



FINANCE AND DEVELOPMENT

JUNE 2018

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Money, Transformed

The future of currency in a digital world

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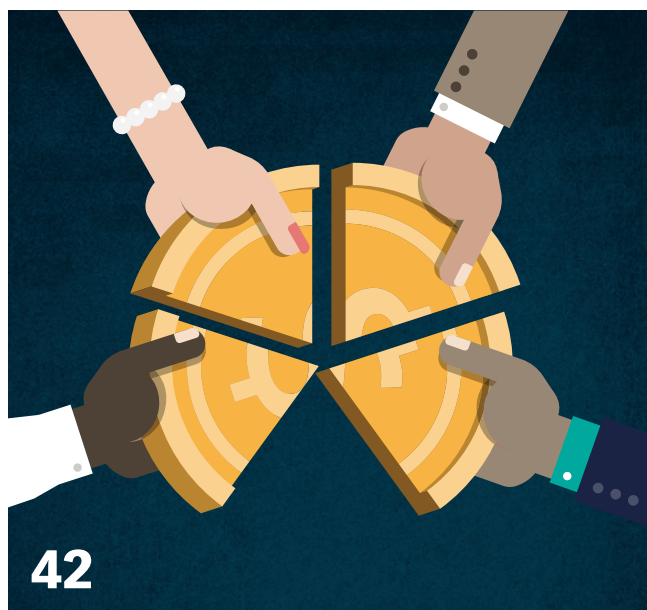
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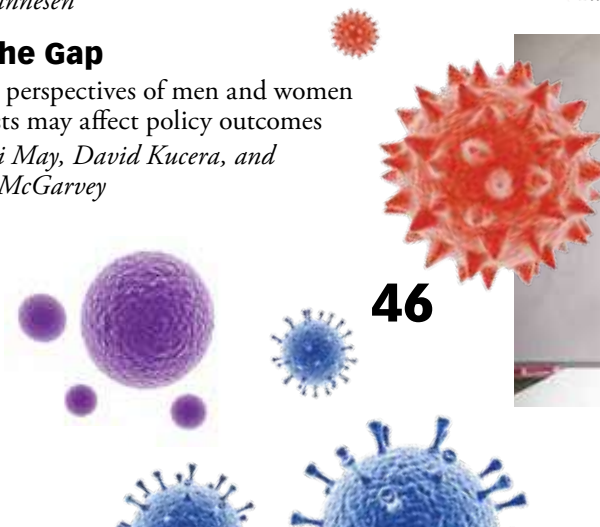
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Our Digital Future

“**MONEY MAKES THE** world go around,” Liza Minnelli famously sang in the movie *Cabaret*. Money has for centuries been central to human relationships. Loss of faith in its value can result in economic and political instability, even war. In the past few years, financial technology—fintech for short—has caught the world’s imagination by offering alternatives to traditional means of payment. Will digitalization redefine money? We explore the possible consequences, good and bad.

Traditionally, money has always been an expression of sovereignty, writes Harold James of Princeton University—even if states at times failed spectacularly to guarantee its value. Today, most experts agree that so-called cryptocurrencies do not possess all the core attributes of money. But they also believe that distributed ledger technology (which underpins such assets) has the potential to transform payment services by removing the need for an intermediary. This would reduce the role of central banks and weaken state authority over the money supply. Indeed, that was the political motivation behind Bitcoin, the first decentralized digital currency.

Swedish central bank governor Stefan Ingves points out that, at present, only 13 percent of transactions in his country are settled with cash. If banknotes and coins have had their day, then soon the public will no longer have access to a state-guaranteed means of payment. That is, unless central banks redefine their role. One possibility would be for central banks to issue their own digital tokens—a solution that would require careful consideration of choices and policy trade-offs, says the IMF’s Dong He.

Worries about the misuse of financial technology should be weighed against its potential benefits to society. IMF Managing Director Christine Lagarde offers the following advice: “Above all, we must keep an open mind about crypto assets and financial technology more broadly, not only because of the risks they pose, but also because of their potential to improve our lives.” **FD**

CAMILLA LUND ANDERSEN, Editor-in-Chief



ON THE COVER

Money is something that holds its value over time, can be easily translated into prices, and is widely accepted. Illustrator Michael Waraksa’s June 2018 cover depicts its evolution. With digitalization, money may be entering a new era.

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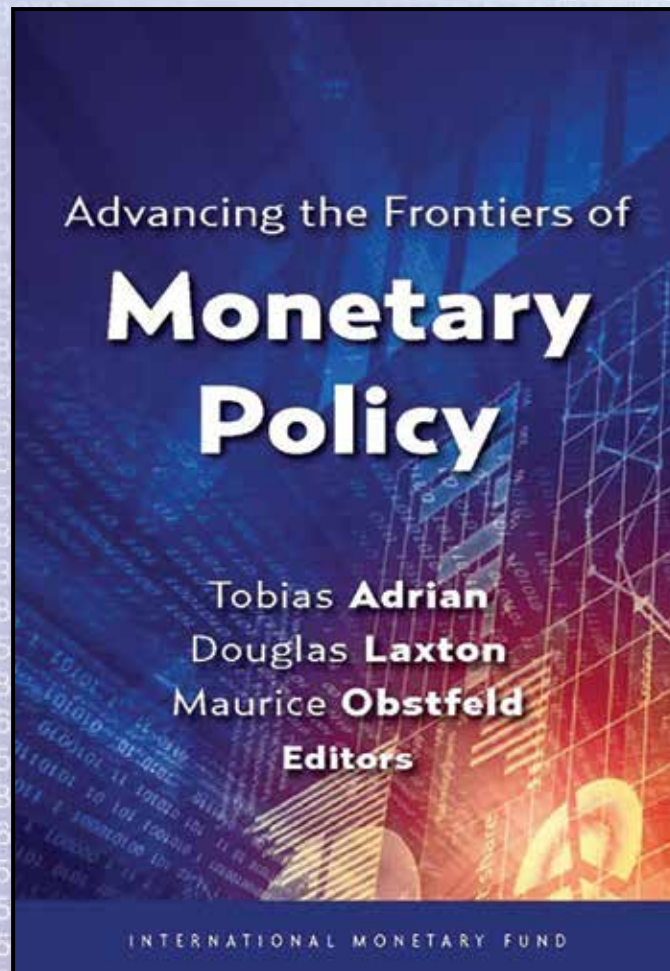
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I N T E R N A T I O N A L M O N E T A R Y F U N D

THE LONG AND SHORT OF

The Digital



Revolution

Smart policies can alleviate the short-term pain of technological disruption and pave the way for long-term gain

Martin Mühleisen



Digital platforms are recasting the relationships between customers, workers, and employers as the silicon chip's reach permeates almost everything we do—from buying groceries online to finding a partner on a dating website. As computing power improves dramatically and more and more people around the world participate in the digital economy, we should think carefully about how to devise policies that will allow us to fully exploit the digital revolution's benefits while minimizing job dislocation.

This digital transformation results from what economists who study scientific progress and technical change call a general-purpose technology—that is, one that has the power to continually transform itself, progressively branching out and boosting productivity across all sectors and industries. Such transformations are rare. Only three previous technologies earned this distinction: the steam engine, the electricity generator, and the printing press. These changes bring enormous long-term benefits. The steam engine, originally designed to pump water out of mines, gave rise to railroads and industry through the application of mechanical power. Benefits accrued as farmers and merchants delivered their goods from the interior of a country to the coasts, facilitating trade.

Adopt—but also adapt

By their very nature, general-purpose technological revolutions are also highly disruptive. The Luddites of the early 19th century resisted and tried to destroy machines that rendered their weaving skills obsolete, even though the machines ushered in new skills and jobs. Such disruption occurs precisely because the new technology is so flexible and pervasive. Consequently, many benefits come not simply from *adopting* the technology, but from *adapting to* the technology. The advent of electricity generation enabled power to be delivered precisely when and where needed, vastly improving manufacturing efficiency and paving the way for the modern production line. In the same vein, Uber is a taxi company using digital technology to deliver a better service.

An important component of a disruptive technology is that it must first be widely adopted before society adapts to it. Electricity delivery depended on generators. The current technological revolution depends on computers, the technical backbone of the Internet, search engines, and digital platforms.

Because of the lags involved in adapting to new processes, such as replacing traditional printing with online publishing, it takes time before output growth accelerates. In the early stages of such revolutions, more and more resources are devoted to innovation and reorganization whose benefits are realized only much later.

For example, while James Watt marketed a relatively efficient engine in 1774, it took until 1812 for the first commercially successful steam locomotive to appear. And it wasn't until the 1830s that British output per capita clearly accelerated. Perhaps it is no wonder that the digital revolution doesn't show up in the productivity statistics quite yet—after all, the personal computer emerged only about 40 years ago.

But make no mistake—the digital revolution is well under way. In addition to transforming jobs and skills, it is also overhauling industries such as retailing and publishing and perhaps—in the not-too-distant future—trucking and banking. In the United Kingdom, Internet transactions already account for almost one-fifth of retail sales, excluding gasoline, up from just one-twentieth in 2008. And e-commerce sites are applying their data skills to finance. The Chinese e-commerce giant Alibaba already owns a bank and is using knowledge about its customers to provide small-scale loans to Chinese consumers. Amazon.com, the American e-commerce site, is moving in the same direction.

Meanwhile, anonymous cryptocurrencies such as Bitcoin are posing challenges to efforts to combat money laundering and other illicit activities. But what makes these assets appealing also makes them potentially dangerous. Cryptocurrencies can be used to trade in illegal drugs, firearms, hacking tools, and toxic chemicals. On the other hand, the underlying technology behind these currencies (blockchain) will likely revolutionize finance by making transactions faster and more secure, while better information on potential clients can improve the pricing of loans through better assessment of the likelihood of repayment. Regulatory frameworks need to ensure financial integrity and protect consumers while still supporting efficiency and innovation.

Looking forward, we may see even more disruption from breakthroughs in quantum computing, which would facilitate calculations that are beyond the capabilities of traditional computers. While enabling exciting new products, these computers could undo even some new technologies. For example, they could render current standards in cryptology obsolete,

potentially affecting communication and privacy on a global level. And this is just one aspect of threats to cyber security, an issue that is becoming increasingly important, given that almost all essential public services and private information are now online.

Accelerated pace

Digitalization will also transform people's jobs. The jobs of up to one-third of the US workforce, or about 50 million people, could be transformed by 2020, according to a report published last year by the McKinsey Global Institute. The study also estimates that about half of all paid activities could be automated using existing robotics and artificial and machine learning technologies. For example, computers are learning not just to drive taxis but also to check for signs of cancer, a task currently performed by relatively well-paid radiologists. While views vary, it is clear that there will be major potential job losses and transformations across all sectors and salary levels, including groups previously considered safe from automation.

As the McKinsey study underscores, after a slow start, the pace of transformation continues to accelerate. The ubiquitous smartphone was inconceivable to the average person at the turn of the 21st century. Now, more than 4 billion people have access to handheld devices that possess more computing power than the US National Aeronautics and Space Administration used to send two people to the moon. And yet these tiny supercomputers are often used only as humble telephones, leaving vast computing resources idle.

One thing is certain: there's no turning back now. Digital technology will spread further, and efforts to ignore it or legislate against it will likely fail. The question is "not whether you are 'for' or 'against' artificial intelligence—that's like asking our ancestors if they were for or against fire," said Max Tegmark, a professor at the Massachusetts Institute of Technology in a recent *Washington Post* interview. But economic disruption and uncertainty can fuel social anxiety about the future, with political consequences. Current fears about job automation parallel John Maynard Keynes's worries in 1930 about increasing technological unemployment. We know, of course, that humanity eventually adapted to using steam power and electricity, and chances are we will do so again with the digital revolution.

The answer lies not in denial but in devising smart policies that maximize the benefits of the new technology while minimizing the inevitable short-term

disruptions. The key is to focus on policies that respond to the organizational changes driven by the digital revolution. Electrification of US industry in the early 20th century benefited from a flexible educational system that gave people entering the labor force the skills needed to switch from farm work as well as training opportunities for existing workers to develop new skills. In the same way, education and training should give today's workers the wherewithal to thrive in a new economy in which repetitive cognitive tasks—from driving a truck to analyzing a medical scan—are replaced by new skills such as web engineering and protecting cyber security. More generally, future jobs will probably emphasize human empathy and originality: the professionals deemed least likely to become obsolete include nursery school teachers, clergy, and artists.

One clear difference between the digital revolution and the steam and electricity revolutions is the speed at which the technology is being diffused

Digital technology will spread further, and efforts to ignore it or legislate against it will likely fail.

across countries. While Germany and the United Kingdom followed the US take-up of electricity relatively quickly, the pace of diffusion across the globe was relatively slow. In 1920, the United States was still producing half of the world's electricity. By contrast, the workhorses of the digital revolution—computers, the Internet, and artificial intelligence backed by electrical power and big data—are widely available. Indeed, it is striking that less-developed countries are leading technology in many areas, such as mobile payments (Kenya), digital land registration (India), and e-commerce (China). These countries facilitated the quick adoption of new technologies because, unlike many advanced economies, they weren't bogged down in preexisting or antiquated infrastructure. This means tremendous opportunities for trial and error to find better policies, but also the risk of a competitive race to the bottom across countries.

