Higher entropy is associated with those norms and regulations that provide for more articulated information and details.

Emergency regulations introduce a high degree of entropy, tantamount to an inadequately defined therapy: new therapeutic protocols and drugs may lead to adverse effects on the patients they are intended to treat.

The hitherto approach of regulators, in the financial sector and in particular in the fintech space, of following the evolutions of the market with little regulatory intervention may be naïve: few norms to govern such dramatic innovations in financial services and products may leave room for uncertainties that have often led to bubbles and crises in the past. A new model that responds more precisely to the need for certainty and predictability would lie on the concept of *controlled regulatory entropy (CRE)* based on more elaborated and better-defined rules, precisely targeted at the specific operational contexts, features, activities, and actors.

In managing the pandemic emergency, different countries developed various regulations: lockdown measures in most countries are geographically sensitive, defined by specific scientific and operational parameters (health statistics such as intensive care units' occupancy rates, number of patients per population, number of new cases in a certain period of time, transmission rate, and so on). Rules and regulations designed in response to the pandemic embody this concept of CRE thanks to their granularity. The granularity is exemplified in the restrictive measures, from closure of certain types of economic activities, travel restrictions for certain periods and locations, targeted and profiled measures depending on age and health status, to the regulatory aspects of financial intermediation, such as the ban on dividends and buybacks for listed financial intermediaries or short-selling in selected stock markets.

The challenge for policy makers and regulators hence is to govern the uncertainty by developing targeted norms and regulations that may be taken downstream to the final recipients (citizens, patients, companies). Such mechanism of "managed entropy" then becomes a virtuous system, as opposed to generic

norms that do not trigger entropy but do not reach the final recipients to inform and influence their behavior.

Continuing with the health and medicine analogy: experimental therapies may treat a viral condition, but also trigger side effects. These side effects in an immunosuppressed older patient may be greater than any potentially beneficial effect. Resilience in regulation is a necessary complement to a robust infrastructure that in its own way may not sufficiently shield against shocks. In the case of health systems reacting to the pandemic, an interesting resource is the 2019 Global Health Security (GHS) Index,[1] one of the first attempts to assess the state of national health security capacity as well as to gauge the epidemic and pandemic preparedness of 195 countries.

GHS measures different dimensions[2] of the health system of a country to identify possible gaps in its ability to respond to global health challenges, in particular the outbreak of infectious diseases and pandemics. Data on the COVID-19 infection and death rates of the first 40 countries in the GHS ranking provide ground for interesting correlations and considerations.

According to the GHS ranking (Table 1), the United States was the country best positioned to respond to pandemics, yet it is the one reporting the second highest infection rate with 5.10% cases over the total population (second after Belgium at 5.36%) and the fifth highest death rate with 0.09% casualties over the total population (fifth after Belgium at 0.16%, Italy at 0.11%, Slovenia and Spain both at 0.10%).

This paper is not concerned with establishing correlation and causation between policy response and COVID-19 infection and deaths, but the case of the United States' comparatively high infection and death rates, in spite of being the best equipped country in the world to respond to a pandemic, provides for interesting insight into the argument that more granular regulatory activity is welcome to manage uncertainty.

While European countries have embraced, although at varying degrees, similar restrictive measures at similar paces, the U.S. response appeared to be less concerted and coordinated, not only between federal and state levels but also among and within states. Akovali and Yilmaz (2020) analyzed how individual states in the United States responded to COVID-19 tended to confirm that higher infection rates are observed in those states that had lax government and community response to the pandemic. Research from Columbia University by Pei, Kandula, and Shaman (2020) estimates that better-timed and more coordi-

[1]The Global Health Security (GHS) Index is the first comprehensive assessment and benchmarking of health security and related capabilities across the 195 countries that make up the States Parties to the International Health Regulations (IHR) (WHO 2005). The GHS Index is a joint initiative of the Nuclear Threat Initiative (NTI), Johns Hopkins Center for Health Security (JHU), and The Economist Intelligence Unit (EIU). The GHS received support from the Open Philanthropy Project, the Bill & Melinda Gates Foundation, and the Robertson Foundation.

[2]The GHS is based on 140 indicators grouped along six categories:

1. Prevention: Prevention of the emergence or release of pathogens.
2. Detection and reporting: Early detection and reporting for epidemics.
3. Rapid response: Rapid response to and mitigation of the spread of an epidemic.
4. Health system: Sufficient and robust health system to treat the sick and protect health workers.
5. Compliance with international norms: Commitments to improving national capacity, financing plans to address gaps, and adhering to global norms.
6. Risk environment: Overall risk environment and country vulnerability to biological threats.

TABLE 1. Global Health Security Ranking and COVID-19 Deaths and Cases

Country	Rank in GSH	Number of Deaths	Deaths as Percent of Population	Number of Cases	Cases as Percent of Population
United States	1	303,872	0.09%	16,725,039	5.10%
United Kingdom	2	65,006	0.10%	1,893,436	2.83%
Netherlands	3	10,254	0.06%	638,801	3.69%
Australia	4	908	0.00%	28,060	0.11%
Canada	5	13,685	0.04%	479,064	1.27%
Thailand	6	60	0.00%	4,261	0.01%
Sweden	7	7,667	0.07%	341,029	3.32%
Denmark	8	975	0.02%	116636	2.00%
South Korea	9	612	0.00%	45,442	0.09%
Finland	10	472	0.01%	31,870	0.58%
France	11	59,182	0.09%	2,447,458	3.65%
Slovenia	12	2,190	0.10%	100,389	4.81%
Switzerland	13	6,316	0.07%	394,453	4.60%
Germany	14	23,595	0.03%	1,391,081	1.67%
Spain	15	48,401	0.10%	1,762,212	3.74%
Norway	16	402	0.01%	41,852	0.78%
Latvia	17	382	0.02%	27,495	1.44%
Malaysia	18	429	0.00%	87,913	0.28%
Belgium	19	18,178	0.16%	611,422	5.32%
Portugal	20	5,733	0.06%	353,576	3.44%
Japan	21	2,623	0.00%	187,673	0.15%
Brazil	22	182,799	0.09%	6,970,034	3.30%
Ireland	23	2,134	0.04%	76,776	1.55%
Singapore	24	29	0.00%	58,353	1.02%
Argentina	25	41,204	0.09%	1,510,203	3.36%
Austria	26	4,764	0.05%	33,0343	3.72%
Chile	27	15,949	0.08%	575,329	3.04%
Mexico	28	115,099	0.09%	1,267,202	0.99%
Estonia	29	160	0.01%	19,271	1.45%
Indonesia	30	19,248	0.01%	636,154	0.24%
Italy	31	65,857	0.11%	1,870,576	3.10%
Poland	32	23,914	0.06%	1,159,901	3.05%
Lithuania	33	907	0.03%	99,869	3.58%
South Africa	34	23,661	0.04%	873,679	1.49%
Hungary	35	7,381	0.08%	288,567	2.95%
New Zealand	36	25	0.00%	2,100	0.04%
Greece	37	3,785	0.04%	126,372	1.18%
Croatia	38	2,870	0.07%	183,045	4.50%
Albania	39	1,028	0.04%	50,000	1.75%
Turkey	40	16,881	0.02%	1,898,447	2.28%

Sources: GHS ranking: Global Health Security (GHS) Index. Data on COVID-19 cases and deaths: COVID-19 Dashboard by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University (JHU), data as of December 16, 2020. Population data: World Development Indicators, 2020, the World Bank. Data from database "Health Nutrition and Population Statistics," last updated July 2020.

nated restrictive measures from federal and state authorities might have reduced infections by 62% and deaths by 55%.

