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COVER ARTWORK BY
VICTO NGAI

“My understanding of innovation is that it’s curiosity about the unknown and a desire to push the boundary between the possible and impossible. Here I hope to convey this sense of wonder with a dizzying Escheresque structure filled with fun, strange objects waiting to be investigated.”

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—Christine Harper, Editor 9/24/2019

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The Innovation Issue

Politicians get the attention, but innovators are creating our future. For this issue, *Bloomberg Markets* reports on what some of them are doing today and what obstacles they're encountering.

Europe's startup scene has long been overshadowed by Silicon Valley, much to the chagrin of policymakers across the Continent. One simple, but politically risky, change could make a big difference, explains Edward Robinson in "Europe Neglects Its Unicorns" (page 58).

At Oxford University, American chaos scientist Doyne Farmer is intent on upending economic modeling, just as he revolutionized investing. Now some central bank research departments are starting to experiment with his ideas, as Vincent Bielski describes in "Getting Comfortable With Chaos" (page 62).

The world of fintech can sometimes seem more hype than reality. What should investors be taking seriously? Julie Verhage helps to break it down for you in "Fintech Facts" (page 54).

Hydraulic fracturing, photovoltaic cells, and wind turbines have transformed the energy industry over the past decade. Yet none compare with the potential of nuclear fusion—a process that scientists have been studying for a century—if it can be safely and cost-effectively harnessed. In "Star Power" (page 68), Jon Asmundsson and Will Wade check in on three companies pursuing this holy grail.

Cryptocurrencies attract idealists like Ashleigh Schap, who want to fundamentally replace the existing financial structure. But Schap, 27, has learned that even crypto pioneers are divided. Alastair Marsh details the schism in "A Rebel's Guide to Finance" (page 76).

We hope you find the issue illuminating and inspiring. As always, we welcome your feedback.

Christine Harper, Editor

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A few key events for your calendar in the coming months.

<p>Oct ▶</p>	<p>14–20</p> <p>IMF and World Bank annual meeting</p> <p><i>Washington, D.C.</i></p> <p>New International Monetary Fund and World Bank Group leaders host for the first time</p> <div data-bbox="1141 619 1417 958"> <p>Run {TOP ECO <GO>} for the latest important economic news from around the globe. {BE <GO>} provides a menu of news and analysis for a selected country or region.</p> </div>	<p>27</p> <p>Election in Argentina</p> <p>Markets plunged in August on early signs that President Mauricio Macri will lose to Alberto Fernández</p>	
<p>Nov ▶</p>	<p>2</p> <p>Rugby World Cup Final</p> <p><i>Yokohama, Japan</i></p> <p>First rugby World Cup tournament hosted in Asia</p>	<p>11–14</p> <p>International Petroleum Exhibition & Conference</p> <p><i>Abu Dhabi</i></p> <div data-bbox="1616 1148 1893 1430"> <p>Run {TOP OIL <GO>} for the most important global news affecting the oil market. For Bloomberg Spot Oil prices, check out {BOIL <GO>}.</p> </div>	
<p>12–14</p> <p>Global Grain conference</p> <p><i>Geneva</i></p> <p>Europe’s biggest annual event for companies in the grain trade</p>	<p>13</p> <p>Private Capital</p> <p><i>London</i></p> <p>One-day Bloomberg event for private market investors</p>	<p>Dec ▶</p>	<p>2</p> <p>Cyber Monday</p> <p><i>U.S.</i></p> <p>E-commerce sales day to kick off the holiday shopping season</p>
<p>2–3</p> <p>The Global Responsible Investing Forum</p> <p><i>New York</i></p> <p>Second annual two-day Bloomberg summit</p>	<p>2–13</p> <p>Climate Change Conference</p> <p><i>Santiago</i></p> <p>25th session: the Conference of the Parties to the United Nations climate accord</p> <div data-bbox="1141 2180 1417 2491"> <p>Run {TOP CLIMATE <GO>} for today’s most important global news about climate change. {MAP CLIMATE <GO>} maps the effects of climate change.</p> </div>	<p>5–8</p> <p>Art Basel</p> <p><i>Miami Beach</i></p> <p>Elite showcase of modern and contemporary art</p>	

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By BLOOMBERG NEWS

EVERYONE WANTS AN EARLY glimpse of the next big thing, a peek into the future. So we went to Asia to ask some leading investors, financiers, and technology executives for their take on what the global herd doesn't fully appreciate—yet.

What important innovation or idea is being overlooked today?

We are still early in the blockchain adoption curve. The [fintech] industry will continue to go through various iterations in which a killer application will push the limits of the existing infrastructure, and that demand will create a breakthrough at the protocol level—be it scalability, interoperability, or privacy. Startups that can improve the user experience and provide key services for developers, investors, and end users will succeed regardless of main chain outcomes. Seamless customer onboarding, user interface, security and privacy of personal data and assets—and a killer reason to use **blockchain technology** or crypto assets—still need to happen, whether it be in developing countries or the U.S.

Ahn Le

PARTNER, FINTECH PRACTICE
CHINAROCK CAPITAL MANAGEMENT VENTURES

As the global society gets older, we need to think about offering more creative business opportunities for elderly people. Some may think about writing novels, doing research and teaching history, or programming for apps. They could provide their services or products via the internet, and companies could offer platforms to connect them. The target customers for these products would be also elderly people. They know what other people their age want. This **elderly-to-elderly**, or e-to-e, business would give the older generation not only money, but also motivation to live long and healthy lives.

Nana Otsuki

CHIEF ANALYST
MONEX INC.

With so many devices connected to the internet, from laptops to mobile phones to wearables, people are generating a **vast amount of data**. In 2015 an average person generated around 0.32 gigabytes per day. By the year 2020 it is estimated that an average person will generate 1.5 gigabytes per day. ¶ Hence in today's world of complex information systems and connected platforms/networks, it is crucial to explore creative solutions to extract valuable insights from users' data while protecting users' data privacy as information travels through a network of systems.

Simon Loong

FOUNDER AND CHIEF EXECUTIVE OFFICER
WELAB HOLDINGS LTD.

As the pace of innovation has accelerated, particularly in a tech hotbed such as the [Guangdong-Hong Kong-Macau] greater bay area, companies can overlook the importance of an open, interoperable customer experience. This is not a groundbreaking idea, per se. But the main challenges for fintech are also consumers' challenges—namely, how can we broaden consumer choices when it comes to payment? Consumers should be able to pay with whichever payment method they choose, be it standardized contactless payments or QR code via digital wallets, at the point of sale. For that to happen, we need to foster an **open-loop payment** ecosystem, enabling full and consistent interoperability.

Maike Steinebach

HONG KONG AND MACAU GENERAL MANAGER
VISA INC.

In recent years, emerging markets have become major hubs for innovation and technology adoption, and hence investment opportunities. Their strengths: nascent infrastructure with room for substantial growth, highly innovative companies addressing challenges from the ground up, and greater openness to experimentation. ¶ Over the long term, we believe that technological disruption can be even more powerful in emerging economies, as these economies have more unmet and undiscovered needs and more **leapfrogging** opportunities. Their companies offer products that are better, cheaper, and faster. New entrants and innovators often create entirely new categories. For example, micro banking and e-commerce have been big boons to small businesses and consumers, giving them much-needed access to financing and new marketplaces.

Kevin Bong

DIRECTOR OF ECONOMICS AND INVESTMENT STRATEGIES
GIC

We live in an era where all of the ways in which we live and work today can be made far more efficient and inclusive through digital technology. Not just seeking out far-fetched moonshots, but also focusing on the ordinary that's all around us—conventional ideas that haven't been reimaged in decades or even centuries. Take, for example, how we buy and sell, receive and pay, and how we transfer money globally. All these have hidden possibilities waiting to be revolutionized through **digitalization**, to make it easier to do business anywhere, and bring equal opportunities all around the world.

Cheng Li

CHIEF TECHNOLOGY OFFICER
ANT FINANCIAL

Unstructured data currently accounts for more than 80% of all data, but the centralization and governance of **unstructured data** in text, voice, and video have not yet been well established. The value of applying this data still needs to be further developed. The current research and development of fundamental AI technology is relatively robust; however, the application of AI technology into finance still needs work. Due to the lack of cross-border discipline talent and the sensitivity of financial data, the fast development of innovation in AI plus finance is currently limited. The establishment of standards and risk-prevention systems also lags behind.

Hannah Qiu

CO-GENERAL MANAGER
PING AN ONECONNECT

AI and data are getting a lot of investment and attention. I think the related important thing will be **augmented reality and virtual reality**, because when you merge AR into virtual reality, you can get into a completely different world. ¶ It's meaningful because—can you imagine?—you can live in a whole alternate world your whole life. I don't need to be physically here. I can be sitting in my office, I project, and you can see my augmented-reality thing and I can be telling you everything you really need. I don't physically move. So the notion of hologram, the notion of avatar, the notion of virtual people going everywhere—we can make that possible.

Piyush Gupta

CHIEF EXECUTIVE OFFICER
DBS GROUP HOLDINGS LTD.

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Technology Needs To Reinvent Trust

By ELAINE OU

ILLUSTRATION BY MATT CHASE

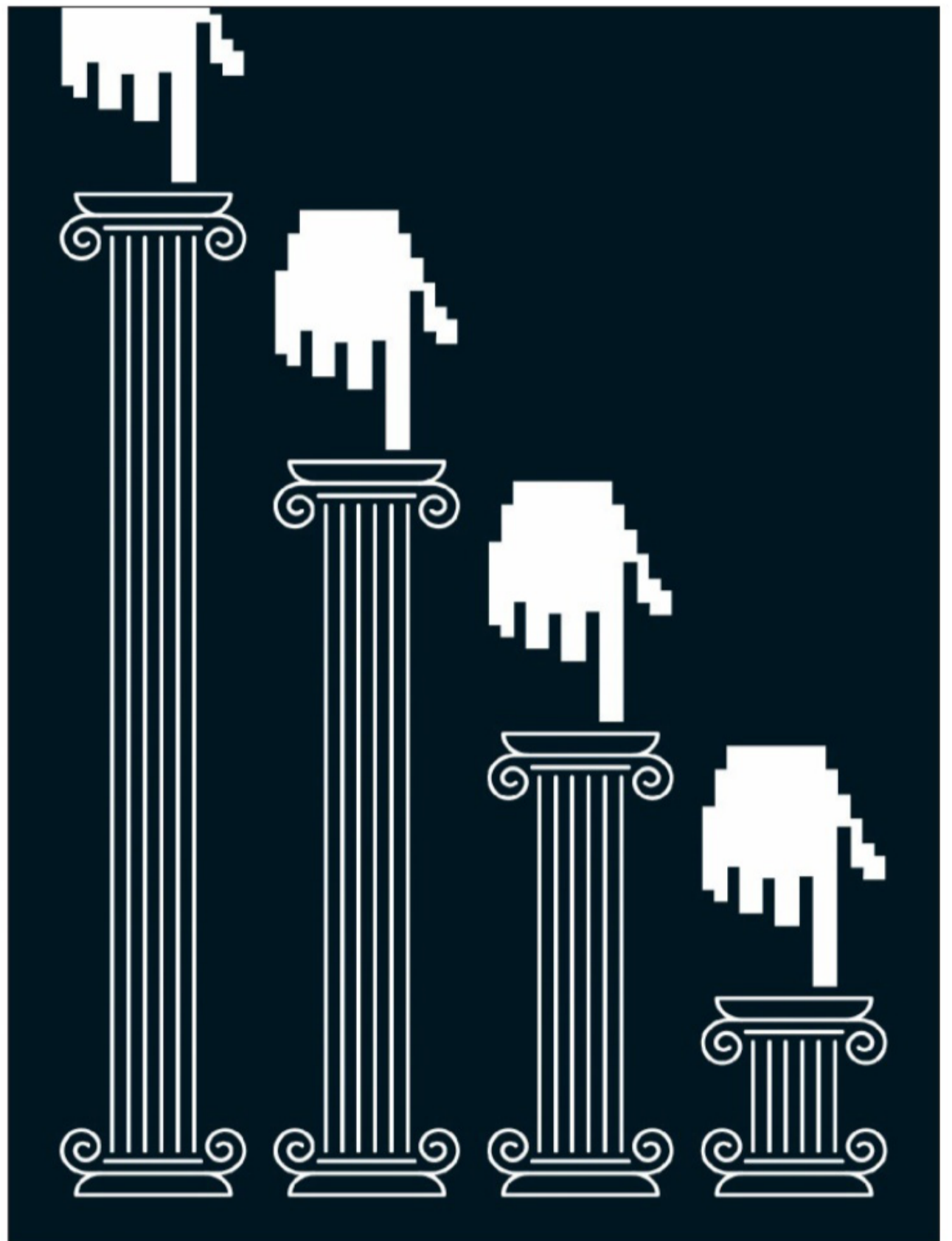
INFORMATION USED TO be a localized affair. Before the internet, bank accounts were confined to physical ledgers in a filing cabinet and took so much work to copy that they rarely left the building.

IBM mainframes entered the office in the 1960s and '70s and introduced the era of digital centralization. It wasn't a conscious shift as much as a convenient one. Computers were good at managing information, so we kept giving them more. Bank checks, bond coupons, and stock certificates soon disappeared in favor of electronic record keeping. Today it would be unthinkable to rely on a paper bearer instrument of significant value.

Digital databases enabled features that would otherwise be unwieldy: fraud detection, credit scores, targeted advertising. But it placed a responsibility on the data collectors as well. As a central source of information, they inevitably become arbiters of human interactions.

Historically, powerful entities tend to consolidate their power. But the recent populist backlash might push technologists to move in the opposite direction.

HUMANS ORIGINALLY lived in small communities where social capital was paramount and trust was granted accordingly. It wasn't that long ago that people conducted all their banking at a single branch office and bank staff knew customers by name. This led to the sort of personal relationships we see in old movies such as *It's a Wonderful Life*. ▶



Such relationships may feel comfortable, but they don't accommodate the size and scale of modern societies. As civilization evolved, institutions arose to enforce rules and lower the risk of cooperating with strangers. Instead of trusting each of our counterparties, we need only trust the institutions. Now we can trade trillions of dollars in assets in the financial markets every day without worrying whether a stock certificate might be a forgery.

We don't outsource trust in all aspects of life. A lot of laws aren't strictly followed or enforced. Instead we rely on communities to come to a consensus regarding socially acceptable behavior. For example, U.S. traffic laws: Boston-area drivers get away with a lot of behavior that would get them promptly arrested in Portland, Ore.

It's not unusual for friends to get together for a game of poker with a cash buy-in. Technically, gambling is illegal in the U.S.! The Constitution's Fourth Amendment limits the state's power to control our lives, protecting us from having police randomly barge into our homes. Even if the government wanted to regulate private behavior, it couldn't station a police officer in every home to follow our every move.

Except, increasingly it can. Today, people are unlikely to pay cash for their March Madness office betting pools. More likely they're using Venmo, where payments are automatically screened for suspicious activity. Anything that appears illegal, even transactions between friends, results in a locked account.

DIGITAL PANOPTICONS enable stricter enforcement of rules than previously seemed possible (and maybe were ever thought desirable). Money laundering was criminalized in the 1930s, but it wasn't until the Bank Secrecy Act of 1970 that financial institutions were required to actively police it. Back when customer records lived in filing cabinets, it was infeasible to monitor every transaction for suspicious activity.

Once it was established that a financial-services provider could be found liable for a customer's source of funds, its responsibilities rapidly expanded. Today, not only do banks need to comply with know your customer (KYC) laws,

they're also expected to know your customer's customer (KYCC). The idea of currency—money that belongs to its current holder—is gone, replaced by the notion that the provenance of every asset must be traced. Even gold bars can be burdened by their history.

Regulatory outsourcing isn't limited to banks. Any company with an internet-connected database can be deputized for law enforcement. Facebook Inc. and Alphabet Inc.'s Google respond to tens of thousands of government data requests each year. Amazon.com Inc. has been ordered to turn over Echo recordings from its smart home speakers. Large tech companies even provide handy web portals through which law enforcement agencies can request records.

Facebook Chief Executive Officer Mark Zuckerberg made the most compelling case against breaking up his company at the Aspen Ideas Festival in June, when he pointed out the potential loss of an ally in helping regulators address problems like election interference and misinformation campaigns: "Breaking up these companies wouldn't make any of these companies better....You would have those issues, you'd just be much less equipped to deal with them."

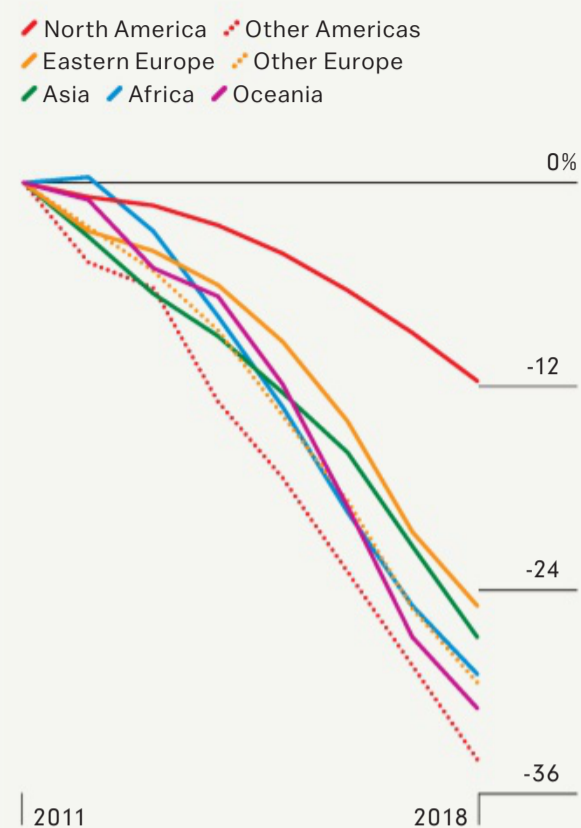
Facebook keeps intimate information on more than 2 billion people in one convenient location. Why would the government break that up?

THERE'S A CONFLICT here. Technology that was created to promote cooperation between strangers is now being used to control them.

As businesses become increasingly global, they're torn between a need to comply with U.S. laws and a desire to avoid alienating their own customers. After Edward Snowden's disclosures of tech companies' complicity in National Security Agency surveillance, foreign customers fled U.S. tech providers in favor of overseas competitors. More recently, workplace productivity app creator Slack Technologies Inc. came under fire for blocking users in Iran, Cuba, and other countries sanctioned by the U.S. Microsoft Corp.-owned GitHub followed with similar actions soon after.

Fraying Ties

Change in the number of active U.S. dollar correspondents by region since 2011



Sources: National Bank of Belgium, SWIFT

That tension is creating demand for technology design choices that won't permit companies to police their customers. Facebook enabled end-to-end encryption for its Messenger app, and Apple Inc. built its iPhones in such a way that even Apple can't hack into them. When Open Whisper Systems received a subpoena requesting user information for its encrypted messaging app Signal, it was only able to supply the duration of a user's membership. The company retained no other information about its users.

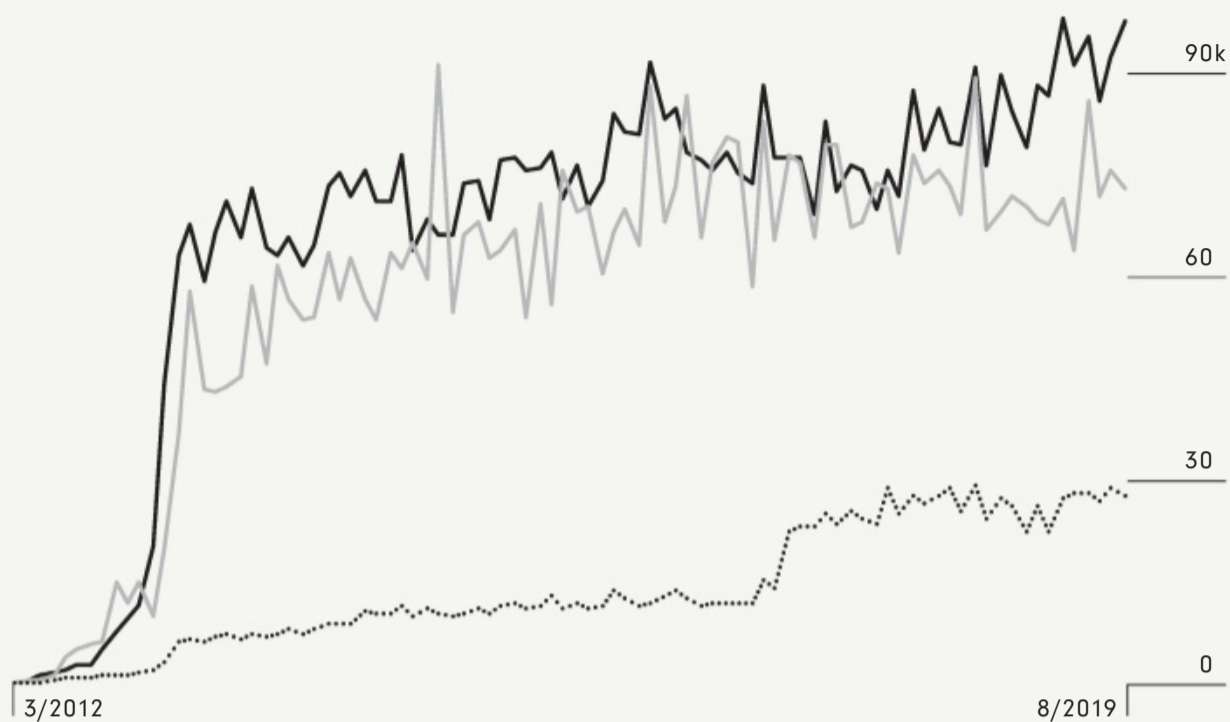
Tech companies are also starting to use a double-blind information-sharing technique known as homomorphic encryption to collect and analyze data. They get the benefits of massive data mining without the responsibility for monitoring it. Proposed applications for this technology range from medical records to voting software. Double-blind computation used to be prohibitively expensive, but technological advances have made it feasible for large-scale analysis. Instead of a reassuring motto like Google's "Don't Be Evil," systems can now be designed to preclude evil.

THE CYPHERPUNK movement in the early '90s foresaw the lawlessness of

Growing Distrust

Suspicious Activity Reports filed with the U.S. Department of the Treasury Financial Crimes Enforcement Network, by industry

Depository institution Money services business Other



Source: Financial Crimes Enforcement Network

cyberspace. It proposed technological solutions to facilitate cooperative behavior in the absence of a governing body. The goal was anarchy—not in the sense of chaos, but in the sense that no one would be in charge. Instead of relying on regulators and police, user-defined rules would be enforced with economic incentives and software.

Bitcoin is the most prominent example. It's a bearer instrument, but instead of a certificate, cryptographic signatures are used to authorize unforgeable transactions. Ledger history is stored in a database replicated across tens of thousands of machines around the world, and users are expected to verify transactions for themselves.

In a world where confidence in the establishment has fallen to an all-time low, "Don't trust us" is an attractive sales pitch. When Facebook announced Libra, the company was careful to emphasize its limited authority over the proposed cryptocurrency. Libra will be managed by a Swiss foundation of which Facebook is only one member.

The company didn't fool anyone with those decentralization claims, but the goals are instructive. Facebook knows that the best way to win over users is to minimize its own involvement.

EVEN CENTRAL BANKS can appreciate this. At this year's Economic Policy Symposium in Wyoming's Jackson Hole, Bank of England Governor Mark Carney suggested a synthetic hegemonic currency that could be provided through a network of central bank digital currencies.

It's a distinct break from a half-century of dollar dominance. U.S. Treasuries make up about two-thirds of global reserve holdings, all residing as database entries at Federal Reserve Banks, where every transaction can be monitored or stopped.

Other countries don't share Americans' appreciation for U.S. regulatory authority, especially those at the receiving end of sanctions.

European Union member states are reluctant to sacrifice trade and investment opportunities with Russia, Iran, and other economies by adhering to U.S. sanctions. As a solution, European banks set up a special-purpose vehicle called the Instrument in Support of Trade Exchanges, or Instex, to help companies do business with Iran without actually sending money across borders. Instex acts as a clearinghouse that matches credits and debits for trade, but transactions get netted and batched so

that money doesn't cross Iranian borders. It hasn't been put to much use so far, but an informal version has existed for centuries. Hawala is an international value-transfer system that relies on a global network of brokers. It may look primitive because of the absence of contracts and courts, but hawala scales remittances to poor countries that international banks find too risky to serve. Hawala brokers don't comply with KYC requirements—not in the legal sense, anyway. Participants know each other based on informal relationships in local communities.

A crypto version exists as well. Bitcoin Lightning is a decentralized clearing system where participants send Bitcoin payment messages all around the world. Earlier this year, a series of Lightning payments took place between users in the U.S. and Europe, then to Iran, then Israel, concluding with a donation to a humanitarian aid program in Venezuela. The payments were privately cleared through the Lightning protocol, and if participants hadn't announced their game on Twitter, no one would have known.

TRUST TAKES a long time to create but only a moment to destroy. When people lose confidence in the institutions that serve them, economic activity breaks down. The solution isn't to make powerful institutions even more powerful but to create technology that reduces the need to trust powerful institutions.

The greatest innovations leverage human instinct to expand what's possible. Financial institutions talk a lot about banking the unbanked, but that might do the unbanked a disservice. A monolithic panopticon is no substitute for local knowledge.

This all sounds bad if you're in charge of U.S. foreign policy or any type of regulation. It's good if you want a world where people can cooperate without interference. After all, that's how economic progress is made. ●

Ou is a blockchain engineer at Global Financial Access in San Francisco who writes about technology for Bloomberg Opinion. This column doesn't necessarily reflect the opinion of Bloomberg LP and its owners.

<GO>



Hot Wheels



HOW DO YOU get around the city?

More than half of the world's 7.7 billion people live in urban areas. The United Nations says 2.5 billion more people could join them by 2050. That means traffic and congestion fees. For many of the short trips city dwellers make, cars aren't necessary or practical. Which explains the boom in bikes and scooters, privately owned or shared. A growing number are electric.

"We're seeing a tremendous push, enabled by venture capital but not always, to spread and sprinkle around the world hundreds of millions of potential vehicles," Horace Dediu, founder of research firm Asymco, said at the BloombergNEF San Francisco event this year. "Once they're available, the bet of micromobility is that they will be picked up and used."

One luxury option is the foldable Gocycle, created by a former designer for the race car maker McLaren. The GX model, pictured here on a Berlin street, allows the rider to customize how much pedaling assistance the motor provides.

Just remember your helmet.