While the digital revolution is global, the pace of adaptation and policy reactions will—rightly or wrongly—be largely national or regional, reflecting different economic structures and social preferences.

Even with short-term dislocations, reorganizing the economy around revolutionary technologies generates huge long-term benefits.

The revolution will clearly affect economies that are financial hubs, such as Singapore and Hong Kong SAR, differently than, for example, specialized oil producers such as Kuwait, Qatar, and Saudi Arabia. Equally, the response to automated production technologies will reflect possibly different societal views on employment protection. Where preferences diverge, international cooperation will likely involve swapping experiences of which policies work best. Similar considerations apply to the policy response to rising inequality, which will probably continue to accompany the gradual discovery of the best way to organize firms around the new technology. Inequality rises with the widening of the gap in efficiency and market value between firms with new business models and those that have not reorganized. These gaps close only once old processes have been largely replaced.

Education and competition policy will also need to be adapted. Schools and universities should provide coming generations with the skills they need to work in the emerging economy. But societies also will need to put a premium on retraining workers whose skills have been degraded. Similarly, the reorganization of production puts new strains on competition policy to ensure that new techniques do not become the province of a few firms that come first in a winner-take-all lottery. In a sign that this is what is already happening, Oxfam International recently reported that eight individuals held more assets than the poorest 3.6 billion combined.

The railroad monopolies of the 19th century required trust busting. But competition policy is more difficult when future competitors are less likely to emerge from large existing firms than from small companies with innovative approaches that have the capacity for rapid growth. How can we ensure that the next Google or Facebook is not gobbled up by established firms?

Avoiding a race to the bottom

Given the global reach of digital technology, and the risk of a race to the bottom, there is a need for policy cooperation similar to that of global financial markets and sea and air traffic. In the digital arena, such cooperation could include regulating the

treatment of personal data, which is hard to oversee in a country-specific way, given the international nature of the Internet, as well as intangible assets, whose somewhat amorphous nature and location can complicate the taxation of digital companies. And financial supervisory systems geared toward monitoring transactions between financial institutions will have trouble dealing with the growth of peer-to-peer payments, including when it comes to preventing the funding of crime.

The importance of cooperation also implies a role for global international organizations such as the World Bank and the International Monetary Fund. These institutions, with their broad membership, can provide a forum for addressing the challenges posed by the digital revolution, suggest effective policy solutions, and outline policy guidelines. To be successful, policymakers will need to respond nimbly to changing circumstances, integrate experiences across countries and issues, and tailor advice effectively to countries' needs.

The digital revolution should be accepted and improved rather than ignored and repressed. The history of earlier general-purpose technologies demonstrates that even with short-term dislocations, reorganizing the economy around revolutionary technologies generates huge long-term benefits. This does not negate a role for public policies. On the contrary, it is precisely at times of great technological change that sensible policies are needed. The factories created by the age of steam also ushered in regulations on hours of work, juvenile labor, and factory conditions.

Similarly, the gig economy is causing a reconsideration of rules: for example, what does it mean to be self-employed in the age of Uber? To minimize disruptions and maximize benefits, we should adapt policies on digital data and international taxation, labor policies and inequality, and education and competition to emerging realities. With good policies and a willingness to cooperate across borders, we can and should harness these exciting technologies to improve well-being without diminishing the energy and enthusiasm of the digital age. **FD**

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PHOTO: IMF

A Regulatory Approach to Fintech

We must guard against emerging risks without stifling innovation

Christine Lagarde

IN THE 19TH CENTURY, when Alexander Graham Bell was awarded a patent for the telephone, the only way to communicate rapidly over long distances was by telegraph. The dominant company in that market dismissed Bell's invention as a useless toy and rejected an opportunity to buy his patent. The rest, as they say, is history.

This anecdote illustrates the disruptive and unpredictable nature of technological innovation. Today, some enthusiasts say crypto assets may represent the beginning of a similar breakthrough. Others condemn crypto assets as little more than a fad or a fraud. We should not dismiss them so lightly.

Crypto assets are just one example of how new technologies are being used to deliver financial services—Fintech for short. In Kenya and China, mobile payment systems have brought millions of previously “unbanked” people into the financial system. In Latvia, Brazil, and elsewhere, peer-to-peer lending has opened up a new source of credit

for small businesses that have trouble borrowing from a bank.

Around the world, advances in artificial intelligence promise to extract more value from data that is ever more abundant and ubiquitous. Its applications in the realm of financial services include enhancing fraud protection and regulatory compliance, potentially expanding access to financial services, and deepening financial inclusion.

Fintech offers considerable promise, but it also poses risks. Consider distributed ledger technology, which underpins crypto assets. It can enable faster and cheaper transactions, from trading securities to sending money to relatives abroad. It can be used to securely store records such as diplomas and real estate deeds and to automatically execute so-called smart contracts. But clearly the technology has also been used for illicit purposes.

How should regulators respond? Their task isn't an easy one. On the one hand, they must protect

consumers and investors against fraud and combat tax evasion, money laundering, and the financing of terrorism, ensuring that risks are thoroughly understood and managed. They must also protect the integrity and stability of the financial system.

On the other hand, they must beware of stifling innovation that responsibly and sustainably benefits the public. By constructively engaging with market participants at the center of financial innovation, regulators can stay abreast of the benefits of new technologies and quickly identify emerging risks. Developing a forward-looking regulatory framework calls for creativity, flexibility, and new expertise.

Crisis lessons

As I see it, the experience of the financial crisis and its aftermath yielded three important lessons that can guide us as we seek answers.

Lesson number one: *trust is the foundation of the financial system, but it is a fragile foundation that can easily be shaken.* How can we reap the benefits of the new technologies while maintaining trust?

Lesson number two: *risk accumulates in unexpected places.* The years preceding the global financial crisis saw the emergence of financial instruments, such as collateralized debt obligations, that were poorly understood by investors. Will a more decentralized financial system be more stable, or less? Will risk be more dispersed? Will the diminished role of traditional intermediaries mean that emerging risks are more likely to go undetected?

Lesson number three: *in a globalized world, financial shocks quickly reverberate across national boundaries.* Responding to a crisis requires concerted action on a global scale; in other words, we are all in this together. Will the evolving global financial system transmit shocks more quickly? How can resilience be strengthened? What can be done to enhance international cooperation?

Global action

So far, national authorities have reacted with varying degrees of regulatory stringency. If this uncoordinated response continues, activity will simply migrate toward more lightly regulated jurisdictions in a “race to the bottom.” Because crypto assets know no borders, a global approach is vital.

Such an approach is taking shape. The Financial Action Task Force, a global standard-setting body, has already provided guidance to its members on how they should address money-laundering and

terrorist-financing risks associated with crypto assets. The Financial Stability Board (FSB), which coordinates financial regulation for the Group of 20 (G20) largest advanced and emerging economies, is studying ways to monitor the growth of crypto assets with an eye toward identifying emerging threats to stability.

In March, I flew to Buenos Aires to participate in a meeting of G20 central bankers and finance ministers. The G20 agreed with the FSB’s assessment that crypto assets do not currently pose a threat to stability. They also agreed that crypto assets could pose a threat at some point in the future. They asked the FSB, along with other standard-setting bodies, to continue their work on crypto assets and report on their progress.

IMF’s role

Here at the IMF, we can serve as a forum for the exchange of ideas and a catalyst for forging consensus. It is our job to monitor the economies and financial systems of our 189 members, help them build institutional capacity, and offer advice on improving policies and regulatory structures. That gives us a unique global perspective.

To do our jobs properly, we must understand the innovative technologies, learn from them, and perhaps even adopt some of them to improve regulation, supervision, and surveillance. In some cases, it will be enough to apply existing regulations. In others, new approaches may be required as new risks—including cybersecurity—emerge and as distinctions between entities and activities break down.

One thing seems certain: we shouldn’t put off action until the answers become completely clear. Instead, we must begin to consider the regulatory framework of the future. We must do so in a manner attuned to the rapid pace of change, and with the awareness that unexpected new opportunities and risks may emerge. One approach, undertaken in Hong Kong SAR, Abu Dhabi, and elsewhere, is to establish regulatory “sandboxes” where new financial technologies can be tested in a closely supervised environment.

Above all, we must keep an open mind about crypto assets and financial technology more broadly, not only because of the risks they pose, but also because of their potential to improve our lives. When in doubt, just think of Alexander Graham Bell and his telephone. **FD**

CHRISTINE LAGARDE is managing director of the IMF.

Going Cashless

The governor of the world's oldest central bank discusses his country's shift toward digital money

Stefan Ingves



PHOTO: PETER KARLBERG/KARLBERG MEDIA AB

SWEDEN IS RAPIDLY moving away from cash. Demand for cash has dropped by more than 50 percent over the past decade as a growing number of people rely on debit cards or a mobile phone application, Swish, which enables real-time payments between individuals. More than half of all bank branches no longer handle cash. Seven out of ten consumers say they can manage without cash, while half of all merchants expect to stop accepting cash by 2025 (Arvidsson, Hedman, and Segendorf 2018). And cash now accounts for just 13 percent of payments in stores, according to a study of payment habits in Sweden (Riksbank 2018).

Digital solutions for large payments between banks have existed for some time; the novelty is that they have filtered down to individuals making small payments. And my country isn't alone in this regard. In several Asian and African countries—for example, India, Pakistan, Kenya,

and Tanzania—paying by mobile phone instead of cards or cash is commonplace.

Given that the role of a central bank is to manage the money supply, these developments potentially have wide-ranging consequences. Are central banks needed as issuers of a means of payment in a modern digital payments market? Are banknotes and coins

In a cashless society, what would legal tender mean?

the only means of payment for retail payments that should be supplied by a central bank? Is there a risk of future concentration in the payments market infrastructure that central banks should be monitoring?

In Sweden, clearing and transfers between accounts are concentrated in one system, Bankgirot. Once the payments market infrastructure is in place, the marginal costs for payments are low and positive externalities are present. What do we mean by “positive externalities”? A classic example is the telephone. Having the first telephone is not very valuable, as there would be no one to call. However, as more people eventually connect to the telephone network, the value of the phone increases.

The same is true for the payments market—the value of being connected to a payments system increases as more people join. Moreover, payments can also be regarded as collective utilities. Considering this, my view is that the state does indeed have a role to fill in the payments market—namely, to regulate or provide the infrastructure needed to ensure smooth functioning and robustness.

Citizens can expect a payments market to meet a few basic requirements. First, its services should be broadly available. Second, its infrastructure should be safe and secure. Sellers and buyers should be convinced that

Are central banks needed as issuers of a means of payment in a modern digital payments market?

the payment order will be carried out—a necessary condition for people to be willing to use the system. Third, it should be efficient: payments should be settled fast, at the lowest possible cost, and the system should be perceived as simple and easy to use.

Do we fulfill these requirements? I am becoming increasingly uncertain whether we can respond with an unequivocal yes.

If banknotes and coins have had their day, then in the near future, the general public will no longer have access to a state-guaranteed means of payment, and the private sector will to a greater extent control accessibility, technological developments, and pricing of the available payment methods. It is difficult to say at present what consequences this might have, but it will likely further limit financial access for groups in society that currently lack any means of payment other than cash. Competition and redundancy in the payments infrastructure will likely be reduced if the state is no longer a participant. Today, cash has a natural place as the only legal tender. But in a cashless society, what would legal tender mean?

In this regard, one might ask whether central banks should start issuing digital currency to the public. This is a complex issue and one central banks will likely struggle with for years to come. I approach the question as a practical, not a hypothetical, matter. I am convinced that within 10 years we will almost exclusively be paying digitally, both in Sweden and in many parts of the world. Even today, young people, at least in Sweden, use practically no cash at all. This demographic dimension is also why I believe that cash's decline can be neither stopped nor reversed. While the Nordic countries are at the forefront, we are not alone. It is interesting to see how quickly the Chinese payments market, for instance, is changing.

And then there is the emergence of crypto assets. I do not consider these so-called currencies to be money, as they do not fulfill the three essential functions of money—to serve as a means of payment,

a unit of account, and a store of value. This view is shared by most of my colleagues. Crypto assets' main contribution is to show that financial infrastructure can be built in a new way with blockchain technology, smart contracts, and crypto solutions. Although the new technology is interesting and can probably create value added in the long run, it is important that central banks make it clear that cryptocurrencies are generally not currencies but rather assets and high-risk investments. The clearer we are in communicating this, the greater the chance that we can prevent unnecessary bubbles from arising in the future. We may also want to review the need for regulatory frameworks and supervision for this relatively new phenomenon.

It is worth mentioning that digitalization, technical improvements, and globalization are positive developments that increase our collective economic welfare. We can only speculate on what new payments services may be developed in the future. But there are several challenges ahead. One key issue we face is whether central banks can stop supplying a state-guaranteed means of payment to the general public. Another is whether the infrastructure for retail payments should be transferred to a purely private market. The state cannot entirely withdraw from its social responsibility in these areas. But exactly what its new role will become remains to be seen. [FD](#)

STEFAN INGVES is the governor of Sveriges Riksbank, the central bank of Sweden.