COVID-19 is triggering socioeconomic dynamics that require a variety of regulations that can tackle the many social and economic facets of the pandemic. This requires a strategic vision—rather than a patchy series of regulatory initiatives—that coordinates within a framework approach to tackle three segments: (1) public health, (2) economic recovery, (3) regulatory effectiveness and efficacy.

The first public good of safeguarding health and citizens' well-being should rely on universally accepted and validated models of disease prevention, containment, and treatment. In the case of COVID-19, while it is true that the novelty of the virus took the system by surprise, it is also true that some countries reacted better than others by adopting classic models of public health management (for example, Italy compared to South Korea, dramatically different numbers of cases and deaths, primarily due to two different approaches at the onset of the pandemic).

The second challenge of sustaining economic recovery is currently based on typical public policy response with a combination of fiscal policy and public investment, tantamount to tackling the side effects in patients.

The third challenge is similar to the efforts to gauge the efficacy of therapies, where the therapy is the regulatory activity of policy makers. In this case, just as it happens in the scientific sphere of pharmaceutical and drug development, regulators and policy makers should mimic the role of researchers and scientists to identify the "virus," isolate and neutralize it, while at the same time equipping the economic ecosystem to prevent the spread of further infections, in other words, "vaccination."

PANDEMIZATION OF ECONOMY: SEARCHING FOR RESILIENCE (AND A VACCINE FOR THE ECONOMY)

In addition to health and social impact, the pandemic has badly hit economic actors as well: not only individuals, but also legal entities (i.e., companies) are impacted. No sector is immune and no market is shielded from the economic impact of the pandemic: companies in retail, transportation, energy, and travel and leisure have either closed or significantly reduced their business. Regardless of social implications and costs (loss in employment, GDP contribution, and value creation), the pandemization of the economy (PoE) is a process by which only the healthiest companies sail through the crisis and survive, while those with "chronic conditions" succumb. The health of a company may lie in its business model, value proposition, management structure, human resource management strategy, and cash-flow. In the domain of banking and finance, the actors that are best poised to survive the PoE are those with robust business models, credibility (vis à vis consumers, regulators, industry peers, etc.), a secure technology stronghold, and the ability to respond to fast-changing operational settings.

Further on the health analogy, the "technological age" of a company can be compared to the age factor determining and contributing to individuals' health-related quality of life. COVID-19 has more adversely affected older patients, with age playing a considerable role shaping restrictive measures as well as therapeutic protocols (for instance, many countries prioritize beneficiaries of the COVID-19 vaccine by age).

The concept of technological age for companies mirrors the concept of age of patients: those companies that have not invested in new technologies—hence relied on aged systems—were less equipped to manage the accelerated digital transformation triggered by the pandemic. In the financial sector, an "aging" factor for companies is the low or slow adoption of innovative methods for risk and crisis management. "Age" also triggered co-morbidity in those companies that had prior conditions (convoluted management practices, undercapitalization, cash-flow challenges).

Just as individuals adopted restrictive measures to minimize the contagion risk (e.g., wearing face masks, social distancing, self-isolation, curfews, drastic behavioral changes), so did companies adopt radical measures, such as cost cutting, adopting telecommuting as the norm for their employees, revising their business models and revenue streams, adapting new profitability models, and so on.

Examples of this include the car rental business Hertz that went bankrupt, while Airbnb, in the hospitality sector, actually turned a profit in the third quarter of 2020. Airbnb reported a yearly 18% decline in revenues ($1.34 billion) and a net profit ($219 million) in the quarter. The former failed due to internal cash flow and management issues, while the latter flourished thanks to self-imposed disciplined measures of cost cutting and diversified business models.

Looking at the PoE parallel, restrictive health measures are comparable to cost-cutting and revising business models and internal management practices; vaccination is like the compliance with uncommon regulatory provisions (for instance the prudential measures of financial regulatory agencies to prevent short selling or redistribution of dividends to shareholders); and bankruptcy is similar to the intensive care unit for COVID-19 patients who, due to co-morbidity and lack of effective preventive measures, require hospitalization.

PoE requires strong and credible authorities (regulators and policy makers) that can provide reliable information and guidance while commanding credibility by setting rules. The availability of common and reliable diagnostic mechanisms is imperative to monitor the evolution of the disease: in the case of banking and finance, stress-test methodologies are used to gauge the robustness of market actors. Moreover, therapies for COVID-19 are being tried; similarly, remedy measures are available in the financial sector to deal with inefficiencies in the system (at both individual intermediary and systemic levels).

The concept of PoE may lead to the concept of developing a vaccine for those market operators in the domains of fintech and blockchain. In this case, not a vaccine to avoid harm to self, but a remedy to prevent harm to others and the system as a whole.

The pandemic represents the external shock that leads to the selection process that strengthens the virtuous applications and ventures while revealing the inefficiencies of others. The pandemic is functioning as the "reset button" for the sector. The pandemic is "filtering" the industry, tantamount to the dot-com bubble for the information and communications technology (ICT) sector in the late 1990s though early 2000s, and like the great financial crisis for the banking and financial sectors in the late 2000s.

In a sense, COVID-19 is triggering market selectivity and investors' decisions toward those applications that prove useful at the expense of applications that are appealing but not necessary. Hence, blockchain and fintech applications emerge and consolidate to secure and accelerate supply/value chains' viability,

promote and facilitate health surveillance, secure data processing and sharing, provide continuity to education and health services, as well as promote eCommerce and financial intermediation.

Two COVID-19 vaccines have been developed in record time and are now approved for use in the United Kingdom, United States, and European Union for rollout in late 2020 and early 2021. In the meantime, large cohorts of citizens are becoming skeptical about a vaccine that was developed using a relatively new technology (mRNA) and in a relatively short amount of time. Safety concerns, doubts about efficacy, and the overall perception of not being a person at risk reportedly are the main reason for such skepticism.