For BNEF research on micromobility, type "NSE micromobility in wire: BNEF" and hit <GO>. —Christine Harper

PHOTOGRAPH BY TOBIAS HUTZLER

The Woman Trying to Shake Up Israel's Financial System

By IVAN LEVINGSTON

PHOTOGRAPH BY MICHAL CHELBIN

Ber, with portraits of the Bank of Israel's previous bank supervisors



ISRAEL IS KNOWN FOR tech innovation, but its banks have a lot of catching up to do. So Hedva Ber, the supervisor of banks within Israel's central bank, is cutting red tape and spurring competition. That includes awarding the first new bank license since the 1970s, to a digital bank led by two tech entrepreneurs—Marius Nacht of cybersecurity company Check Point Software Technologies Ltd. and Amnon Shashua of Mobileye NV, which develops autonomous driving software. Ber said the new branchless bank, which will offer credit and brokerage services, will “lead a change in the market.” With a Ph.D. in economics from Hebrew University, she has spent more than two decades learning about the financial sector from positions within the Bank of Israel and Bank Leumi, the country's biggest lender by assets. In an interview in Tel Aviv, Ber, 51, described the challenges of moving the industry away from its socialist roots while keeping risks under control.

IVAN LEVINGSTON: How did you get into bank regulation?

HEDVA BER: I started to work in the Bank of Israel at age 25. I fell in love with banking and bank regulation. And in the process of my career, all the different choices I made, I had in the back of my mind that I'd want to one day be the supervisor of banks, and 23 years later I received the position. Today I've been doing it for more than four years, and I can say it was the right dream. It's a significant job—exciting, challenging, and I enjoy it.

IL: What specifically made it your dream job?

HB: The regulator has a very elevated influence on the banking system and via the banking system on the entire economy, on households, on who takes mortgages and who can't get one and buy an apartment, on small businesses and big businesses, on economic growth, on financial stability. What's exciting at the end is the people, that the regulation influences them.

IL: Why move between the private and the public sector?

HB: It gave me a lot of perspective, to see things from the side of Bank of Israel, the regulator, and also from the side of a bank. This gives me tools to do this job in a balanced way, with an understanding of which risks are big and mustn't be implemented, and which risks are possible to handle.

IL: Israel's known as “startup nation.” How do banks compare?

HB: The banking system in Israel is innovative. Startup nation is also fintech nation, and there were big and innovative changes in recent years—in the banking system, technology, and also in managing risk. The cybersecurity of the banking system is a leader in the world. We, the bank supervisor, actually have set as our central goal for the past few years to make the banking system more

innovative and technologically advanced. We removed all restrictions on digital banking. We required that on every bank's board of directors at least one director should have knowledge and experience in technology and innovation. The board should advise and push the bank to fit its business model to the changing world. We made it possible for the banking system to move to cloud technology, making it possible for more collaboration with fintechs. And we put out just recently, just about a month ago, a letter to the banking system that said we encourage them in implementing innovation and as regulators we are ready for risks to be realized. So again we essentially give them comfort to advance with innovation that has risks. But we make demands for how to manage the risks.

We recently permitted banks to open client accounts from afar with face recognition, without a banker on the other side. Just technology. Now more and more accounts are opened this way.

IL: Can the financial sector learn from the tech world?

HB: Banks fundamentally are more conservative, and it's harder for them to change compared to startups. The win-win is when there's cooperation between a bank with a culture of risk management, good processes, and understanding of risks and fintech companies that are faster, more flexible, and innovative. This cooperation allows each to benefit from the other's world: Fintechs to test their products on the bank's data and clients, to learn from the bank's experience, and the bank can bring in the innovation and implement it. This speeds things up and provides the public with much more accessible, customized services and enables more competition. The technology lowers barriers for entry. That's also a target that we gave ourselves, to raise the competition in the financial system in general and banks specifically.

IL: How do you modernize an industry with socialist roots?

HB: You have to think outside of the box. In Israel it's known there are banks with labor unions, and the workers have tenure, and this framework is often inflexible and makes it difficult to become more efficient quickly. So about four years ago we told the banks that they need to become more efficient. But we said that we will permit the big expense of offering workers good voluntary retirement packages to be spread over a few years so that it doesn't affect profits. And we gave them relief on capital requirements. So this triggered them to reduce manpower, rein in the labor unions, and to do this in a way that respects the workers. Thousands of workers chose to retire voluntarily with a good financial package. The banks reduced a non-negligible percentage of their workforce, about 12% of the bank system. The banks were able to adjust ►

their organizational structure, hire technologists, and move from a worker-based structure to one based on technology.

IL: What was involved in preparing to give out Israel's first new bank license in decades?

HB: We lowered capital requirements for a new bank in coordination with what is accepted globally, consulting with the IMF. The Bank of Israel built a credit database to make the information available to new players. We changed the entire licensing process: Today, I have a staff that works with each entrepreneur who wants to open a bank and guides them to understand the regulations and the requirements. We supported the creation of a bureau of computing services that permits many players—a new bank, credit organizations, small banks—to share IT infrastructure. This lowers the barrier of high technology costs. That's not the only step we took to help the competition. Another step was the decision to separate the credit card companies from the banks.

IL: You took the words out of my mouth.

HB: The legislation requires the banks to sell their credit card companies. The thinking was to create new players to compete in specific niches of the banking system, in the areas of payments, home credit, small-business credit, and maybe others. Two credit card companies separated from the banks, and we are seeing them now building a business model and actually starting to compete in some of these areas.

IL: Israel is creating a new database of credit information to enable lending. What about the risk of an Equifax-style hack?

HB: We are really happy and proud that the credit database became active in Israel this year. This kind of thing has existed in many other countries for years. The Bank of Israel made it happen and also built around it a kind of "Iron Dome" to defend it from cyberattacks. The Equifax hack is definitely a major event that teaches what risks can be realized. It's impossible to say that events like this can't happen; our job is to be prepared and to recover in a quick way with minimum damage. This is a topic that's on our agenda in the Supervisor of Banks. We took many steps not just for the credit bureau but for the whole banking system so there won't be a large data breach like that. It requires continuous work; it's a big risk.

IL: In 2016, Israel passed a law that effectively limited the annual pay of top bank executives to 2.5 million shekels (\$705,000). Could this stifle innovation?

HB: My assessment is no. Despite this salary cap on senior executives, which is unique on a global level, we don't see evidence at least at this stage that it's restricting innovation or the ability to recruit good people. Banking is still a leading sector, very influential on the economy, undergoing a large digital transformation. Good people want to be in bank management, want to be a CEO of a bank. Of course legislators in Israel need to evaluate this restriction and whether some kind of refining is necessary. Young people today may be more attracted to the world of technology because there are high salaries and good conditions. Down the road we want our best kids to manage the public's money responsibly, so in the medium term we need to examine this issue. But for now the system is changing and innovating in a really professional way.

IL: Are the banks ready for potential big tech rivals?

HB: Definitely the big techs could be a game changer in the world and also Israel, if and when they decide to enter banking in a more significant way. The banks need to take more steps to be ready if this happens.

IL: I've heard criticism that you should be moving even faster to deregulate to make it easier for new players to enter the market.

HB: In Israel the financial system went through the financial crisis very successfully, and there wasn't even a moment of doubt that a bank would go bankrupt. This comes from the regulation and the conservative management. But still I understand this criticism. I think that we took a big leap in the past few years to be faster, to permit innovation, but there's always room to improve.

IL: Israeli banks have a reputation for slow service, long lines. What is it like trying to improve on that?

HB: In the past few years we as a regulator put a lot of pressure on the banks to improve service, and the banks took steps. For example, a few months ago we did a satisfaction survey of Israeli households, a very large survey, and we published it for the public. This created a lot of buzz. The survey showed that for the small and midsize entities, customer satisfaction was much higher than for the big banks. We also saw that digital service was very good; really, almost all the banks received more than 90 on a scale of 0 to 100. We as a regulator demanded that the banks streamline and reduce branches but also improve the service, with an emphasis on the older customers who need more digital guidance.

IL: Israel is working to introduce securitization and long-term interest-rate derivatives. Will that be difficult?

HB: We definitely want a more sophisticated capital market in Israel, and unfortunately some financial tools that are very accepted elsewhere don't exist here. The Bank of Israel supports the development of a securitization market. A committee that has members from all of the regulators is addressing the issue. We believe this is important to permit all the players in the economy, banks and also nonbank entities, to manage their credit portfolio more dynamically, to increase liquidity. It would permit credit card companies to access liquidity. The entire economy will benefit.

We learned from the financial crisis, when they had very complex tools. Here we are talking about plain-vanilla securitization and tools that are clear and transparent.

IL: Does all this reform ever feel risky?

HB: Definitely. We need to ensure that the reforms are enacted and then let the dust settle so that we can see how the new equilibrium is doing, so that there aren't unmanaged risks. It's possible that down the road we'll need to refine some things.

IL: What's your long-term vision for Israeli banks?

HB: I expect that the banking system will be more competitive, more innovative and technological, more efficient. The benefits will go to households and small businesses. The shareholders of the banks will enjoy these fruits, and more than 80% of the shares are in the hands of the wider public directly or via institutional investors, Israelis or foreigners.

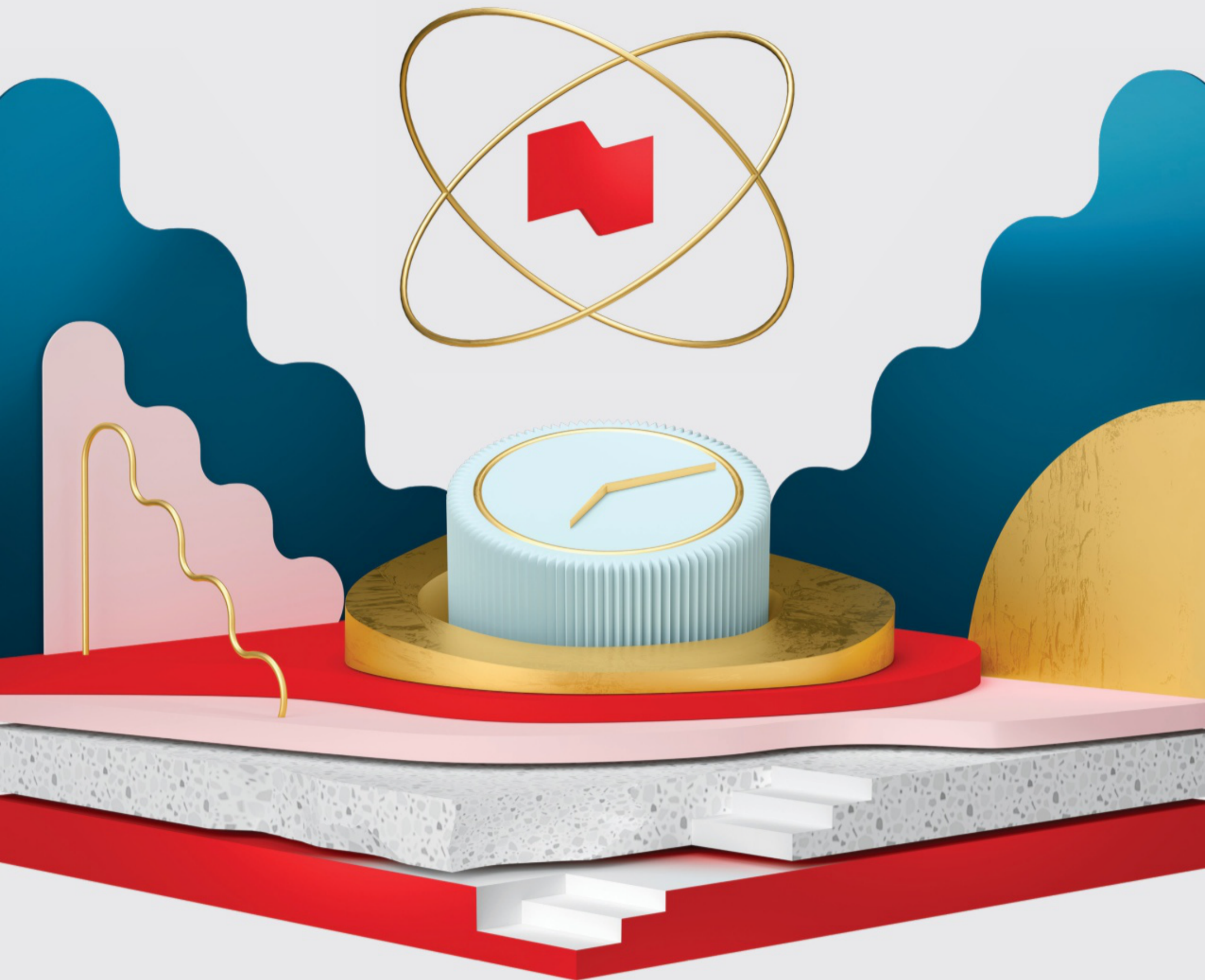
In the area of payments, Israel lags a large part of the world. We have a vision that in the coming years there will be significant changes to permit more advanced payments, so it will be possible to pay businesses with a cellphone, digitally. We really hope international players will enter the market.

IL: Now that you've approved a new bank, will you open an account there?

HB: Of course. No question. ● —*With Gwen Ackerman*

Levingston is a reporter covering the Israeli economy and government for Bloomberg News in Tel Aviv.

159 years.
251 billion in assets.
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Our client-first approach and long-term focus empower our teams to build lasting relationships.

Automate Your Pricing Chores With A Bit of Python Code and the MARS API

By FRANCESCO TONIN and SAMUEL POPPER

REPETITIVE PRICING TASKS have been part of the job of sell-side salespeople and traders for decades. In the old days, when clients called in to request indicative prices, bank employees would compile them by hand. Over time, computers picked up the chore of running the numbers. The salespeople and traders would decide what instruments the computer should price, input market parameters, and compile long menus of indications from which clients could choose.

Nowadays, manually feeding individual pricing requests into computers is generally considered a bad use of time for highly educated finance professionals, including trainees. It's repetitive and boring.

Consider foreign exchange, the most liquid market in the world. Typically a client request would simply specify the currency, whether she intends to buy or sell, and the value date for the transactions—buy euros a week from today, for example. The client would expect her salesperson to come back shortly with a handful of prices for a number of structures.

The structures are usually the same. For a client looking to buy euros and sell U.S. dollars, they would be something like this:

- The **forward** rate for the EURUSD currency pair;
- The premium of an at-the-money euro **vanilla option**—in this case a call, which grants the right to buy euros at a set exchange rate on or before expiration;
- The premium of a euro call option with a 25% probability of being exercised, referred to as a **25-delta option**;
- Two EURUSD spot levels, such that the client can buy at the higher if the euro rises but has to sell at the lower if the euro falls, with a combined cost of zero. The structure is known as a risk reversal, or a **collar**;
- The price of a euro **call spread**, an instrument that

indemnifies the client for any euro appreciation above a specified level (up to a ceiling amount);

- A combination known as a **participating forward**, where the client buys a euro call at the same strike as she sells a euro put, which grants the right to sell. The notional of the euro put is half the notional on the euro call, and the combination has a net cost of zero.

SEASONED TRADERS AND salespeople often price this list a few times each day. They can be very quick at it, but it will still take 15 minutes each time—if you're good—and there's always the possibility of a clerical error.

With more and more computer-savvy graduates entering the financial workplace, coding skills are widespread. You can easily use an open-source computer language such as Python to automate pricing all of these structures so you can focus on adding value. If you're not familiar with coding, chances are one of your colleagues is.

THE CODE NEEDED to price the above structures is pretty basic if you have access to Bloomberg's extensive library of pricing functions and portfolio manipulation via MARS API. Bloomberg's Multi-Asset Risk System (MARS) provides consistent pricing and risk data to model every deal in your portfolio. MARS API offers programmatic access to that pricing and risk infrastructure: Access to it is triggered by a few lines of boilerplate code. For more info on MARS, go to [{RISK <GO>}](#).

Here's a sample of how you can use Python to perform pricing tasks.

First, let's take a look at the code that creates a vanilla option using function calls to the MARS API (**FIG. 1**). The code specifies the deal type as a vanilla FX option, or VA.FX. The expiration and ▶

Fig. 1 Here's the code that creates a vanilla FX option with a strike price equal to the euro-U.S. dollar forward rate.

```
deal_type = "VA.FX"
expiry_date = datetime.date(2020,11,16)
settlement_date = datetime.date(2020,11,18)
strike_atmf = get_strike_atmf("FX1YEUUS Index", datetime.datetime.now())
print("Creating a long European Call on EURUSD with a strike at " + '{:,.4f}'.format(strike_atmf))

overrides ={
    "UnderlyingTicker": "EURUSD Curncy",
    "CallPut": ["Call"],
    "Direction": ["Buy"],
    "ExerciseType": ["European"],
    "Notional": 1000000.0,
    "NotionalCurrency": "EUR",
    "ExpiryDate": expiry_date,
    "SettlementCurrency": "USD",
    "SettlementDate": settlement_date,
    "Strike": strike_atmf
}

request = marsapisvc.createRequest("structureRequest")
request.set("sessionId", session_id)
request.set("tail", deal_type)

deal_structure_overrides = request.getElement("dealStructureOverride")
set_overrides(deal_structure_overrides, overrides)

deal_handle = send_request(request, blpapi_session, identity, process_structure_response, 'structureResponse')
```

Fig. 2 Create a matrix of prices for five different dates and at levels 5%, 10%, 15%, 20%, and 25% above spot.

```
valuation_dates = ["2019-11-15", "2019-12-16", "2020-01-15", "2020-02-18", "2020-03-16"]
spot_levels = [1.05, 1.10, 1.15, 1.20, 1.25]
shocs = create_scenarios(shocapisvc, blpapi_session, identity, spot_levels)
if not shocs:
    print("Could not create the scenarios")
    sys.exit(ERROR_CREATE_SCENARIO)

dataframe = pandas.DataFrame()
securities = [{"type": "dealHandle", "value": deal_handle}]
for valuation_date in valuation_dates:
    request = create_scenario_request(marsapisvc, session_id, shocs.keys(), valuation_date, securities)
    scenario_to_port_val = send_mars_api_pricing_request(request, marsapisvc, blpapi_session, identity, process_
        scenario_pricing_response, {})
    matrix_row = pandas.DataFrame(scenario_to_port_val, index=[valuation_date])
    dataframe = dataframe.append(matrix_row)
print(str(dataframe.rename(columns=shocs).T.sort_index()))
```

Fig. 3 The code makes it easy to output a set of prices that you can share with your client.

Client needs to buy EUR and sell USD on the following dates:

Forward

Delivery Date	Forward Rate
11/15/2019	1.1160
12/16/2019	1.1185
1/15/2020	1.1212
2/18/2020	1.1240
3/16/2020	1.1260

Vanilla Option: Client Buys EUR Call

Delivery Date	Strike	Premium
11/15/2019	1.1160	1.08%
12/16/2019	1.1185	1.30%
1/15/2020	1.1212	1.46%
2/18/2020	1.1240	1.64%
3/16/2020	1.1260	1.79%

25-Delta Option: Client Buys EUR Call

Delivery Date	25-delta strike	25-delta premium
11/15/2019	1.1377	0.51%
12/16/2019	1.1451	0.59%
1/15/2020	1.1513	0.65%
2/18/2020	1.1582	0.70%
3/16/2020	1.1635	0.75%

Collar

Delivery Date	Client buys EUR Call	Client sells EUR Put
11/15/2019	1.1377	1.0991
12/16/2019	1.1451	1.0991
1/15/2020	1.1513	1.0991
2/18/2020	1.1582	1.0991
3/16/2020	1.1635	1.0991

Call Spread

Delivery Date	Client buys EUR Call	Client sells EUR Call	Premium
11/15/2019	1.1377	1.1620	0.50%
12/16/2019	1.1451	1.1749	0.55%
1/15/2020	1.1513	1.1852	0.59%
2/18/2020	1.1582	1.1966	0.63%
3/16/2020	1.1635	1.2057	0.67%

50% Participating Forward

Delivery Date	Forward Rate
11/15/2019	1.1327
12/16/2019	1.1369
1/15/2020	1.1409
2/18/2020	1.1452
3/16/2020	1.1484

settlement dates are set, in this case the option is set to expire on Nov. 16, 2020. The option's strike price is set equal to the at-the-money forward rate using the data series ticker `{FX1YEUUS Index}`, the one-year forward rate in EURUSD. Run this code, and you'll have generated a vanilla call from your Python program.

Now, suppose you want to price the option at five different dates and at five different market levels for EURUSD. This is the kind of request that can start to get laborious quickly. Here, though, a couple more lines of code can take care of it (**FIG. 2**). In this case, the code specifies five particular dates and levels that are 5%, 10%, 15%, 20%, and 25% above spot rates.

IT'S VERY EASY to set up an automatic pricer this way. For a collar, you'd typically set the EUR call strike to 25 delta and create a loop

that solves for the EUR put strike such that the two legs end up equally valued.

So what's the advantage of using Python instead of a manual process for pretrade indications? It can save time, eliminate clerical errors—and improve the quality of your output (**FIG. 3**). In addition, Python makes it easy to create state-of-the-art term sheets that contain pricing charts and indications for a set of structures.

To download a document with the complete sample code for pricing these structures, go to `{DOCS 2092163 <GO>}` and click on the gray button. ●

Tonin is Americas head of the financial products knowledge group and Popper leads the MARS API engineering team at Bloomberg in New York.



The complexity of global currencies has evolved 12-fold over the last decade.

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Nigeria's Missing Mobile Banking App

By EMELE ONU and ANTONY SGUAZZIN

PHOTOGRAPH BY BERNARD KALU

EVERY MONTH, IFEYINWA ABEL, the secretary of a Pentecostal church in Lagos, spends as much as a quarter of her salary sending money to pay for diabetes drugs to her mother 430 miles away in Abia Ohafia, a small agricultural village.

It isn't easy. First Abel, 35, has to go to a bank branch in Lagos, the country's commercial hub, and transfer 6,000 naira (\$17) into the account of a friend in Ebem Ohafia, another town in Abia state. Then she's got to pay 2,000 naira to 4,000 naira for her 65-year-old mother, Uche Arua, to get on the back of a motorcycle and ride 8 miles from her village to Ebem Ohafia to pick up the money.

At least that's what happens if this fragile arrangement doesn't break down. Some months, Abel can't afford the motorcycle fare; other times, rains make the dirt road impassable. "Sometimes I am unable to send the money, and she stays without the drug, and I am pained," Abel says, shaken and dabbing her eyes with a handkerchief. "She must get the money and buy her drugs to survive."

Abel's story would be unusual across much of the rest of sub-Saharan Africa. In a region that accounts for half of the world's 866 million mobile banking and payment accounts and two-thirds of all money transferred by phone, Nigeria is a laggard. There are an estimated 172 million mobile phones in the country, but it didn't award a single mobile banking license until July, when it gave one to South Africa's MTN Group Ltd. Its foot-dragging—encouraged by the traditional banking sector, say industry analysts and telecommunications companies—is blamed for declining financial inclusion in this country of almost 209 million people.

Nigeria vies with South Africa as the continent's largest economy and is its most populous, but it's a "sleeping giant" in the world of fintech, according to GSMA, a trade body that



represents 750 mobile phone operators globally. Across sub-Saharan Africa, the adoption of mobile payments, which incur lower costs than traditional banking, has helped bring financial tools to the masses. Financial inclusion in the region grew by more than 8 percentage points from 2014 to 2017, to an average of 43%, according to World Bank data. In Nigeria the rate dropped almost 4 percentage points, to 39%—far short of the Central Bank of Nigeria target of 80% by 2020.

Even with its new license, MTN doesn't look much like a bank: It can't lend money or pay interest. In Kenya, by contrast, Safaricom Ltd. acts much more like one. Part-owned by a unit of Vodafone Plc, it launched its M-pesa app in Kenya in 2007. Today 22 million people, almost half of the population, use M-pesa as a mobile bank—buying groceries, borrowing money, transferring cash. “There's no excuse for not sending money home because it's now very easy,” says Kip Ngetichi, a 28-year-old waiter in Nairobi, who, with a few keystrokes, sends money twice a month to his mother 240 miles away in the western town of Kitale.

Telecommunications companies and analysts say Nigeria is straggling behind its neighbors because its banks successfully

campaigned to forestall the introduction of mobile payments. “The banks have been lobbying hard to protect their interests,” says Christophe Meunier, a senior partner at Delta Partners Group, an advisory firm for technology and media companies.

The new law, critics say, is hardly a cure-all; indeed, the way it's structured will likely slow MTN and its rivals in line for licenses—Bharti Airtel, Globacom, and 9Mobile—in their attempts to roll out services. Without the ability to lend or pay interest, mobile operators may struggle to encourage people to keep money in their accounts, says Usoro Usoro, the general manager of mobile financial services for MTN Nigeria. “Mobile money in its delivery is intrinsically a collaboration of multiple industries,” he says. “We haven't received as much collaboration as required.” As things stand, says Meunier, “the way the legislation is written, even now, is very favorable to the banks.”

With 61.5 million subscribers and a network that spans all of Nigeria's 774 local government jurisdictions, MTN can offer a larger consumer base than any of the nation's banks. It plans to accredit 500,000 agents just to pay money out to recipients of mobile transfers if they want hard cash. Still, Usoro says, adoption of the technology will be slower than it could have been if regulators had allowed MTN to provide a wider range of financial services, including savings accounts and loans. “For mobile money to make the impact that we've seen in other African countries, it needs to be utilized as far more than a simple money-transfer business,” he says.

For their part, Nigeria's banks are adamant that they haven't intentionally slowed the introduction of mobile money. They blame the country's low literacy levels and poor financial infrastructure in rural areas. Nigeria's literacy level is 51%, compared with 79% in Kenya, according to the World Bank. “Financial presence as well as financial literacy is not adequate in rural and remote areas,” says Iphy Onibuje, head of digital banking at Lagos-based Fidelity Bank Plc. Digital transfers only began to be piloted in 2012, she says. To win more business, she adds, the bank is willing to partner with mobile phone companies that have greater reach into rural areas.

As inadequate as the new legislation is from the standpoint of the mobile phone companies, their services are hugely in demand and are expected to take off fast as more licenses are granted. The country's adult population of 111 million—which dwarfs the 64 million in Ethiopia, another major sub-Saharan country where mobile banking has made limited inroads—is a big draw for providers.

The presence of two large mobile phone companies that have track records and extensive operations in other countries—MTN and Bharti Airtel Ltd.—will probably accelerate the take-up of services in Nigeria, Meunier says. “MTN and Bharti Airtel will be pushing their platforms, and I think the other two will follow suit,” he says.

For Abel, who also often sends home a little extra to pay people to help her mother with plowing and weeding around her plot of land, that can't come soon enough. “I have heard about mobile money,” she says wistfully. But for her, even now, the idea that you can move money through an app on your phone still seems a distant fantasy. ● —*With Loni Prinsloo and David Malingha*



When it comes to banking by phone, Nigeria is way behind its neighbors. Here, customers wait their turn at a cash machine in Lagos.

Onu is a reporter in Lagos. Sguazzin is a senior writer in Johannesburg.

One Man's Crusade to Reinvent Mutual Funds for the ETF Era

By RACHEL EVANS

DAN MCCABE IS on a quest to transform your finances. The chief executive officer of Bedminster, N.J.-based Precidian Investments has a new way to invest that could make thousands of mutual funds obsolete, and he's persuaded the likes of BlackRock Inc. to license the idea.

His big pitch? An exchange-traded fund that hides its holdings. Active managers have largely steered clear of the rapidly expanding \$4 trillion U.S. market for ETFs, fearing that the daily disclosure these funds require would compromise their secret sauce. But McCabe's patented structure allows ETFs to report once a quarter, like a mutual fund, protecting that intellectual property. As a result, stockpickers' most popular strategies could be coming soon to an exchange near you.