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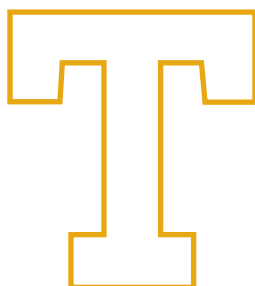
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MONETARY POLICY

IN THE DIGITAL AGE

Crypto assets may one day reduce demand for central bank money

Dong He



he global financial crisis and the bailouts of major financial institutions renewed skepticism in some quarters about central banks' monopoly on the issuance of currency. Such skepticism fueled the creation of Bitcoin

and other crypto assets, which challenged the paradigm of state-supported currencies and the dominant role of central banks and conventional institutions in the financial system (He and others, 2016).

Twenty years ago, when the Internet came of age, a group of prominent economists and central bankers wondered whether advances in information technology would render central banks obsolete (King 1999). While those predictions haven't yet come to pass, the rise of crypto assets has rekindled the debate. These assets may one day serve as alternative means of payment and, possibly, units of account, which would reduce the demand for fiat currencies or central bank money. It's time to revisit the question, will monetary policy remain effective in a world without central bank money (Woodford 2000)?

For the time being, crypto assets are too volatile and too risky to pose much of a threat to fiat currencies. What is more, they do not enjoy the same degree of trust that citizens have in fiat currencies: they have been afflicted by notorious cases of fraud, security breaches, and operational failures and have been associated with illicit activities.

Addressing deficiencies

But continued technological innovation may be able to address some of these deficiencies. To fend off potential competitive pressure from crypto assets, central banks must continue to carry out effective monetary policies. They can also learn from the properties of crypto assets and the underlying technology and make fiat currencies more attractive for the digital age.

What are crypto assets? They are digital representations of value, made possible by advances in cryptography and distributed ledger technology. They are denominated in their own units of account and can be transferred peer to peer without an intermediary.

Crypto assets derive market value from their potential to be exchanged for other currencies, to be used for payments, and to be used as a store of value. Unlike the value of fiat currencies, which is anchored by monetary policy and their status as legal tender, the value of crypto assets rests solely on the expectation that others will also value and use them. Since valuation is largely based on beliefs that are not well anchored, price volatility has been high.

Deflation risk

Some crypto assets, such as Bitcoin, in principle have limited inflation risk because supply is limited. However, they lack three critical functions that stable monetary regimes are expected to fulfill: protection against the risk of structural deflation, the ability to respond flexibly to temporary shocks to money demand and thus smooth the business cycle, and the capacity to function as a lender of last resort.

But will they be more widely used in the future? A longer track record may reduce volatility, boosting further adoption. And with better issuance rules—perhaps, “smart” rules based on artificial intelligence—their valuation could become more stable. “Stable” coins are already appearing: some are pegged to existing fiat currencies, while others attempt issuance rules that mimic inflation- or price-targeting policies (“algorithmic central banking”).

As a medium of exchange, crypto assets have certain advantages. They offer much of the anonymity of cash while also allowing transactions at long distances, and the unit of transaction can potentially be more divisible. These properties make crypto assets especially attractive for micro payments in the new sharing and service-based digital economy.

And unlike bank transfers, crypto asset transactions can be cleared and settled quickly without an intermediary. The advantages are especially apparent in cross-border payments, which are costly, cumbersome, and opaque. New services using distributed ledger technology and crypto assets have slashed the time it takes for cross-border payments to reach their destination from days to seconds by bypassing correspondent banking networks.

So we cannot rule out the possibility that some crypto assets will eventually be more widely adopted and fulfill more of the functions of money in some regions or private e-commerce networks.

Payment shift

More broadly, the rise of crypto assets and wider adoption of distributed ledger technologies may point to a shift from an account-based payment system to one that is value or token based (He and others 2017). In account-based systems the transfer of claims is recorded in an account with an intermediary, such as a bank. In contrast, value- or token-based systems involve simply the transfer of a payment object such as a commodity or paper currency. If the value or authenticity of the payment object can be verified, the transaction can go through, regardless of trust in the intermediary or the counterparty.

Such a shift could also portend a change in the way money is created in the digital age: from credit money to commodity money, we may move full circle back to where we were in the Renaissance! In the 20th century, money was based predominantly on credit relationships: central bank money, or base money, represents a credit relationship between the central bank and citizens (in the case of cash) and between the central bank and commercial banks (in the case of reserves). Commercial bank money (demand deposits) represents a credit relationship between the bank and its customers. Crypto assets, in contrast, are not based on any credit relationship, are not liabilities of any entities, and are more like commodity money in nature.

Economists continue to debate the origins of money, and why monetary systems seem to have alternated between commodity and credit money throughout history. If crypto assets indeed lead to a more prominent role for commodity money in the digital age, the demand for central bank money is likely to decline.

Monopoly supplier

But would this shift matter for monetary policy? Would diminished demand for central bank money reduce the ability of central banks to control short-term interest rates? Central banks typically conduct monetary policy by setting short-term interest rates in the interbank market for reserves (or clearing balances they keep with the central bank). According to King (1999), ceasing to be the monopoly supplier of such reserves would indeed deprive central banks of their ability to carry out monetary policy.

Economists disagree about whether massive adjustments in central bank balance sheets would be necessary to move interest rates in a world where central bank liabilities ceased to perform any settlement functions. Would the central bank need to buy and sell a lot of crypto assets to move interest rates in a crypto world?

Regardless of such disagreements, the ultimate concern is similar: “The only real question about such a future is how much the central banks’ monetary policies would matter” (Woodford 2000). To Benjamin Friedman, the real challenge is that “the interest rates that the central bank can set . . . become less closely—in the limit, not at all—connected to the interest rates and other asset prices

Central banks should strive to make fiat currencies better and more stable units of account.

that matter for ordinary economic transactions” (Friedman 2000).

In other words, if central bank money no longer defines the unit of account for most economic activities—and if those units of account are instead provided by crypto assets—then the central bank’s monetary policy becomes irrelevant. Dollarization in some developing economies provides an analogy. When a large part of the domestic financial system operates with a foreign currency, monetary policy for the local currency becomes disconnected from the local economy.

Competitive pressure

How should central banks respond? How can they forestall the competitive pressure crypto assets may exert on fiat currencies?

First, they should continue to strive to make fiat currencies better and more stable units of account. As IMF Managing Director Christine Lagarde noted in a speech at the Bank of England last year, “The best response by central banks is to continue running effective monetary policy, while being open to fresh ideas and new demands, as economies evolve.” Modern monetary policy, based on the collective wisdom and knowledge of monetary

Central banks must maintain the public's trust in fiat currencies and stay in the game in a digital, sharing, and decentralized service economy.

policy committee members—and supported by central bank independence—offers the best hope for maintaining stable units of account. Monetary policymaking can also benefit from technology: central banks will likely be able to improve their economic forecasts by making use of big data, artificial intelligence, and machine learning.

Second, government authorities should regulate the use of crypto assets to prevent regulatory arbitrage and any unfair competitive advantage crypto assets may derive from lighter regulation. That means rigorously applying measures to prevent money laundering and the financing of terrorism, strengthening consumer protection, and effectively taxing crypto transactions.

Third, central banks should continue to make their money attractive for use as a settlement vehicle. For example, they could make central bank money user-friendly in the digital world by issuing digital tokens of their own to supplement physical cash and bank reserves. Such central bank digital currency could be exchanged, peer to peer in a decentralized manner, much as crypto assets are.

Safeguarding independence

Central bank digital currency could help counter the monopoly power that strong network externalities can confer on private payment networks. It could help reduce transaction costs for individuals and small businesses that have little or costly access to banking services, and enable long-distance transactions. Unlike cash, a digital currency wouldn't be limited in its number of denominations.

From a monetary policy perspective, interest-carrying central bank digital currency would help transmit the policy interest rate to the rest of the economy when demand for reserves diminishes. The use of such currencies would also help central banks continue to earn income from currency issuance, which would allow them to continue to finance their operations and distribute profits to governments. For central banks in many emerging

market and developing economies, seigniorage is the main source of revenue and an important safeguard of their independence.

To be sure, there are choices and policy trade-offs that would require careful consideration when it comes to designing central bank digital currency, including how to avoid any additional risk of bank runs brought about by the convenience of digital cash. More broadly, views on the balance of benefits and risks are likely to differ from country to country, depending on circumstances such as the degree of financial and technological development.

There are both challenges and opportunities for central banks in the digital age. Central banks must maintain the public's trust in fiat currencies and stay in the game in a digital, sharing, and decentralized service economy. They can remain relevant by providing more stable units of account than crypto assets and by making central bank money attractive as a medium of exchange in the digital economy. **FD**

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This article draws on "Virtual Currencies and Beyond: Initial Considerations," January 2016 IMF Staff Discussion Note 16/03, by Dong He, Ross Leckow, Vikram Haksar, Tommaso Mancini Griffoli, Nigel Jenkinson, Mikari Kashima, Tanai Khiaonarong, Céline Rochon, and Hervé Tourpe.

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LUCRE'S ALLURE

Throughout time, new currency has been associated with mystical qualities, and Bitcoin is no exception

Harold James

ART: MICHAEL WABAKSA

A decorative background featuring green foliage, including palm fronds and bamboo-like leaves, and a small orange and black butterfly in flight. The overall aesthetic is natural and organic.

Money is a central element of human relationships. We exchange it, but we find it hard to explain either where it comes from or why other people accept it. We are upset when they don't. Monetary disruptions— inflation or deflation—lead to widespread social disruption. New technologies have from time to time held out alluring and transformative opportunities, but also deep suspicion about the relationships involved in monetary exchange. Suspicion flares up at moments of innovation, when the risks associated with money appear at their greatest.

Today's challenge from Bitcoin as a plausible alternative currency depends on the superficially attractive notion that it is based on an inherently superior and more secure payment technology. The distributed ledger, or blockchain, offers a way of being absolutely secure about a transaction without the need for a central authority or bank as an arbitrator. It promises to replace electronic currency in traditional bank accounts just as surely as electronic transfers replaced paper money and as paper money succeeded gold and silver. It holds out the possibility of a major transformation in which the link between money and the state is broken. Libertarians celebrate the innovation as a way of shrinking state power; pariah states such as Venezuela and North Korea see it as a way of building an alternative to the international political order.

Economics textbooks traditionally give three functions of money, as a unit of account, a store of value, and a means of payment. Existing moneys, however, never fulfill all of these functions perfectly. Indeed, in a world in which technology means changing relative prices, it is logically impossible to combine being a really secure store of value with providing a measure of prices that are moving in different directions, affecting goods that matter differently to different groups of people. With greater economic uncertainty and instability, there is greater demand for currency innovation, a process that is always mysterious. Because of its function as a means of payment, money looks as if it transforms goods quasi magically. At the beginning, this magic looked either divine or diabolical. Innovation highlights the need for stories about origins.

Traditionally money was almost always an expression of sovereignty. Private currencies were very rare. In the case of metallic money, coins bore the sign of the state. Minerva's owl, the symbol of Athens, was one of the first expressions of state identity. There was initially some confusion as to whether the sign of sovereignty was at the same time a sign of divinity: was it Philip of Macedon or Alexander or Hercules whose head was on the coin? Roman emperors who set their divine heads on coins played on the same confusion. British coins still have embossed words that link the monarchy to God.

For much of the past 2,000 years, moneys were ambiguously positioned between an intrinsic value and a state guarantee of their acceptance as a means of payment. Commodity moneys, usually metallic, had a clear initial attraction in that they possessed a basis in terms of an intrinsic value, but they could be inconvenient as a practical means of payment. Gold coins were unsuitable for small daily transactions, while copper currencies were clearly problematic when it came to the settlement of large accounts.

In addition, metallic currencies were prone to arbitrary fluctuations, driven by the possibility of new mineral discoveries. The discovery of California gold in the 1840s, and later the Alaskan, Australian, and South African fields that opened up in the 1890s, produced benign and mild inflation; the absence of new discoveries in the early 19th century and then again in the 1870s and 1880s was deflationary and depressing.

By the late 19th century, economists were thinking about nonconvertible paper currencies—that is, with no link to precious metals or other commodities—regulated by the state as potentially offering a more stable store of value. A wise authority could use a new sort of money to hold the value of money absolutely stable.

But currency innovators in the 20th century had to wrestle with a devastating prehistory of nonconvertible paper currencies. In the early 18th century, in the aftermath of the ruinous fiscal legacy of Louis XIV's wars, Scottish financier John Law instituted a scheme for a currency backed by the activities of a general company. The stock in the company was sold in a pyramid scheme, with rapid

appreciation of the original shares, that appeared to generate new money. The scheme triggered an immense level of activity, with frenetic speculation in stocks and land, before it collapsed in chaos and confusion.

During the French Revolution, the history was repeated, when state paper (*assignats*) was issued against the security of confiscated land, and when overissuance produced new inflation. Drawing on the reports of French émigrés, the German poet Johann Wolfgang von Goethe added a section to his *Faust* drama in which he identified money creation with the promises of the devil. Mephistopheles persuades the emperor to issue paper money, explaining that the precise charm of the new approach to monetary security lies in the unlimited nature of note issuance, which made possible a new level of confidence in the capacity of the state: “Wise men will, when they have studied it, place infinite trust in what is infinite.” Innovation in monetary affairs thus came from the devil.