While surveys and polls vary depending on the sampling methods and size, country, and date of surveying, there are interesting trends to be observed. Almost half of adult U.S. citizens would not get a vaccine[3] while adult citizens in different European countries have different attitudes, with 37% of British, 44% of Germans, 45% of Italians, and 63% of French[4] reporting that they would definitely not get the vaccine or do not know whether they will get vaccinated; more than 40% of Spaniards would prefer not to be vaccinated.

Leaving aside the debate about the causes of this wave of skepticism, there are objective elements to take into account in the development process of the COVID-19 vaccine that highlight the exceptionality of this endeavor. These include the global scientific coalition; international collaboration among pharmaceutical companies along different segments of the value chain; availability of funding from governments, private sector, and third sector, all converging toward the same objective, but funding different technologies and approaches; seamless transparency in data collection, collation, and processing; fast-track regulatory and administrative processes. In the United States, Operation Warp Speed (OWS) embodies the unprecedented collaborative nature of the efforts to develop a vaccine. OWS builds on the partnership among different federal agencies and bodies to accelerate the development, manufacturing, and distribution of the vaccine through direct collaboration with the private sector. Driven by science, OWS is capitalizing on different agencies' competences: Department of Health and Human Services (HHS), Center for Disease Control and Prevention (CDC), National Institutes of Health (NIH), Biomedical Advanced Research and Development Authority (BARDA), and Department of Defense (DoD), this last one also providing overall guidance to secure a streamlined and efficient supply chain.

Needless to say, the financial prudence and the need to safeguard international financial markets cannot be compared to the urgency and pressure to save lives and the humanitarian rationale behind the COVID-19 vaccine process. Nonetheless, the development of the COVID-19 vaccine lends itself to providing interesting insight for the management of uncertainty in other fields. The fintech domain could become an interesting test-ground to replicate some features of the process for COVID-19 vaccine development. For instance, consolidated

[3]A national survey by Pew Research Center (Tyson, Johnson, and Funk 2020), conducted September 8–13 among 10,093 U.S. adults reports that 51% of respondents would definitely or probably get a vaccine, while 49% of respondents would definitely or probably not get vaccinated. A previous survey carried out in May 2020 reported a higher interest in the vaccine, reportedly at 72% of respondents. This is a counterintuitive result whereby the higher the number of cases the less interest in the vaccine.

[4]EuroNews Survey carried out by Redfield & Witlon Strategies in October 2020 with a sample of 1,500 adult respondents per country (EuroNews 2020).

multinational corporations collaborating with start-ups and new companies to complement proven track record and experience in the sector with novel and advanced technologies to advance product development. The regulatory fast-tracking coupled with industry collaboration are also valuable experiments that can be suitable for the fintech space.

The trends of social malcontent toward restrictive measures and growing skepticism about the vaccine among the adult population in the United State and European Union provide an interesting parallel on the attitude of the market being regulated: in spite of an imminent and real health risk, companies tend to resist supervisory and regulatory efforts that aim at achieving the greater good of public interest (in the case of financial markets: transparency and investors' protection).

THE DISRUPTION BEFORE COVID, HOW FINTECH HAD CHANGED THE WORLD

Since the 1950s, the debate about the role and function of financial intermediaries revolved around the key themes of optimal resources allocation, agency costs, asymmetric information, delegated monitoring, and so on. But also the social role of banks, their relevance and capability to contribute to socioeconomic development was considered from a Walrasian perspective (Gurley and Shaw 1960). Jensen and Meckling (1976) emphasized the role of moral hazard; Leland and Pyle (1977) considered asymmetric information as well; and Diamond (1984) discussed delegated monitoring. In academic circles, innovative—and at times, provocative—thinking led to questioning the essence of banks, even suggesting that banks were not needed in the first place, that they represented a useless layer of intermediation in the circulation of money and facilitation of credit. This innovative and provocative thinking was also gaining momentum in the 1970s and 1980s on the premise of growing concerns about the issue of asymmetry of information that characterized the debate about the role of financial intermediaries and facilitation of financial intermediation.

Later, over the 1990s and the last twenty years, the debate about financial innovation and risk transfer—in both banking and (now) the insurance field—was mostly focused on structured finance, asset-backed securities, and securitization (before, and more explicitly after, the 2007 crisis). Debate also focused on the convergence of insurance and financial markets (Babbel and Santomero 1997; Cummins and Weiss 2009), alternative risk transfer (e.g., Banks 2004; Culp 2006), and financial reinsurance. This was followed by concern with peer-to-peer (P2P) lending (Suryono, Purwandari, and Budi 2019), P2P insurance, insurance-linked securities, then cryptocurrencies, fintech, blockchain, and now (in random order) unicorns, tokenomics, new payment platforms, and other related, let's say, "genius findings." There is a considerable intersection between some of these topics, and that the most comprehensive is fintech, followed by blockchain.[5]

[5]Liu, Li, and Wang (2020) offer an interesting scientometric analysis devoted to identify the latest hot topics in fintech. This is done by means of bibliometric research on fintech business model research. Hot topics in fintech turn out to be mobile payment, microfinance, peer-to-peer lending, and crowdfunding; it also suggests fields outside these keywords that ought to be further investigated from both a practical and academic perspective.

Some sort of "provocative thinking" about the role of the banks is currently being revamped by the second wave of technological developments that is investing the financial and banking sector with innovations such as blockchain, fintech, and peer-to-peer intermediation that have an impact on banks as well as non-banking financial intermediaries, users, etc. Such phenomenon is not relegated only to financial intermediation and banking services, but interests also the non-banking financial intermediaries, above all the insurance sector that is poised to being affected by technology applications, such as big data and the Internet of Things.

The first wave of technological development of the 1980s and 1990s (often referred to as "FinTech 1.0") changed the financial and banking sector by providing innovative tools and solutions that made intermediation easier and faster, led to new business models and interaction modalities between banks and clients.[6]

In some instances, the technological advancements led to the fast obsolescence of what were considered successful applications. For example, phone banking was, in a relatively short period of time, replaced by the advent of faster and more reliable connectivity coupled with—almost—ubiquitous ICT hardware. Specifically, the advent of smartphones allowed the introduction of "home banking," and more specifically "mobile banking," superseding "phone banking" thanks to increased convenience for customers and cost-cutting opportunities for providers.[7]

The first technology revolution of the industry changed the way banks and clients interacted and accelerated the development of new products. On the one hand, technologies led to the categorization of functions within the banking sector, defining clearer boundaries and interactions between the so-called front office and back office. On the other hand, technologies (e.g., automated transactions through machines and personal computers) allowed clients to bypass internal intermediaries within the financial institutions. Similar technologies developed new products, such as electronic payment systems that are challenging the validity and use of plastic money, although credit cards remain the underlying and backing mechanism for such innovative payments.