Roughly \$7.2 trillion in mutual fund strategies may ultimately work within this wrapper, according to analysts at JPMorgan Chase & Co., which may also issue these products. The first ActiveShares funds, as McCabe's model is branded, are scheduled to start trading within months. They're aimed at investors who desire the lower cost and liquidity of an ETF but also want to beat their benchmark.

The growing popularity of passively run funds—like most ETFs—has drained active managers' assets. Index-huggers now manage about 40% of assets in the U.S., up from less than 10% two decades ago, according to Morningstar Inc.

Cost is a major factor behind this shift. Tracking an index is cheaper than hiring a star manager, but that's not the only reason ETFs are pushing management fees toward zero. ETFs are also inherently cheaper than mutual funds because they don't need the same administrative support: They don't maintain a record of their owners, they typically don't pay incentives to distributors, and they shield investors from capital gains taxes by using securities to pay off redeeming fund holders.

By eliminating these costs, active funds could charge a lower fee, allowing the merits of their investing strategies to shine through—in theory, at least.

In his 35-year career on Wall Street, McCabe has seen changes in regulation and technology disrupt the business model of trading stocks and options. After working in sales, options trading, and index arbitrage at various brokerages, he rose to lead Bear Hunter Structured Products LLC, a unit of a so-called specialist that helped make markets on the New York Stock Exchange and American Stock Exchange. But new Securities and Exchange Commission rules in 2007 ushered in an electronic age, weakening the grip that specialists and exchanges had on markets. Today, computerized high-speed traders such as Virtu Financial Inc. and Citadel Securities rule the markets, including arbitraging ETFs.

So more than 10 years ago, McCabe and his partners—all from sales and trading backgrounds—turned to reinventing active money management, another business that was being disrupted.

Now 55, McCabe has spent the last decade educating regulators, asset managers, and brokers about how to trade a fund that doesn't disclose its holdings every day. To price conventional ETFs, market makers use real-time information about the value of a fund's holdings. When a fund's price falls below the aggregate value of its components, these electronic traders step in to buy shares in the fund and redeem them for the underlying securities, profiting from the difference. This arbitrage keeps the price of the ETF in line with its value—but it requires portfolio transparency.

Under McCabe's model, market makers will use an indicative value of the holdings published by the fund every second to judge whether its price is too high or low, rather than scrutinizing its portfolio. And when they buy discounted ETF shares to redeem for higher-value holdings, they won't deal directly with the fund or end up with those stocks. Instead, an agency broker will confidentially receive the securities and sell them for cash that it returns to the market maker. McCabe's structure finally secured regulatory approval in May.

"By the nature of the product, there are going to be wider spreads on account of the additional uncertainty—especially in the early days," says Craig Messinger, CEO of Virtu Americas, a

broker-dealer affiliate of Virtu Financial. “But we have a good idea of how to price this. You’re going to have a good universe of market makers.”

Investors may prove tougher to attract. The S&P 500 index of U.S. stocks gained more than 35% in the five years through 2018, and it’s available via an ETF at just 30¢ for every \$1,000 invested. By contrast, fewer than 1 in 5 funds that actively picked U.S. large-capitalization stocks beat that benchmark over the same period, data from S&P Dow Jones Indices show. The lower embedded costs of ETFs can help stockpickers be competitive on expenses, but they won’t transform a dud strategy into a success.

Put simply, can an ETF structure save active managers?

“It’s packaging something that people haven’t wanted for years,” says Ben Johnson, director of global ETF research at

Morningstar. “The challenges that [active managers] face in picking good securities that do at some point in time prove to be underpriced still apply here, and there’s still a fee to be considered.”

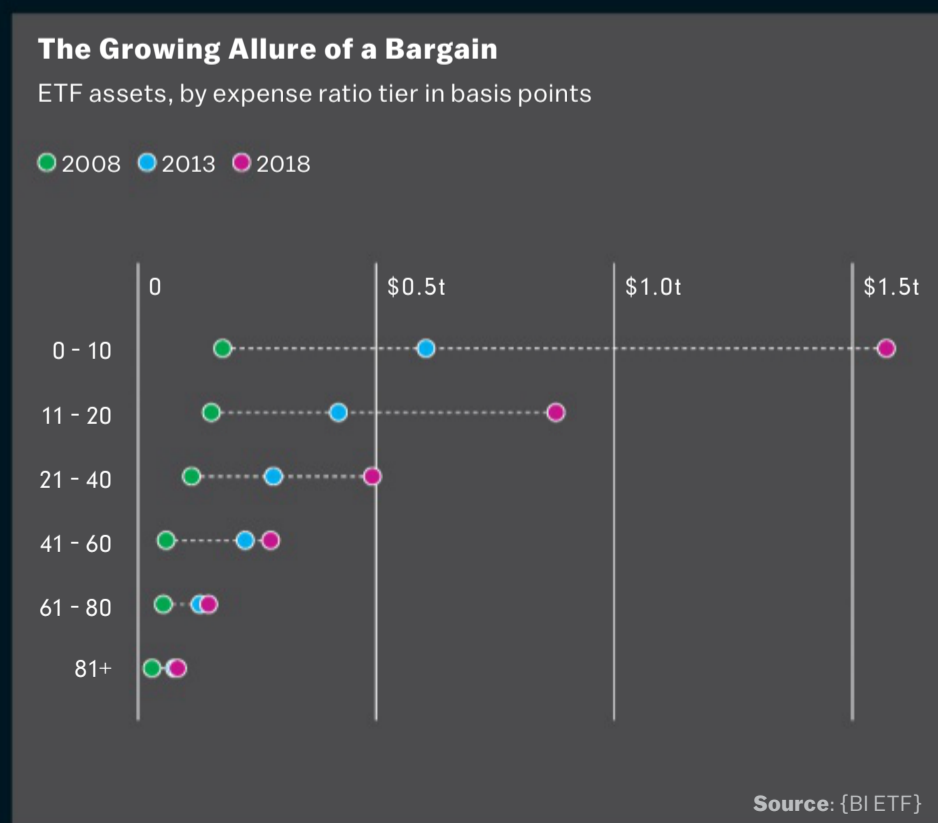
These new ETFs won’t necessarily be particularly cheap. Active managers want to charge a premium over index-tracking funds to compensate their stockpicking efforts and may wish to discreetly finance distribution efforts. As Messinger says, trading costs for these funds could also be higher. The regulator wants offering documents to make this clear.

And then there are the alternatives. T. Rowe Price, Fidelity Investments, the New York Stock Exchange, and Blue Tractor Group have all proposed different ways to create ETFs based on actively managed strategies with less frequent disclosure. While none has won regulatory approval yet, they could one day vie with McCabe’s structure for investor attention.

For now, the ActiveShares idea is gaining traction. American Century Investments is moving to list growth and value funds using McCabe’s design, Gabelli Funds has sought permission to start 10 strategies, and other licensees include Goldman Sachs Asset Management, Capital Group, and Legg Mason, which owns 20% of McCabe’s company. Licensing the structure is free; asset managers will pay a portion of their revenue only as these funds attract assets.

The struggle to get to this point reminds McCabe of the decade of tribulations endured by the eponymous hero of Homer’s *The Odyssey*, a favorite book from high school.

“If I had known at the time it was going to take that long, and the effort—it was going to be that hard or that expensive—I probably wouldn’t have started it,” he says. “But when I’m an old, gray man someday, I’ll look back on this as a tremendous accomplishment to be able to move a market as massive as this—hopefully in a very good direction.” ●



Evans covers ETFs at Bloomberg News in New York.

How a Financial Pioneer Turned His Attention to Replacing Libor

By ALEXANDRA HARRIS and NICK BAKER

PHOTOGRAPH BY LUCY HEWETT

AFTER RICHARD SANDOR sold his carbon exchange for almost \$600 million in 2010, the Chicago trading legend set out to find another big idea.

He's good at that.

When he was an economics professor at the University of California at Berkeley, a half-century ago, Sandor drafted one of the first plans for an all-electronic market, around the time Wall Street was drowning in paper. Then at the Chicago Board of Trade in the 1970s, he was a driving force in extending derivatives beyond corn, soybeans, and other tangible commodities. Now futures let traders hedge or speculate on financial intangibles such as interest rates and the S&P 500. Indeed, the U.S. Treasury bond futures that Sandor got going in 1977 turned into such a valuable franchise that the Chicago Mercantile Exchange paid \$11 billion to buy the Board of Trade in 2007.

A decade ago, when Sandor was looking for his next big thing, he thought it would be water. "It's going to be the commodity of the 21st century," the 78-year-old recalls in an interview at his office in Chicago's Wrigley Building. But in 2011 news about the London interbank offered rate, known as Libor, caught his attention. A scandal was roiling the heart of global finance, the benchmark for rates on mortgages, student loans, and a gazillion other things that together are valued at hundreds of trillions of dollars. "Libor is going to lose its preeminence as a benchmark," Sandor remembers thinking. "Let's bet the ranch on that."

And so Sandor—whose nickname "Doc" was on the yellow badge he wore in the trading pits, a nod to a doctoral pedigree that stood out on the rough-and-tumble floor—created his own rates index, dubbed Ameribor. His aim was to fix something he thought was wrong with Libor from the start. Traditionally, Libor was derived from a daily survey of large banks, which provided estimates of how much it would cost them to borrow from each other without putting up collateral. It turns out a bunch of the banks

manipulated it for years, fudging numbers to serve their interests.

The problem, Sandor says, is that it wasn't based on real transactions. "It's not a free market, where prices are determined by supply and demand," he says. "It's not the Chicago way."

Sporting black-and-teal eyeglasses and a fedora, Sandor stands out in Chicago's financial community. With his wife, Ellen, who is an artist, Sandor has amassed one of the world's top private collections of photography. Some 200 of their pieces adorn the walls at the American Financial Exchange, an electronic marketplace where small, midsize, and regional banks can lend and borrow short-term funds, and where Sandor is chairman and chief executive officer.

His efforts to create a new interest-rate benchmark initially elicited eye rolls from experts. After all, the Federal Reserve was already several years into its campaign of holding rates at zero. Institutions could access cheap capital in the debt markets, reducing the need for interbank lending, which Libor is supposed to measure.

But two years ago came a huge opening for Sandor. The head of Libor's overseer, the U.K. Financial Conduct Authority, said it would stop making banks contribute estimates to the index by the end of 2021. The move would wean the market off the benchmark, though it would stop short of killing it.

Regulators around the world rushed to find replacements. The U.K. opted to enhance an existing benchmark called the Sterling Overnight Index Average, or Sonia. The U.S. decided to create a rate based on overnight repurchase agreement transactions secured by U.S. Treasuries: the Secured Overnight Financing Rate, or SOFR. Intercontinental Exchange Inc. (ICE)—which happens to be the company Sandor sold his Climate Exchange Plc to in 2010—made its own alternative: the Bank Yield Index, a benchmark that is a rolling five-day average of term funding transactions by Libor panel banks. In addition, ICE Benchmark



Administration, the current operator of Libor, has evolved the benchmark's methodology so that submissions are based on transactions to the greatest extent possible.

It's unlikely that any of these will ever match Libor's predominance. Although the Alternative Reference Rates Committee (ARRC), a collection of market participants and regulators engineering the transition in the U.S., is pushing SOFR as the heir, many are wary of adopting it. Libor has long been used as a barometer of stress in credit markets, but SOFR wasn't designed for that. It only tracks overnight repurchase agreements and lacks a forward-looking curve with tenors extending beyond a day, though Fed staffers have issued a paper about inferring

term rates from SOFR futures prices. By contrast, Libor has rates ranging from overnight to one year.

The Basel, Switzerland-based Bank for International Settlements, which serves as the bank for central banks, said in March that a one-size-fits-all alternative to Libor may be neither feasible nor desirable. And that's what Sandor is betting on. "Multiple benchmarks and choice, as an economist, is good for the market," he says. "What is this love affair with a single index?"

He's going big by aiming small. There's about \$18 trillion in the U.S. banking system, according to Federal Deposit Insurance Corp. data. Roughly half of that is stashed at the largest banks. That leaves \$9 trillion or so in the hands of thousands of smaller ►

Fig. 1 Run {SOFRRATE Index AMERIBOR Index HS D <GO>} to compare the Secured Overnight Financing Rate, or SOFR, with Ameribor.



SOFR has proved volatile, spiking because of supply differences in funding markets.

Ameribor was less erratic than SOFR when the repo market went haywire in September.

banks. And Sandor thinks half of that money—around \$4.5 trillion—is held in variable-rate products that need a new benchmark to reflect their true costs.

Ameribor is a daily rate based on the volume-weighted average of transactions in the overnight loan market between preapproved counterparties, which include banks, broker-dealers, and private equity firms, on the American Financial Exchange.

For someone accustomed to schmoozing finance professionals in London, New York, Paris, Shanghai, and Singapore, selling institutions on Ameribor required a different itinerary. Sandor found himself meeting with bankers in smaller towns, such as Tupelo, Miss. (population 38,206), and Bentonville, Ark. (population 51,111).

Now, he can even point you to the best barbecue joint in the U.S.

AMERIBOR'S CHILLY RECEPTION was similar to what Sandor remembers hearing when he evangelized for financial futures decades ago. "It's a stupid idea. Interest rates don't fluctuate," he says.

But when the Fed convened ARRC to find a new rate in 2014, Ameribor suddenly seemed less outlandish. In December 2015, Sandor's American Financial Exchange introduced the interest rate with a handful of banks at Cboe Global Markets Inc., the market operator formerly known as the Chicago Board Options Exchange. The platform hosts more than 160 companies, mostly banks, and just had a record week, as \$13 billion traded on Sept. 16-20 amid turmoil in the repo market.

Frost Bank, founded in the 19th century in the back of a San Antonio store selling supplies to frontier Texans, took part in

the first overnight loan transaction in 2015 and still uses Ameribor all the time. "It is the best proxy out there for where we can incrementally fund ourselves in the short-term space," says Mark Brell, an executive vice president at the bank.

AFX INTRODUCED AMERIBOR futures, also at Cboe, on Aug. 16. That's right out of Sandor's playbook from 1977, when the Chicago Board of Trade began offering contracts on the 30-year Treasury bond. He says the first step is "the building of the cash market," proving that it's volatile and that there's a need to trade. The next step is building a hedging tool, "because that's the natural evolution of markets." Those 30-year futures began trading when the U.S. had about \$550 billion of debt outstanding. The government sold more than that in the month of August 2019. Today, volume across the Treasury futures franchise (which has expanded to include almost every maturity) has exploded as the debt has swelled to \$16 trillion.

The futures launch is just the beginning of Ameribor's influence. To expand, Sandor and his team will keep meeting with bankers, academics, accountants, and lawyers, trying to prove to them that the benchmark is a true representation of interbank lending costs. And that means more time traveling through tiny towns, helping the smaller banks who finance "the milk farmers and whatnot to the burgeoning tech sector in Indianapolis."

Oh, and the best barbecue?

Sandor says it's Joe's Kansas City Bar-B-Que. "Joe's is a must." It's located at a gas station at West 47th Street and Mission Road in Kansas City, Kan. ●

Harris covers interest rates and foreign exchange at Bloomberg News in New York. Baker is an editor in Chicago.

These Tickers Show What the Market Is Betting the Fed Will Do

By DEIRDRE FRETZ

Fig. 1 To chart the number of estimated moves priced in for the U.S., run `{USOANM Index GP <GO>}`.



“MIDCYCLE ADJUSTMENT.” That was how U.S. Federal Reserve Chair Jerome Powell on July 31 characterized the Fed’s first rate cut since the financial crisis. “It’s not the beginning of a long series of rate cuts,” he added.

Fed funds futures traders accepted that statement at face value. Futures priced in just one more rate cut before the end of 2019. A day later, though, they changed their mind and priced in two cuts.

Bloomberg recently drew on the World Interest Rate Probability (WIRP) function, which calculates probabilities of benchmark rate changes, to create a series of WIRP tickers. You can use them to visualize changing expectations for the next Federal Open Market Committee meeting or to measure expectations for cumulative changes by specific dates in the future.

To see how expectations for U.S. rates have evolved over the past year, type “WIRP number of moves U.S. futures” and select USOANM Index. Then select GP - Line Chart.

After the Fed’s second cut, on Sept. 18, the chart showed futures pricing in about half of a 25-basis-point cut at the next FOMC meeting. To see how expectations for the number of cuts by December have changed, insert “DEC2019” between

USOANM and Index in the ticker box and hit <GO> (**FIG. 1**).

The chart shows that in September 2018, futures priced in three to four rate hikes by the end of 2019. After the Fed raised rates on Sept. 26 and Dec. 18, 2018, expectations changed as global growth slowed. At the end of 2018, futures prices indicated rates would hold steady. Then came the May FOMC meeting, when Powell hinted the committee’s next move could be a cut. Traders adjusted and priced in a 25-basis-point cut. In June and July, trading implied as many as three cuts.

In addition to tracking fed funds futures, WIRP tickers also let you analyze expectations implied by trading in overnight index swaps in seven countries and the euro zone. For a table of available tickers—which track the probability of a move implied by prices of these instruments, the number of moves, and what the forward rate is expected to be—run `{WIRP <GO>}` and click the help icon at the upper right corner of the screen. Select Launch Help Page, click on Calculations, and then on Current Tickers. ●

Fretz is a Functions for the Market editor at Bloomberg News in New York.

Good News, Fund Managers. AI Isn't Ready to Take Your Jobs—Yet

By KSENIA GALOUCHKO

HOW GOOD IS artificial intelligence at managing money? To judge by the recent performance of some AI-driven strategies, it doesn't look like the robots are going to take over from the humans anytime soon.

In August 2018, a quantitative team at Aberdeen Standard Investments started a \$10 million Artificial Intelligence Global Equity Fund, betting that an algorithm can be more effective at figuring out the complex world of factor investing than a human portfolio manager. A year later, the fund had underperformed the broader stock market's powerful rally, and its assets had grown only 8%. Institutional investors say they'll hold off committing money until they see a longer track record.

ARTIFICIAL INTELLIGENCE has penetrated almost every area of our lives, from online customer support to facial recognition to self-driving cars. But investing is proving to be one of the toughest challenges for machine learning.

The main problem is financial market data, according to Bryan Kelly, head of machine learning at \$194 billion AQR Capital Management LLC. Market data—unlike photos or road traffic information or chess games—is finite, and the algorithms can learn only from past performance. “This isn't like a self-driving car where you can drive the car and generate enormous amounts of additional data,” Kelly says. “The dual limitation of very noisy data and not a lot of it in financial markets means that it's a big ask to want the machine to identify on its own what a good portfolio should look like without the benefit from human insight.”

People who try to predict the stock market or interest rates using AI might end up with flawed analysis that can lead to financial

losses, warns Seth Weingram, director of client advisory at \$97 billion Acadian Asset Management. “You see market-naive folks who are trying to apply these techniques get into trouble,” he says. “There's a risk that you don't actually have enough data to meaningfully train your algorithm.”

What's being touted as a revolution has been used by quantitative whizzes for years. Almost all quant funds use machine learning to sweep through social media, news articles, and earnings reports.

PanAgora Asset Management, a \$45 billion quant fund based in Boston, has been creative in using natural language processing to analyze Chinese equities. Its machine-learning tool spiders through online forum posts by retail Chinese traders and identifies cyber slang words they use to avoid government censors, who might crack down on negative language, such as discussions of poor earnings results. Canny Chinese bloggers, for example, replace the word “rubbish” with a phonetically similar expression, “spicy chicken.” PanAgora's model identifies such similar-sounding words and the context in which they appear to gauge sentiment about Chinese companies.

PanAgora is also looking at using AI to execute trades and spot accounting abnormalities that a simple analysis wouldn't find. “We have tons of data [on the execution of trades], and now instead of making all these individual decisions using anecdotal evidence from the trading desk, we can make a much more quantitative decision given past results,” says George Mussalli, equities chief investment officer at PanAgora.

ONE REASON Aberdeen Standard and others are turning to robots for help is the recent market environment. Investors are fretting

Fig. 1 Run {ABAIZAU LX Equity COMP <GO>} to use the Comparative Returns function to track the performance of Aberdeen Standard's Artificial Intelligence Global Equity Fund.



over the end of the bull market as trade tensions and an inverted yield curve flash warning signs for global growth. But they're afraid to exit too early and miss out on late-cycle returns.

Yet swings in investor sentiment are hard for machines to navigate, too. "If the market becomes unpredictable, it's always more challenging for AI," says Anand Rao, global artificial intelligence lead at consulting firm PwC. "This time around, there are different forces acting. But [the collapse of the credit market bubble in] 2007 was also very different, and so was [the end of the dot-com bubble in] 2000. With more data and more history, AI funds will get better."

So far, machines seem befuddled by these markets. After outperforming the Hedge Fund Research HFRX Equity Hedge Index in four of the last five years, Société Générale SA's long-short U.S. stock index based on a machine-learning model has been lagging this year, with a return of less than half that of HFRX. The Eureka hedge Artificial Intelligence Hedge Fund Index, which tracks hedge funds that use machine learning, has also underperformed in 2019: Its gain of 2.3% through Aug. 31 trailed the 6.9% return for the broader HFRX Index.

"This year has been challenging for AI funds. It's probably the first time in the history of the U.S. that you have a president tweeting these kinds of things," says Nicky Indradi, an analyst at Eureka hedge. "If you give AI funds more time to better understand the technology they're using, I'm optimistic that they'll be able to perform well."

ONE OF THE SOCGEN INDEX'S creators, Andrew Lapthorne, says the robot's strength is in feature recognition: picking biotech

stocks that have a better chance of outperforming, for example. But he also warns that the strategy needs time to develop before it can be offered to a larger number of clients—about \$39 million of assets currently track SocGen's machine-learning strategies. In addition, he says double-digit returns are unrealistic.

Nobel Prize-winning economist Robert Shiller is also tempered on AI's prospects. "I think we still need human oversight," Shiller says in a London interview. "AI can really mess up when reacting to text because a word may have a new meaning or there could be a typo—we would recognize it as a typo, but the machine might not."

Still, Boyan Filev, co-head of quantitative equity at Aberdeen Standard, says the advantage of utilizing machine learning to manage a portfolio is that it adapts to the market and improves over time. The fund's underperformance, he contends, is mainly the result of challenging markets and changing behavior of so-called equity factors, which have led to losses at many quant funds in 2019. "Our fund was positioned more defensively at the start of the year in line with the bear market of the end of 2018. However, the sharp reversal of equity markets this year hasn't been particularly helpful," Filev says. "A more stable and slower-evolving environment is more beneficial to our product. Very sharp reversals in market directions are very hard to position against in the short term."

Filev expects the fund to adapt to conditions, he says. It just hasn't done so yet. ●

Galouchko covers European stocks for Bloomberg News in London.

Metrics Such as Subscriber Numbers Move Stocks. Here's How to Track Them

By DAVID TUNG

WHEN ANALYSTS BUILD earnings models for a company, they typically include forecasts for particular business lines, products, and regions—metrics that often determine a company's bottom line and stock performance.

These data points tell the story of what's happening at a company. To track them, you can use the Analyst Estimates and Models (MODL) function. MODL lets buy-side users see consensus numbers and request entitlement to view and download the models of specific sell-side analysts.

Let's take a look at some info you can glean from MODL.

Key Drivers

Netflix Inc. shares plunged as much as 11% shortly after the market opened on July 18, ending the day down 10.3%.

What caused that drop? Subscriber numbers. The streaming video giant has consistently found more people around the world willing to pay for access to its content. But on July 17, when the Los Gatos, Calif.-based company announced second-quarter results, its subscription numbers came up short of expectations.

So how do you find the consensus for such a metric? That's where MODL comes in. First, type "Netflix" in the command line and click on the NFLX US Equity match. Then type "estimates and models" and click on the MODL—Analyst Estimates and Models item. The shortcut is **{NFLX US Equity MODL <GO>}**. In MODL, scroll down to the Net Membership Additions section to see consensus numbers for paid memberships.

Before Netflix reported, the consensus of analysts' models called for the company to add a bit more than 5 million paying streaming subscribers in the quarter: 309,000 in the U.S. and 4.75 million outside of the U.S. Instead, the company added only

2.7 million subscribers—losing 126,000 in the U.S. while gaining 2.83 million internationally.

Altogether, subscriber gains were 2.35 million fewer than anticipated. Hence, the dramatic drop in the stock. For Netflix, subscriber numbers are a key driver of performance.

Product

Another way to use MODL is by looking at product breakdown estimates. Consider, for example, cloud revenue at big tech companies. Famously, the growth of Amazon Web Services helped to make Amazon.com Inc. into one of the most valuable companies in the world. How fast are its competitors growing? You can use the consensus analyst forecasts from MODL to put together a simple comparison. Here's how.

Let's start with the Amazon of China, Alibaba Group Holding Ltd. Type "Alibaba" and click on the BABA US Equity match. Run **{MODL <GO>}** again and click on the Source View tab. Scroll down to the Business Breakdown section, then under that heading, to the Cloud Computing item. As of early September, the consensus, which was based on nine analysts' models, called for cloud computing to generate 9.34 billion yuan (\$1.31 billion) in revenue for Alibaba in the second quarter of the 2020 fiscal year (**FIG. 1**). The projection for one year out: 14.14 billion yuan. That's a growth rate of 54%. You can use the slider at the bottom of the screen to see estimates for further in the future.

If you plug in Amazon's ticker, you can see that the e-commerce giant is expected to increase revenue from AWS by 32% over the next four quarters. Do the same with Microsoft (24% growth), Oracle (1%), and Salesforce.com (17%), and you can get a picture of which company is expected to increase cloud computing revenue the fastest. The

Fig. 1 To see consensus numbers for Alibaba's cloud computing revenue from analysts' models, go to **{BABA US Equity MODL <GO>}**.