Most of the 20th century was filled with devastatingly destructive experiences with the mismanagement of currencies: inflation during war and in the aftermath of war—and in the midst of social turmoil in the 1960s and 1970s—and the deflation of the Great Depression. It took a long time for government to learn how to handle money properly.

By the late 20th century, improved monetary policymaking in most countries at last solved the problem of price stability. But this apparent monetary paradise just brought to the fore new problems. The store-of-value function looked problematic. Was it adequate to measure price stability in terms of consumer prices when there was dramatic inflation of some asset prices, in stock markets, or in real estate?


In practice, the replacement of paper currency with electronic transfers both on a wholesale level and for consumers with credit and debit cards also brought a new debate. Electronic money is convenient for making transfers, even across large distances. But it is easily trackable. Part of the demand for a new technology comes from privacy concerns: a wish to get back to the anonymity of cash transactions. In many countries, vigorous campaigns have been mounted to preserve coins and notes. Physical money represents what Fyodor

Dostoyevsky referred to in his semiautobiographical novel about convict life in Siberia, *The House of the Dead*, as “coined freedom.” Dostoyevsky was actually imagining the value of a coin to an imprisoned man, who could not spend the money to derive real resources but could dream of that freedom.

Bitcoin’s claim to combine anonymity and untraceability with security is what makes it attractive. Bitcoin originated around the time of the global financial crisis, in 2008–09. It is unclear whether the ostensible founder, the cryptically named Satoshi Nakamoto, really exists. In this

It took a long time for government to learn how to handle money properly.

sense Bitcoin fits perfectly into the historical pattern of diabolical currencies with a mysterious origin and uncertainty about whether trust is justified.

Bitcoin looks like a 21st century version of gold. It can be created or mined through effort. Its creators ingeniously established an analogy with gold. Just as the price of gold depended on the fact that it took a great deal of human exertion to extract it from large quantities of earth in remote locations, Bitcoin requires large amounts of computer power driven by cheap energy in remote areas of Asia or in Iceland. It marks a transformational shift in the perception of fundamental value. The metallic currencies of the premodern world encouraged the formulation of a labor theory of value: value was produced when humans added their labor to nature. Blockchain technology means that value reflects a combination of stored energy and intelligence, none of it human. It may point to a new age when most and eventually all value may be created by the nonhuman interaction of machines and energy. It is not surprising that the fear of instability—and the association of new money with diabolical qualities—has reappeared. 

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A Short History of Crypto Euphoria

An eminent economist's taxonomy of bubbles is applied to the latest financial fad

Andreas Adriano

Financial bubbles are easy to identify after the fact. But how do you spot one in advance? It's a question that has flummoxed generations of economists, not least the many who failed to foresee the global financial crisis. Now, with the rise of crypto assets, the question is taking on renewed relevance. Rather than engage in more or less informed intellectual speculation on the subject, we decided to consult the preeminent expert on bubbles: John Kenneth Galbraith.

Granted, the eminent Harvard professor and best-selling author of *The Great Crash, 1929* and *The Affluent Society* died in 2006, three years before Bitcoin came into existence. But Galbraith predicted what could happen in a caustic book, *A Short History of Financial Euphoria*, in which he analyzes major speculative events in history, from the tulip mania of 1630s Holland to the Wall Street crash of 1987, and identifies their common features. His taxonomy would have nailed the dot-com bubble and the 2008 crisis. So let's apply some of his criteria to crypto assets.

"The thought that there is something new in the world..."

"The world of finance hails the invention of the wheel over and over again, often in a slightly more unstable version," Galbraith wrote.

What does a leading crypto evangelist have to say? In an e-book titled *Bitcoin vs. the 2018 Recession*, Remy Hauxley, a self-described "cryptocurrency educator," says Bitcoin is "unlike anything we have ever seen. It'll change the world." Hauxley calls Bitcoin "a new form of gold, of money, of stocks. It's a trifecta." (He doesn't explain why a recession is so surely coming in 2018.)

"The extreme brevity of the financial memory..."

"Financial disaster is quickly forgotten," Galbraith observed. "When the same or closely similar circumstances occur again, sometimes in only a few

years, they are hailed by a new, often youthful, and always supremely confident generation as a brilliantly innovative discovery in the financial and larger economic world."

It has been about a decade since the 2008 crisis and almost a generation since the dot-com bubble, so the irrational exuberance of those two periods has largely faded from memory. Many Bitcoin traders are too young to remember either episode.

"The specious association of money and intelligence..."

Galbraith noted that people often think that "the more money, the greater the achievement and the intelligence that supports it." Rich people receive adulation for being rich, and those less well-off follow in their footsteps and make the same investments. This provides a stock of greater fools to keep the speculative engine running and, in the short term, reassures the rich that they are in fact smarter than the rest.

"Speculation became more and more intense..."

"The bulbs might now change hands several times at steadily increasing and wonderfully rewarding prices while still unseen in the ground," Galbraith wrote, describing the Dutch mania for tulips.

In the old days of bricks and mortar, an initial public offering, or IPO, was a kind of corporate rite of passage for a start-up. Nowadays, it's the initial coin offering, or ICO. Instead of stock, ICO investors buy tokens redeemable in the new currency once, *if* it goes into circulation. Unlike stock, tokens don't confer any ownership rights. Block.one, in the most successful ICO so far, has raised more than \$1.5 billion since July 2017, despite the clear indication that its tokens "do not have any rights, uses, purpose, attributes, functionalities and features." All told, ICOs raised \$6.5 billion in 2017, and more than \$4 billion in the first quarter of 2018, according to the *Wall Street Journal*.

Many speculative investors snap up tokens just to flip them to others eager to join the race.

“All crises have involved debt that has become dangerously out of scale...”

Short memory? A false sense of novelty? The supposed intellectual superiority of the moneyed folk? People eager to pour money into business plans as thin as ether? All these elements have been present in every big speculative episode in history. Crypto assets (that’s what we call them at the IMF, to distinguish them from old-fashioned currencies) appear to check all these boxes. One big element is still not clear: how much debt is involved.

Debt is what drives the “insanity born of optimism and self-serving illusion,” Galbraith wrote, describing how the 18th century bubbles in the United Kingdom and France became a systemic crisis. People borrow money to join the party, because other people are making tons of money. (They must know something, right?)

Just how much money investors are borrowing to buy crypto assets is still mostly unknown, because of this market’s opaque and unregulated nature and early stage of development and the seemingly minimal exposure of major banks. But leverage is clearly involved. Some crypto exchanges allow investors to borrow as much as 100 times the cash balance in their accounts. A recent poll by LendEDU, a financial education website, found that a growing number of investors use credit cards to buy coins, and then carry the balance—a risky strategy.

Some people grow ridiculously rich, while others lose the farm. Anyone who bought Bitcoin in the last two months of 2017, when the price reached almost \$20,000, has been played for a greater fool. Volatility isn’t the only risk. Since 2011, according to *Reuters*, hackers have stolen almost 1 million Bitcoins (worth over \$9 billion in early May) from several exchanges. Of course, bubbles do happen without excessive leverage. The dot-com boom is an example. Many analysts believe that is why the ensuing recession was relatively short and mild.

“The speculative episode always ends not with a whimper but with a bang...”

Galbraith concluded that, by their nature, all bubbles end badly, triggering a period of intense scapegoating, during which those previously called geniuses are

blamed, but societies usually don’t recognize their collective insanity—or learn from it. The current episode may produce more of a whimper than a bang. As Bank of England governor Mark Carney noted in a recent speech, even at their peak, all crypto assets combined were worth less than 1 percent of global GDP, while tech stocks at the height of the dot-com mania were valued at close to a third of global GDP.

Can any good come of this?

The so-called South Sea Bubble hit the United Kingdom during the early 18th century. For the first time, investors were able to buy shares of companies offering new and exciting products and services, like the one that promised to develop a precursor to the typewriter.

Webvan, one of the many casualties of the dot-com bubble, offered fast delivery of groceries. Founded in 1996, it went bankrupt in 2001,

The current episode may produce more of a whimper than a bang.

after burning through more than \$800 million in investors’ money. In July 2000, *Fortune* called AllAdvantage “the dumbest dot-com in the world.” It actually *paid* people to surf the web in return for showing them ads. It, too, folded.

The typewriter, of course, turned out to be the main text processing device for more than a century. Amazon (which bought Webvan), Walmart, and many other companies now offer quick grocery delivery. Facebook made a \$16 billion profit in 2017 with targeted advertising, the principle that AllAdvantage tried to develop—and without paying anyone!

Yes, many crazy ideas are thrown around during periods of financial euphoria. Some do stick. Some asset price bubbles, like the dot-com episode, are periods of creative destruction that give rise to inventions that change people’s lives in a lasting way. It’s too early to say whether crypto assets will have a similar impact, though the signs are promising. The problem is that, while only a few bubbles create something worthwhile, all are destructive—of value, wealth, and trust in institutions. Humanity has figured out how to innovate without euphoria. But, as Galbraith shows, it rarely learns the lessons of financial bubbles. **FD**

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The Industrialization of **CYBERCRIME**

Lone-wolf hackers yield to mature businesses

Tamas Gaidosch

Cybercrime is now a mature industry operating on principles much like those of legitimate businesses in pursuit of profit. Combating the proliferation of cybercrime means disrupting a business model that employs easy-to-use tools to generate high profits with low risk.

Long gone are the legendary lone-wolf hackers of the late 1980s, when showing off level 99 computer wizard skills was the main reason to get into other people's computers. The shift to profit making, starting in the 1990s, has gradually taken over the hacking scene to create today's cybercrime industry, with all the attributes of normal businesses, including markets, exchanges, specialist operators, outsourcing service providers, integrated supply chains, and so on. Several nation-states have used the same technology to develop highly effective cyber weaponry for intelligence gathering, industrial espionage, and disrupting adversaries' vulnerable infrastructures.

Evolution

Cybercrime has proliferated even though the supply of highly skilled specialists has not kept pace with the increasing technical sophistication needed to pull off profitable hacks with impunity. Advanced tooling and automation have filled the gap. Hacking tools have evolved spectacularly over the past two decades. In the 1990s, so-called penetration testing to find vulnerabilities in a computer system was all the rage in the profession. Most tools available at that time were simple, often custom built, and using them required considerable knowledge in programming, networking protocols, operating system internals, and various

other deeply technical subjects. As a result, only a few professionals could find exploitable weaknesses and take advantage of them.

As tools got better and easier to use, less skilled, but motivated, young people—mockingly called “script kiddies”—started to use them with relative success. Today, to launch a phishing operation—that is, the fraudulent practice of sending email that appears to be from a reputable sender to trick people into revealing confidential information—requires only a basic understanding of the concepts, willingness, and some cash. Hacking has become easy to do (see chart).

Cyber risk is notoriously difficult to quantify. Loss data are scarce and unreliable, in part because there is little incentive to report cyber losses, especially if the incident does not make headlines or there is no cyber insurance coverage. The rapidly evolving nature of the threats makes historical data less relevant in predicting future losses.

Scenario-based modeling, working out the costs of a well-defined incident affecting certain economies, produces estimates in the tens or hundreds of billions of dollars. Lloyd's of London estimates losses of \$53.05 billion for a cloud service outage lasting 2½ to 3 days affecting the advanced economies. An IMF modeling exercise put the base-case average aggregated annual loss at \$97 billion, with the worst-case scenario in the range of \$250 billion.

Causes and consequences

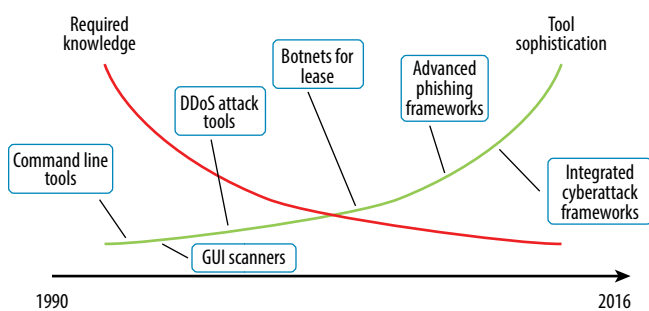
Crime in the physical world—with the intent of making money—is generally motivated simply by profit potentially much higher than for legal business, which criminals view as compensation for the high risk. In the world of cybercrime,



ART: ISTOCK / OUBRIAN VANREEL

Child's play

As tools become more sophisticated, hacking requires less technical knowledge, and it is now much easier to pull off a hack.



Source: Carnegie Mellon University.

Note: DDoS = distributed denial of service; GUI = graphical user interface.

similar or even higher profits are possible with much less risk: less chance of being caught and successfully prosecuted and almost no risk of being shot at. Phishing profitability is estimated in the high hundreds or even over a thousand percentage points. We can only speculate on the profits made possible by intellectual property theft carried out by the most sophisticated cyber threat actors. The basics, however, are similar: effective tooling and an exceptional risk/reward ratio make a compelling case and ultimately explain the sharp increase in and industrialization of cybercrime.

Cybercrime gives rise to systemic risk in several industries. While different industries are affected differently, the most exposed is probably the financial sector. A relatively new threat is posed by destruction-motivated attackers. When seeking to destabilize the financial system, they look at the most promising targets. Financial market infrastructure is the most vulnerable because of its pivotal role in global financial markets. Given the financial sector's dependence on a relatively small set of technical systems, knock-on effects from defaults or delays due to successful attacks can be widespread, with potentially systemic effects.