Another considerable impact of the first wave of technological change came from the advancements in computational capacity that allowed the development of innovative financial products thanks to enhanced means and methods to gather, collate, crunch, and process large amounts and flows of data. Technological advancements coupled with innovative modelling techniques led to the proliferation of financially engineered products that, in different forms and for various reasons, paved the way to the financial crisis with the banks and financial intermediaries as the main perpetrators. Nonetheless, the origin and motivation for derivatives was a virtuous mechanism (since the 1920s in the Chicago trading floor) for hedging operational and business risks. The evolution of such instruments lead to financial engineering and structured finance *strictu sensu* that resulted in a mechanism to raise funds irrespective of the credit worthiness of companies beyond the scope of conventional forms of "on balance sheet se-

[6]For a good literature review refer both to Ali, Ally, Clutterbuck, and Dwivedid (2020), and Milian, de Spinola, and de Carvalho (2019)

[7]Which is still a topic under research; see for instance: Shankar and Rishi (2020).

curities" (bond, debt, and equity) (Jobst 2005), reversing the innate purpose of structured finance.

Thanks to technological advancements, innovations in the forms of payment, such as credit/debit cards, and automation in transaction intermediation, such as phone and e-banking, were accompanied by innovation in financial products. Such innovative products covered the whole cycle of banking services and financial intermediation: from saving and investment products, like exchange traded funds (ETFs) and structured products, to lending that was enhanced by automated credit scoring and algorithms that accelerate credit-worthiness assessment and risk management techniques that used derivatives and asset securitization.

Securitization and related financial products were soon deemed the main culprit of the financial crisis, notwithstanding that financial innovation was just one prong of a multifaceted system that led to the global financial crisis (i.e., excessive risk taking by financial firms, uncontrolled information asymmetries, increased complexity of structured financial products combined with weak corporate governance systems and lax regulatory oversight and/or lagging regulation).

FINTECH 1.0 AND 2.0, FROM ICT TO BLOCKCHAIN

The second wave of technology innovations that are now interesting the financial sector and banks are the above-mentioned distributed ledger technologies (DLTs) and blockchain (often referred to as "FinTech 2.0"). Such innovations are poised to redefine the way financial intermediation is structured and carried out, potentially overcoming barriers to access financial services, facilitating interactions, and bypassing intermediaries.

Ledgers have been used since ancient times to keep track and record transactions, ensure certainty, and provide transparency in commerce and finance. In the financial industry, each bank and financial intermediary keeps their own repository of information and data about transactions, assets, and actors.

This requires the presence of intermediaries that ensure interoperability, transparency, and certainty of transaction, such as clearing houses. The most relevant technological revolution in banking and financial intermediation was the introduction of electronic ledgers that informatized and automated the crucial function within banks to keep track of and record transactions.

The FinTech 2.0 technologies promise to transform the way information about assets and transactions are collected, collated, stored, processed, and shared: the concept of distributed ledgers allows the processing of data across shared ledgers (record of data) across different parties that are linked through the Internet. This generates a network that, coupled with cryptography and algorithms, allows data to be processed and recorded in an absolute manner, as none of the participants in the network can revert operations and none of the participants in the network has sole control of information, data, and processes.

This epitomizes the value of DLTs as the "magic wand" to overcome the steps and actors of traditional intermediation and the need for a third party that centralizes interactions with inevitable layers and associated transaction costs and processing time.

As such, the DLT seems to have the potential of eliminating the need for intermediaries breaking the silos of individual repositories of information, replacing them with a transparent and safe mechanism.

TABLE 2. Technology Revolutions in Banking and Finance: A Comparison of Features

	Traditional Banking	First ICT Innovations—FinTech 1.0	Blockchain and Banks—FinTech 2.0
Consumer Experience	Uniform scenarios Homogenous service Poor customer experience	Rich scenarios Personalized service Good customer experience	Rich scenarios Personalized service Good customer experience
Efficiency	Many intermediate links Complex clearing process Low efficiency	Many intermediate links Complex clearing process Low efficiency	Point-to-point transmission, disintermediation Distributed ledger, transaction = clearing High efficiency
Cost	Large amount of manual inspection Many intermediate links High costs	Small amount of manual inspection Many intermediate links High costs	Completely automated Disintermediation Low costs
Safety	Centralized data storage can be tampered Easy to leak users' personal information Poor safety	Centralized data storage can be tampered Easy to leak users' personal information Poor safety	Distributed data storage cannot be tampered Use of asymmetric encryption Users' personal information is more secure Good safety

Source: Based on ideas from World Economic Forum, 2016.

These innovative features of DLT and blockchain are triggering a vivid debate among practitioners and academia on the potentially disruptive impact on traditional banking and finance (see Table 2).[8]

The topics for debate all revolve around the key themes of safety, stability, consumer protection, need for regulation and the depth of public sector intervention, role of governing bodies and regulatory authorities such as central banks, and so on. Some of them (depth of public sector involvement and role of central banks) are debated by practitioners and scholars.

THE SECOND WAVE OF TECHNOLOGICAL INNOVATION UNDER COVID PRESSURE

The spread of structured finance that followed the former applications of ICT has shown all its limits with the lack of information (asymmetric information) derived from a poorly intelligible innovation (and consequently useless, or even harmful, from a social perspective). The benefits brought about by the opportunities and the variety of products made possible by ICT reached only a few market actors, at the same time imposing huge costs on the community as a result of the financial crisis.

From this perspective, the diffusion of the culture of distributed databases and DLT represents a revolutionary philosophic shift because its foundation lies in the immediate, simultaneous, and shared dissemination of information related to any market fact, making information asymmetries virtually impossible, or reducing them drastically. Nevertheless, the most-known blockchain applications relate to cryptocurrencies that already provide ground for information asymmetries to widely materialize.

[8]This was also a "hot topic" at the institutional level. See for instance: ECB (2016); He et al. (2017); EPRS (2016); Board of Governors of the Federal Reserve System (2016); EBA (2018).

According to the new logic, which applies to an endless series of economically relevant cases, the role of networks (networking) becomes predominant. The ledger, which traces the transactions and retains a memory which may be relied on against third parties (thus validating any transaction), passes from the hands of the individual certifier (bank, insurance, public register, etc.) to a series of nodes (servers), thus making the process irreversible and fraud, as well as misappropriation of funds, impossible. Everyone knows everything about each transaction at the moment when it is finalized.

Given that ICT for finance and fintech are intimately connected, they do represent two different phenomena. On one hand, ICT means the use of informatics in the financial sector, on the other hand fintech identifies some sort of business model, some sort of revolutionary way of intermediating funds and influence markets, a new philosophy.

A noteworthy feature of this latest wave of change in the financial sector lies in the open-source approach made possible by new technologies: rather than innovation coming from large companies, most of the novelties that are currently impacting the financial sector are from newcomers. Rather than incumbent-led innovation, this wave is primarily pushed by small firms and start-ups that proliferate in the many cracks opened by the Internet and from which large companies shied away.