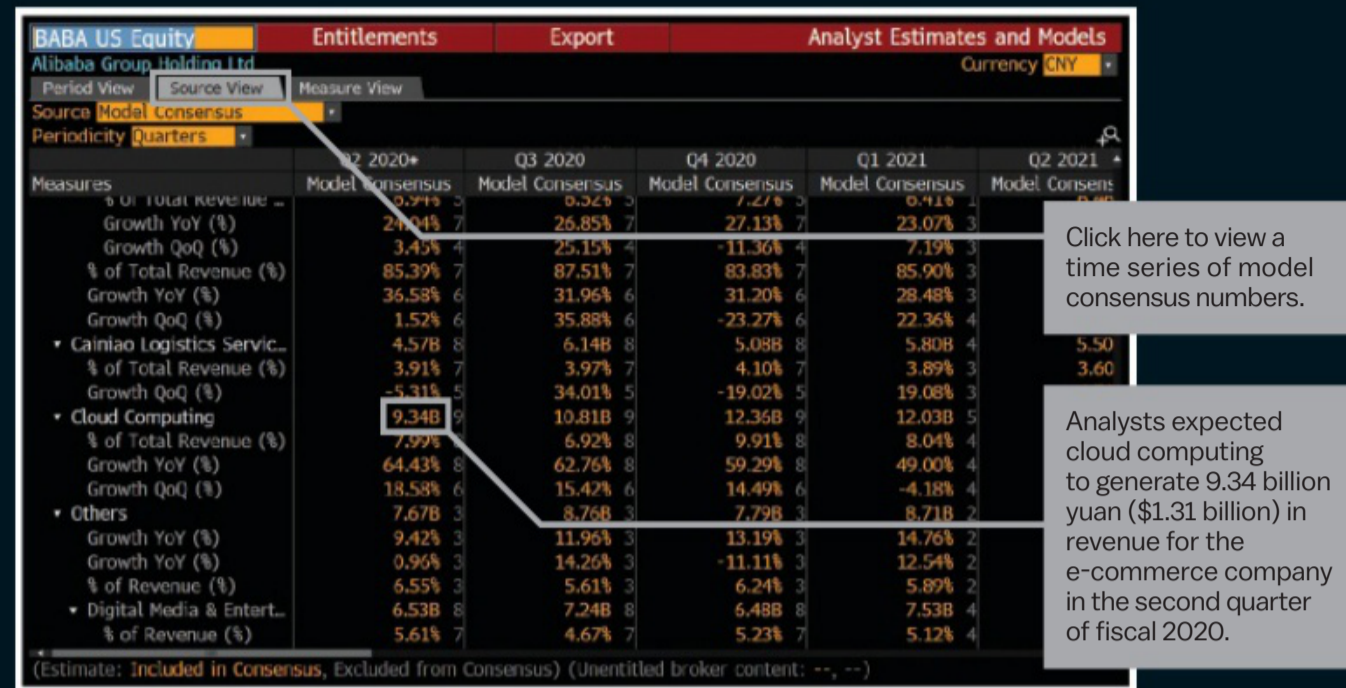
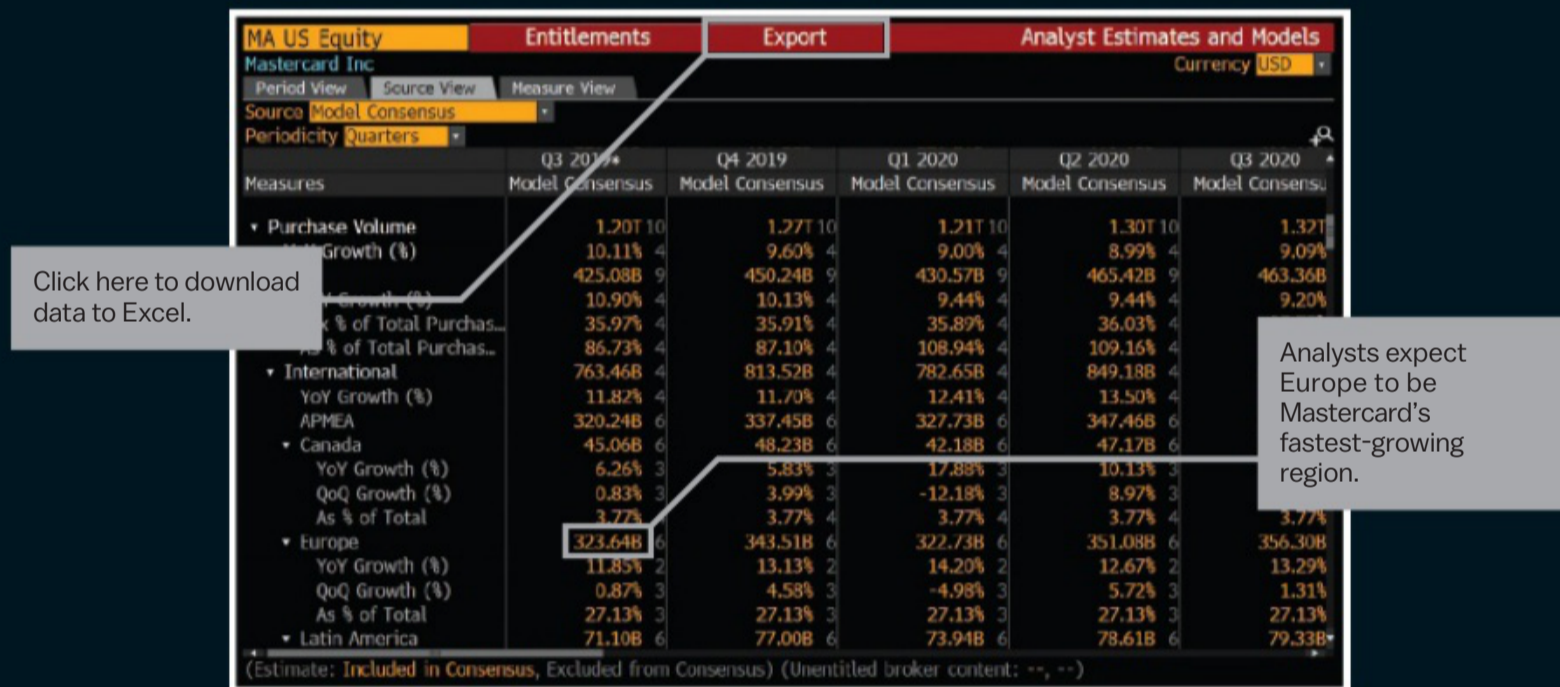


Fig. 2 What regions will drive Mastercard's growth? Run **{MA US Equity MODL <GO>}** to dig into analysts' projections.



two e-commerce companies, it turns out, are leading the way among the big tech companies that break out cloud computing revenue, (which Google parent Alphabet Inc. doesn't do). Alibaba is expected to grow the fastest, followed by Amazon.

Geographic

MODL data can also help you compare geographic data. Let's take a look at the purchase volume of Mastercard Inc. and Visa Inc., two U.S.-based card companies with business all over the world.

Run **{MA US Equity MODL <GO>}** for data on Mastercard. Click on the Source View tab again and scroll down to the Purchase Volume section. Here you can find consensus expectations for purchase volume in the U.S.; the Asia-Pacific, Middle East, and Africa region; Canada; Europe; and Latin America (**FIG. 2**). Click the Export

button in the red toolbar to download a spreadsheet version.

Next, run **{V US Equity MODL SOURCE <GO>}** to find a similar series of numbers for Visa. You can use these numbers to compare regional growth for the two companies.

When we plotted out the change in consensus total purchase volume for the companies through the end of 2022, we found that Mastercard was expected to grow faster in 8 of the next 10 quarters.

The regional growth numbers add some nuance: Analysts expect growth in the U.S. to be substantially similar for both companies. The difference is that they expect Mastercard to increase purchase volume faster internationally. They expect Europe to be its fastest-growing region. ●

Tung is on the global data team at Bloomberg in Princeton, N.J.

A Tech Veteran's Search for Green Fields

By MARTY SCHENKER

PHOTOGRAPH BY REED YOUNG





BEN ROSEN HAS HAD several careers—technology analyst, early venture capitalist, entrepreneur—any one of which would have made him notable. A New Orleans native educated at the California Institute of Technology, Stanford, and Columbia Business School, Rosen introduced Steve Jobs to Morgan Stanley and financed Compaq Computer, Lotus Software, and Electronic Arts. With his older brother, Harold, Rosen co-founded in 1992 an electric car company that employed J.B. Straubel—long before Straubel helped start Tesla Inc. In an interview at his home in Kent, Conn., Rosen, 86, looks back over his pathbreaking career and describes what excites him today. Here are some highlights.

MARTY SCHENKER: You were there at the crossroads of some historic developments.

BEN ROSEN: The timing was fortunate. I just happened to cross paths with some people who were really important in our lives. Steve Jobs and Bill Gates when they were 22 years old. And then Gordon Moore. He was my teaching assistant—when I was a freshman at Caltech, he was a first-year graduate student. So I've known him since 1950, and we stayed in touch. Later, Compaq was Intel's No.1 customer. The inventor of the spreadsheet, Dan Bricklin, and his associate Bob Frankston, I knew. They showed it to me in the beginning. And Mitch Kapor, who took it to the next step. Bob Noyce and Jack Kilby, who invented the integrated circuit. Kilby got the Nobel. Bob didn't get it—only because he was dead.

MS: And Morgan Stanley's position as an underwriter of technology company initial public offerings [IPOs] started with your introductions.

BR: First was the Apple IPO [in 1980]. They'd done one [technology IPO] many years ago, decades earlier. I don't even remember the name of it. They apparently lost their shirts on it. They were embarrassed. It violated their rules, which was to be the banker for the No.1 or No.2 major companies in the major industries. They took a chance on this company. It was a disaster, so they decided no more technology.

MS: But then you introduced Steve Jobs?

BR: To Bob Baldwin. And it was funny to watch them. This was at a small trade show at the Hilton a few blocks from Morgan Stanley. And Steve knew nothing about the financial world, and Bob [who led Morgan Stanley from 1973 to 1983] knew less about technology. And the two of them were each trying to sell themselves. Neither heard the other or understood what they were saying. But anyway, they [Morgan Stanley] became a big technology underwriter. I had just left Morgan Stanley, and I was a one-year consultant before I moved out altogether.

MS: You could have been an early investor in Apple?

BR: Mike Markkula, who is the original investor in Intel—he bought a third of the company in 1976, I believe, for \$91,000—one might call it really good venture investing. I knew him when I was an analyst. I used to see him at Intel. And he met Steve at a homebrew computer club in 1975. We were good friends, and he offered me \$1 million of Apple stock at the time. I thought that somehow this was a conflict, even though Apple was a private company. I was an analyst. I was never on the banking side.

MS: So do you follow technology now? What interests you?

BR: Well, there are a lot of things that interest me. But to what extent? I'm an optimist. I got the optimism from my brother. He was the inventor of the geostationary communications satellite. He would always see the glass half full. ▶

With something like climate change, I don't minimize the issues, but I think that the solutions are being minimized. And the way to do something is to fund science.

The only investment I've made in 20 years, I just made [in Energy Vault SA]. There's a longtime friend who runs an incubator in Pasadena, a Caltech graduate named Bill Gross. He's actually the inventor of something called paid search, and he had a company called GoTo.com that started before Google, and they created the system that allowed one to get paid for search online.

He has a new invention now with another person, attempting to solve the single problem that is most impeding renewable energy, and that is storage.

Nature does it by having a lake at a high altitude, and you can release the water when you need the energy to generate electricity, and when you have excess electricity you pump it up again. But all of the natural storage areas are taken. So Bill came up with the idea to emulate nature, but instead of using water to use concrete. So the [Energy Vault] system takes 35-ton concrete blocks, lots of them, in a solar field or a wind farm, and when they're generating energy that's not needed, they have a six-arm crane very high up that pulls these up. And when they need energy, the cranes let these things down and they generate electricity. I'm not interested in apps—they're useful and all—but I like things that are grand, and this is grand.

MS: When you started in venture capital in technology, it was a relatively new field.

BR: This is '81. You could count on your hand how many venture firms there were. So what we were [Sevin Rosen Funds, founded with L.J. Sevin] was a startup only, just green fields. We didn't do, with very few exceptions, any secondary investments.

MS: What always fascinates me is the difference between the person and the idea. How do you weigh those in your investments? Is it the idea or is it the person that's more important?

BR: You mean in making the decision? The answer is yes.

MS: [Laughs] So it's both.

BR: In some cases it's one. For instance, in Compaq. At our initial meeting with the three entrepreneurs in Houston, they presented us with a hard drive for the then-just-introduced IBM PC. They were all at the hard-drive division at TI [Texas Instruments]. This is what they knew, and this is what they wanted to do. And we didn't think that was enough, for us anyway, to build a company with. We encouraged them to go back and come up with another idea because we liked them.

Then they had a sketch of a portable PC. That sold us, and we invested in them because it was something that nobody was really doing at the time. The other thing we did was subtler but more important, and that was to make the first fully compatible PC with IBM. We knew IBM would get the business market, and we had to make something that a buyer and a customer wouldn't get fired for [having].

Some people—Trip Hawkins at Electronic Arts—he was at Apple before. We liked the guy, and he said he was going to become a game studio.

One of the big risks is falling in love with a product. Because products usually have a lifetime, and if you don't have an organization that comes up with the next product and the next and the next, then it will be a short-lived investment.

MS: There are people who are raising questions about [Apple Inc. CEO] Tim Cook and what's next after the iPhone.

BR: Why don't you come up with another half-a-trillion-dollar product? What's wrong with you? [Laughs]

MS: In terms of people, I'm also curious about your involvement in politics. You held the first fundraiser for Barack Obama, or among the first.

BR: Not the first. I don't know who the others were, but yeah, we'd seen Barack Obama on television. This is before he declared in Springfield in February '07.

We saw Mayor Pete [Buttigieg] on *Charlie Rose* a couple of years ago. He was just a mayor. And then we started hearing about him late last year. And so I wrote, "To the mayor of South Bend, South Bend, Indiana: I would like to invite you to a fundraiser."

With both of them it was hard inviting people. The first time, because Hillary was inevitable. We had a different problem with Pete because we sent the invitations in February, and he was really not known. And then 10 days before our meeting was the [Buttigieg] CNN town meeting, and that was really a spike. So we got 85 people to come to our apartment [in Manhattan].

MS: Is there anything, looking back on your career, that you would love to have done differently?

BR: Well, let's see. I made a huge investment in a company my brother and I started, to make a hybrid electric power train for hybrid cars. Rosen Motors. It was one of those things that was an artistic success and a commercial failure. The technology was incredible. Some of it lives today in other companies, but not the promise that we had for it.

Other things, well, if I got another chance, I'd go to a liberal arts school because I'm more interested now in the cultural world. I went to Stanford after Caltech, and I saw the difference, because it had a student body that was interested in everything.

MS: So if someone in business school was interested in an entrepreneurial career, what would you advise him or her to do?

BR: I'd advise them to go to work in a company that's doing something that would provide requisite experience—organizationally, maybe technically—in what the real world is like. Even though I went to business school, I don't think it's as helpful as getting industrial experience. And when I see now who's in venture capital firms, they're replete with people who've been in the industry. The other thing you learn by going into the real world is the network you develop. The network I got, even though it wasn't industrial, but just by starting a conference and by starting a newsletter, I knew everybody in the part of the technology world I was interested in. And it was invaluable.

MS: You want to change philanthropy now?

BR: We live near Lincoln Center, and when we go to the ballet, we go to David Koch hall, and when we go to the Philharmonic, we go to the David Geffen hall. But if a person could go to a ballet at the Balanchine hall or a concert at the Leonard Bernstein hall, it would have such a different impact. There are 60 buildings at Caltech that have names, but there's no Richard Feynman physics building, there's no Linus Pauling chemistry building. The largest single contribution that we've made has been to start a biotechnology center at Caltech, and it's a big deal there. And the woman who runs it, Frances Arnold, won the Nobel this past year. So the Donna and Benjamin M. Rosen Bioengineering Center is going to be the Frances Arnold Bioengineering Center. ●

Schenker is Bloomberg's chief content officer in New York.

Here's Help for Spotting Potentially Profitable Market Anomalies

By MARK JORDAN

IN THE EQUITY DERIVATIVES WORLD, there are no coincidences. At least that's the way it seems to skeptical options traders: Events happen for a reason, whether it's causation or correlation.

Market anomalies offer opportunities if you're of that statistically oriented mindset. A weird "coincidence" must have some explanation, even if you don't know what it is yet. What's more, it might be a signal you could profit from.

The difficulty, of course, is that it takes a lot of bandwidth to scan all of the relevant market information to uncover and analyze such signals. That's where Bloomberg Automated Intelligence can help. BAI identifies anomalies in Bloomberg's vast data sets and analytics and then alerts you with automated, actionable news stories. For more on BAI, type `HELP BAI` in the command line and hit `<GO>`.

There are many different types of BAI stories. Coded to the companies they concern, the stories show up in regular news flow and include a button that lets you subscribe. Here's a cheat sheet for some of the key varieties of BAI stories:

{NI RTOPTBAI <GO>} Real-Time Options Surges: Publishes a real-time alert when trading in options on a U.S. or European company's stock is more than three times the 20-day average volume.

{NI SVELBAI <GO>} Social Velocity Alerts: Generates an alert when there is a significant increase in social media postings about a company. In some cases, also shows a reading on whether sentiment is positive or negative.

{NI IMPVOLBAI <GO>} Implied Volatility Changes: Creates an alert when there is a significant change in one-month, at-the-money volatility for options on a company's shares.

{NI TRACEBAI <GO>} Trace Volume Spikes: Notifies you when trading in a company's bonds is at least double the average for that time of day based on data from the U.S. Financial Industry Regulatory Authority's Trade Reporting and Compliance Engine, or Trace.

{NI 13DBAI <GO>} Individual 13D Filings: Publishes an alert when a 13D filing shows that an activist investor has disclosed a stake of more than 5% in a company.

Fig. 1 BAI stories on options volume surges publish when trading in options on a company's stock exceeds three times the average.



{NI VOLSPKBAI <GO>} Volume Spikes: Publishes alerts when trading in a liquid stock is at least three times higher than the 20-day average volume for that time of day.

CONSIDER THREE EXAMPLES in which these kinds of BAI alerts signaled market events that emerged later.

PG&E: A Possible Settlement

On June 5, BAI picked up bullish signals on shares of PG&E Corp., the San Francisco-based power company that sought Chapter 11 bankruptcy protection in January because of potential liability from California's deadly wildfires.

PG&E shares opened at \$18.74 on June 5, unchanged from the previous day's close. At 10 a.m. New York time, a BAI story noted that option volumes had surged, led by the June \$22 calls (**FIG. 1**). (Call options grant the right to buy shares at a specified strike price on or before expiration.) Then, at 2:16 p.m., a second BAI story reported that the volume of social media postings related to PG&E had quadrupled and that sentiment on Twitter was some-

what positive. At 3:15 p.m., another BAI article reported that implied volatility had jumped, reaching the 88th percentile of its levels during the preceding 12 months.

Right before the market closed, news reports said that PG&E was putting together an \$11 billion pool of capital to settle its wildfire claims. The stock closed at \$20.75, an increase of almost 11%.

For options traders who don't believe in coincidences, the potential upside was even greater: The June \$22 calls rose 145% on the day.

Mylan: A Deal

On July 23, a BAI alert pointed out that trading in options on shares of specialty drugmaker Mylan NV had swelled. The most-traded contract was the September \$20 calls. Later another story noted that volume in Mylan bonds was more than twice the average: Trading totaled \$51 million at 5 p.m., vs. an average of \$21 million (**FIG. 2**). The next day another alert showed another surge in options volume.

The following Monday, July 29, Mylan announced it was combining with Pfizer Inc.'s off-patent drug unit in an all-stock deal. ►

Fig. 2 Stories on Trace volume spikes let you know when trading in a company's bonds is twice the average.



Fig. 3 This alert publishes when an activist investor files a 13D disclosing a stake in a company.



When the market reopened, the September \$20 calls rose by as much as 140% from the time of the first alert.

Cloudera: An Activist Stake

A third example started on July 31. A BAI alert that day reported a jump in Cloudera Inc.'s implied volatility, bringing it up to the 83rd percentile. The next day at 10:15 a.m., another alert noted that volatility dropped. But subsequent BAI stories noted that social media volume climbed, the company's share price rose the most in six weeks, and options volume surged again, led by the February \$5 calls. At 4:39 p.m., yet another BAI alert revealed that Carl Icahn had reported a 12.62% stake in the Palo Alto, Calif.-based software company in a 13D filing with the U.S. Securities and Exchange Commission (FIG. 3).

An options trader who was skeptical of all of those

"coincidences" could have profited. The 13D announcement sent Cloudera shares up 20% in after-hours trading. The February \$5 calls could have spun profits of as much as 30% when the market reopened.

BAI IS ESPECIALLY POWERFUL for derivatives because of options' leverage and the integral nature that volatility plays in their prices. These characteristics often result in a very small window of opportunity for a trade to be profitable—or to exit a potentially loss-making position. Any advance warning of a potential move, therefore, is highly sought after by options traders. The edge in timing that BAI delivers can be extremely valuable. ●

Jordan is an equity derivatives market specialist at Bloomberg in New York.

Scan Completed: Wed 01 2018 16:28

Symbol	Price OCT 26 2018	Seq All c/d Daily OCT 26 2018	Combo/b All c/d Daily OCT 26 2018	All Setup Daily OCT 26 2018	Seq 15 Min Daily OCT 26 2018
INTC UW Equity	45.69	9	10	5	1
JNJ UN Equity	136.97	9	10	4	1
JPM UN Equity	103.42	10	10	5	1
KO UN Equity	45.92	11	7	1	1
MCD UN Equity	173.34	10	10	5	1
MMM UN Equity	184.95	10	10	5	1
MRK UN Equity	70.40	10	9	3	1
MSFT UW Equity	106.96	10	10	5	1
NKE UN Equity	72.07	5	9	5	1
Total Up		7	9	0	0
Total Down		9	9	0	0



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Paytm's Sharma Is Ready To Take On the World

By SARITHA RAI

PHOTOGRAPH BY ANSHIKA VARMA

VIJAY SHEKHAR SHARMA, 41, founded closely held One97 Communications and its brand Paytm (rhymes with ATM) almost two decades ago. It offered a variety of digital services before moving into payments in 2014, just as millions of urban Indians began shopping online. Two years later, India's banks created the Unified Payments Interface, a tech umbrella to help banks and fintech startups create services quickly, and the government eliminated high-value currency notes, turbocharging demand for Paytm's services. Sharma, a self-described hippie who loves to sprinkle U2 and Pink Floyd lyrics into his conversation, now has backers including Alibaba's Jack Ma, SoftBank's Masayoshi Son, and Berkshire Hathaway's Warren Buffett.

Paytm is the market leader in India, where KPMG sees digital payments growing at the fastest rate of any country, with transaction value rising at an estimated annual rate of 20.2% from 2019 to 2023. But competition is heating up as Google, Walmart, and Facebook jump into India, wielding cashback offers to lure customers. Meanwhile, the government has proposed scrapping fees on digital payments, Paytm's core product. In an interview in Delhi, Sharma described his career and how Paytm is adapting to India's changing market, cutting annual expenses 45% and preparing to raise new funds to accelerate the next phase of growth in smaller cities.

SARITHA RAI: What led you to digital payments and e-commerce?

VIJAY SHEKHAR SHARMA: I grew up in a small town called Aligarh where I studied in a very basic Hindi medium school [where Hindi

is the medium of instruction]. I didn't have fancy schooling. I was lucky to get into engineering college in Delhi at the age of 15. I taught myself English by memorizing rock songs and simultaneously reading translated textbooks in English and Hindi. When I graduated, I was the youngest teenage engineer out of the University of Delhi. As the Pink Floyd song [*Breathe*] goes,

Run, rabbit run.
Dig that hole, forget the sun,
And when at last the work is done
Don't sit down it's time to dig another one.
For long you live and high you fly
But only if you ride the tide
And balanced on the biggest wave
You race towards an early grave.

My early heroes were internet entrepreneurs Jerry Yang and Mark Andreessen. I started One97 Communications in 2000 and began by selling content to users through telecom operators. By 2010 the smartphone became the distribution channel. Payment became our thing, and destiny was in our hands. In 2014 we launched our licensed wallet product. By 2015, Ant Financial had invested in us, then Alibaba and then SoftBank.

A whole generation of internet entrepreneurs in India have small-town roots and hunger to build something significant and successful. My father was a schoolteacher. I had four siblings;



there was no money to go around. I had to find ways to make money through weekend consulting jobs to set up computer networks for small businesses. At engineering college, I naively asked around [to find out] what the best-paying job is. Somebody said CEO. I didn't even realize the person was being sarcastic. I knew the only way to get to be CEO was to build my own company. Looking back, I've never had a business card which said CEO. When I set up One97 Communications, my business card stated my title as EO. My engineering school buddy and one of my first employees, Harinder Takhar, also had the same title. We were both EOs.

I couldn't get to Stanford or Silicon Valley. Somewhere there was the urge that I should do something worthwhile, but I would have to do it in the Silicon Alley called Delhi. I wanted to build a great company; I wanted to attract the best talent. The internet age was calling. Paytm began offering people searches and went from there into business services, payments, commerce, gaming, content, financial services, and banking.

SR: Are you satisfied with what you've built so far?

VSS: Many entrepreneurs are called "overnight success." I say, "Yeah, my overnight was 19 years long." We started in the dial-up internet era, where we ran up huge phone bills. We now carry the internet in our pockets. How far we have come! The last 20 years have been the most significant for India. It is an unprecedented kind of change the world hasn't seen, not even in the U.S. or China. Nowhere else have such a large number of users come online in such a short period of time.

SR: How will India's digital payment transformation be different from China's?

VSS: China has two players. We will not have that kind of dominance. India will have four or five players, with a leader, which will have significant market share. Everybody can coexist. Payment is way too huge a problem for one or two players to control.

India is far more competitive. We have neither the best talent nor the best infrastructure, nor the required levels of capital. We have to be far more resourceful. To raise money we have to take a flight out of India and explain our market to investors. Neither the Chinese nor the Americans have had to describe their market to their investors.

SR: Is India changing?

VSS: With low mobile data tariffs, the internet is reaching the corners of India. That's spawning a huge number of startups in payments, cloud, and even startups that help people file taxes. There is a large local market. Risk capital is available to win the market. We are now grade-A entrepreneurs, not Third World businesses. It is possible to build a business to serve this country and then take it to the rest of the world. These are phenomenal days. Ten years ago, there was no local market, no risk capital, no internet infrastructure, no customers. When we started, it was the very beginning of the internet era of the country. I feel tickled that I am now bracketed with today's young entrepreneurs of India, like Ritesh Agarwal of OYO [Oravel Stays Pvt.] and Bhavish Aggarwal of Ola [Electric Mobility Pvt. and ANI Technologies Pvt.]. ▶

**“If you build in India, you can go build anywhere
in the world. What do you think is the first thing an Indian kid learns?
That the bus stop is not where the bus will stop”**

●

Nobody remembers that I started with old-generation internet businesses.

SR: Competition is building up in digital payments—Walmart, Google, and others whose launch is imminent.

VSS: Rivals are spending huge amounts of money, but none of them have dented our market share. India’s digital payments market share is expanding. In the next five years, India will be a much more digitized country. That’s a good thing. As for rivals spending money, the big giants with the deep pockets never win the war. Microsoft didn’t win the search war. Search didn’t win the social war. Social didn’t win the messaging war.

I can bet that none of the above is going to win the digital payments war. It’s a huge opportunity. There will be many players. This country could produce the payment player which will go on to dominate the world. It will be an Indian player, not a Chinese one. The payments leader of India will build a low-cost, highly scalable model in an extremely competitive environment. The winner here can go and win anywhere.

SR: Why is cash still king in India?

VSS: We’ve had the first phase of India’s digital payments journey with many world players as our rivals. We were the clear leader in the digital wallet phase.

The second phase began with the United Payments Interface, which is the tech backbone linking banks and digital payments players so they can create services quickly and cheaply. Our rivals are using that backbone for person-to-person money transfers rather than merchant payments. Our business model is in merchant payments, in the everyday experience of users paying businesses. That’s our journey now.