Given the inherent interconnection of financial sector participants, a successful disruption to

the payment, clearing, or settlement systems—or stealing confidential information—would result in widespread spillovers and threaten financial stability.

Fortunately, to date, we have not experienced a cyberattack with systemic consequences. However, policymakers and financial regulators are increasingly wary, given recent incidents that took out ATM networks and attacks against online banking systems, central banks, and payment systems.

The financial sector has been dependent on information technology for decades and has a history of maintaining strong IT control environments mandated by regulation. While the financial sector may be most at risk of cyberattack, such attacks also carry a higher risk for cyber criminals, in part because of greater attention from law enforcement (just like old-fashioned bank robberies). The financial sector also does a better job of supporting law enforcement—for example, by keeping extensive records that are valuable in forensic investigations. Deeper budgets can often lead to effective cybersecurity solutions. (A recent notable exception is Equifax, whose hack was arguably a consequence of a cyber regulatory regime that was not proportional to its risk.)

The situation is different in health care. Except in the wealthiest nations, the health care sector typically does not have the resources necessary for effective cyber defense. This is evident, for example, in ransomware attacks this year that targeted computer systems at the electronic health record company Allscripts and two regional hospitals in the United States. Although also heavily regulated and under strict data protection rules, health care has not relied nearly as much on IT as the financial sector has, and consequently has not developed a similar culture of strict IT controls. This too makes the health care sector more susceptible to cyber breaches. What is most worrisome about this weakness is that, unlike in the financial sector, lives can be lost if, for example, attackers hit computerized life-support systems.

Utilities, especially the power and communication grids, are often cited as the next sectors where large-scale cyberattacks can have severe consequences. In this case, however, the main concern is

International cooperation in combating and prosecuting cybercrime lags well behind the global nature of the threat.

disruption or infiltration of systems by rival states, either directly or through proxy organizations. As famously exemplified by the massive 2007 attack against Estonia's Internet infrastructure—which took down online financial services, media, and government agencies—the more advanced and Internet-based an economy, the more devastating cyberattacks can be. Estonia is among the most digitalized societies in the world (see “E-stonia Takes Off” in the March 2018 *F&D*).

Countermeasures

If critical infrastructure—say, a power grid—or telecommunication and transportation networks are affected, or an attack prevents governments from collecting taxes or providing critical services, major disruptions with systemic economic implications could ensue and potentially pose a public health or security hazard. In such instances, the aggregate risk to the global economy could exceed the sum of individuals' risks, because of the global nature of IT networks and platforms, the national nature of response structures, ineffective international cooperation, or even the presence of nation-states among the attackers.

International cooperation in combating and prosecuting cybercrime lags well behind the global nature of the threat. The best way to tackle cybercrime is to attack its business model, which relies on the exceptional risk/reward ratio associated with ineffective prosecution. In this context, the business risk of cybercrime must be raised significantly, but this is possible only with better international cooperation.

Cybercrime operations can span several jurisdictions, which makes them harder to take down and prosecute. Some jurisdictions are slow, ineffective, or simply uncooperative in tackling cybercrime. Stronger cooperation would make tracking down suspects and charging them faster and more effective.

In the financial sector, regulators have developed specific assessment standards, set enforceable

expectations and benchmarks, and encouraged information sharing and collaboration among firms and regulators. Bank regulators conduct IT examinations that factor cybersecurity preparedness into stress testing, resolution planning, and safety and soundness supervision. Some require simulated cyberattacks designed specifically for each firm, drawing on government and private sector intelligence and expertise, to determine resilience against an attack. Companies have also increased investment in cybersecurity and are incorporating cybersecurity preparedness into risk management. In addition, some have sought to transfer some risk via cyber insurance.

The current cybersecurity landscape remains disparate and decentralized, with risks handled mainly as local idiosyncratic problems. There are some cooperation mechanisms, and governments and regulators are stepping up their efforts, but the choice of cybersecurity is largely determined by corporate need—“each to its own.” This must change to bring about generally enhanced cyber risk resilience. Strong preventive measures are needed both at the regulatory and technology levels and across industries. Among the most important of these is adherence to minimum cybersecurity standards, enforced in a coordinated way by regulators. Stepped-up cybersecurity awareness training will help defend against the basic technical weaknesses and user errors that are the source of most breaches.

Cyberattacks and cybersecurity breaches seem inevitable, so we also need to focus on how fast we detect breaches, how effectively we respond, and how soon we get operations back on track. **FD**

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We are pleased to revive *F&D*'s popular "Back-to-Basics" series, which we discontinued at the end of 2015. In this series, we explain the economic terms that our readers encounter on a daily basis. Check out the "Back-to-Basics" videos, too, at www.fandd.org.

What Are Cryptocurrencies?

A potential new form of money offers benefits while posing risks

Antoine Bouveret and Vikram Haksar

HUNDREDS OF THEM have sprouted, with fanciful names like Primecoin, Dash, and Verge. They have developed cult-like followings among the tech-savvy. Their values fluctuate wildly. Some people say these mysterious bits of computer code will someday replace money as we know it. What exactly are these cryptocurrencies, and what makes people think they are worth anything at all? To answer these questions, let's first look at how money evolved.

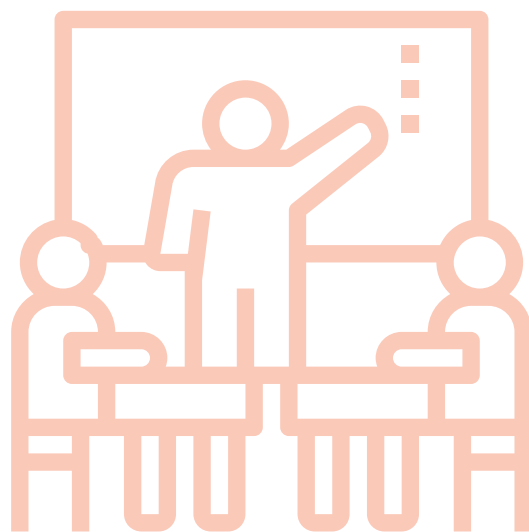
Uses of money

Money serves as a store of value, a means of exchange for goods and services, and a unit of account that measures value. Before money, human societies exchanged goods and services directly—a bushel of grain for a pig, say. This was not very efficient. As societies grew more complex, commodity monies were developed—from seashells to copper, silver, and gold. Some states introduced fiat money—which has no intrinsic value other than the promise to pay—such as paper money in eighth century China under the Tang dynasty.

Most early forms of fiat money were neither very stable nor widely accepted, as people did not believe the issuer would honor its commitment to redeem the money. Governments were tempted to print more money to buy goods or raise wages, which fueled inflation (think of people moving cash around in wheelbarrows in post-World War I Germany). Modern central banks seek to maintain price stability by regulating the supply of money on behalf of governments.

Bookkeeping and ledgers

An increasingly extensive and complex financial system gave rise to the need for trusted intermediaries and credible accounting systems. The



development of double-entry bookkeeping in Renaissance Italy was a major innovation that strengthened the role of large private banks. In modern times, central banks emerged at the apex of payment systems. With computerized bank ledgers, the coordinating role of central banks increased.

How do such ledgers work? Financial institutions adjust the positions of their account holders in their internal ledgers, while the central bank validates transactions among financial institutions in a central ledger. For example, Mehrnaz uses money from her account in bank A to buy goods from Mary, who has an account in bank B. Bank A debits the money from Mehrnaz's account. The central bank moves money from bank A to bank B and records the transaction in its central ledger. Bank B then adds the money to Mary's account. As you can see, the system is based on trust in the central bank and in its ability to safeguard the integrity of the central ledger and ensure that the same money is not spent twice.

With many cryptocurrencies, on the other hand, there is no need for a trusted central agent. Instead, they rely on distributed ledger technology, such as blockchain, to construct a ledger (effectively a database) that is maintained across a network. To ensure that the same cryptocurrency is not spent twice, each member of the network verifies and validates transactions using technologies derived from computing and cryptography. Once a decentralized consensus is achieved among members of the network, the transaction is added to the ledger, which is validated. The ledger provides a complete history of the transactions associated with a particular cryptocurrency that is permanent and cannot be manipulated by a single entity. This ability to achieve consensus on the validity of transactions between accounts in a distributed network is a foundational technological shift.

Network members who verify and validate transactions are usually rewarded with newly minted cryptocurrency. Many cryptocurrencies are also pseudo-anonymous: holders of the currency have two keys. One is public, such as an account number; another, private key is required to complete a transaction. So, to continue the previous example, Mehrnaz wants to buy goods from Mary using a cryptocurrency. To do so, she initiates a transaction with her private key. Mehrnaz is identified in the network by her public key, ABC, and Mary is identified by hers, XYZ. Network members verify that ABC has the money she wants to transfer to XYZ by solving a cryptography puzzle. Once the puzzle is solved, the transaction is validated, a new block representing the transaction is added to the blockchain, and the money is transferred from ABC's wallet to XYZ's.

Benefits, risks

Now that we understand the technology, let's return to the genesis of cryptocurrencies. The first one, Bitcoin, was introduced in 2009 by a programmer (or group of programmers) using the pseudonym Satoshi Nakamoto. As of April 2018, there were more than 1,500 cryptocurrencies, according to coinmarketcap.com; along with Bitcoin, Ether and Ripple are the most widely used.

Despite the hype, cryptocurrencies still don't fulfill the basic functions of money as a store of value, means of exchange, and unit of account. Because their value is highly volatile, they have little use so far as a unit of account or a store of value. Limited acceptance for payment restricts their use as a medium of exchange. Unlike with fiat money, the cost of producing many cryptocurrencies is high, reflecting the large amount of energy needed to power the computers that solve the cryptographic puzzles. Finally, decentralized issuance implies that there is no entity backing the asset, so acceptance is based entirely on users' trust.

Distributed ledger technology could reduce the cost of international transfers, including remittances, and foster financial inclusion.

Cryptocurrencies and their underlying technologies offer benefits but also carry risks. Distributed ledger technology could reduce the cost of international transfers, including remittances, and foster financial inclusion. Some payment services now make overseas transfers in a matter of hours, not days. The technology can provide benefits beyond the financial system. For example, it can be used to securely store important records, such as medical histories and land deeds. On the other hand, the pseudo-anonymity of many cryptocurrencies makes them vulnerable to use in money laundering and terrorism financing, if no intermediary checks the integrity of transactions or the identity of the people making them. Cryptocurrencies could also eventually present challenges for central banks were they to affect control over the money supply and therefore the conduct of monetary policy. **FD**

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aibo

The latest version of Sony's robotic puppy Aibo, released in early 2018, has artificial intelligence capabilities.



Land of the Rising **ROBOTS**

Japan's combination of artificial intelligence and robotics may be the answer to its rapidly shrinking labor force, but will this be good news or bad for human labor?

Todd Schneider, Gee Hee Hong, and Anh Van Le

While automation will eliminate very few occupations entirely in the coming decades, it is likely to have an impact on portions of almost all jobs to some degree—depending on the type of work and the tasks involved. Set to move beyond routine and repetitive manufacturing activities, automation has the potential to appear in a much broader range of activities than seen until now, and to redefine human labor and work style in services and other sectors. In Japan, the rapid decline in the labor force and the limited influx of immigrants create a powerful incentive for automation, which makes the country a particularly useful laboratory for the study of the future landscape of work.

Vanishing act

Japan's estimated population fell by a record-breaking 264,000 people in 2017. Currently, deaths outnumber births by an average of 1,000 people a day. The Tohoku region in northern Japan, for example, now has fewer inhabitants than it did in 1950. Japan's birth rate has long been significantly below the 2.1 births a woman needed to sustain

PHOTO: GETTY IMAGES / KYODO NEWS

The success of the first marriage of Japan’s labor force with robotics augurs well for the next wave of technology.

growth—it currently stands at about 1.4 births a woman—and unlike for many other advanced economies, immigration is not sufficient to fill the gap. Nearly a third of Japanese citizens were older than 65 in 2015—research from the National Institute of Population and Social Security Research suggests that number will rise to nearly 40 percent by 2050. The Population Division of the UN Department of Economic and Social Affairs released an estimate for Japan that showed the country’s population will dip below 100 million shortly after the middle of the 21st century. By the century’s end, Japan stands to lose 34 percent of its current population.

Japan’s domestic labor force (those ages 15–64) is projected to decline even faster than the overall population, dropping by some 24 million between now and 2050. With immigration unlikely to rise enough to compensate for this dramatic decline anytime soon, Japan faces dim prospects for productivity, potential output, and income growth (see Chart 1).

Made in Japan

Japan is no stranger to coping with limited resources—including labor—and has historically been a leader in technological development. Automation and robotics, either to replace or enhance human labor, are familiar concepts in Japanese society. Japanese companies have traditionally been at the forefront in robotic technology. Firms such as FANUC, Kawasaki Heavy Industries, Sony, and the Yaskawa Electric Corporation led the way in robotic development during Japan’s economic rise. Automation and the integration of robotic technology into industrial production have also been an integral part of Japan’s postwar economic success. Kawasaki Robotics started commercial production of industrial robots over 40 years ago. About 700,000 industrial robots were used worldwide in 1995, 500,000 of them in Japan.