Fintech and blockchain technologies developed at different paces in various ecosystems in Western Europe, the United States, China, and Russia, just to mention a few of the global hubs of these technologies. Yet, the pandemic appears to have affected the blockchain and fintech space, with a dual positive effect: the impact of the first nine months of the pandemic enhanced the visibility of useful applications while ridding the sector of fanciful ones. Hence, there may be a potential, and counterintuitive, positive impact of COVID-19 on the blockchain and fintech domains as the pandemic rids the system of what could be described as extravagant initiatives and fantasy valuations.

The advent of increased computing and processing capability, cloud technologies, and enhanced connectivity led to the development of blockchain technologies and applications. The adoption of blockchain in various fields—from logistics to health and finance—also generated increased expectations for their potential to not only improve, but even disrupt, sectors as a whole.

As such, blockchain and fintech have been often referred to as "silver bullet" applications that could revolutionize the processes behind financial intermediation and unhinge the role of financial intermediaries and banks especially—both central and commercial. Such expectations were based on the genuine belief that the new "ecosystem" based on blockchain and fintech were bringing about enhanced transparency, safe data flows, and trusted sharing of information, coupled with real-time capabilities and a truly decentralized mechanism of securing transactions. The enhanced security that comes with the mechanism of blockchain, by which not one single participant can control or manipulate transactions, increased the expectation.

A booming economy, together with euphoric investors, escalated such expectations to a hype for anything that was blockchain and fintech related. By this new mantra, distributed ledgers were destined to break the conventional wisdom not only in financial intermediation, but also innovative business models, new ventures, and so on. Nonetheless, as in many waves of innovation, blockchain

and fintech also generated opportunities for less-virtuous initiatives, opening the door for creative ways to take advantage of unaware market participants, and generating opportunities for recklessness.

While generating virtuous mechanisms that address information asymmetries (the transparency and seamless sharing of information), blockchain and fintech also increased the role of regulatory and supervisory agencies.

As mentioned, many observers, especially from the fintech sector and mass media, have found inspiration in similarly disruptive technologies and applications in other industries, such as mobility and lodging, to describe the disruption potential of DLT and blockchain on banking and finance (Kessler 2016; Kharpal 2016). Indeed, such considerations were more common and relevant before the global attention of industry participants, scholars, practitioners, and most importantly public opinion and consumers was diverted toward the pandemic. COVID-19 played the important effect of scaling back and refocusing the attention toward safety and health, rather than secondary topics, such as technology disruption in banking or whether Airbnb and Uber could be the precursor of peer-to-peer forms of financial intermediation.

Let's assess the real implications and changes that the second wave of technological innovation is bringing into the banking and financial systems, and put forward a method to evaluate the impact of new technologies, their actual degree of disruption, and potential regulatory implications.

SECURITIES AND DIGITAL TOKENS, THE WAY TO TOKENOMICS

As previously mentioned when referring to the role assigned to securitization in the context of the global financial crisis, the "financialization" and financial engineering changed the playing field of traditional fundraising and risk management for both corporate and retail financial intermediation. This phenomenon paved the way to a new paradigm: from "risk warehousing" to externalization.

The use of DLTs spurred the development of innovative financial services and products, including *tokenomics,* the framework in which digital tokens are used by blockchain projects to raise capital. Tokenomics hence is an innovative form of fundraising that hinges on blockchain technology: a new model of initial coin offering (ICO) is gaining momentum especially in the sphere of innovative start-ups in high-tech sectors.

In tokenomics an initiator (i.e., a company) launches the creation of tokens to raise capital through an ICO for a business proposition that is based on the use of the tokens. As opposed to an initial public offering (IPO) by which investors acquire shares of a company, in an ICO the investor purchases tokens that may become tradable at a later stage (this would be a *security token* that entitles a share of the company once the business becomes operational) and/or entitles the bearer to access products or services provided by the company (this would be a *utility token*). Tokens are denominated in a cryptocurrency that then allows for the trading and exchange of the tokens within and outside the ICO's ecosystem for which they were created.

Notwithstanding the increasing popularity of ICOs, uncertainty persists with regards to the nature of the tokens, often referred to as *crypto assets,* which are difficult to classify as a commodity, currency, or investment/security.

The interest in tokenomics stems from its ability to capture and represent the features of the eternal struggle between virtuous and bad finance. Virtuous finance is represented by the quest for tools and solutions that enhance transparency, increase intermediation, lower risks, and ultimately provide for stability with virtuous redistribution mechanisms. Bad finance, on the other hand, is represented by those products and processes that end up generating unnecessary risks and funnel money through channels and mechanisms that ultimately lead to shocks and crisis that not only halt development, but also limit innovation while triggering uneven redistribution.

The innovative instrument of ICOs has raised interest as an alternative means for small- and medium-mid-sized enterprise (SME) financing and its potential has been initially investigated in a recent OECD study that highlights a few salient challenges, in particular in the domain of valuation of tokens (OECD 2019).

If tokens are considered as currencies, their valuation would hinge on the cash and/or cryptocurrency of reference: this would lead to instability due to the high volatility of the cryptocurrencies (just as a reference, bitcoin valuation experienced dramatic oscillations from the bottom of just above $5,000 in January 2020 to breaking the $30,000 threshold in January 2021).

If the ICO issues utility tokens, their value would be based on the commercial value of the service/product to be launched by the initiator: this would imply a high degree of uncertainty as a function of the type of service/product whose value can be of difficult estimation.

If the token is an investment (security or equity stake), the value of the token would rely on the company's valuation, and also in this case there is a high degree of uncertainty as ICOs' initiating companies are seldom valuated using traditional corporate finance techniques and investment metrics.

ICOs are an innovative instrument, and it is hence too early to draw conclusions on their robustness and validity. Nonetheless, recent studies of ICO examples raise concerns about their viability. While in principle token valuation should follow market dynamics to establish a fair value, initial comparative studies indicate that tokens' valuation hinges on simplistic indicators, such as Twitter followers and social media activity, rather than robust business metrics.

Moreover, the same research provides interesting insights on returns and survival rates of ICOs, with average returns of 179% between ICO price and the value of the token on its first day of trading, while fewer than 50% of projects survive 120 days after ICO.

The purpose here is not to delve into the aspects of ICOs and tokenomics, reference to which is made to lead to a key message of concern: tokenomics and ICOs provide worrisome similarities to the misuse of securitization that contributed to triggering the global financial crisis, in combination with excessive risk taking, dramatic information asymmetries, complexity of financial products, weak governance mechanisms, and loose regulatory oversight.