Less than 10% of payments made by users to businesses is through digital means. We believe merchants should provide their customers the whole range of options, and that’s what we offer through the Paytm wallet, which accepts cash, debit cards, credit cards, UPI-linked bank accounts, and other wallets. A digital wallet is far more inclusive. Even if a user doesn’t have a bank account, he can do digital payments.

SR: When UPI was introduced, it seemed that digital wallets were going to die.

VSS: In the early days, I had assumed that people would give up on the wallet after you could link a bank account and begin using UPI. But users are still uncomfortable with linking bank accounts. There is low penetration of digital money and low consumer trust. The pecking order in the country is: cash, followed by card, then wallet, and UPI.

We do more than 600 million merchant payments a month. All UPI payments together are not even as big as our wallet transaction numbers. The whole UPI universe has 110 million registered users, but less than 10% of them account for more than 80% of transactions. On UPI, all apps put together have a \$150 million monthly payments volume. We have a total of \$390 to \$400 million volume via Paytm through UPI, other wallets, cards, and cash. After spending billions of dollars, Google Pay and Walmart’s PhonePe haven’t been able to touch us.

SR: How do you enlist merchants?

VSS: It takes time. Shopkeepers need a lot of hand-holding for digital payments, cloud services, and everything else. They are underserved by tech companies. We are currently at 13 million merchants and will reach 25 million by March 2020. It’s all about how many cities, how many shops, how many markets give consumers the chance to use digital payments. We are very visible in India’s main cities. We are now headed to Tier 3 and Tier 4 markets.

SR: To transition merchants to digital payments and other digital services can’t be easy.

VSS: We are offering software where they can create their own store and start selling online. They can build their business’s credit score and access our instant business loans. We have leapfrogged from being a payment company to a complete ecosystem for small and medium enterprises for their software and financial-services needs. Our “Business With Paytm” app is in 10 languages. In this era of zero-margin digital payments, as mandated by the government, we have to make money on additional services such as financial services and cloud services.

SR: Isn’t every digital payments service using cashbacks as a lure?

VSS: Cashbacks are a good thing. They incentivize users and merchants to try out digital payments. Our cashbacks, by the ►

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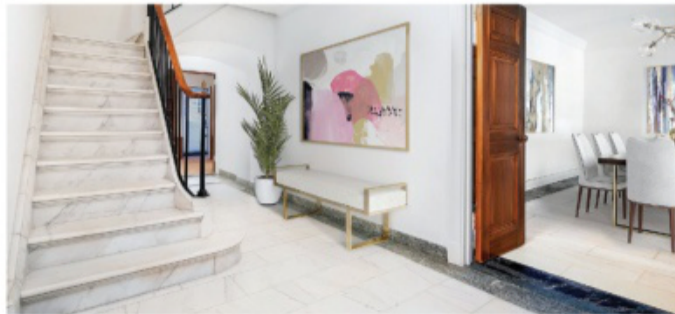
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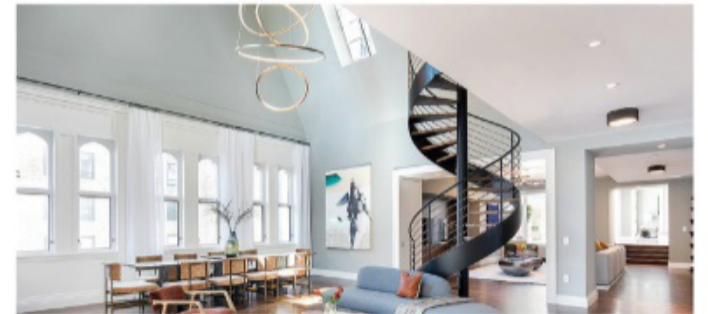
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**“For a payment company like ours,
competition does not come from another payment company.
It comes from hackers”**

●

way, are not in cash. They are in the form of movie vouchers, flight vouchers, and so on. Cashback is a strategy for us. We have pushed the Paytm cashback logo a lot more in the last few months.

SR: How have you innovated for users in the smaller towns and semi-urban India?

VSS: We use a lot of data. Rich users don't value the 20 rupee [28¢] cashback. Our engine understands who values the small sum of money. Our AI is built at Paytm Labs in Toronto. We started in 2014. We have the ecosystem advantage because we can be the one stop for many things. We introduced cancellation insurance for movie tickets. This is a global first. The cancellation value is extremely low, and our AI engine ensures that it's an extra revenue earner.

Here's another example: India saves in gold. We allow users to buy infinitesimal amounts of the metal. For example, a user can buy gold for 11 rupees and aggregate. Buying gold is a wealth service we offer everyone. Our gold product has more customers than all wealth management companies in India put together. We have 17 million users.

SR: What will it take to win India?

VSS: Some people still want to pay by card—card transactions are the highest by value. Others want to pay by wallet because they do not want to link their bank account to third-party apps for fear of digital theft. As the market matures, all use-cases as a combined offering makes sense rather than just one. In the countryside, there's huge fear they'll get defrauded of their money. Soon as one system grows, fraudsters walk into that system. That is why we have a large investment in setting up a lab in Canada building fraud detection systems. We have 110 people there. We have been lucky so far. We have been working hard. For a payment company like ours, competition does not come from another payment company. It comes from hackers.

SR: What's the life of an Indian entrepreneur like? We had a tragic suicide recently of the founder of India's largest cafe chain [V.G. Siddhartha], who described himself as a failed entrepreneur.

VSS: In India it is particularly tough. Entrepreneurship is looked down upon, unlike in the U.S. We are just above Africa markets in terms of per capita income. We have to build a business

model for that. Then there are many rules and regulations, sentiments, behavior.

Siddhartha's suicide is heartbreaking for entrepreneurs like me.

You have to be far more Zen to survive in this country. As I said, if you build in India, you can go build anywhere in the world. What do you think is the first thing an Indian kid learns? That the bus stop is not where the bus will stop.

SR: Is there an IPO round the corner? Some of the most high-profile companies backed by Masayoshi Son, such as Uber, have gone the IPO route.

VSS: Masa has never mentioned the word IPO to me. We will remain private for the next two or three years for sure. I look up to Warren Buffett, Masayoshi Son, and Jack Ma. Their ambition is to build huge impact on their markets, cities, countries, business domains. They are all market share-centric. What I take from them is: First, learn to do one thing really well. Then build the next level of business on top of it. That's the common thread. We're not even on the preparation journey for the IPO, which itself takes a couple of years.

SR: Then are you looking to raise funds?

VSS: There is a huge amount of incoming investor interest. People with large-dollar checks are knocking at our doors. Once we figure out the business requirement and get the necessary board OK, we will raise money. We are very well-capitalized for our business model.

SR: Where is Paytm headed in the next few years?

VSS: Paytm is [dominating] and will dominate India's mobile payments ecosystem. Paytm Payments Bank has overtaken India's No.1 mobile bank, state-owned lender State Bank of India. Just like Ant Financial dominates payments in China, Paytm wants to dominate in India. We are getting into insurance and lending. We've created world-class tech that can be replicated both in emerging and developed markets. We built payments from the bottom up in Japan with Made in India technology. PayPay [a joint venture among Paytm, SoftBank, and Yahoo Japan] today has 10 million customers. We will go to the Americas and Europe. ●

Rai is a reporter covering technology for Bloomberg News in Bengaluru.

Fintech Facts

A Gold Rush Overseas

■ Mobile phones are transforming finance. While most *Bloomberg Markets* readers have a mobile phone and a bank account—and perhaps a bank app on their phone—millions of people around the world have the phone but no bank. These underbanked markets, led by countries in Asia and Africa, have inspired fintech innovation that’s leapfrogging the technology available in the developed world. The sheer number of potential customers doesn’t ensure success, however. The winners are the companies that have devised business models that can profit in less developed markets, or that expand to serve wealthier customers. Ant Financial Services Group’s Alipay and Tencent Holdings’ WeChat Pay in China, Paytm in India, and Safaricom’s M-Pesa in Kenya are some well-known examples.

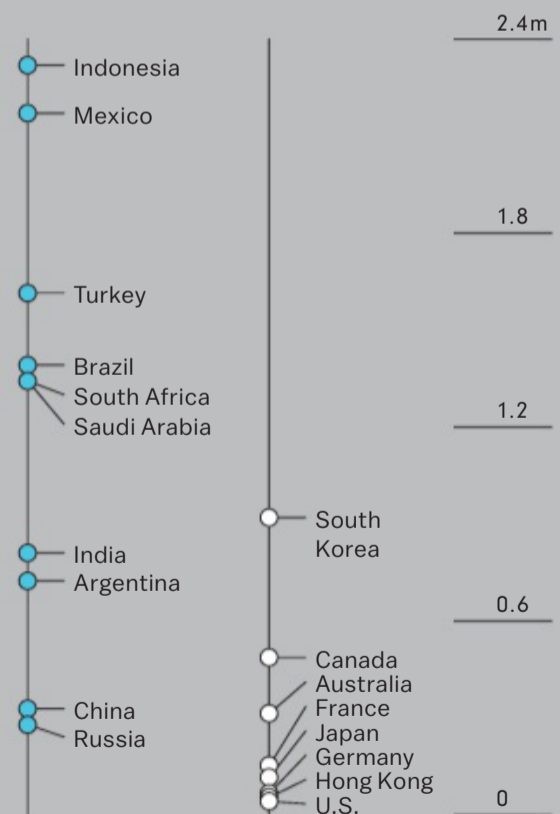
Mapping the Opportunity

Adults who own a mobile phone but have no bank account



People per bank*

● Emerging markets ○ Developed markets



*Figures based on banks and populations in 2017.

Sources: World Bank, Gallup World Poll 2017, Bank for International Settlements

Few industry combinations are as alluring to investors as finance and technology. For the past decade fintech startups have offered new ways to help people handle money. As startups face more competition from tech giants and deep-pocketed banks, investors are turning their attention to fintech in new markets. Here's a look at some of the developments and trends that are driving the industry today. —*Julie Verhage*

Facebook's Plan to Bring Cryptocurrency to the Masses

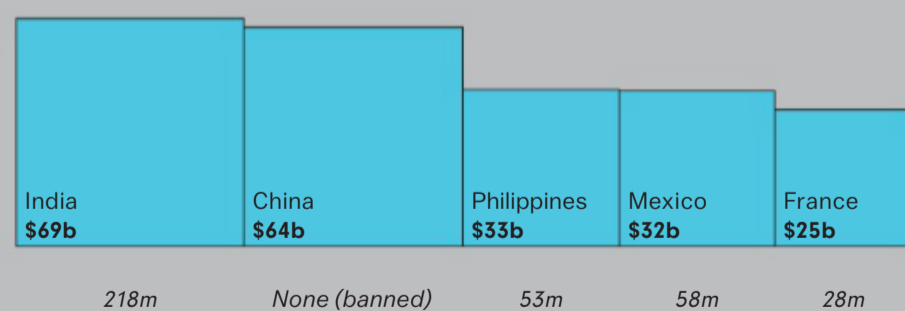
■ Fintech innovation is no longer dominated by scrappy startups—big tech companies are getting involved. Take Facebook Inc.'s plan to launch a digital currency called Libra in 2020. The social network's gigantic reach—more than 2.4 billion active monthly users—could

draw a much wider audience to Libra than has used previous cryptocurrencies. For instance, global remittances by migrants reached a record \$689 billion last year, according to the World Bank. If Libra tapped into even a portion of that, the potential would be huge. So far,

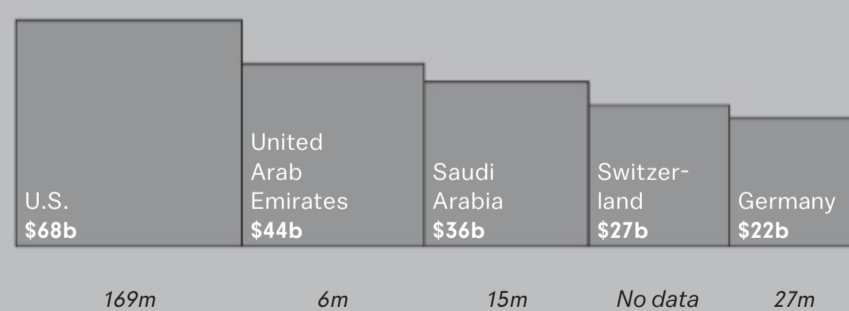
policymakers in the U.S. and other major economies are resisting the tech giant's plan, which could undermine their monetary authority. In August, Bank of England Governor Mark Carney suggested that central bankers could create a digital currency themselves.

Where Libra Could Shine

Top nations by remittance inflows, 2017



Top nations by remittance outflows, 2017



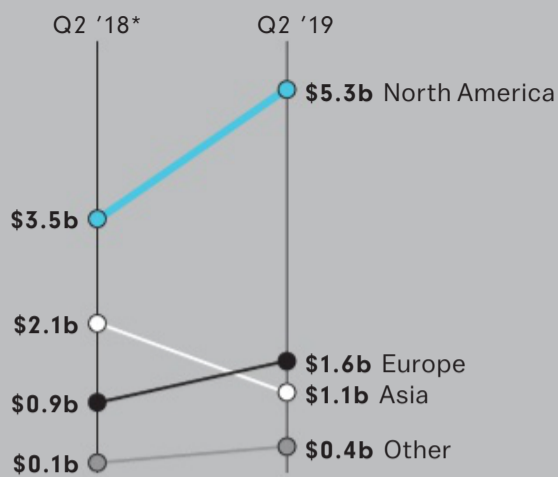
Facebook users*

Facebook users*

*Internet users who use their Facebook account at least once a month. Figures as of yearend 2018.
Sources: Global Knowledge Partnership on Migration and Development/World Bank, EMarketer

U.S. Venture Firms Stay Dominant

Venture capital-backed fintech funding



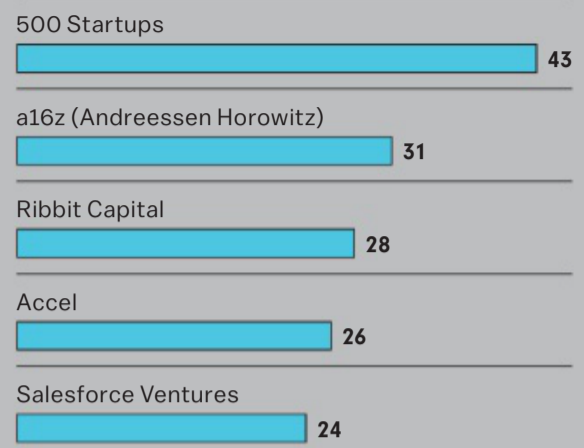
*Excludes Ant Financial's \$14 billion round.
Source: CB Insights

Who's Funding the Revolution?

Startups in almost every sector have benefited from a surge in venture capital investment. Fintech is no exception. North America holds the top spot in terms of dollars spent. Some VC firms are making multiple bets on fintech. San Francisco-based 500 Startups staked 43 such companies in the 12 months ended June 30. Some manage funds that specialize in particular areas, such as Andreessen Horowitz's crypto-focused a16z.

Prime Players

Most active venture capital firms by number of fintech investments made from Q2 '18 to Q2 '19



Source: CB Insights

Where the Biggest Fintechs Live

North America, with the most venture capital, is also home to many of the hottest fintechs. Payments startup Stripe Inc.'s \$35 billion valuation exceeds that of more than half of the S&P 500's members. Cryptocurrency platform Coinbase, free trading app Robinhood Financial, digital bank Social Finance, and credit score platform Credit Karma are each valued at \$4 billion or more.

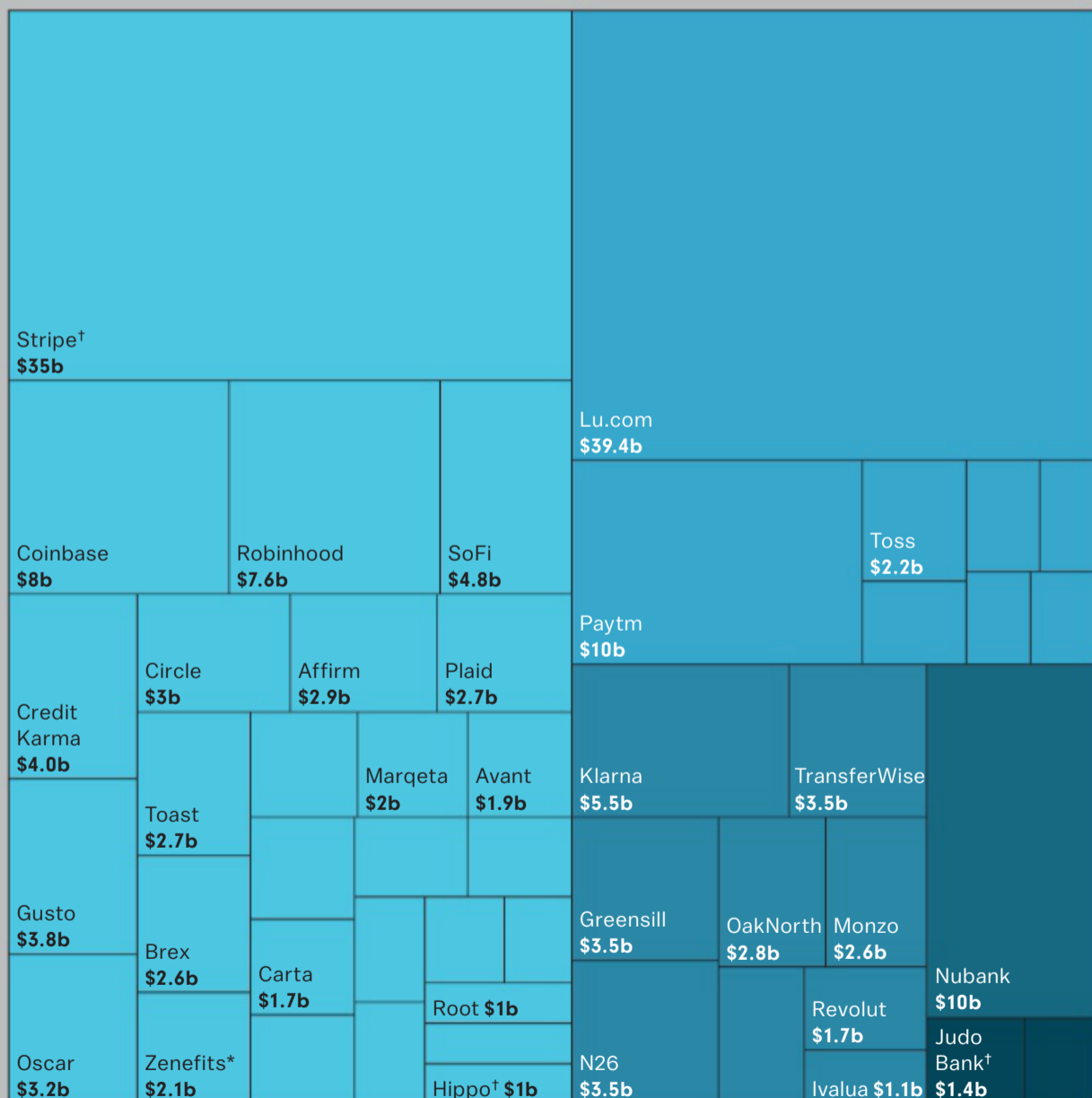
In the second quarter, India—home of mobile payments startup Paytm—surpassed China in the number of deals. But China still boasts the most valuable fintech. Lu.com, the wealth management platform backed by Ping An Insurance (Group) Co., was most recently valued at \$39 billion.

In Europe and Latin America, 2018 and the first half of 2019 have been good to the digital banks raising new capital. OakNorth, Monzo, and Revolut in the U.K., N26 in Germany, and Nubank in Brazil are among the most valuable fintechs in those regions.

Sizing Up the Unicorns

Venture capital-backed fintech companies with a private market valuation of at least \$1 billion, as of Aug. 8

North America Asia Europe South America Australia



*As of Q2 2015. †As of Q3 2019.
Sources: CB Insights, Stripe

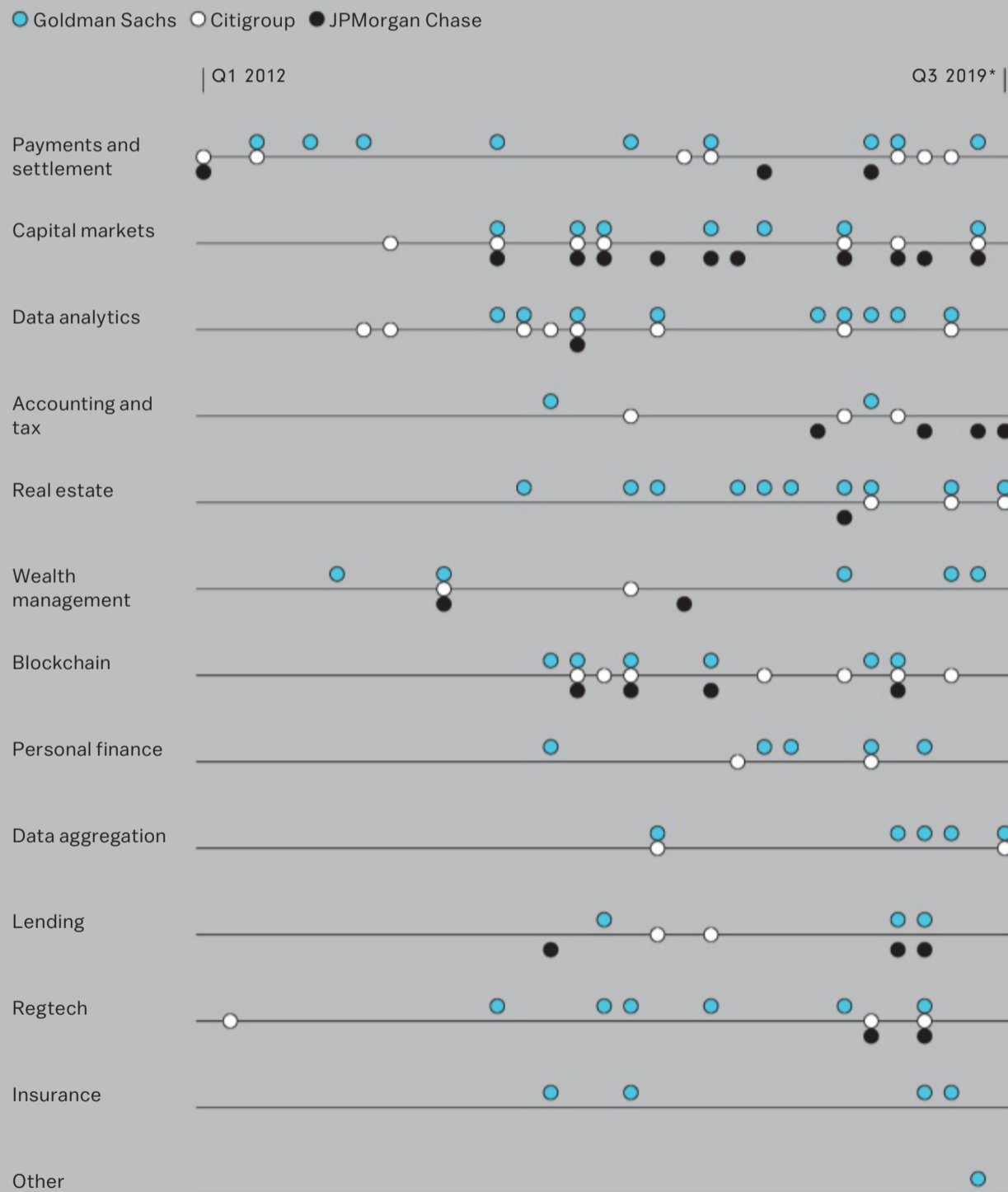
For Wall Street, It's Innovation by Acquisition

■ As of August, U.S. banks had already made 24 fintech investments in 2019. The most active were Goldman Sachs, Citigroup, and JPMorgan Chase. Each has looked at deals with startups in a variety of areas, including consumer-facing personal finance applications and data analytics and aggregation capabilities that are deep in the back office. Payments and the capital markets business have driven a lot of the investment by these banks.

Rival banks don't often invest in the same companies, but in the fintech space it's not unheard of. Digital Asset Holdings LLC, a blockchain startup, is backed by all three, for instance, while Plaid Inc., which connects bank customers' data to third-party finance apps, is backed by Goldman and Citigroup. Last year, Goldman acquired Clarity Money, a personal finance website in which Citigroup had previously invested.

Fintech Investment Activity by U.S. Banks Rises

Quarter in which selected banks made one or more fintech investments, by category



*Through Aug. 20.
Source: CB Insights

Changing Fortunes

■ Some will go public, others will evolve. Here's a list of private fintech companies to keep tabs on in 2020.

Five Fintechs to Watch

stripe Likely to pursue an initial public offering, joining other payments companies among the most highly valued fintechs. Stripe's founders are Ireland's richest entrepreneurs.

credit karma A key question for this credit monitoring service is how many of its more than 30 million weekly users are actually applying for credit cards on the site.

ny bank This Brazilian challenger bank has raised almost \$1 billion since its founding in 2013. Now it has a \$10 billion valuation and has expanded into Mexico.

PLAID You may not have heard of it, but chances are you've used it. Plaid helps send information from your bank to any app or service that needs it (think Venmo). Banks don't love it, but customers do.

robinhood The free trading app's checking account idea ran afoul of regulators last year. It's since raised more funding and plans to introduce new features soon, including a cash management product.

Source: Bloomberg reporting

Silicon Valley Has A Seat at the Table

■ It's not just Facebook. Most big tech companies have started dipping their toes into finance. They've been strategic, picking businesses that are subject to less regulatory scrutiny than banking and leveraging partnerships with banks. Apple Inc. teamed up with Goldman Sachs Group Inc. on a new credit card and worked with a variety of banks on Apple Pay. Facebook has had dozens of partners to help with Libra, including Visa Inc. and PayPal Holdings Inc. Amazon.com Inc. lends millions of dollars to sellers on its platform each month—always through partnerships with banks. Sense a trend?



EUROPE
NEGLECTS ITS
UNICORNS

By EDWARD ROBINSON

ILLUSTRATION BY
JAYA NICELY

Lawmakers across the Continent haven't given startups the compensation tools they need to share profits with employees. That's changing



Johannes Reck should be feeling pretty groovy. He's the co-founder of one of the hottest startups in Berlin. GetYourGuide lets holiday makers book tours online in 150 countries and is on course to increase ticket sales this year by 75%. In May it raised \$484 million from investors, and it's now valued at more than \$1 billion.

Reck's company is precisely the type of unicorn European policymakers want to see more of as they champion entrepreneurship that can kick-start much-needed economic growth. But he's fuming. "It's not even that I am disappointed—I am angry, really angry, because you don't need to reinvent the wheel here," says Reck, a 34-year-old German with the wiry build of a marathoner. "It's not like we are asking politicians to do something unheard of."

The problem? Reck can't provide his people with a stake in the future of their venture without incurring crushing costs and hassle. For decades, tech mavens in the U.S. have used stock options for employees to spur innovation—and unprecedented wealth. Unlike Silicon Valley, where equity incentive plans have become as ubiquitous as foosball tables and midday yoga sessions, the options culture has yet to take root in many European countries. While some lawmakers are taking action to loosen restrictions on pay, it's going to be hard to close the gap when income inequality is becoming a more urgent issue on both sides of the Atlantic.