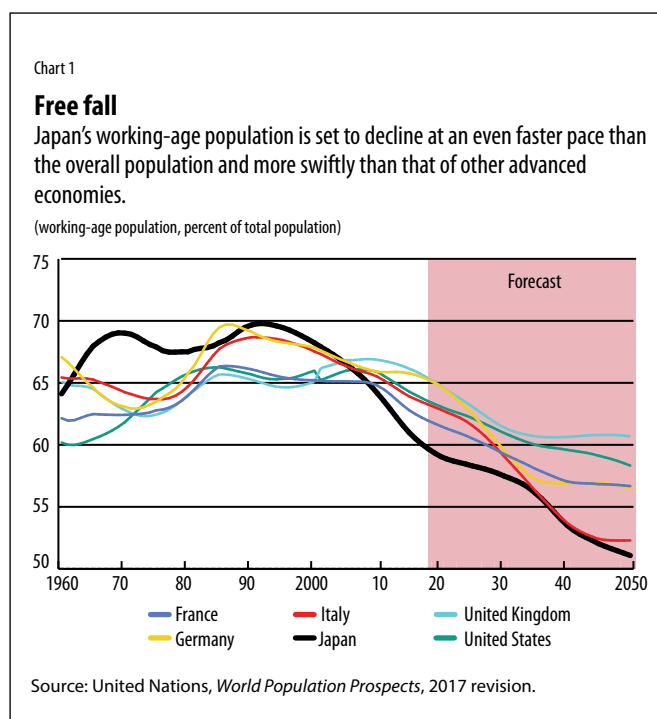
Japan is still a leader in robot production and industrial use. The country exported some \$1.6 billion worth of industrial robots in 2016—more than the next five biggest exporters (Germany, France, Italy, United States, South Korea) combined. Japan is also one of the most robot-integrated economies in the world in terms of “robot density”—measured as the number of robots relative to humans in manufacturing

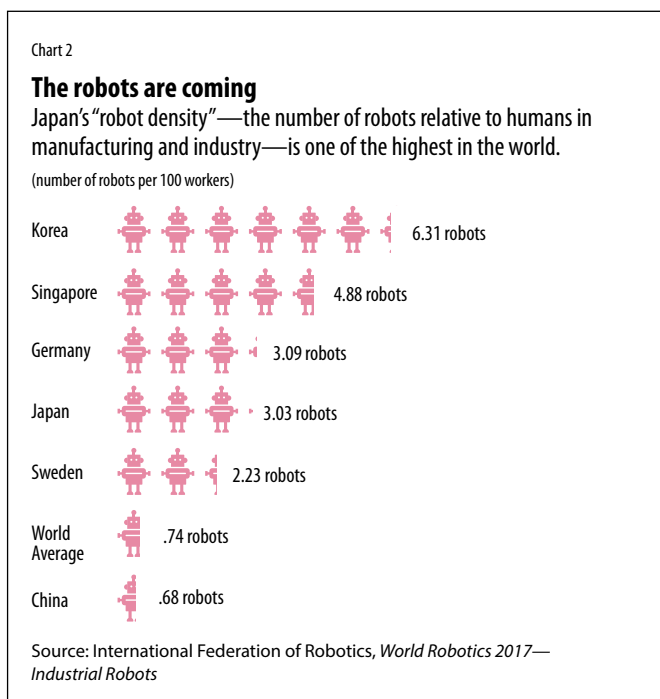
and industry. Japan led the world in this measure until 2009, when Korea’s use of industrial robots surged and Japan’s industrial production increasingly moved abroad (see Chart 2).

For richer or for poorer?

The success of the first marriage of Japan’s labor force with robotics—the automation of key sectors such as the automotive and electronics industries in the 1970s, 1980s, and 1990s—augurs well for the next wave of technology and artificial intelligence and for an impact on employment and wages beyond manufacturing.

First, the gap in productivity growth between the manufacturing and services sectors in Japan is extremely wide. While there are many causes, the largest gains in industrial productivity have been closely correlated with increased use of information and communication technology and automation. Perhaps it is no coincidence that the most productive manufacturing sectors in Japan—automotive and electronics—are the ones whose production processes are heavily reliant on automation. By contrast, the services sector, which accounts for





75 percent of GDP, has seen little annual productivity growth—only about half that of the United States. Labor productivity has roughly tripled since 1970 in manufacturing, but improved by only about 25 percent in the nonmanufacturing sector.

The coming wave of automation technology and artificial intelligence promises new possibilities for replacing or augmenting labor in the nonmanufacturing sector (for example, in transportation, communications, retail services, storage, and others). According to several government reports (including the Bank of Japan's *Regional Economic Report* and the annual survey on planned capital spending by the Development Bank of Japan), even small and medium-sized firms are embracing new technology to compensate for scarce labor and stay competitive. For example, Family Mart, a Japanese retail convenience store chain, is accelerating implementation of self-checkout registers, while the restaurant group Colowide and many other restaurant operators have installed touch-screen order terminals to streamline operations and reduce the need for staff. Other examples abound in health care, financial, transportation, and other services—including robot chefs and hotel staff.

Second, empirical evidence suggests that—contrary to fears for the worst—automation and increased use of robotics have had an overall positive impact on domestic employment and income growth. IMF staff

calculations—based on an approach pioneered by Acemoglu and Restrepo (2017) using prefectural level data from Japan—found increased robot density in manufacturing to be associated not only with greater productivity, but also with local gains in employment and wages. Notably, these findings—which exclude crisis periods—are the opposite of results of a similar exercise based on US data. It appears that Japan's experience may differ significantly from that of other advanced economies.

For better or worse?

Japan's progress in automation, use of robots, and integration of artificial intelligence with daily living is likely to move at a faster pace than in many other advanced economies for several reasons:

- **Shrinking population and the more rapidly shrinking workforce:** As noted above, the constraint on productivity implied by a secular decline in the labor force will effectively push many industries to invest in new technology—as appears evident in Japan now, including among small and medium-sized enterprises, which have a more difficult time attracting and retaining labor. Japan is not alone in this demographic trend, but is well ahead of other advanced economies.
- **Aging population:** The aging of Japan's population—the so-called baby boom generation will reach 75 in just a few years—is creating substantial labor needs in health and eldercare that cannot be met by “natural” workforce entrants (that is, natives). As a result, the proliferation of robots will extend well beyond Japanese factories to include schools, hospitals, nursing homes, airports, train stations, and even temples.
- **Declining quality of services:** Surveys support the view that both the volume and quality of services in Japan are in decline. Recent work by the research arm of Japan's Research Institute of Economy, Trade and Industry (Morikawa 2018) shows that the quality of services is eroding as a result of labor shortages. Most critically affected are parcel delivery services, hospitals, restaurants, elementary and junior high schools, convenience stores, and government services.

These same factors may explain why—in model-based simulations—Japan could experience higher

and more immediate gains from the continued advance of robotics and artificial intelligence in the economy. Looking at data across the Group of 20 industrialized countries, a simulation prepared by the IMF staff points to the risk of declining labor shares, income polarization, and rising inequality. This assumes substantial transition costs (unemployment, lower wages) as increasing automation substitutes for and displaces existing human labor.

However, applying this same approach only to Japan yields some very different results. Specifically, with a shrinking labor force, even fully substitutable automation could boost wages and economic growth. In other words, with labor literally disappearing and dim prospects for relief through higher immigration, automation and robotics can fill the labor gap and result in higher output and greater income rather than replacement of the human workforce.

These positive results notwithstanding, Japan is not immune from societal and welfare risks linked to increased automation. Polarization of the labor force, in which a relatively small proportion of workers have the training and education needed to fully leverage productivity from robotics, is always a social risk. Research suggests that the female labor force, which has swelled in the past five years, is particularly vulnerable to displacement, given the heavy concentration of women in nonregular jobs (that is, temporary, part-time, or other positions outside the mainstream of Japan's lifetime employment system), whose tasks are more susceptible to automation (Hamaguchi and Kondo 2017).

Domo arigato, Mr. Roboto?

There is no crystal ball that can accurately predict how fast and how far robotics and artificial intelligence will advance in the next few decades. Nor is there perfect foresight with regard to how these technologies will be adapted to substitute for human labor—particularly in sectors outside of manufacturing. Aside from the nontrivial technological challenges, there are a range of hurdles related to supporting infrastructure—including the legal framework for the use of such technologies alongside the general population—that will need to be worked out. Key issues could include consumer protection, data protection, intellectual property, and commercial contracting.

But the wave of change is clearly coming and will affect virtually all professions in one way or another. Japan is a relatively unique case. Given the population and labor force dynamics, the net

benefits from increased automation have been high and could be even higher, and such technology may offer a partial solution to the challenge of supporting long-term productivity and economic growth. Japan's experience could hold valuable lessons for such countries as China and Korea, which will face similar demographic trends in the future, and for Europe's advanced economies.

For policymakers, the first hurdle is to accept that change is coming. The steam engine was likely just as disconcerting, but it came nonetheless—putting an end to some jobs but generating many new ones as

The proliferation of robots will extend well beyond Japanese factories to include schools, hospitals, nursing homes, airports, train stations, and even temples.

well. Artificial intelligence, robotics, and automation have the potential to make just as big a change, and the second hurdle may be to find ways to help the public prepare for and leverage this transformation to make lives better and incomes higher. Strong and effective social safety nets will be crucial, since disruption of some traditional labor and social contracts seems inevitable. But education and skills development will also be necessary to enable more people to take advantage of jobs in a high-tech world. And in Japan's case, this also means a stronger effort to bring greater equality into the labor force—between men and women, between regular and nonregular employees, and even across regions—so that the benefits and risks of automation can be more equally shared. **FD**

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BUILDING TALLER LADDERS

Technology and science reinforce each other to take the global economy ever higher

Joel Mokyr

In recent years, many economists have questioned the ability of technological progress to keep propelling the economy forward despite declining population growth and rising dependency ratios (Gordon 2016). According to those in this camp, the low-hanging fruit have mostly been picked, and further advances will become increasingly difficult (Bloom and others 2017).

Others would counter that science allows us to build taller and taller ladders to reach ever-higher-hanging fruit. Based on rapidly improving scientific insights, technological breakthroughs still have the potential to change life in the foreseeable future as much as they did in the century and a half since the US Civil War, proponents of this view contend.

Why is it plausible that scientific progress will continue to advance? Technological progress does not just affect productivity directly; it also pulls itself up by the bootstraps by giving science more powerful tools to work



with. Humans have limited ability to make highly accurate measurements, to observe extremely small objects, to overcome optical and other sensory illusions, and to process complex calculations quickly. Technology consists in part in helping us overcome the limitations that evolution has placed on us and learn of natural phenomena we were not meant to see or hear—what Derek Price (1984) has called “artificial revelation.” Much of the 17th century scientific revolution was made possible by better instruments and tools, as exemplified by Galileo’s telescope and Hooke’s microscope.

Scientific progress in the modern age was similarly dependent on the tools at the disposal of researchers. A combination of improved microscopy and better lab techniques made possible the discovery of the germ theory, arguably one of the greatest medical advances of all time. In the 20th century, the number of examples that demonstrate the impact of better instruments and scientific techniques multiplied. One of the greatest heroes of modern science is X-ray crystallography. The technique has been instrumental in discovering the structure and function of many biological molecules, including vitamins, drugs, and proteins. Its most famous application was no doubt the discovery of the structure of the DNA molecule, but its use has been instrumental in 29 other Nobel-Prize-winning projects.

Of the traditional tools in use in our age, the microscope is still one of the most prominent, as it is basic to the ubiquitous tendency toward miniaturization—that is, to understand and manipulate the world at smaller and smaller levels. Scanning tunneling microscopes invented in the early 1980s started research at the nanoscopic level. The more recent Betzig-Hell super-resolved fluorescent microscope, whose developers were awarded the Nobel Prize for chemistry, is to Leeuwenhoek’s microscope what a thermonuclear device is to a firecracker. The same can be said for telescoping, where the revolutionary Hubble telescope is soon to be replaced by the much more advanced James Webb space telescope.

Two powerful scientific tools that have only recently become available and that represent

complete breaks with the past are fast computing (including practically unlimited data storage and search techniques) and laser technology. Both, of course, have found innumerable direct applications in the production of capital and consumer goods. The impact of computers on science has gone much beyond analyzing large-scale databases and standard statistical analysis: a new era of data

Technological progress does not just affect productivity directly; it also pulls itself up by the bootstraps by giving science more powerful tools to work with.

science in which models are replaced by powerful mega-data-crunching machines has arrived. Powerful computers employ machine-learning algorithms to detect patterns that human minds could not have dreamed up. Rather than dealing with models, regularities and correlations are detected by powerful computers, even if they are “so twisty that the human brain can neither recall nor predict them” (Weinberger 2017, 12).