Using the lenses of a skeptical reader, ICOs may provide dangerous entry points for reckless initiatives. With the intent of being provocative, in the same way securitization proved to be in the past, tokenomics appear as no-asset-backed securities (or nothing-backed securities [NBSs]) denominated in cryptocurrencies in a mostly unregulated environment.

As such, notwithstanding the great merit of ICOs as innovative financial instruments that are poised to provide new forms of intermediation, it appears

that tokenomics is a mechanism still in its infancy that requires a clear definition of actors, products, and services for it to materialize their potential.

These considerations lead to the vexing issue about regulatory frameworks and attitudes for DLTs, blockchain, and cryptocurrencies.

Tokenomics and Regulators: A Case in Point

In addition to funding pressures and lower investors' confidence, increased regulatory scrutiny is putting DLT, blockchain, and tokenomics under pressure. The case of the unregistered ICO launched by Telegram to finance the Telegram Open Network (TON) is a crucially relevant case that promises to shed light on ICOs and tokenomics.

Back in the spring of 2018, Telegram raised approximately $1.7 billion from investors globally, including professional investors from the United States.[9] In October 2019, the U.S. Securities and Exchange Commission (SEC) filed a legal complaint[10] against Telegram and halted the sale on the grounds that the ICO was a vehicle to issue securities. Specifically, the SEC alleges that the "gram tokens" are unregistered securities: paragraph 3 of the complaint clearly profiles the grams as securities and not digital currency as at the moment of issuance there were no products and services that could be purchased with the gram tokens. Moreover, the SEC claims that investors' expectations to profit from the TON categorizes the grams as securities.

With a March 24, 2020 order,[11] the Court agrees with the SEC that Telegram's Grams is an offering of securities under the so-called "Howey test." The order also granted an immediate injunction preventing Telegram from distributing gram tokens to investors.

The legal case is evolving with the parties engaging in fruitful dialogue. According to a court order of May 8, 2020, Telegram has agreed to collaborate with the SEC and will disclose relevant documentation of the 2018 ICOs as well as provide information. The proceedings and results of this legal case will surely set a precedent for the industry as a whole and provide guidance to ICOs and develop the concept of tokenomics. Operationally, the setbacks of the TON ICO led Telegram to further delay the launch of TON to 2021.

The case of the TON ICO is gaining attention and traction for the entire fintech industry. Irrespective of the outcome, regulators are sending clear messages that attention is high and that innovation does not necessarily mean disruption at all costs.

The fundamentals of regulation, investors protection, and oversight remain. What this example puts forward is the need to investigate the adequacy of norms and regulations that were developed for different times and products. The debate should also focus on whether the advent of technology and financial innovation could thrive in the current regulatory environment, always with the

[9]According to SEC filings, the ICO involved 31 U.S.-based investors for a total of $424.5 million raised.

[10]Complaint 19 Civ. 9439 (PKC) United States District Court, Southern District of New York, Securities and Exchange Commission, Plaintiff, against Telegram Group Inc. and Ton Issuer Inc. defendants, https://www.sec.gov/litigation/complaints/2019/comp-pr2019-212.pdf.

[11]*Securities and Exchange Commission v. Telegram Group Inc. et al.*, No. 1:2019cv09439—Document 227 (S.D.N.Y. 2020).

ultimate goal of promoting innovation and generating efficiencies, while protecting investors and consumers.

REGULATORY APPROACHES AND RESPONSE

The use of distributed ledgers and the involvement of many actors scattered across various networks in a virtually uncontrollable mechanism makes blockchain applications—in particular cryptocurrencies—subject to use in nontransparent, if not outright illegal, activities. The adoption of cryptocurrencies has seen a spike in those countries characterized by high political instability and corruption, for example, Venezuela. A World Bank paper (World Bank 2018) establishes statistically significant inverse correlations between bitcoin adoption and the four elements of rule of law, regulatory quality, political stability, and control of corruption.

Cryptocurrencies and ICO volumes are in aggregate still negligible to be considered a systemic risk for the global financial system. Nonetheless, regulators are on the alert and constantly monitor the evolution of DLT and cryptocurrencies. In addition to investors' protection and transparency, other priority concerns related to Know Your Customer requirements, money-laundering, financing of terrorism, and other illicit activities. In this sense, central banks, regulatory authorities, and supervisory bodies are all keen to ring-fence potential negative impact and, in most instances, maintain their role as external observers.

Growing regulatory and consumer-protection concerns led to attention from regulators and policy makers: in the last few years cryptocurrency and blockchain technology landed on the "radar screen" of central banks and regulatory agencies. Cryptocurrency and blockchain was high on the agenda of the meeting of the central banks' representatives of the G20 countries in Buenos Aires in 2018. Paragraph 25 of the G20 Joint Statement and G20 Leaders' Declaration is all about DLTs, blockchain, and cryptocurrencies: "We look forward to continued progress on achieving resilient non-bank financial intermediation. We will step up efforts to ensure that the potential benefits of technology in the financial sector can be realized while risks are mitigated. We will regulate crypto-assets for anti-money laundering and countering the financing of terrorism in line with FATF [Financial Action Task Force] standards and we will consider other responses as needed."

The G20 statement is representative of a generalized policy shift from a previously softer stance to a more proactive attitude toward regulation and "other responses" on a need basis and on either individual (i.e., country/ies specific) or collective (i.e., international efforts under the aegis of international fora and/or organizations) initiatives.

Nonetheless, regulatory approaches toward cryptocurrencies are still developing, ranging from a handful of countries with outright bans of the technology, to a few countries devising control systems and mechanisms. The most recent and reliable effort to take stock of regulation of cryptocurrencies at an international level is the U.S. Library of Congress' survey of cryptocurrency regulation. This 2018 world survey provides a very interesting picture of the regulatory landscape and diverse attitude toward blockchain, cryptocurrencies, and ICOs.

A first takeaway is the fragmentation in the definitions and terms used to describe the same phenomena: *digital currency* (Argentina, Thailand, and Australia), *virtual commodity* (Canada, China, Taiwan), *crypto-token* (Germany), *payment token* (Switzerland), *cyber currency* (Italy and Lebanon), *electronic currency* (Colombia and Lebanon), and *virtual asset* (Honduras and Mexico).

Second, the survey reveals that most of the countries have official notices to warn investors and consumers about the risks associated with innovative financial instruments, products, and investments based on DLTs, blockchain, ICO, or cryptocurrency. Such warnings establish direct linkages between such innovative products and potential frauds, corruption, illicit activities, money laundering, and terrorism financing.