European consumers and lawmakers here have long decried outsize paydays as unfair and vulgar. A few years ago the Dutch capped bonuses for bankers, money managers, and other financial professionals at 20% of their base salaries. Entrepreneurs must navigate onerous tax rates and restrictions that often make equity sharing and options more trouble than they're worth. When employees in Germany exercise options, they have to pay income tax on the difference between the fair market value and the strike price, and that rate runs from 14% to 47.5%. They also have to pay a 25% capital-gains tax on additional profits when they sell their shares.

In contrast, American employees typically pay a 0% to 20% rate on capital gains when options are redeemed, though they may have to pay additional levies when they're exercised,

depending on the timing and the type of equity incentive program. Germany and 14 other countries, including Sweden and the Netherlands, are more burdensome than the U.S. regarding options, according to a 2018 study by Index Ventures, a venture capital firm in London and Silicon Valley.

For entrepreneurs and venture capitalists, the problem isn't just about attracting top talent. The compensation bind may also be a big reason why Europe doesn't produce world-beating tech companies at the same level as the U.S.

Other forces are at work, too. Even though they're part of the European Union, member states remain a fragmented collection of markets that can't muster the borderless scale achieved in America. Plus, there's the widely shared belief that European business culture simply doesn't tolerate the experimentation and inevitable failures that are par for the course in, say, Silicon Valley. While governments across the EU have devoted hundreds of millions of euros to venture capital-style programs to invest in startups, the one tool entrepreneurs truly want remains out of reach.

"There are two ingredients to growth in a startup," says Martin Mignot, an Index Ventures partner. "One is capital, and the other is talent, and when you're not highly profitable you have to incentivize employees on the promise of the upside. Your currency is that promise."

Spotify, Klarna, and TransferWise lead a roster of European companies that have shaken up industries with new products and created wealth for their investors and employees. Likewise, a handful of countries hew to the American approach on compensation; Britain, Italy, Portugal, and, interestingly enough, France, tax options as capital gains when they're cashed in.

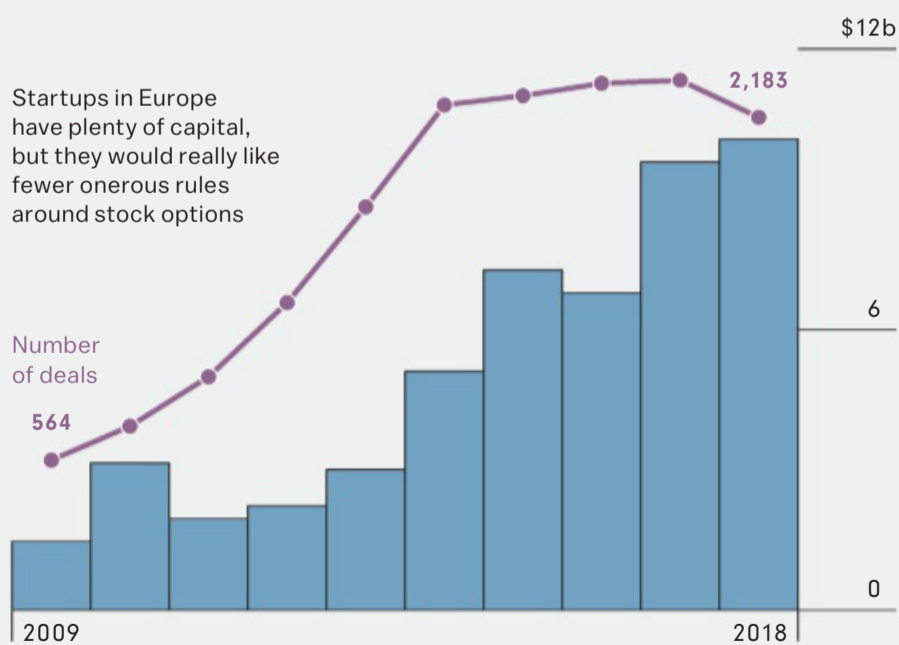
Yet they're the exceptions. In many other European markets, startup founders have to use various workarounds to vest employees in their businesses. In Sweden, options can be taxed as income at rates of more than 50%. Klarna, a digital payments powerhouse, sidesteps the bill by issuing warrants priced at fair market value using the Black-Scholes model, which are taxed as capital gains at 25% to 30% at the time of sale. But, as incentives, fully priced warrants aren't as potent as cheaper priced options, says Knut Frangsmyr, Klarna's chief operating officer. Companies in Austria, the Czech Republic, Germany, and Spain distribute "virtual share options," but the instruments are really just cash bonuses by another name and may not deliver the windfalls that bona fide options do when a company is acquired or holds an initial public offering.

IN GERMANY, at least, help may finally be on the way. Bettina Stark-Watzinger, chairwoman of the Finance Committee in the Bundestag, Germany's parliament, has crafted legislation that would cut the tax rate on stock options in half by treating them as capital gains instead of income. Stark-Watzinger, a member of the centrist opposition Free Democratic Party, argues that Germany has become complacent about supporting digital innovation.

She worries that promising tech companies will decamp to other countries if lawmakers don't change things. "We are so preoccupied with the economy of the last century," Stark-Watzinger says in her office suite near Berlin's iconic Brandenburg Gate. "We are so proud of our trade surplus and our automobile industry, but we have fallen behind in the digital economy. This

Money's Not the Problem

VC-backed investment in European technology companies



Figures as of August 6, 2019
Source: PitchBook

is where value and growth will come from in the future.”

It won't be easy for Stark-Watzinger to persuade parties in Germany's governing coalition to embrace legislation that might be seen as favoring workers in the relatively well-off tech sector. Germany has been far less comfortable than the U.S. and the U.K. about carving out exceptions in its tax system for specific sectors, even to stimulate innovation, says Michael Mandel, an economist at the Progressive Policy Institute in Washington who has studied the issue. It wasn't until this year that the German government proposed a tax break for research and development investments across industries, a common policy in many Western countries.

Whenever the issue of tax credits has come up in the Bundestag, lawmakers have tended to question whether lower revenue will undermine support for social services—a political third rail in a nation that provides free tuition at public universities and universal health care.

Mandel says that just because Washington is willing to bet that forgoing tax revenue now will result in bigger inflows later, that doesn't mean Berlin should. “Germany has a very successful industrial system, so why should they break something that's working?” he says. “And while German leaders would love to have more unicorns, they might want to develop them their way, not the Silicon Valley way.”

Even so, there's little doubt that stock options have fueled wealth and innovation in the U.S. Companies such as PayPal Holdings Inc., the online payments pioneer, haven't just made their founders wildly rich; members of the so-called PayPal mafia like Elon Musk, Peter Thiel, and Reid Hoffman went on to start ventures that minted fortunes for rank-and-file employees who can then start their own companies and begin the cycle anew.

Index's Mignot calls this the flywheel effect. The flywheel isn't nonexistent in Europe: The 2018 IPO of Adyen, a Dutch digital payments processing company, made its top brass billionaires. Yet reforming options rules across the EU would help make creating such flywheels the norm instead of the exception, says Magnus Henrekson, the director of the Research Institute of Industrial Economics in Stockholm. At the top of the reform list is making sure beneficiaries aren't hit with taxes until gains are realized.

GetYourGuide's Reck, for one, is relieved the issue is finally on the agenda. In many respects, his company looks like a classic Valley performer. It's backed by SoftBank Vision Fund, and in September it moved its headquarters into a renovated electrical substation that's a model of post-industrial hipness, with exposed red brick walls, cast-iron beams, and fridges stocked with high-caffeine Club-Mate drinks.

Even though Reck was determined to add the *pièce de résistance*—options—he gave up after realizing that the upfront tax bill would empty workers' pocketbooks. So he implemented ersatz shares that are essentially cash awards tied to GetYourGuide's valuation.

Those payouts are taxed as income, but only when they're redeemed, and there's no capital-gains tax. But GetYourGuide, which isn't profitable yet, must reserve cash to cover the outlays. “This has massive disadvantages for the company,” says Reck. “We have a huge liability on our balance sheet toward employees, which is obviously weird. And in an IPO scenario, this is something that you have to explain to investors, and that's not great.”

Raisin, another startup, did bite the bullet, granting stock

“We are so proud of our trade surplus and our automobile industry, but we have fallen behind in the digital economy. This is where value and growth will come from”

●

options to its employees. Located in Prenzlauer Berg, a Berlin neighborhood of funky cafes and old Soviet-style apartment buildings, Raisin runs an online “deposit marketplace” that matches European savers with banks offering the best interest rates. Backed by Goldman Sachs Group Inc. and PayPal, it's invested €16 billion (\$17.7 billion) in assets.

Frank Freund, Raisin's co-founder and chief financial officer, isn't wild about requirements that date to a bygone era. Whenever Raisin grants shares, a notary must literally read the lengthy compensation agreement aloud to both the employee and Freund at a hearing that can take up to 90 minutes. Still, Freund believes the company made the right call. “When you have participation in the company's performance and growth, it makes a big difference,” he says. “It would be great if significantly more companies would follow our example in Germany.”



SCOTT CHACON will take a pass on that. Chacon is an American entrepreneur who co-founded the software development site GitHub Inc. He's been spending time in Berlin with his latest venture, an online language-tutoring service called Chatterbug Inc. Following a panel discussion, he mingles with local techies over beers in a leafy courtyard outside a VC firm.

Amid the bonhomie, he says Chatterbug chose to base itself in San Francisco and Berlin to tap into the German capital's diverse expatriate pool. It offered employees a choice of U.S.-style options or German-style virtual shares. But ensuring the different programs were equitable was impossible. Chatterbug now offers new employees restricted stock units that aren't pegged to a strike price (as options are) and are taxed as income if they're cashed in during a sale of the company.

Standing alongside Chacon, Anne Leuschner, the company's COO, chimes in. She says Chatterbug's compensation fudge isn't ideal, but it'll do for now. “I wish we had the same system as the U.S.,” she says. “But they don't want us to get rich in Germany.” ● —*With Birgit Jennen*

Robinson covers wealth in London.

Getting Comfortable With *Chaos*

CAN **DOYNE FARMER**'S SCIENTIFIC BAG OF TRICKS
HELP ECONOMISTS AND CENTRAL BANKERS BETTER UNDERSTAND
THE NATURE OF RISK?

By VINCENT BIELSKI
PHOTOGRAPHS BY CARLOTTA CARDANA



Oxford University professor Doyne Farmer traces his research exposing risks in the financial system to the roulette wheels of Las Vegas.

In the 1970s, Farmer and two fellow physics students at the University of California at Santa Cruz built a computer small enough to hide in a shoe that helped them predict roughly where roulette balls would land. At casinos in Vegas, they communicated with toe-controlled switches and transmitters, also in their shoes, about what bets to make. The gadget was legal, but they feared their winnings—about a 20% return on their wagers—would lead to trouble. So they quit after a couple of years.

“We were nervous about getting our kneecaps broken,” he explains.

Today, in a more bucolic setting—the Institute for New Economic Thinking at the Oxford Martin School—Farmer is drawing on decades of complexity research that began with roulette. After winning acclaim as a pioneer of chaos theory, which helps explain the unpredictability of complex systems such as the weather, he jumped into markets, co-founding one of the early quantitative investment firms in the 1990s. Now, Farmer and a band of central bank researchers are focusing on the tangled web of global finance, using a tool of the natural sciences called agent-based models to find dangers lurking in the system and uncover ways to avoid them.

Agent-based models, used in fields from biology to sociology, are bottom-up, simulating the messy interactions of hundreds and even millions of agents—human cells or attitudes or financial firms—to explain the behavior of a complex system. The nonlinear interplay can produce unexpected phenomena, such as economic booms and busts, providing insights into the causes of events and the best responses. Epidemiologists have successfully deployed the models for years to test strategies to control everything from obesity to the spread of infectious diseases, including the flu.

Central banks worldwide began experimenting with the agent-based approach after macroeconomists and their standard models were blindsided by the 2008 financial crisis. The European Central Bank, where Farmer is a consultant, as well as central banks in Canada, Germany, South Africa, and the U.K. have taken the lead in building the models to research financial risk. The U.S. Federal Reserve’s regulatory staff is also exploring their use.

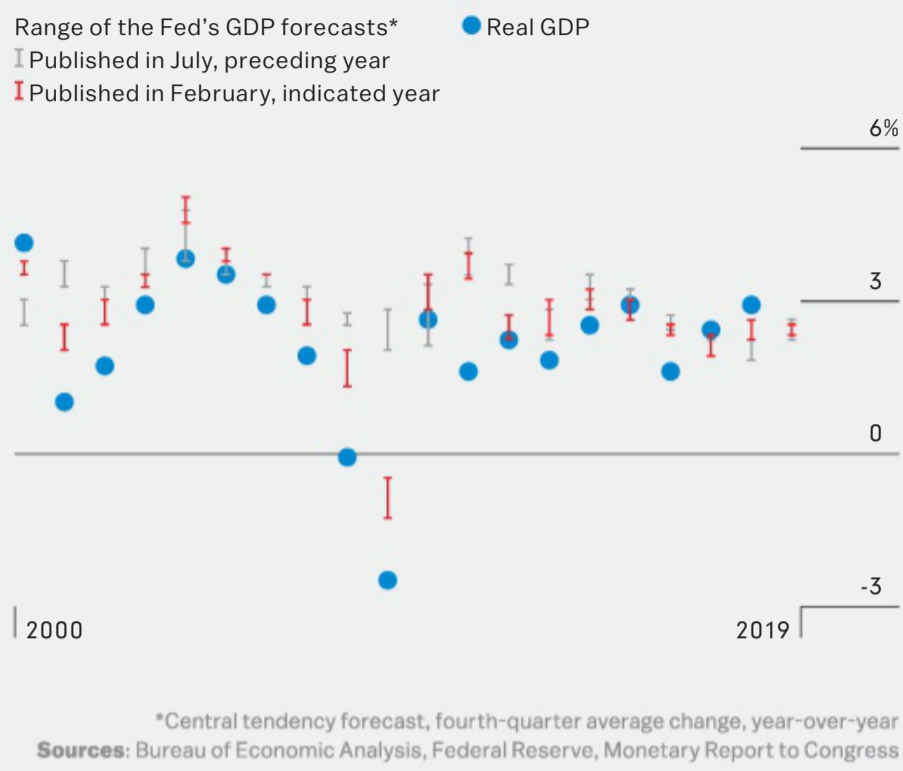
Today, central banks mostly stress-test financial firms individually. But agent-based models are giving regulators a better read by accounting for the systemwide impact of shocks. In the simulations, a shock to a single firm cascades through the network of banks and asset managers, creating feedback loops that significantly amplify the initial losses. It’s the kind of contagion that a decade ago spread from the U.S. subprime mortgage market through lenders, money managers, and insurers, creating a liquidity crisis that doomed Lehman Brothers Holdings Inc. and infected the global economy.

“There are efforts at central banks to integrate systemic stress testing,” says Co-Pierre Georg, a research economist at Germany’s central bank (but he doesn’t speak for it). “The banks are highly interconnected and highly leveraged. We now know from Lehman that if something happens to one big bank it can be devastating to the entire economy.”

Farmer, 67, a gray-bearded scientist whose papers have garnered more than 34,500 citations, can be a provocateur. He sees central banks as a beachhead for a bigger challenge to mainstream economics. In a coming book, he says economists in

Forecast vs. Reality

Federal Reserve growth forecasts have become more accurate



academia resist new approaches such as agent-based models.

It’s a sentiment shared by Bank of England Chief Economist Andrew Haldane, who’s helping lead the push for alternative research. In 2017, Haldane called his profession “insular” for its subpar track record in citing work from other disciplines in its academic journal papers. Farmer says the prestigious top five economic journals rarely if ever publish worthy agent-based model papers, including his own. The *American Economic Review* says papers are evaluated on their merits without bias.

Many macroeconomists shrug off Farmer’s criticism. He’s a physicist, they say, not an economist, and agent-based models have yet to provide real-world verifiable results.

“In science you need a little bit of the rebel, and Doyne is definitely that,” says Georg, who’s also the South African Reserve Bank chair in financial stability studies at the University of Cape Town. “He challenges you to think about your assumptions.”



SINCE MISSING WARNING SIGNS of the Great Recession, economists have improved their DSGE (dynamic stochastic general equilibrium) models, which remain the workhorses of central bank forecasting. The approach is top-down, aggregating the behavior of the economy into a few representative agents—a household, a firm, and a government.

Most precrisis versions at central banks didn’t include a financial sector because it wasn’t considered relevant in making aggregate forecasts for measures such as gross domestic product and inflation, says Frank Schorfheide, chair of the economics department at the University of Pennsylvania and a visiting scholar with the Federal Reserve Banks in Philadelphia and New York.

Since then, some economists have added a financial sector to capture its impact on the economy. “There were certainly many aspects of the financial crisis that were not on the radar screen of things to monitor by central banks that turned out to be important,” Schorfheide says. “People quickly learned what kind of data they

had to collect to understand what just happened and how to modify the models to provide a better narrative.”

Central banks are turning to agent-based models to exploit the wave of new business and social data sets. One of the most data-rich models was built by Farmer and a team including Robert Axtell of George Mason University in Fairfax, Va. They used data from the U.S. Census Bureau, Internal Revenue Service, housing sales, and mortgages to set the behavioral rules for buyers and sellers in the Washington, D.C., housing market from 1997 to 2009. The research, which showed that mortgage lending policy was the key driver of the housing bubble, helped establish agent-based models as an asset for central banks.

Bank of England researchers adapted the Washington model to the U.K. housing market and found that an increase in the size of the “buy-to-let” rental sector could boost the volatility of house prices. Central banks in Hungary and Denmark recently published papers based on the U.K. model.

In 2018, Grzegorz Halaj was a financial stability specialist at the ECB when he used an agent-based model to study liquidity shocks. He tapped balance sheet data for 130 of the largest banking groups in the European Union and aggregated public figures for asset managers. In the simulation, after lenders suffer a drain on deposits, those without an adequate capital cushion cut their interbank lending. In some cases they also dump assets at fire-sale prices. The price drop spills over to fund managers holding the same assets, who then suffer client redemptions and are forced to sell more. That further depresses prices and amplifies the banks’ losses—in some cases possibly leading to defaults, according to the ECB working paper by Halaj, now a principal researcher in the financial stability department at the Bank of Canada.

For Farmer, the upshot is that policymakers need to develop tests that capture the panoply of losses that financial firms face. In an April paper, Farmer and Alissa Kleinnijenhuis, a graduate student at Oxford, describe a preliminary model they created of a systemwide stress test for the European financial system. It reveals that financial losses from shocks could be three times greater compared with a traditional stress test and that current capital buffers may be too small.

“From the research, we can say unambiguously that there is some amplification of losses from shocks, and I would be very surprised if the amplification isn’t very significant, particularly in times of distress,” Farmer says. “So there is a serious problem to worry about.”

While regulators are far from creating a comprehensive testing model, the BOE is already moving down this path. It’s incorporating feedback loops in areas such as counterparty risk and asset fire sales into its stress tests, said a group of three BOE researchers—Marco Bardoscia, Marc Hinterschweiger, and Arzu Uluc—in an email to *Bloomberg Markets*. Germany’s central bank has built models to assess the magnification of losses from contagion and is now discussing whether to include them in stress tests.

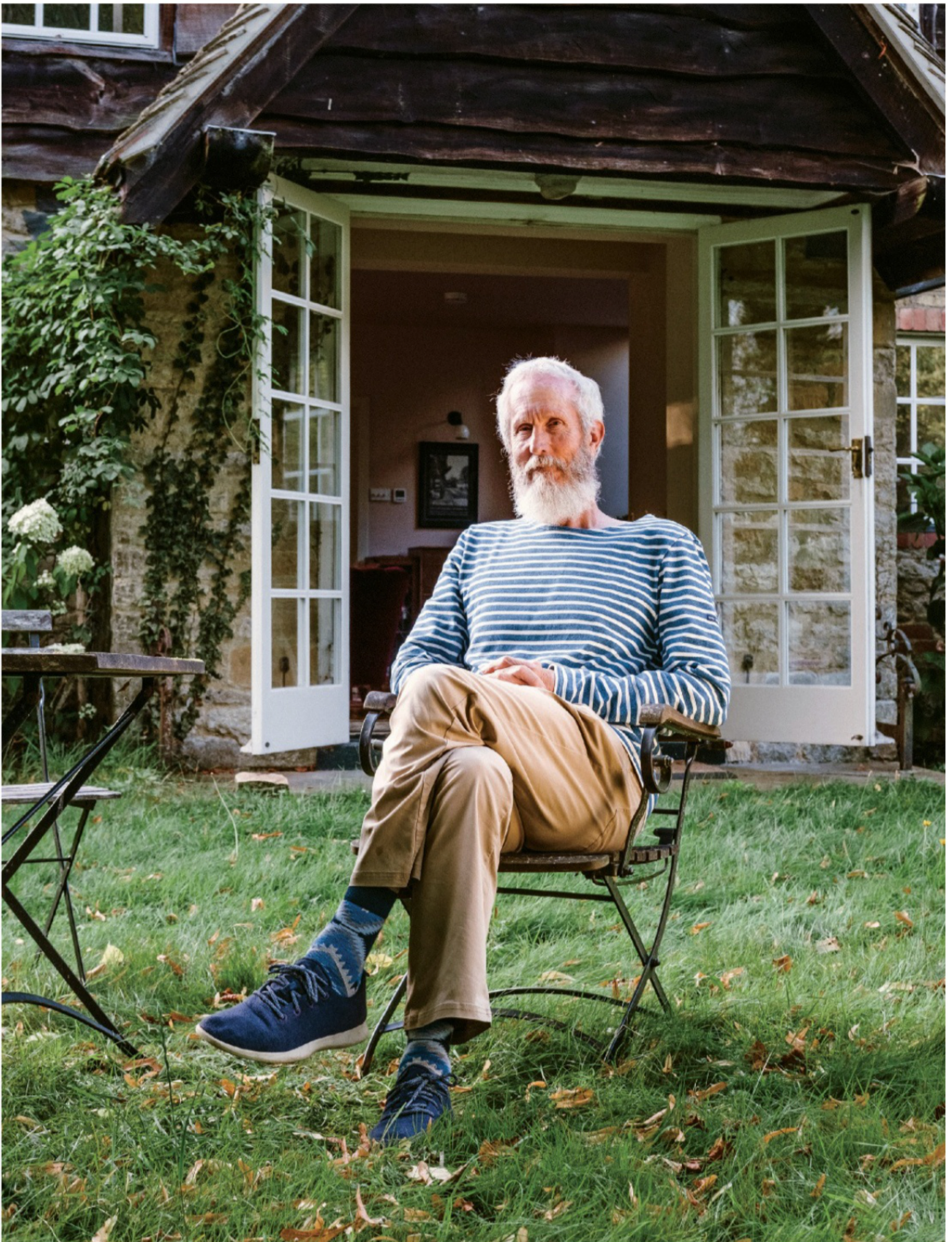


FARMER, WHO GREW UP in the wide-open desert terrain of New Mexico, is fond of chasing big, original ideas. “It’s part of being a scientist to do things that are novel and important,” says Farmer, who likes to explore the mountains of his home state with a backpack and a tent.


He leaped into uncharted territory in the 1970s, when ►

“It’s part of being a scientist to do things that are novel and important”





“How do you communicate these results with the hierarchy? That’s the big missing piece”



he was a physics graduate student specializing in cosmology at UC Santa Cruz. He switched his focus to chaos and complex systems—a subject so new that there were no professors who could teach it. That didn’t deter Farmer and a small group of fellow students, who formed the “Dynamical Systems Collective” to advise one another on their dissertations.

The Santa Cruz students joined researchers across the country to explain why there’s turbulence in the natural world. Consider the weather. At the time, it was assumed that weather changes came from external disturbances hitting the atmosphere. The scientists showed that the volatility is generated from within, caused by chaos, in which a small disturbance in the initial conditions of a complex system is amplified exponentially; that’s why the weather is so hard to predict. The discoveries, which influenced fields from math to the social sciences, were chronicled in James Gleick’s best-selling 1987 book, *Chaos: Making a New Science*.

Chaos theory eventually penetrated pop culture. In Steven Spielberg’s 1993 film *Jurassic Park*, Jeff Goldblum plays a mathematician specializing in chaos. Farmer says Goldblum called him to help prepare for the role. “He wanted to understand how a chaos scientist speaks,” he says.

In 1981, Farmer went to the Center for Nonlinear Studies at Los Alamos National Laboratory—where freewheeling research was the norm. Seven years later he started the Complex Systems Group at the lab in New Mexico, bringing together theoretical scholars who helped develop the nascent field of complexity studies.

After a decade at Los Alamos, Farmer was lured into investing. Scientists helped plant the seed: At conferences, they’d ask him if he’d considered applying his insights about the nature of chaos to the stock market. He didn’t know how to trade, but he knew how to make short-term predictions in complex systems such as fluid flows. So he set himself a goal of making \$5 million in five years—a sum he’d substantially surpass.

In 1991, Farmer started Prediction Co. in Santa Fe, N.M., with two physicist friends, Norman Packard and James McGill. After about five years, Prediction’s automated statistical arbitrage strategy was earning risk-adjusted returns about five times the

S&P 500’s. The company traded proprietary capital for UBS AG, and the partners sold Prediction to the bank for \$100 million in stages, ending in 2005.

Farmer had left Prediction in 1999 with the financial freedom to follow his own research interests. He landed at the Santa Fe Institute, where he revised a paper showing how changes in market ecology, composed of trend followers and value investors, can cause crashes. He says he had several conversations with legendary hedge fund investor George Soros about the paper. When Soros’s Institute for New Economic Thinking formed a partnership with Oxford in 2012, the university hired Farmer to run its complexity economics program.

Complexity economists, while few in number, have a shared ambition to knock holes in a cornerstone of DSGE models: rational expectations, the idea that everyone in the economy understands each other’s decisions, and they’re mutually compatible in their pursuit of their self-interest. Since the crisis, mainstream economists have added “frictions” to the models—such as lenders denying loans to creditworthy businesses—to make them more realistic.

Behavioral economists have shown that people aren’t perfect calculators and often make rule-of-thumb judgments, such as concluding that rising markets will keep going up despite other evidence to the contrary. This is the kind of real-world behavior that agent-based models capture. The agents are also programmed to behave differently to express an economy’s diversity. Heterogeneity is the hallmark of the models. In Farmer’s Washington housing model, 100,000 households made varying buying and selling decisions based on their income and savings.

One challenge unmet by complexity economists is understanding the behavior of complicated humans. Economics is harder than physics, Farmer says. People don’t obey rules as reliably as atoms do. In his stress-test model of the European financial system, for instance, he had to make assumptions about what assets bankers might dump after their firms suffered shocks. “They will likely sell the most liquid assets because they will lose less money,” he says.

Agent-based models also suffer from the black-box problem. The inner workings are so complex, with thousands of agents running in different directions, that it can be difficult to pinpoint the main drivers of a model’s findings. That doesn’t sit well with central bankers who need to know the reasons behind their decisions, says Georg of the University of Cape Town.