But computers can do more than crunch data: they also simulate, and by so doing, they can approximate the solution of fiendishly complex equations that allow scientists to study hitherto poorly understood physiological and physical processes, design new materials, and simulate mathematical models of natural processes that so far have defied attempts at closed-form solution. Such simulations have spawned entirely new “computational” fields of research, in which simulation and large data processing are strongly complementary in areas of high complexity. Historically some scientists dreamed of such a tool, but it is only the most recent decade that will have the capability to do this at a level that will inevitably

If the history of the first two industrial revolutions was dominated by energy, the future may well witness truly radical progress in the evolution of new materials.

affect our technological capabilities and hence affect productivity and presumably economic welfare.

With the advent of quantum computing, computational power in many of these areas may increase by a substantial factor. By the same token, artificial intelligence, while still the source of much concern that it will replace educated knowledge workers and not just routinized jobs, could become the world's most effective research assistant, even if it will never become the world's best researcher (*Economist* 2016, 14).

Laser technology is an equally revolutionary scientific tool; when the first lasers were developed, it was said, its inventors thought it was a technique “in search of an application.” But in the 1980s, lasers were already used for cooling micro samples to extraordinarily low temperatures, leading to significant advances in physics. Nowadays, the deployment of lasers in science has a dazzling range. One of its most important applications is laser-induced breakdown spectroscopy, an astonishingly versatile tool used in a wide range of fields that require a quick chemical analysis at the atomic level, without sample preparation. Lidar (light radar) is a laser-based surveying technique that creates highly detailed three-dimensional images used in geology, seismology, remote sensing, and atmospheric physics and recently helped radically revise upward our estimates of the size and sophistication of pre-Columbian Maya civilization in Guatemala. But lasers are also a mechanical tool that can ablate (remove) materials for analysis. For laser ablation, any type of solid sample can be ablated for analysis; there are no sample-size requirements and no sample preparation procedures. And laser interferometers have been used to detect the gravitational waves Einstein postulated, one of the most sought-after discoveries of modern physics.

Century of biology

Yet there is far more. As Freeman Dyson has remarked, if the 20th century was the century of physics, the 21st century will be the century of

biology. Recent developments in molecular biology and genetics imply revolutionary changes in humans' ability to manipulate other living beings. Of those, the ones that stand out are the decline in the cost of sequencing genomes at a rate that makes Moore's Law look sluggish by comparison: the sequencing cost has declined from \$95 million per genome in 2001 to about \$1,250 in 2015.

Especially promising is the technique to *edit* a base pair in a genetic sequence, thanks to recent improvements in CRISPR Cas9 techniques. The other is synthetic biology, which allows for the manufacturing of organic products without the intermediation of living organisms. The idea of cell-free production of proteins has been around for about a decade, but only recently has its full potential become known to the public, even if its realization is still years away.

Symbiotic relationship

Ecclesiastes notwithstanding, there is much under the sun that is entirely new. If the history of the first two industrial revolutions was dominated by energy, the future may well witness truly radical progress in the evolution of new materials. Naming an economic epoch after its dominant raw material (“the Bronze Age”) is an age-honored habit among historians. Many technological ideas in the past could not be realized because the materials that inventors had available were simply not adequate to make their designs a reality. But recent science-driven advances in material science allow scientists to design new synthetics that nature never had in mind. Such artificial materials, developed at the nanotechnological level, promise the development of materials that deliver custom-ordered properties in terms of hardness, resilience, elasticity, and so on. New resins, advanced ceramics, new solids, and carbon nanotubes are all in the process of development or perfection.

Artificial intelligence, lasers, and genetic engineering seem to qualify as general purpose technologies (GPTs) that have many applications across a wide spectrum of uses in production and research.

It seems widely agreed that usually GPTs—such as machine learning—take time to fully affect the economy, because by definition they require complementary innovations and investments. But they promise transformative changes in the human condition across many dimensions.

None of those technological predictions can be made with any certainty, and it is inevitable that some advances will be made that no one is forecasting, while other promising advances will disappoint. But the case that technological progress will continue to advance at breakneck speed does not depend on one area of technology or another. It is based on the observation that technology and science coevolve in a symbiotic manner by giving scientific researchers vastly more powerful tools to work with. Some of those tools have been known in more primitive form for centuries; others are radical innovations that have no clear-cut precursors.

Much as the new instruments and tools of the 17th century rang in the scientific revolution

and the age of steam and electricity, the high-powered computers, lasers, and many other tools of our age will lead to technological advances that cannot be imagined today any more than Galileo could foresee the locomotive. **FD**

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This article is based on the paper "The Past and the Future of Innovation: Some Lessons from Economic History," forthcoming in Explorations in Economic History.

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INTERNATIONAL MONETARY FUND PODCASTS



Sherlock *of* Trade

Bruce Edwards profiles MIT's **David Donaldson**, who makes no assumptions about trade that are not based on facts

Trading gold for salt is clearly a thing of the past. But studying the market for salt in 19th century India and the effects on trade of building a railroad led the prize-winning economist Dave Donaldson to important new findings that are relevant today.

“Whether it be by the construction of a railroad a hundred years ago or by opening up to trade with the global economy, I’m fundamentally a big believer in the gains from trade,” says Donaldson, a professor at the Massachusetts Institute of Technology (MIT) in Cambridge, Massachusetts. “Trading between pairs of people, whether it’s between two people who happen to live in the same household, the same village, the same country, or the same planet, is the basic source of economic development. It’s the reason that we no longer live like cavemen.”

Donaldson’s work put a value on the economic contributions of trade and won him the 2017 John Bates Clark Medal—known as the Baby Nobel—awarded for the most significant contributions by an economist under the age of 40.

Donaldson’s research reaffirms the benefits of trade and thus flies in the face of a wave of populist skepticism going back to the anti-globalization protests that started almost 20 years ago. Today, the intricate international web of multilateral trading relationships is under pressure from protectionist policies in the United Kingdom, the United States, and elsewhere.

Donaldson, now 40, has changed the way economists conduct empirical research on trade, says Esther Duflo, a cofounder of the Abdul Latif Jameel Poverty Action Lab at MIT and herself the winner of the John Bates Clark medal in 2010.

“He has ushered in a totally new era for our understanding of trade” by studying new, mostly microeconomic data, Duflo says. “He has also had a large impact on development economics by bringing trade and development closer together and introducing development economics to new ways of thinking about key issues such as infrastructure, with a trade lens.”

Although Donaldson’s work does not speak directly to current controversies and tensions over trade, “it contains a powerful message that is relevant to the debate,” says economist and trade expert Douglas Irwin of Dartmouth College. “Integration with global markets produces tangible economic benefits, and economic isolation can leave regions poor and left behind.”

Donaldson did not set out to become an economist or to study trade. Raised in Toronto, he initially focused on physics, completing a master’s degree at the University of Oxford. He was following in the footsteps of his British scientist parents—a father with a degree in physics and a mother who taught chemistry.

While he was still studying physics at Oxford in 1999, the anti-globalization movement came into prominence. Demonstrators hit the streets outside the World Trade Organization’s conference in Seattle and the IMF headquarters in Washington to protest the increasing unification of the world economic order that they maintained was leaving too many people behind.

Donaldson’s then-girlfriend—now wife—was studying economics at the time. The couple talked a lot about the economic issues behind the discontent. Donaldson says he supposes he “fell prey—prior to learning the basic logic of formal economics—to the trap of thinking that international things like trade, development, and FDI [foreign direct investment] might have a strong zero-sum-game feature to them whereby rich countries might get rich at the expense of their interactions with lower-income countries.” It inspired him to pursue a PhD at the London School of Economics (LSE).

“I got hooked on the idea that economics was the physics of the social sciences, or physics for public policy,” Donaldson says, “using theory and evidence to come up with answers to those policy questions that were being raised by the anti-globalization movement—and I wanted to learn how to do that.”

After completing his doctorate at LSE in 2009, Donaldson joined the economics department at MIT. For all his research on trains, Donaldson cycles to work every day from his home on the outskirts of Cambridge. He lives there with his wife and their four children.

Donaldson first traveled to India, “partly because it is a fascinating place that I read a lot about, but partly because my advisors did all their work on India, and their enthusiasm was kind of infectious,” he says. India was also a rare example of a country that taxed trade within its borders, he says.

“That is the kind of thing that doesn’t happen at all in most countries,” he says. “In the US it is constitutionally prohibited.” Also, a professor at LSE suggested that the unusual circumstances around India’s salt trade might contribute to his research.

He spent two years digging into the archives of the British government’s India Office, poring over

salt reports and ledgers from 124 districts dating back as far as 1861. He was trying to determine the extent to which India's colonial railway system might have raised real incomes by reducing trade costs. After collecting data on trade flows among 45 regions in India and more than a hundred thousand observations, Donaldson was able to put a value on the role of trade.

"That number turned out to be about 16 percent of GDP," Donaldson says from his book-lined office at MIT. The study made the case that the benefit of the railways was indeed the result of increased trade.

He published his findings originally in a 2010 working paper, then in the *American Economic Review* in 2018 under the title "Railroads of the Raj: Estimating the Impact of Transportation Infrastructure." His extensive use of data made the work stand out and led to his winning the John Bates Clark Medal last year.

He just started doing things that nobody else was doing.

"Donaldson's work on railroads brought a whole new approach to 19th century history, particularly in India," says Nobel laureate Angus Deaton.

The "Railroads of the Raj" study was not driven by a particular interest in railways but by the desire to better understand the true value of large transportation infrastructure projects, Donaldson says. More World Bank lending in 2007, for example, went toward transportation infrastructure than to education, health, and social services combined, he says, without a rigorous empirical understanding of just how much transportation infrastructure projects actually reduce the costs of trade, and how those cost reductions affect welfare.

In the India study, Donaldson learned of one of the world's truly unusual trade barriers. To enforce a tax on salt in the early 19th century, the colonial British authorities built a thorny, 12-foot-high thicket stretching 2,300 miles down the middle of India. The Salt Hedge blocked hundreds of millions of people in India's interior from getting tax-free salt from the seacoasts as the British administration's appetite for tax revenue grew. The wildly unpopular salt tax eventually spurred Mahatma Gandhi's campaign against British rule. In the end, it was found that the Salt Hedge was too much of an impediment to trade and was abandoned.

"I read about all this history and found it fascinating but quickly realized that salt had a completely auxiliary benefit for me," Donaldson says. "They collected a lot of data about salt." Because salt production was confined to a very small region and everyone needed it, Donaldson says, it was the perfect product for measuring the impact on trade of the railroad system that was built during the same period.

Donaldson found that the railroads brought significant welfare gains to India because they reduced the cost of trading and enabled India's diverse districts to enjoy unprecedented gains from trade.

In a separate study of the economic impact of railroad expansion in the United States in the late 1800s, published in the *Quarterly Journal of Economics* in 2016, Donaldson and coauthor Richard Hornbeck examined the effect of increased market access to counties across the country. Using a sophisticated geographic information system data network, digitized maps, and advanced trade theory, they looked at how market access raised agricultural land values and compared their findings with those of the Nobel laureate economist Robert Fogel in his 1964 study *Railroads and American Economic Growth: Essays in Econometric History*. They found that railroads had a substantially larger economic impact than Fogel estimated based on data and analytical tools available 50 years earlier.

"Fogel's approach and our approach both focus on railroads' impacts through the transportation of agricultural goods, but Fogel's estimates neglect ways agricultural land value fails to bound the economic losses from impacts on the agricultural sector," the authors wrote.

"He just started doing things that nobody else was doing," says Arnaud Costinot, a fellow MIT economics professor and frequent collaborator. "He uses a lot of new data sources and is seemingly unconstrained about what you are able to do empirically."

Donaldson's work on railways is important because it documents and quantifies *intranational* trade, Costinot says—something that often gets lost in all the noise about international trade.

"In the case of a large country like India, for instance, trade flows between states are subject to many frictions, and the gains from removing them are potentially large, likely larger than cutting import tariffs further," Costinot says.

While railways were once the backbone of trade and development, technology has moved on, radically changing the nature and role of the transportation infrastructure. Donaldson says

the move away from rail to more modular forms of shipping such as trucking indicates how economies are evolving and becoming more diverse.

“Just as the economy modernizes, things become less commoditized in some sense,” he says. “The complexity of the product space is always growing, and I can’t help but think that as we get richer and our needs and capabilities to produce get more complex and more luxurious that diversity will rise. Things that allow diverse people to connect with one another will rise in importance. So modes of transportation that allow that will become more and more important.” Extrapolating from there, Donaldson says, “I have to wonder what’s the next thing that would be even more modular than truck shipping. Perhaps it will be drones that could just pick up whatever you need at the factory and take it to you at your house.”

Just nine years into his career as a professional economist, Donaldson has seen how technology is transforming the field.

“The biggest change by far in economics, I think, in the last 10 years has to be the massive flood and availability of data,” he says. And Donaldson loves to dive into the data. “I was inspired by something I read by Angus Deaton. He said something along the lines of looking at raw data and getting your hands dirty with collecting and finding and cleaning and understanding the sources behind the data somehow makes you see economics differently.”

In some ways, Donaldson’s background as a physicist may give him an edge in interpreting raw, highly technical data. He and Tufts University economist Adam Storeygard in 2016 published an article, “The View from Above: Applications of Satellite Data in Economics,” in the *Journal of Economic Perspectives*. It amounts to a guide for economists on the use of satellite data such as measurements of nighttime light to calculate economic activity or information on weather to predict the potential yields for any crop anywhere on Earth.