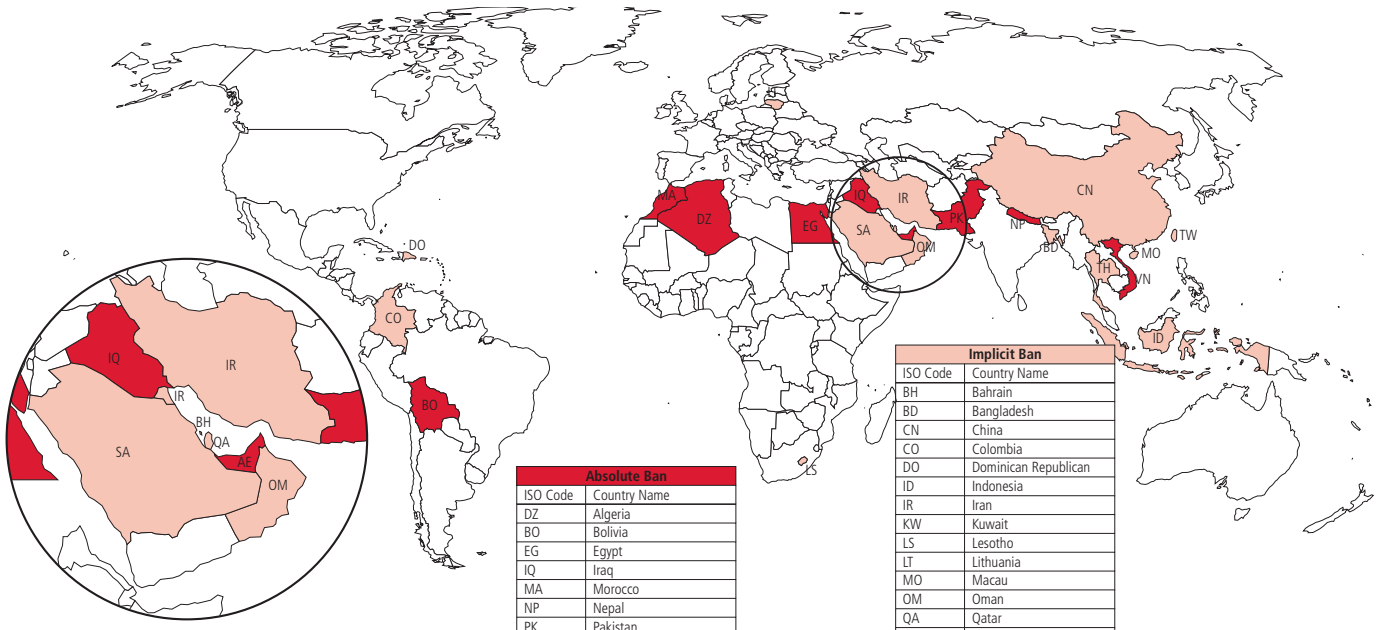
Conversely, in a handful of countries, cryptocurrencies are accepted as a means of payment: in selected Swiss local authorities, cryptocurrencies are accepted as a means of payment by government agencies. The Isle of Man and Mexico allow cryptocurrencies as a means of payment along with their national currency. The government of Antigua and Barbuda allows the funding of projects and charities through government-supported ICOs.

Some countries also address ICOs: banning them (mainly China, Macau, and Pakistan, see Figure 1), or trying to define regulatory boundaries of ICOs, like New Zealand where obligations may apply depending on whether the token offered is categorized as a debt security, equity security, managed investment product, or derivative.

The regulatory landscape is poised to evolve as technology solutions and products will become more mature, widespread, and significant (both in terms of number and volumes of intermediation). As highlighted by the G20 statement, there is growing attention by the part of governments and regulatory agencies/authorities to clear the ground from uncertainties and safeguard investors while reducing the risks of illicit behaviors.

As any evolution, blockchain technologies will have an impact on products, processes, and intermediaries, hence we foresee a *transformation* rather than a *disruption* in which once technology solutions are tested and validated, and once

FIGURE 1. Cryptocurrencies' Legal Status Around the World, 2018



Absolute Ban	
ISO Code	Country Name
DZ	Algeria
BO	Bolivia
EG	Egypt
IQ	Iraq
MA	Morocco
NP	Nepal
PK	Pakistan
AE	United Arab Emirates
VN	Vietnam

Implicit Ban	
ISO Code	Country Name
BH	Bahrain
BD	Bangladesh
CN	China
CO	Colombia
DO	Dominican Republican
ID	Indonesia
IR	Iran
KW	Kuwait
LS	Lesotho
LT	Lithuania
MO	Macau
OM	Oman
QA	Qatar
SA	Saudi Arabia
TW	Taiwan
TH	Thailand

Source: Regulation of Cryptocurrency Around the World, June 2018, The Law Library of Congress, Global Legal Research Center.

business models are mature, trusted intermediaries (i.e., the incumbents at the various layers of financial intermediation) will adopt those solutions, technologies, and business models to provide "intermediation" services (with the understanding that the concept of intermediation and the number and types of actors may vary as a result of such an evolution).

The technology advancements provide a unique opportunity for regulators to intervene and play a leading role in shaping applications, services, and products. While a risk-based approach in regulatory intervention once issues arise allows for innovation and product development, the fluid nature of blockchain innovations and the fast pace of market introduction may call for a more proactive approach of regulators.

Rather than following industry evolutions and providing regulatory patches, regulatory agencies could define guiding principles and operational guidelines that industry should follow to strike the balance between innovation, market discipline, and investors protection.

The development of regulatory safeguards and the definition of implementation boundaries would provide certainty to operators and market participants. The approach of regulatory sandboxes could provide a "safe space" for the development and testing of innovative systems and products: the establishment of a "controlled environment" for innovation has merits.

The recent establishment of the Global Financial Innovation Network[12] is an encouraging sign. Nonetheless, regulatory sandboxes are not a silver-bullet solution to complex policy and regulatory challenges (UNSGSA/CCAF 2019). Sandboxes should not be a substitute for regulators' responsibility of defining policies and setting priorities and objectives, and policing the market.

Regulatory agencies have the authority and legitimacy to intervene beforehand and become a player in the innovation process. This can be achieved through dialogue and consultation with industry and market participants.

CONCLUDING REMARKS

COVID-19 triggered social, economic, and humanitarian challenges on a global scale. This paper's analysis was on the health and economic aspects: on the one hand to draw parallels and similarities between the dynamics in health and in the financial sector, and on the other hand to provide a rationale for a more dynamic approach of regulators in certain domains of fintech and financial supervision. The health dimension of the pandemic is proving resilient and efficient; the financial sector and fintech space are also providing evidence of resilience in its connotation of "good finance" that should accommodate the dual purpose of:

a) Leveraging complementarities and identifying resources to tackle challenges that require collaborative approaches.
b) Safeguarding the stability of a virtuous financial system in which resources are mobilized in a transparent and efficient manner so as to minimize the risks of shocks, recession, and unemployment.

[12]GFIN was established in January 2019 and it now comprises approximately 50 members representing financial sector regulators and related organizations. GFIN is meant to be the "global sandbox" for financial innovation.