“With DSGE models, we know exactly how A follows from B, and I can explain that to my governor,” he says. “But in an agent-based model, I can’t do that. So how do you communicate these results with the hierarchy? That’s the big missing piece.”

Farmer says it could take years of research to make the models a mainstay of central banking. To achieve this, researchers will need lenders to provide them with more detailed balance sheet data showing the linkages among them—something European banks have resisted because of privacy and cost concerns. He says the payoff—addressing risks before they cascade into meltdowns—seems worth the effort.

“Agent-based models can be a game changer,” he says. “I’m convinced we can solve these problems.” ● —*With Lucy Meakin in London*

Bielski is a senior editor on Bloomberg News’s investing team in New York.

S T A R

P O W E R

ILLUSTRATION BY STORY TK
PHOTOGRAPHS BY IAN ALLEN

By

JON ASMUNDSSON and WILL WADE

Startups take aim at energy's holy grail

A bout two dozen private companies around the world are working to harness a transformative energy technology that could rescue the planet from climate catastrophe. One is using space in an old factory that's home to a mothballed U.S. Department of Energy-funded research machine in Cambridge, Mass. Another is housed in an industrial building behind a Costco outside Vancouver. A third is down the street from a self-storage facility in the foothills of Orange County, Calif.

The companies are working on commercializing fusion.

Fusion's promise is huge. It would be the most energy-dense form of power: A liter of fusion fuel is equivalent to 55,000 barrels of oil. In its most common form, that fuel would come from a practically inexhaustible source: water. In fact, 2 cubic kilometers of seawater could in theory provide energy equivalent to all the oil reserves on Earth. "It's ubiquitous, inherently safe, zero-carbon energy—at a scale that can fuel the planet," says Matt Miller, president of Stellar Energy Foundation Inc., a nonprofit that promotes the development of fusion power. "Now that's worth working on."

It was only about 100 years ago that people came to understand that fusion was the process powering the sun. Shortly thereafter, scientists began trying to re-create it. From tabletop experiments, fusion quickly developed into Big Science. Since 1953 the U.S. government has devoted more than \$30 billion to fusion research, including basic science and weapons-related work, according to data from Fusion Power Associates, another nonprofit. European countries, Russia, China, and Japan have also made huge investments in pursuit of the holy grail of energy.

Since the 1950s, however, expectations that researchers were on the verge of breakthroughs have repeatedly come up short. What's different now is that advances in technology are bringing fusion within reach.


Turning theory into practical devices is being enabled by advances in supercomputing and complex modeling, says Steven Cowley, director of the Princeton Plasma Physics Laboratory and former head of the U.K. Atomic Energy Authority. Fusion used to be defined as "the perfect way to make energy except for one thing: We don't know how to do it," Cowley says. "But we do."



SO WHAT IS FUSION again? The idea is deceptively simple: Smash two atoms together so they fuse into a single heavier element and release energy. It's the opposite of fission, the process used in today's nuclear power plants and the bombs dropped on Hiroshima and Nagasaki.

In fission, a large, unstable nucleus is split into smaller elements, releasing energy. Fusion, by contrast, starts with light atoms. Take two hydrogen nuclei, for example. Ordinarily, their positive charges repel each other. But apply enough heat and pressure, and they might get close enough for the attraction of the extremely short-range but powerful nuclear force to kick in, joining them into a single helium nucleus. When that happens, the mass of the newly formed nucleus ends up slightly less than the sum of the two hydrogen nuclei. And that difference in mass gets released as energy, in accordance with Albert Einstein's famous equation $E=mc^2$. Simple. Stars do it. The sun does it. It's the basic energy process of the universe.

**Fusion was
once defined as "the perfect
way to make energy
except for one thing: We don't
know how to do it.
But we do"**



Early efforts to harness it, though, gave fusion a reputation for hype and disappointment. After World War II, an Austrian scientist who'd worked in Germany ended up in Argentina, where he persuaded dictator Juan Perón to fund his fusion experiments. On an island in a remote Andean lake, the scientist, Ronald Richter, set up an elaborate facility. In February 1951, he detected what appeared to be heat from a thermonuclear reaction in his reactor. The next month, Perón announced at a press conference that Argentina had harnessed the atom to create unlimited energy. A subsequent investigation found that a glitch in Richter's instruments led to his mistaken heat reading. Richter was discredited.

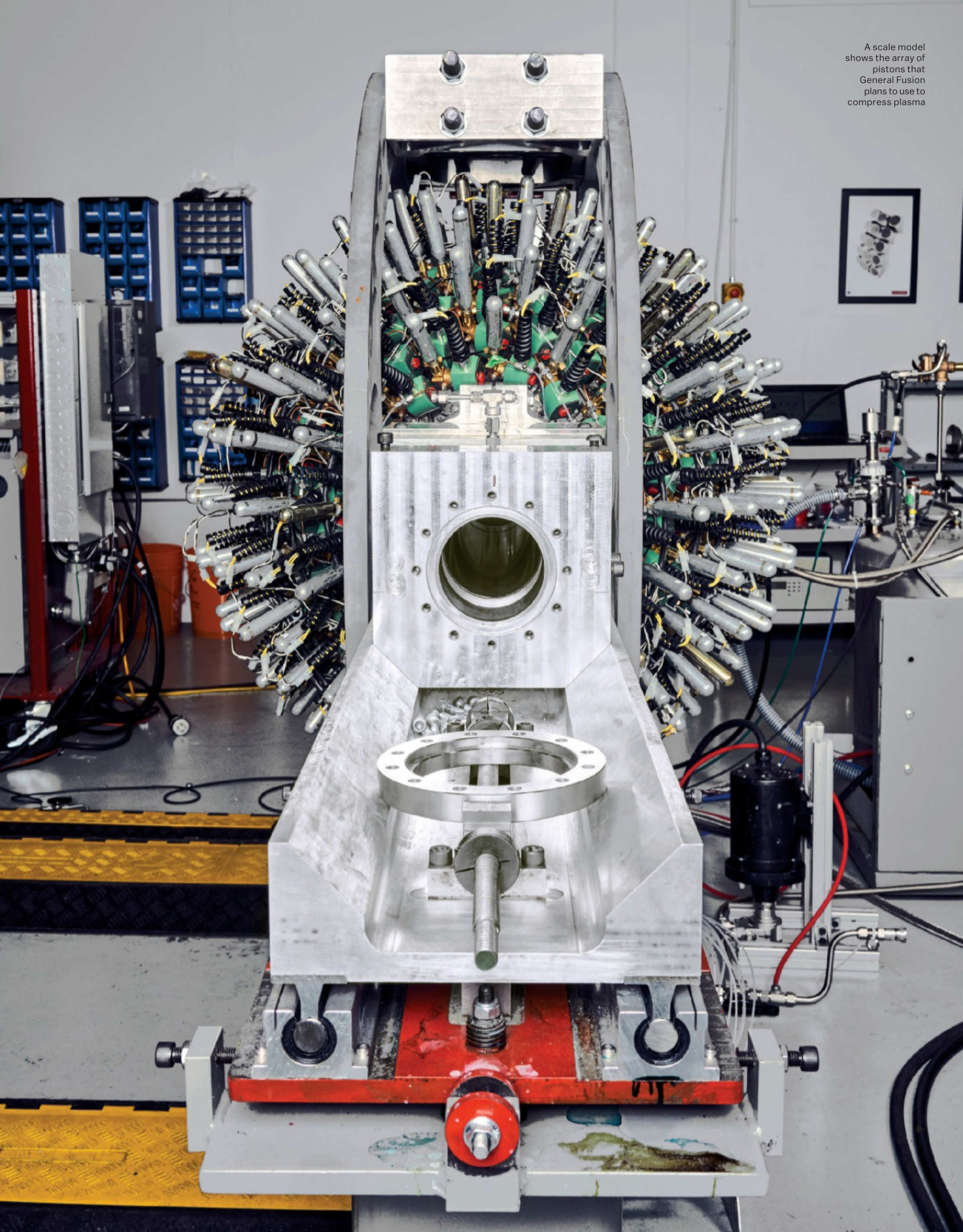
Many physicists were skeptical of the initial report, but news of the apparent breakthrough spurred research in the U.S., the U.K., and the Soviet Union. At Princeton, a top-secret U.S. government project aimed at working on the H-bomb started researching fusion technology. In 1951 scientists there began developing a device called a stellarator that would use magnetic fields to confine superheated plasma. The effort, code-named Project Matterhorn, was eventually declassified and became the Princeton Plasma Physics Laboratory.

In the U.K., work on a machine called Zeta, which "pinched" fusion fuel by running a huge current through it, led to another premature announcement of the dawn of the fusion age, in 1958. It turned out that strange instabilities in the fuel were what led researchers to mistakenly think they were seeing evidence of fusion.

The Argentine news also fast-tracked work on an idea developed by Soviet physicist Andrei Sakharov, a dissident and Nobel Peace Prize winner: confining fusion fuel in a doughnut-shaped configuration with a machine called a tokamak.

Since the 1960s, when government labs and universities ►

A scale model shows the array of pistons that General Fusion plans to use to compress plasma



Long Road

Fusion's history is studded with disappointments as well as advances



1920

British astronomer Arthur Eddington's "The Internal Constitution of the Stars" posits that stars including the sun are powered by the fusion of hydrogen.



1938

Nuclear physicist Hans Bethe describes the fusion reactions that create the energy emitted by stars, for which he later wins the Nobel Prize.



1951

Juan Perón (far right) and scientist Ronald Richter (second from right) announce that Argentina has developed fusion energy.



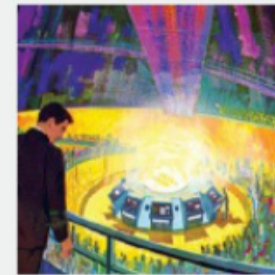
1952

The first test of a hydrogen bomb, code-named Ivy Mike, uses a fission explosion to ignite a fusion reaction in deuterium fuel. The 10-megaton blast leaves a big crater on Enewetak atoll.



1958

ZETA excitement and disappointment as U.K. researchers announce they've likely created a controlled fusion reaction, but later retract.



1964

A fusion demonstration at Progressland at the World's Fair in New York.

around the world began constructing tokamaks in earnest, more than 200 working machines have been built. A key sign of progress in the fusion field is the chart of the so-called triple product, a measure of reactor performance. Plot this number—how hot, how dense, and how well-insulated the systems are—against a timeline, and it looks a lot like Moore's law, the famous doubling of computing power every two years. But fusion's improvement is even faster. "Tokamaks have beat Moore's law," says Bob Mumgaard, chief executive officer of Commonwealth Fusion Systems, which was spun out of MIT.

So why does it matter how hot a fusion system gets? Consider the sun. Our local star has a lot of plus-size gravity to apply to the fusion process. Its interior brings the pressure of a mass equivalent to about 333,000 Earths and a temperature of about 15 million C (27 million F). That's the kind of forge in which fusion happens.

On Earth, with so much less gravity, you need higher temperatures: 100 million C, for example. So the first step to get there is to heat a gas and turn it into a plasma, says Michl Binderbauer, CEO of TAE Technologies Inc., based in Foothill Ranch, Calif. "That happens through adding more energy, so at some point the ions and electrons that make up the atoms fall apart into a soup of charges," he says. "That's the state that actually most of the universe is in—what we call a plasma."

Almost all of the visible stuff in the universe is plasma. "We're living probably in one of the few specks of the universe where there's no plasma in our immediate surroundings other than lightning or something," Binderbauer explains. What's more, in the 1950s, when instabilities and other "funky behavior" in plasma turned out to make fusion much harder than expected, Mumgaard says, it led to the development of an entire discipline, plasma physics. The field has in turn contributed advances in medicine and in manufacturing semiconductors.

Now, heating plasma to 100 million C sounds daunting and terrifying. Wouldn't it vaporize whatever it touches? Short answer: no. The plasma is a handful of particles in a vacuum chamber, Binderbauer says. It's millions of times less dense than air, its state is extremely fragile, and if it touches anything it instantly cools down. TAE's Norman machine heats plasma to 35 million degrees, says

Binderbauer. If, hypothetically, he could stick his hand into the vacuum shell, he says the plasma wouldn't burn him. "My arm will absorb all of the energy," he says. "I won't even turn very warm." Fusion, unlike fission, has no risk of meltdown. "You have to protect the plasma from the surrounding environment, not the other way around," he says.

Fusion would have one other important benefit over solar, wind, and other intermittent sources of renewable energy, says Christofer Mowry, CEO of General Fusion Inc., based in Burnaby, B.C., near Vancouver: It's "dispatchable" power. In most of the applications anticipated for fusion, the energy created in a reaction would heat water and run a conventional steam turbine generator. Plants could be safely and conveniently situated in cities and other places power is needed, Mowry says.

One obvious downside to fusion, reflected in the field's 70 years of history and dashed hopes for imminent breakthroughs: It's extraordinarily difficult to bring off.

In 1983 the late Lawrence Lidsky, an associate director of what was then called MIT's Plasma Fusion Center, wrote an article titled "The Trouble With Fusion." Fusion, he wrote, "is a textbook example of a good problem for both scientists and engineers. Many regard it as the hardest scientific and technical problem ever tackled, yet it is nonetheless yielding to our efforts." Still, Lidsky laid out a laundry list of problems that, he contended, made it unlikely that fusion would ever be an economically viable source of power.

More than three decades later, the problems Lidsky identified remain. Chief among them is radioactivity. To be sure, the fuel used in fusion doesn't pose quite the same dangers as fission's uranium and nuclear waste. To understand fusion's radioactivity challenge requires a slightly deeper dive into the science.

To begin, a variety of different light elements can be combined in a fusion reaction. However, the fuel that's easiest to fuse is a 50-50 combination of two isotopes of hydrogen: deuterium and tritium. D-T, as it's called, has been the main focus of the field. Deuterium is heavy hydrogen, the stuff found in seawater. Its nucleus consists of a proton plus a neutron (in contrast to plain old hydrogen's lonely proton). Tritium is heavy, heavy hydrogen: a proton with two neutrons. It's radioactive, with a half-life of about



1969

In an example of cooperation, the U.K. brings laser equipment to the Soviet Union to measure the temperature of the T-3 tokamak, confirming 10 million C plasma.



1982

Tokamak Fusion Test Reactor, or TFTR, starts at the Princeton Plasma Physics Laboratory. It sets a record plasma temperature of 510 million C.



1985

The Soviet Union proposes international collaboration on fusion at the Geneva summit of Mikhail Gorbachev and Ronald Reagan, which leads to the start of ITER.



1989

Chemists Martin Fleischmann and Stanley Pons's cold fusion experiment can't be replicated.



1997

The Joint European Torus, or JET, sets a record with a fusion output of 16.1 megawatts, equivalent to about 67% of the input energy, a Q of 0.67.



2019

Construction of ITER, an international fusion demonstration project, in the south of France is 60% complete. When turned on, ITER is expected to produce 10 times the energy it consumes, a Q of 10.

12 years. It's also extremely rare and expensive, but it would be bred in fusion reactors.

When deuterium and tritium nuclei fuse, energy gets released as an alpha particle (a helium nucleus, which is two protons and two neutrons) and a very energetic neutron. Those neutrons are neutral, unconfined by the magnetic field holding the plasma. They crash into whatever material is facing them, which in tokamaks, for example, is called the first wall. The crash transfers heat and also knocks the atoms in the wall's material out of place, damaging it and making it radioactive.

Daniel Jassby, a retired researcher from the Princeton Plasma Physics Lab, says the incessant barrage of neutrons from burning D-T will create a lot of radioactive waste. Replacing weakened first-wall structures will drive up costs, he says, because of the expense of installing the new components as well as the downtime in which the system won't be selling power. What's more, the size of the machines means fusion reactors may produce as much as 10 times more waste than conventional fission reactors, he says. And while the levels of radiation may not be as intense as those of spent uranium fuel rods, that just means the byproducts of fusion systems are dangerous for a century instead of millennia.

The true operating costs for fusion reactors may not be low

enough to cover their costs, let alone compete with existing power plants, according to Jassby. "Why would anybody want this?"

Nevertheless, a certain strain of utopian idealism has always run through the fusion endeavor. It may be what prompted the 1985 agreement between U.S. President Ronald Reagan and the Soviet Union's Mikhail Gorbachev to cooperate on building a fusion energy project. Now known as ITER, the giant, long-delayed, 35-nation cooperative project is under construction—and about 60% complete—in the south of France.

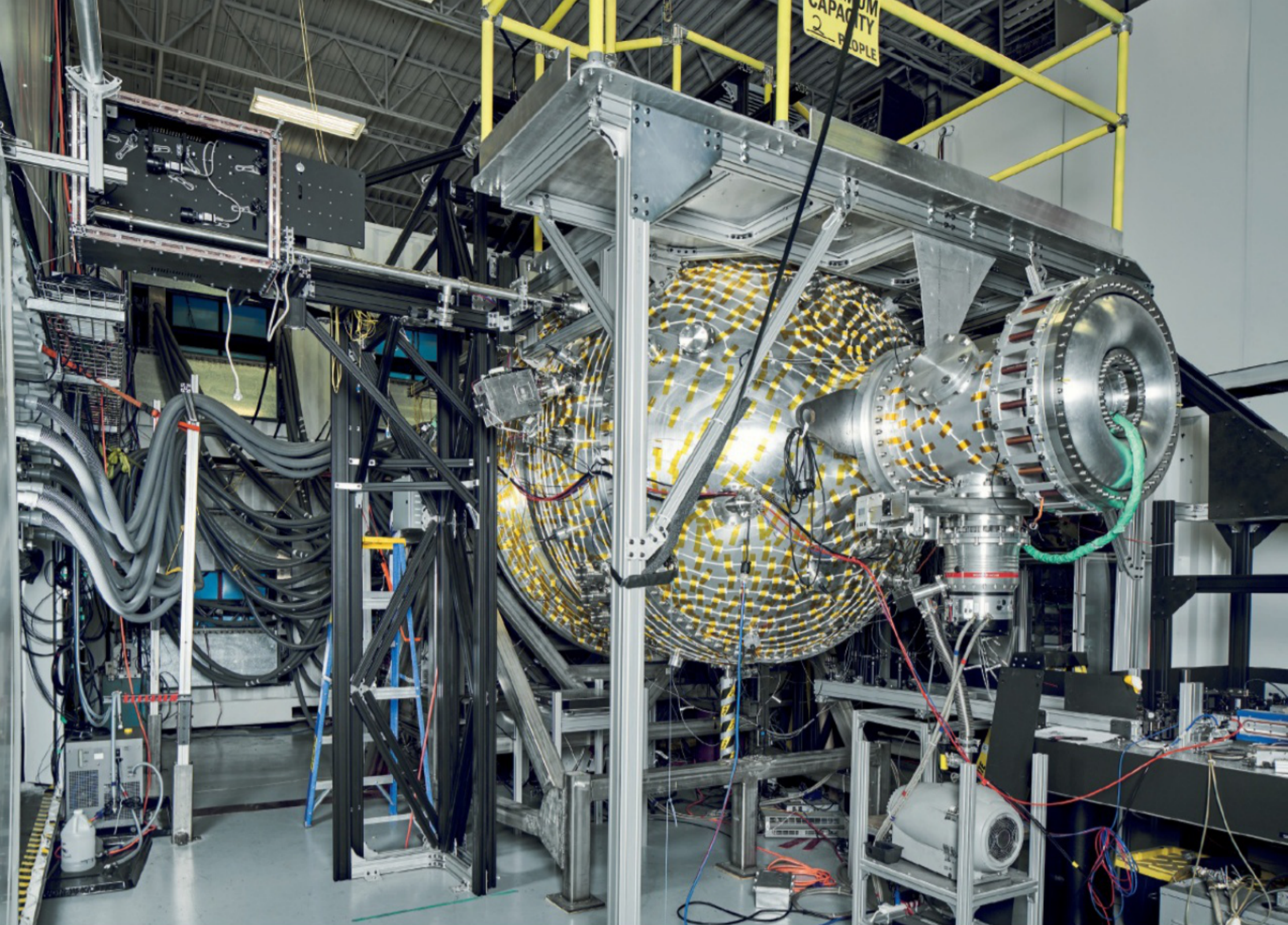
When ITER achieves its first plasma, which is slated for 2025, it's expected to hit a fusion milestone: It will produce more energy than it consumes. "There's nobody knowledgeable in the space who doesn't believe when they turn ITER on that it's going to produce net energy out," says General Fusion's Mowry. ITER is expected to produce 500 megawatts while consuming 50. In the parlance of the field, it will have a $Q > 1$. Specifically, since it's expected to produce 10 times the energy put in, it would have a $Q = 10$.

In the plasma physics community, there's no question that fusion is viable. Now these startups are aiming to build a working—and profitable—fusion power plant, Mowry says. "Private fusion ventures are not going to work on fundamental plasma physics and fusion science," he says. "They sit on top of that half a century of ▶

“Private fusion ventures are not going to work on fundamental plasma physics and fusion science. They sit on top of that half a century of hard-won knowledge, and they’re all about commercialization”



FROM LEFT: HULTON/GETTY IMAGES; BETTMANN/GETTY IMAGES; INTERFOTO/ALAMY; CTBTO; DAILY SKETCH; COURTESY G.E. COURTESY CULHAM CENTER FOR FUSION ENERGY; DIRK HALESTEAD/LIFE COLLECTION/GETTY IMAGES; RAVEN CALL/AP PHOTO; COURTESY PRINCETON PLASMA PHYSICS LAB; COURTESY EURO VISION; COURTESY ITER



A plasma injector at General Fusion. Such machines are designed to shoot fusion fuel into a vortex of liquid metal where it would be compressed by pistons and ignite.

hard-won knowledge, and they're all about commercialization.”

Here's a snapshot of three such companies:



COMMONWEALTH FUSION SYSTEMS, which was launched by professors from MIT's Plasma Physics and Fusion Research Center in 2018, is looking for space. For the time being, CFS and MIT design and technical teams are working in what used to be the control room for Alcator C-Mod, an Energy Department-funded experimental tokamak on MIT's campus. The machine, which sits in a large bay two doors away, ran a so-called high field using especially powerful magnets and set a record for plasma pressure.

CFS is seeking to make the next advance in magnetic confinement using new, commercially available high-temperature superconductors. The discovery of such materials was an advance that won the Nobel Prize in Physics in 1987.

Before high-temperature superconductors became available

in the past decade, tokamak builders faced a trade-off: use a lot of power to run a high magnetic field or run a lower magnetic field in a much bigger device, like ITER, says Mumgaard of CFS. The new superconductors will enable the company to build a smaller, cheaper version of an ITER-like machine. “Two years from now, we will have that magnet done,” he says.

CFS's subsequent step will be to build a demonstration machine called Sparc that will use the new magnet technology. Sparc will be about 12 feet tall and could fit into half a tennis court. Construction is supposed to start in 2021 and finish in 2025. A commercial version, called Arc, is expected to follow. It would be approximately twice as big, fitting into a basketball court.

CFS's tokamak will burn D-T fuel, which means it will confront the first-wall problem. The solution, Mumgaard says, is “to build a machine so you can replace the wall very easily.” Replace it often enough, he says, and it wouldn't get very radioactive and could be stored and then recycled. “You can choose what you put around the machine,” he says. “Right now we can go with the stuff that's cheap

and easy. And yeah, it's activated. But in the future we can put in stuff that lasts longer." One potential solution would be using specialized alloys that are more resistant to becoming radioactive, though the industry is still working to develop such materials.

The radioactive material from fusion reactors is drastically different from fission waste, Mumgaard adds. "It's basically not stuff that's biologically active," he says, unlike the volatile gases that can escape in a fission accident. "So it's like a completely different category. Whether or not we can explain that well to the public, you know, is one of the challenges that we have to figure out in fusion."

Still, Mumgaard is upbeat. "Fusion is a big endeavor, and there's a lot of excitement around it," he says, adding that enthusiasm is coming from energy people, investors, and academics. "We're trying to birth an industry here. And it's a fun place to be."



GENERAL FUSION, OUTSIDE VANCOUVER, is taking a different approach to building a reactor. Founded in 2002 by plasma physicist Michel Laberge, the company dusted off a 1970s design by the U.S. Naval Research Laboratory. Called Linus, the design included features that inspired General Fusion's concept. "It's basically the fusion equivalent of a diesel engine," Mowry says. General Fusion's machine addresses the first-wall problem by facing the plasma with swirling molten lead and lithium, which absorbs the neutrons. "We inject the plasma into a spherical cavity made out of liquid metal, and then we have basically an array of lots of pistons that are synchronized to collapse that cavity down very quickly around the plasma, heating it up until it burns—just like the analogy of a diesel engine," he says.

Today's high-speed electronic controls made it possible to synchronize the pistons with a precision that was impossible in the 1970s, according to Mowry. "That's an example of what we call enabling technologies," he says. The company is getting ready to build a scale model demonstration that it aims to complete in 2025.

"Fusion's time is really coming now," Mowry says. Before joining General Fusion, he worked in the energy industry for 30 years, including founding a company that designed so-called small modular reactors for fission energy. Now, he says, fusion is becoming competitive with fission. "When you look at the realistic time frames for commercializing advanced gen-four fission technologies, it's no shorter than that time frame to commercialize fusion these days," he says.



TAE TECHNOLOGIES, started in 1998, is the oldest company in the field. The late plasma physicist Norman Rostoker, who co-founded the company, took a long view, CEO Binderbauer says. Early on, Rostoker asked what fuel would be most likely to enable a viable fusion power plant—instead of what would be the easiest. He chose hydrogen and an isotope of boron, known as boron-11, because they produce no radiation during fusion and are readily available.

The catch? You have to cook the boron-11 fuel at temperatures of billions of degrees. So that's the path TAE is taking. Such temperatures have already been achieved in particle physics experiments, according to Binderbauer. "When we talk about temperature, what it really is, it's sort of how fast and with what energy are these particles zipping around and colliding with each other," he says. Consider the Large Hadron Collider near Geneva and convert the experiments there into temperature units, Binderbauer says. "CERN actually has created trillions-of-degrees situations where an operator will control it, put these particles into these storage rings, and they run around there," he says.

TAE's current machine, which accelerates two plasmas into each other in a confinement vessel and heats them with particle beams, is called Norman. It operates in the neighborhood of 35 million C. The company's next device, called Copernicus, is aiming for 100 million C.



LIKE OTHER MOONSHOTS, the effort to harness fusion has been both inspiring and frustrating. The finish line may still be years away, but breakthroughs along the way have been sufficient to keep attracting scientists—and, more recently, investors.

And fusion could have an important place in the future energy mix. "The statistics will tell you in the next 25 years we're going to double the amount of electrical demand and consumption," Binderbauer says. "To me, finding baseload power that is decoupled from having to burn fossil fuels is very, very critical."

The potential market is enormous, requiring an investment of \$10 trillion or more in generating equipment by 2050. "You can build multiple very-high-value companies in a market like that," he says. "And we will never even step on each other's toes." ●

Company Snapshots

These three companies are aiming to commercialize fusion

Commonwealth Fusion Systems

Cambridge, Mass.