Fintech embodies the first feature, equipping the market with new financial services and delivering new financial products that build on the empowering capacity of technology. At the same time, fintech appears to be opening paths that in the past have raised concerns over financial systems' stability and transparency, such as securitization and reckless "gambling finance" approaches to exotic valuations and financial products. Certain dimensions of fintech are a reminder that there is a "bad finance" side to which regulators should always pay attention.

The challenges raised by the health emergency, and related economic implications, have all the features of cyclical phenomena. In COVID-19 context, the cyclical oscillation of short duration is determined by the waves of contagion that, when added to the short frequency oscillations, generate shock. Seen from a cyclical perspective and in economic and financial sectors terms, the pandemic triggers deep recessionary trends that rid the market of non-resilient players but paves the way for a recovery model and re-expansion that will close the long cycle.

The exogenous nature of the pandemic makes less relevant the traditional economic and regulatory tools to face the heightened volatility and the swings between peaks and troughs of the cycles. The pandemic severs the linkages between the economic crisis and fundamentals of mainstream economic theory. The resurgence of a deadly and highly contagious virus is unpredictable and almost impossible to counter and manage, at least at the very beginning stages of incubation and contagion.

In this context, policy makers and regulators have the challenging role of decreasing vulnerability and enhancing resilience. The catastrophe that we are witnessing nowadays consolidates the conventional wisdom that certain financial innovations may not necessarily be the only way forward to manage emergencies. Financial reinsurance for catastrophes that cannot be foreseen or pandemic bonds, while innovative, may not be the only answer. This raises two points:

1. Consider the relevance of catastrophe insurance and pandemic bonds (both related to catastrophes that cannot be foreseen), and by association the tokenomics (based on no-assets—as the authors coined—*nothing-backed securities*) as viable solutions or even a useful means in the quest to a "totally liquid" world. The ultimate goal of those tools would be to call the protection sellers (the investors) to cover the costs, as an alternative to the use of public money.

   Nonetheless, history of the financial system provides lessons about the grey area between financial innovations and financial speculations leading to the benefit of a few.

   The case of the World Bank not pursuing a second issuance of the "pandemic bonds" could serve as an example. Launched in 2016 as a financial innovation to respond to emergencies such as the outbreak of Ebola, the World Bank's Pandemic Emergency Financing Facility (PEF) (World Bank 2020) was initially praised as a virtuous example of innovative public-private partnerships and financial engineering for the public good. Yet, the facility has been criticized[13] for its design (triggers favoring

[13]A good summary of the controversy around the PEF is Alloway and Vossos (2020) and Hodgsonm (2020).

private investors over public health), effectiveness (the total cost of the facility was greater than alternatives, such as borrowing) and efficacy (the amounts and timing of disbursement were not aligned with realistic needs of beneficiaries).

The core of the issue should be to refocus the policy discourse not on reducing the severity *(ex post)* by financing the risk, rather to control it. The real concern is not related to pure risk securitization, or making liquid and tradeable any feature and event with the purpose of identifying the last holder of the risk ("holding the bag"), but how to manage the risk. Financial engineering and financial innovation do not address nor settle the eternal struggle between protection (risk financing) and prevention (risk avoiding).

COVID-19 represents a reset of a series of the assumptions and narratives that drove the policy debate and practice, including in finance, about the role of private investors, financial engineering, and innovation. The pandemic is shifting the focus back to the crucial and pivotal role of government and regulators. The International Monetary Fund estimates (IMF 2020) that governments across the globe disbursed approximately $12 trillion in fiscal support to households and firms. Also, the IMF reinforces the role that public spending and investment will play in the process toward recovery: an increase in public investment by 1% of GDP could boost GDP by 2.7%, private investment by 10%, and employment by 1.2% in a two-year period, provided that investment decisions are robust.

2. Question regulators' reliance on the belief that markets self-adjust and converge toward equilibrium, as well as regulators' enactment of reparatory measures that result in being restrictive and invasive exactly because of their "reactive" nature.

As revealed by the analysis of GHS Index and number of COVID-19 cases and deaths, having a robust infrastructure and system does not necessarily shield a country from adverse impacts of the pandemic. A clear and targeted policy response, coordinated and precise, should still be in place to prevent the spread of contagion. Similarly, in the fintech and blockchain space, having a robust financial sector infrastructure is not a safeguard from potential risks stemming from uncontrolled service and product development.

Rather than patchy emergency regulations and measures, policy makers and regulators could gain inspiration from *kintsugi*, the Japanese art of repairing broken pottery using precious materials such as gold, silver, and platinum. *Kintsugi* embodies a more spiritual and philosophical approach of valuing the concept of repairing as part of mending, healing, and re-using.

Notwithstanding the social and economic impact of the pandemic, COVID-19 (whose primary impact we called "pandemization of the economy" [PoE]) provides possible entry-points for regulators and policy makers to regain their pivotal role in ensuring certainty and predictability while driving innovation in the field of technology and innovation in finance and banking. PoE, as we mentioned, requires strong and credible regulators and policy makers that can provide reliable information and guidance while commanding credibility by setting new rules.

The health emergency and its economic implications are leading most governments to launch traditional rescue measures and recovery packages that span from tax deferrals to outright grants. The latest technological revolution is the key. Policy makers could consider the deployment of blockchain- and fintech-specific support programs that could entail guidelines for beneficiaries, so establishing a mechanism for the bottom-up introduction of rules and terms that industry would otherwise not consider.

Being inspired by the way the pandemic has also changed the way policy makers and government agencies interact with private sector stakeholders and market participants, one could draw examples from the interaction between regulators, policy makers, and the pharmaceutical industry. Such models of open dialogue and financial support within a clear, policy-defined framework of interaction could be mutated for the blockchain and fintech domains.

Furthermore, market and industry innovation should also be mirrored in government and public policy innovation. While many governments and regulatory agencies (particularly central banks) have been equipping themselves to better tackle the innovations brought about blockchain and fintech, there seems to be an opportunity for a better structured approach at both institutional and competence levels. The trend of establishing "innovation offices" has proven effective in certain policy domains. Nonetheless, a model of innovation office describing the tasks, composition, functions, and working of such units would greatly benefit policy makers and regulators. International fora could be the preferred setting to develop such models and gather global good practices and lessons learned.

A very useful case in point for such an approach is the recent initiative of the European Central Bank on the options and requirements for launching the digital euro (ECB 2020), in the shape of a central bank liability offered in digital form for use by citizens and businesses for retail transactions. The "Report on a Digital Euro" of October 2020 outlines the opportunities and challenges for a digital euro. The report paves the way for such international and coordinated exchange and interaction among market participants to identify the most suitable type of digital euro, describing the envisaged features and functions of this central bank liability without mandating on its specific architecture, which can be further fine-tuned following a process of consultation with industry and end-users that is planned for mid-2021.

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