TECHNOLOGY

Developing high-temperature superconducting magnets to confine plasma in a small tokamak called Sparc.

FUNDING

\$115 million

INVESTORS

ENI, Breakthrough Energy Ventures*, Future Ventures, Khosla Ventures, and others

General Fusion

Burnaby, B.C.

TECHNOLOGY

Developing magnetized-target fusion machine in which plasma is injected into a cavity surrounded by swirling molten metal and then compressed by synchronized pistons to create fusion.

FUNDING

More than \$100 million

INVESTORS

Bezos Expeditions, Chrysalix Venture Capital, Khazanah Nasional, and others

TAE Technologies Inc.

Foothill Ranch, Calif.

TECHNOLOGY

Developing beam-driven field-reversed configuration machine, which fires two plasmas into each other in a confinement vessel so that their magnetic field holds them while heated by particle beams.

FUNDING

More than \$600 million

INVESTORS

Goldman Sachs Group, Vulcan Capital, Venrock, and others

*Michael Bloomberg, founder and majority owner of Bloomberg LP, which owns Bloomberg Markets, is a member of the Breakthrough Energy Coalition

Asmundsson is <GO> editor of *Bloomberg Markets* and Wade covers energy for Bloomberg News in New York.

A

Ashleigh Schap's quest for a crypto utopia

illuminates a generation's aversion to mainstream banking

and the regulatory establishment

REBEL'S
GUIDE

By ALASTAIR MARSH

TO

PHOTOGRAPH BY HEATHER STEN

FINANCE



For Ashleigh Schap, the 2008 Great Recession was more an ideological awakening than an economic crisis. Her hometown of Houston escaped the worst of the maelstrom that ravaged large parts of the U.S., her parents kept their jobs, and the house she was living in retained most of its value. She had little reason to imagine the wheels would come off America's capitalist machine.

Yet the events of that year left a lasting impression on the teenager. The financial crisis and its aftershocks, which she read about on blogs and discussed with her classmates, made her realize that good times don't last forever. More important to what she would do later in life, she says they left her with a distaste for a lopsided financial system that benefits and protects those at the top at the expense of those at the bottom.

"I'm from Texas. My family is conservative and capitalist," she says. "And this was the first evidence I had seen that the ideas of growth at all times, that the cream always rises to the top, and that markets will be always be efficient, failed."

It would be five more years before Schap would discover Bitcoin—a key moment in her growing rebellion against existing political and financial structures—and five more before she would work on creating what she saw as a fairer financial order. She would also diverge politically from her family. "I don't talk to them about politics anymore," says Schap, who's now 27.

Her path from the high school chess club to crypto rebel was far from inevitable. Even before graduating in 2014 from the University of Texas at Austin, she joined JPMorgan Chase & Co. in Dallas as an analyst in the company's business for wealthy clients. She says she spent less than half a year there, moved to New York, knocked around a fintech firm and a family office for a while, and eventually, in April 2018, landed on the outermost fringes of finance at MakerDAO.

The key to MakerDAO is in its name: DAO stands for decentralized autonomous organization. It's an online platform for creating digital dollars, or so-called stablecoins, and generating loans secured by crypto tokens—all run by a blockchain-based computer program and free of oversight by any central party, such as, say, a government.

MakerDAO is the most important player in the fast-growing movement known as decentralized finance. #DeFi—widely known by its Twitter hashtag—aims to create a financial world where everything from loans to investments is readily available to anyone

without having to go through gatekeepers who decide who gets to play or intermediaries who charge fees at every turn.

It was a world in which Schap felt at home. In her early 20s, the online game *World of Warcraft* had introduced her to Bitcoin: She needed it to buy an accessory for her avatar. She bought five Bitcoin tokens in February 2013 (and then lost the same number a year later when the Mt. Gox exchange froze withdrawals following a hack of its systems). Decentralized finance is a natural outgrowth of crypto's ideology. The DeFi movement is small; it's almost exclusively the preserve of crypto utopians, many of them clustered around San Francisco. Its critics—and there are many—say it's a wild experiment run by people ill-equipped to be designing financial products.

"The technology might be interesting for more efficient delivery of financial services, but the naiveté and lack of knowledge of financial history seem shocking to me," says Richard Bernstein, founder of Richard Bernstein Advisors LLC and a former chief investment strategist at Merrill Lynch & Co. "There's this tear-down-the-house mentality, with minimal understanding of why financial regulation even exists."

Schap says she's no financial ingénue. "I left the traditional financial world for a reason, not because I was not being paid enough, but because I wanted to see what we could do with this new technology and how far we could push it," she says. "I'm not some crazy renegade. I'm quite the opposite. Blockchain has the potential to create a fairer financial system than we currently have, with more flexibility and greater opportunities to access credit."

Indeed, the ideas behind decentralized finance could have broad resonance beyond crypto circles. Popular uprisings from the global Occupy movement to the Hong Kong protests are driven by a young population pushing back against societal injustices and existing power structures, including in finance.

Working for MakerDAO, her hair dyed pink, her workstation a stone's throw from the New York Stock Exchange, Schap had completely transitioned to the financial resistance. She says she loved that MakerDAO was the antithesis of a corporate giant like JPMorgan—less a corporation than a cooperative, a commune for the digital age with developers and entrepreneurs around the world collaborating on an exciting new project.

And yet unbeknownst to Schap, even by the time she joined MakerDAO, a rebellion was brewing within the rebellion. The infighting—in which Schap would become an accidental

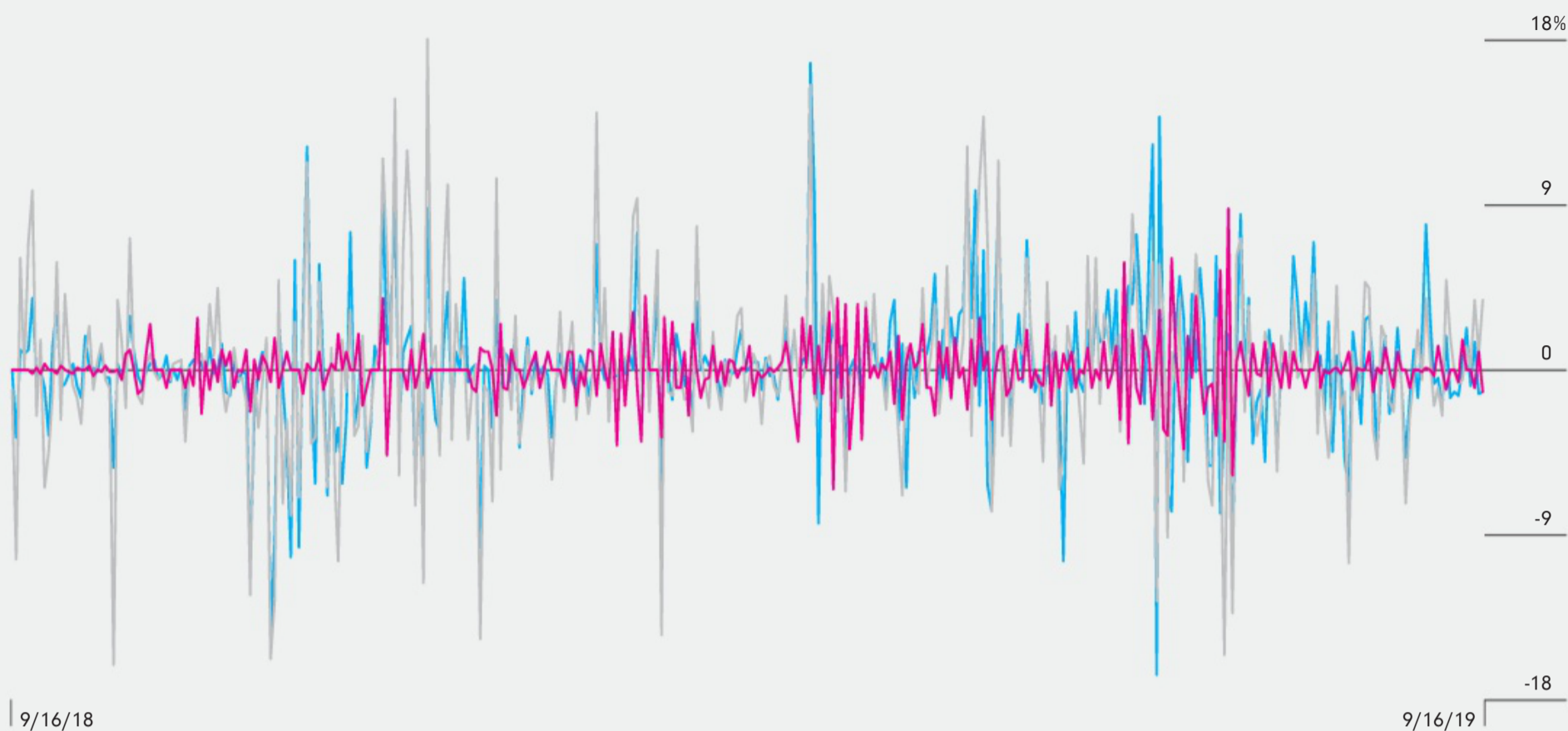
**“I left the traditional financial world for a reason...
I’m not some crazy renegade.
I’m quite the opposite”**



Taming Crypto's Wild Ride

One-day change in cryptocurrency price

Bitcoin Ether Dai



Sources: {XBTUSD FLYR Curncy}, Coinmarketcap.com

combatant—revolved around how decentralized financial services can ever really be. MakerDAO's founder, Rune Christensen, had come to believe it was time to move away from crypto anarchism and integrate the project into the existing financial system. Others, including Chief Technology Officer Andy Milenius and Schap, saw such a move as a betrayal of the ideals they cherished.

In an account of the startup's ideological battles that Milenius shared on the company's chat server in early April, he said Christensen, in trying to force his vision on what had been a loose coalition of developers and businesspeople, gave them an ultimatum to get on board with his agenda or leave. While Milenius's post said numerous staffers were uncomfortable with Christensen's power play, Schap was the only employee he mentioned by name.

As would soon become clear, her days at MakerDAO were numbered.



SCHAP'S STUDIES at UT Austin weren't a natural launchpad for a career in finance. As a philosophy major, with a minor in French, she says she told a JPMorgan recruiter her liberal arts education taught her how to think through problems. The job didn't suit her in the end. "I didn't feel like what we were doing was moving the needle," she says. "We were collecting all these fees, but I thought we were really overpaid. It wasn't exactly rocket science."

Schap felt increasingly pulled to the edges of finance. There just hadn't been many opportunities to make a career in the crypto industry, she says, during the five years she'd spent in traditional

finance. But by last year, she says, she felt qualified enough, and bored enough, to take advantage of an opportunity that arose to join MakerDAO. Schap worked in business development, and what began as a jack-of-all-trades job soon morphed into a singular focus on delivering the most ambitious phase of the project: creating a stablecoin backed by multiple types of collateral. She says she worked on finding partners that could supply collateral to the MakerDAO system.

MakerDAO's stablecoin, Dai, is pegged to the dollar and, in its current iteration, backed by the cryptocurrency Ether. There were \$85 million worth of Dai in circulation as of Sept. 19. Launched in late 2017, Dai was one of the first of what's become a flurry of virtual currencies designed to avoid large price swings.

Stablecoins like Dai can be used as a hedge against volatility. Ether peaked at more than \$1,400 each at the beginning of 2018, only to fall to \$84 at the end of the year and then to trade at \$180 in early September. Dai can also be used to pay for things. Users of Dai claim to have bought cars and paid their employees' salaries with the currency. MakerDAO says some payments companies such as Wirex Ltd. allow customers to use the token to facilitate the movement of funds between cryptocurrencies and traditional money.

The Dai token also enables lending. Dai is created when holders of Ether send their crypto to a blockchain-based computer program developed by MakerDAO and open what's known as a collateralized debt position. The CDP then issues a loan to Ether holders in Dai. The loan is smaller than the amount of Ether posted to maintain overcollateralization in case of market stress.

Dai, sold on exchanges such as Coinbase, is also widely ►

used in other DeFi projects. Advocates of decentralized finance aspire to do more than just replicate the current system: They see a world in which DeFi projects collaborate to create business models and products that couldn't exist without blockchain technology.

"Imagine being able to develop new financial markets that previously needed a multimillion-dollar bespoke contract designed by an investment bank, but with a few points and clicks," says Joey Krug, a DeFi entrepreneur and co-chief investment officer at Pantera Capital, the first U.S. investment firm focused on Bitcoin.

MakerDAO has a second token, MKR. A bit like shares in a public company, it gives holders voting rights on such matters as how much collateral is required to borrow Dai. Holders are rewarded for sound management with money drawn from fees charged to borrowers. The value of these tokens could be diluted if loans aren't repaid. There were \$517 million worth of MKR outstanding as of Sept. 19.

Schap says that if the MakerDAO system works as envisioned, it will be like a decentralized bank, taking deposits, facilitating lending, and managing risks. It also functions like a central bank in that it sets interest rates (in the form of what is called a stability fee, which is designed to help Dai track the dollar).

Before division and disenchantment set in at MakerDAO, Schap says, she felt she was involved in a startup that wasn't only reinventing finance but also creating a new type of corporate structure—impromptu brainstorming, a flat organization, ideas flying in from people regardless of job title or area of responsibility. All this, she says she believed in those early days, wasn't a function of good personal chemistry; it was Maker's DNA.

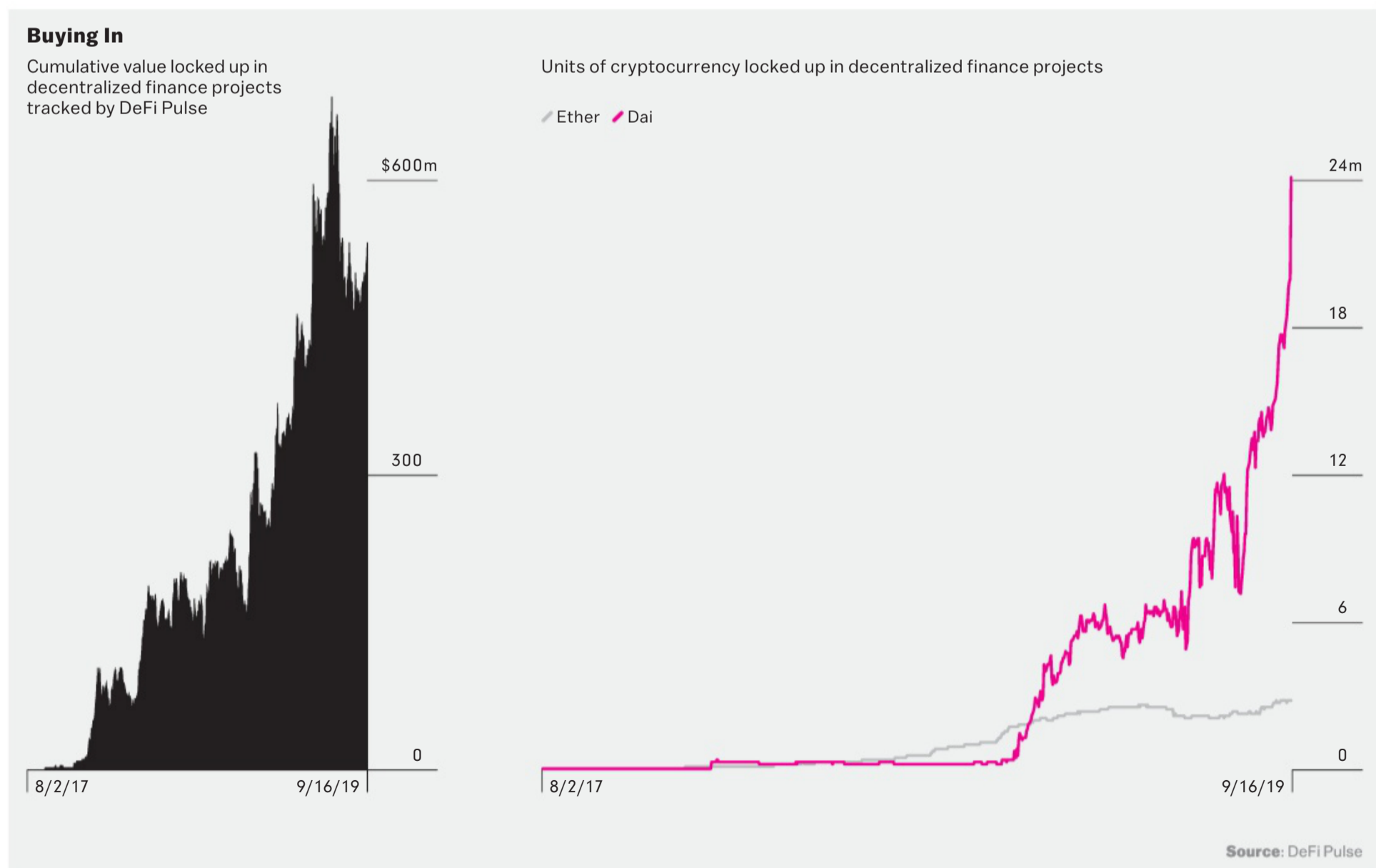
Or maybe it wasn't. Her growing unease was thinly veiled in a series of tweets she sent on her one-year anniversary there. One of them said: "I believe in a global, borderless, decentralized money. I believe in transparency and open governance. I also believe that we are human beings, we are flawed, and we have to set aside our selfish desires to make these things work. Because this work is worth doing. This matters."



A FEW WEEKS EARLIER, Christensen, who co-founded MakerDAO in 2014, had issued his ultimatum in true counterculture style. Christensen is a 28-year-old Danish entrepreneur. While still in college, the Mandarin speaker co-founded a company that recruited European teachers to work in China. Taking inspiration from the sci-fi film *The Matrix*, he gave his MakerDAO development team a choice. The red pill: Get on board with Christensen's vision, whose "main focus," as Milenius described it in his post, "was on government compliance and integration of Maker into the existing global financial system." The blue pill: If you feel differently, finish your work and then leave.

Taking the red pill doesn't mean you're a sellout to mainstream finance, Christensen says: "I reject the idea that I'm not an idealist." He says he believes that startups like MakerDAO have few examples to follow, and to succeed in a fast-paced industry, they need to adapt to the real world.

"The big journey and challenge is how to deliver this vision," he says. "It's quite easy to write a white paper and code, but to get a real live decentralized finance system going, you need to deal



“There’s this tear-down-the-house mentality, with minimal understanding of why financial regulation even exists”



with challenges like regulation and how to integrate with the establishment.” In his view, the DAO-like setup that Schap cherished led to a “tyranny of structurelessness.”

MakerDAO last year established the Maker Foundation. Designed to make the Dai credit system a success, it was intended to formalize the structure. As of mid-September, the foundation was still in the process of recruiting a professional board of directors, according to Christensen.

In response to his ultimatum, Schap and some like-minded employees proposed a third way, which became known as the “purple pill.” They were seeking a compromise to preserve MakerDAO’s decentralization ethos and ensure that its resources would be used to finance as broad a spectrum of DeFi projects as possible. “If you’re going to build a new system, it’s going to require selfless thinking and be designed so that there’s not one company or entity that gets all the rewards,” says Schap. “You need to remove the advantages of being at the top, and that is hard to do: If we build something, we feel we need to get our pound of flesh.”

Christensen, according to Milenius’s post, viewed the purple pill discussion as an uprising. Milenius said numerous purple pill partisans were fired. Schap was fired at the end of April. She says the reason given for her dismissal was violation of a nonsolicitation clause, something she denies. A MakerDAO spokesperson declined to comment.

Milenius, 27, who stepped down as CTO shortly before he wrote his treatise, says the struggles at MakerDAO are representative of a wider conflict that pervades the crypto community—a battle between those who see blockchain technology as a means to entirely reimagine the financial world and those who see it simply as a useful tool to make that world more efficient. “The blockchain community has always been starkly divided between those with a reform agenda and those with a radical vision for a new way to live,” he says. “After the events of this past spring, it has become clear to me that Maker now exclusively falls into the former camp.”

For Christensen, the next phase of the project is about increasing users and profits. He says he’s considering whether MakerDAO should obtain a broker-dealer license or acquire a licensed brokerage firm so the MakerDAO system can accept collateral from the real world to back Dai. “The future is not about making Maker work, but about figuring out how the ecosystem becomes as sprawling as it’s able to and how it can make money,” he says. “There is

so much to be done before the crypto ecosystem becomes this big self-sustaining economy.”

Schap says she was surprised to find herself at the center of the MakerDAO storm. “I somehow ended up being the poster child of this perceived mutiny,” she says. “The reality was quite a bit different. It wasn’t me leading. There was no coup.”



AFTER LOSING HER JOB at MakerDAO, Schap headed to Egypt for some downtime. At Dahab, on the Red Sea, the longtime scuba diver tried something more adventurous: learning to free dive down 66 feet (20 meters). Schap says she relished the mental challenge of “calming your mind and pushing past the urge to breathe or swim up.” From Egypt, she went to Berlin, a hub for blockchain developers, where she advised some DeFi projects.

Schap says her experience at MakerDAO has strengthened, not broken, her conviction that decentralized financial services are necessary and worthwhile. She says she hopes MakerDAO prospers. She put a year of her life into it, after all, and she holds some MKR tokens. But she remains unconvinced that platforms such as MakerDAO need to be regulated.

Decentralized finance is dismissed as little more than a distraction by vast swaths of the financial community, so MakerDAO’s next steps matter: It’s the largest and most closely watched DeFi project. It has a significant bearing on the broader \$275 billion crypto market, says Robert Leshner, CEO of Compound, a virtual-currency money market.

Leshner says MakerDAO and DeFi more generally are helping to provide an answer to the question that hangs over crypto. “After the bubble, then crash, of 2017 and 2018, it’s natural to ask, ‘What do we use this stuff for?’” he says. “[DeFi] is the first legitimate answer to the question. DeFi is starting to have its moment because it’s the next chapter for crypto.”

As for Schap, decentralization has become something of a life goal. She says she’s now working on her own DeFi startup with friends and will split her time between Berlin and New York. “I don’t think Maker will ultimately make or break DeFi,” she says. “It’s already helped to make it. And I don’t think it’s possible, even if Maker were to fail, for this train to stop rolling.” ●

Marsh covers cryptocurrencies in London.

Ana Botín

The chairman of Banco Santander SA was profiled in our final cover story of 2015. Here she divulges some of her off-duty habits and preferences to Bloomberg TV's Francine Lacqua, co-anchor of *Bloomberg Surveillance* and host of *Leaders With Lacqua*.



How many hours of sleep do you get a night?

I average seven hours and 45 minutes, according to my Fitbit. It's more like five to six hours on weekdays, but I try to compensate during weekends and holidays.

What's your typical workout?

I aim to do at least 10,000 steps a day and have averaged 12,000 for the past 12 months, including 30 to 45 minutes of fast walking. I also do yoga on weekends.

What's your favorite sport or sports team?

I enjoy watching football, especially when the Spanish national team plays. Also, the UEFA Champions League, which Santander now sponsors, and tennis (Rafa Nadal fan). I love trekking in the mountains and playing golf.

Which app is in heavy rotation on your phone?

Email during the week, but Twitter and LinkedIn on weekends. And Fitbit.

What's your go-to lunch spot?

I don't have one. I usually eat in the office and often bring my own lunch.

What's the best book you've read recently?

1,000 Years of Annoying the French by Stephen Clarke.

If you had to take a year off, what would you do?

Spend more time with my family, especially my husband, and limit my iPhone/iPad use.

What is your biggest fear?

I always worry when my sons are traveling.

What's the best advice you've gotten?

Invest in your strengths and be yourself.

What's the best advice you've given?

Check, double-check, and triple-check. And ensure your organization is aligned with your strategy, so execution improves. On a personal basis, for women especially, take care of yourself so you can take care of others.

What's your favorite museum or artist?

Javier Camarena, the Mexican tenor who performed in May at the Reina Sofía School of Music [in Madrid]. He's amazing.

A Compendium of Functions— New or Featured In This Issue

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NEW ENHANCEMENTS TO TRY RIGHT NOW

RV	The Relative Value function has been enhanced to let you compare the yield of a bond with an index. To analyze an Apple bond, for example, run {AAPL 2.4 05/03/23 Corp RV <GO>}. Click the Spread drop-down and select Spread to Index. RV defaults to the most popular Bloomberg index that includes the bond.
N	If you want to share a news story with a terminal user, you can now copy an external link to the article and send it to an Outlook account or other email address. Click the Actions button on the red toolbar, select Copy Link, and then Copy External Link (Bloomberg Link). When the recipient clicks the link using a mobile device, the story will open in his or her Bloomberg Professional app.
MARS BCOL	The Multi Asset Risk System Collateral Management function has been enhanced. You can now save your counterparty's initial margin or independent amount and the additional collateral paid above the mark-to-market value of a derivatives deal and easily compare them with your values. Run {BCOL <GO>}, right-click on a margin event to agree, partially agree, or dispute a call, enter the relevant amounts, and click Save.
MODL	The Analyst Estimates and Models function lets you see granular estimates and consensus on a company and download sell-side models. Go to {FB US Equity MODL <GO>}, for example, to see consensus company-specific metrics such as daily and monthly active users for Facebook. 38, 39
WFOR	The Weather Forecasts function now lets you chart past seasonal temperatures for a location. Run {WFOR <GO>}, click on the arrow to the right of 2 Week Forecast, and select Seasonality Chart.

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Test Your Knowledge

By LUJIA YU, HAO DU, ZIJING WU,
and LI ZHAO

WHEN DO ANALYSTS EXPECT Netflix Inc. to reach more than 200 million paying international customers? Which hedge fund strategy returned the most over the past year? Test your knowledge with Bloomberg's Functions for the Market quiz. Then follow the steps to see if you had the correct answer (and learn a bit about how to tap into data and analytical tools in the process).

1. When do analysts expect Netflix to surpass 200 million international paid subscribers?

- FY 2020
- FY 2023
- FY 2024

3. What's the cheapest stock market in the developed world?

- Hong Kong
- London
- Tokyo

2. Which hedge fund strategy delivered the best returns over the past year?

- Credit
- Equity
- Event-driven

4. Interest-rate swaps are currently pointing to rate increases in only a few nations in the coming year. Where is the largest rise expected?

- Hungary
- Ecuador
- Iceland

Type "Netflix" in the command line and select NFLX US Equity.

Type "estimates and models" and select MODL -

Analyst Estimates and Models.

Click the gray Source View tab. The shortcut is {NFLX US Equity MODL SOURCE <GO>}. Set the Periodicity box at the top left to Annals.

Under Memberships, in the Paid Memberships section, the consensus number is shown to the right of International Streaming.

Type "market relative valuation" and select MRV - Market Relative Valuation. The shortcut is {MRV <GO>}.

Click on the Valuations tab, if it's not already selected.

The Valuation Score shows the deviation from the average basket valuation score based on five key ratios. The higher the score, the cheaper the market.

Look at the 1Y Return for items in the Strategy section.

Type "hedge funds" in the command line and select HF - Bloomberg Hedge Fund Indices.

Click World Map in the red toolbar.

For Total Change Over, click 1Y.

Hover over the nations colored green to find expectations for interest-rate increases.



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