At the same time, Donaldson says his grounding in hard science also leaves him conflicted when using economic models that often accommodate considerable variability.

“Social sciences are a little awkward because we don’t have that micro unit that we really think is stable and always behaves in a certain way,” Donaldson says. “You might think the micro unit is a human being, but obviously human beings don’t follow laws of behavior always and everywhere. But equally, the macro units matter to us, whether they’re the market for salt in a



PHOTO: PORTER GIFFORD PHOTOGRAPHY

corner of India, or the market for T-bills right now, or the market for software engineers in Silicon Valley.”

New data sources are helping economists better understand the decisions people make, Donaldson says.

“Recently, I started a project about the high-speed rail system in China where we have access to all the credit card transactions in China,” he says. China built the first 70 miles of its high-speed rail for the Beijing Olympics 10 years ago and has since turned it into a 15,000-mile nationwide system. Meanwhile, China is still a poor country, and it’s unclear how many people can afford to use the system.

“There is an interesting question about the long-run effects of these projects that maybe we can’t fully foresee,” Donaldson says. “The bullet trains are incredibly expensive and an ambitious engineering project that generates nowhere near the short-run economic surplus, the welfare that would be needed to justify its horrendous cost. But I wouldn’t be surprised if we look back in 50 years and say that it’s a heavily used system that is generating lots of benefits for that economy.”

While Donaldson says he believes that trade offers people new opportunities, he also acknowledges that sudden change can leave many behind. “Damages from shifting economic opportunities are happening all around us all the time, usually for reasons that have nothing to do with international trade,” he says. “We can’t have society-level economic growth without new and more remunerative activities replacing old ones. But what is absolutely essential is to make sure that the unlucky few whose expertise is displaced by the sudden arrival of new competition are compensated and helped to adapt.” **FD**

BRUCE EDWARDS is on the staff of *Finance & Development*.

Donaldson says trade is the reason we no longer live like cavemen.



PHOTO: STEPHEN JAFFE/IMF

A Market, Unified

Arvind Subramanian explains the advantages of a new tax for India's economy and budget

AS CHIEF ECONOMIC ADVISOR to the government of India starting in 2014, Arvind Subramanian helped design the country's goods and services tax (GST). In July 2017, the nationwide GST replaced the patchwork of value-added, sales, and excise taxes levied by 29 states and the federal government. The GST was introduced less than a year after demonetization, the government's controversial move to remove 86 percent of currency from circulation.

In this interview with *F&D's* Chris Wellisz, Subramanian, who previously served as assistant director of the IMF's Research Department, discusses how the tax created a single internal market for the first time since independence in 1947.

F&D: What were some of the obstacles to persuading state governments to support the tax?

AS: One, of course, was the loss of fiscal sovereignty. Earlier they used to levy these taxes in various forms, and they had complete freedom to do so. And now it would all be jointly decided by the center and the states. They could also use tax incentives to attract investment. For each state government that was very valuable—but for the country as a whole, it led to a race to the bottom.

F&D: Initially, you argued for a very simple structure for the GST. You ended up with six rates, which many economists say is not optimal because it is more complex.

AS: In principle, everyone bought into the view that it had to be simple. But... each state had its own political compulsions. One state was a producer of some good, and they would say, well, charge that at a lower rate. Unfortunately, politics required that we had to depart from this simple three-rate structure.

Once it was implemented, there was a high rate, a 28 percent slab. People realized that was leading to a lot of evasion; it was too high, and the GST Council—which is the forum that deliberates on this—then started paring down the 28 percent rate. So progress was made. There is still some way to go, and I'm hoping that over time simplicity will be achieved.

F&D: Some significant sectors, like petroleum and real estate, are untouched by the GST. Do you hope to include them at some point?

AS: I'm very hopeful that certainly electricity, real estate, and petroleum will at some stage be brought in. But the way I think it is going to work—and the finance minister has said this very clearly—we're still waiting for the whole GST to stabilize. We're not quite sure how buoyant the revenue take will be, but once it is, all those sectors can be brought in.

F&D: Were you concerned about launching the GST so soon after demonetization, which was blamed for a growth slowdown?

AS: Those two shocks seem to be behind us, and the economy has started to recover again. But there is no question that there were transitional impacts from those two policy experiments.

F&D: Has the GST improved tax collection?

AS: There has been an almost 50 percent increase in the number of registered GST taxpayers. We are going to see an increase in taxpayer registration, which will lead to better compliance over time. Our conservative estimate is that once it stabilizes, we should get another 1 to 1.5 percent of GDP extra revenue from the GST. It is going to be a unique system, possibly one of the few VAT [value-added tax] systems around the world where you're going to get this matching of what the supplier says he sold to a buyer and what the buyer says he has bought from the supplier. Once that matching happens, then you can try to reduce the evasion and the lack of compliance.

F&D: What about the economic impact?

AS: Barriers to the movement of goods and services within India are going to come down. So we also expect this huge increase in trade within India, and that's like a kind of tariff cut in a sense. That should also add to trade and growth as well and make the Indian economy a much more attractive place to invest.

F&D: Have these benefits been diminished by the complexity of the tax?

AS: Some of the benefits you get from simplicity and transparency do get undermined. This is something that the GST Council is acutely aware of.

F&D: Exporters have complained that it has taken them quite some time to get reimbursements. Should there have been a bigger effort to test the GST before it was rolled out?

AS: There is never a right moment to implement something as vast and as complicated as this. Preparation could have been better in some respects, but that's not the way the real world and politics work. You have to seize the moment. What

is important, then, is not whether you're well prepared or not, but whether you have systems that can respond to the problems.

F&D: How does this mesh with advances in banking and electronic payments?

AS: One of the big collateral benefits is going to be financial inclusion. A lot of small and medium enterprises don't have easy access to credit because

There is never a right moment to implement something as vast and as complicated as this.

they don't have documentation or a track record. So now the tax payments that are made electronically can be discounted, and you can create a market for bills and a backbone where these people can have better access to credit.

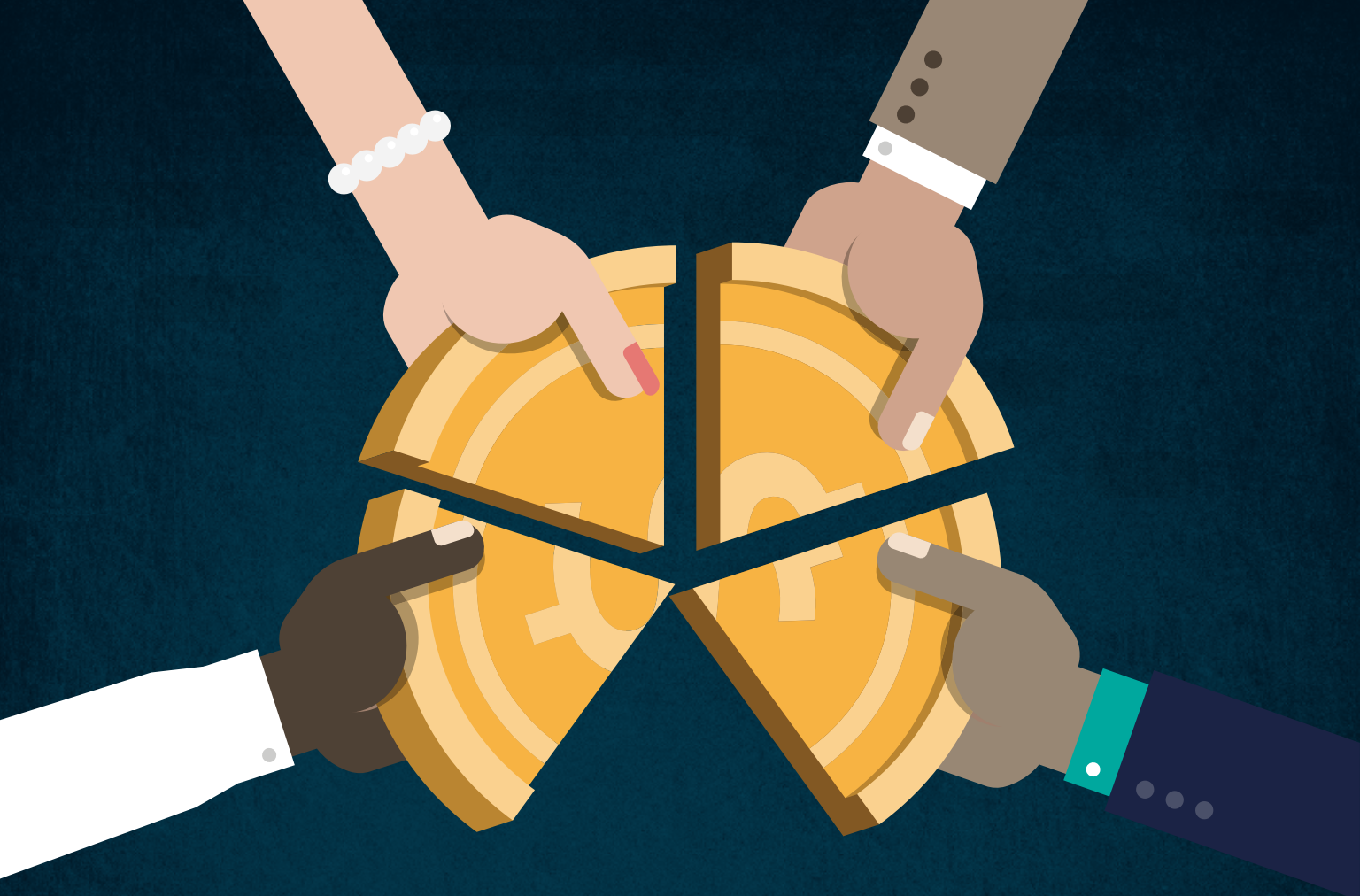
F&D: What has the introduction of the GST taught you about the economy?

AS: India is a vast country, so individual states want to know how much they export internationally. There was no way of knowing until we did this exercise. Also, we're now able to get a better handle on the size of the informal and the formal sectors in India in a way that we never could before. Quite apart from the tax side and the cooperative federalism boost, just the information that we're going to get to be able to better understand the economy and, hence, providing inputs into policymaking, is going to be quite, quite huge.

F&D: Do next year's elections create a risk that concessions will have to be made or that improvements to the GST will have to be postponed?

AS: If the GST Council succumbs to this kind of populism, it will have pretty negative impacts on the long-run functioning of the GST. I think there is enough of a collective spirit in the GST Council that populism can be avoided. **FD**

This interview has been edited for length and clarity.



Growth *or* Inclusion?

With the right policies, countries can pursue both objectives

Jonathan D. Ostry

With the global economy enjoying its broadest synchronized expansion since 2010, and further gains forecast for this year and next, it is tempting to conclude that economic dangers have receded and that a new normal of healthy growth is upon us. Of course, economists always see risks on the horizon, be they the buildup of financial vulnerabilities, trade protectionism, or various geopolitical calamities. One that is persistently in their sights is the risk that policymakers will grow

complacent and fail to press on with the reforms needed to lay a foundation for sustained growth.

Economists have long believed that improving the supply side of the economy—reducing barriers to entry in product markets and making labor markets more flexible—are notable examples—is *the* key to sustaining growth. That is why there is so much emphasis in IMF (and other) policy advice on removing impediments to the movement of goods and capital across borders and improving economic efficiency through liberalization and deregulation.

In work undertaken several years ago, we found strong support for the idea that structural reforms conferred sizable benefits for economic growth. Among the benefits, overseas companies invest more capital as the business environment improves, and local firms benefit from easier access to credit. Firms also shift capital to more productive uses as distortive subsidies and tariffs are removed, and their improved prospects are reflected in higher credit ratings, which allow them to borrow more cheaply. These same forces may also help make growth more durable—contributing to longer growth spells. This improvement in the sustainability of growth is critical: it is only when spells extend over many years or decades that per capita income gaps between developing and developed economies will close. Jump-starting growth is much easier and more common than *sustaining* durable growth.

Costs of inequality

Since the global financial crisis of 2008, however, economists and policymakers have begun to question whether supply-side policies alone can ensure sustained growth. They point to mounting evidence that growth tends to be more fragile and less resilient when it is not inclusive and its fruits accrue mainly to the wealthiest.

This could reflect the fact that—when adverse shocks occur—there is less support in unequal societies for the kinds of policies that help right the economic ship, because the short-term pain doesn't bring broadly shared longer-term gains. It could also simply reflect the fact that these societies don't offer equal access to education, health care, nutritious food, credit markets, and even the political process (equality of opportunity for short), making them less resilient in general.

Economists, including Raghuram Rajan and Joseph Stiglitz, have pointed to growing inequality in many countries as a prime cause of the 2008 crisis. My own work also found that the likelihood of succumbing to a severe downturn was greater in countries with high or rising inequality in the years and decades before the crisis (Berg and Ostry 2017). We argue (Ostry, Loungani,

and Furceri 2018) that policymakers' faith in their ability to get growth going through supply-side measures and deal with distributional issues later is a dangerous gamble, and that they should instead focus *simultaneously* on the size of the pie and its distribution. I call this a macro-distributional view for short.

Economists have generally frowned upon paying attention to distributional issues.

Economics and economists (not just at the IMF, but generally) came under fire after the crisis because their models paid insufficient attention to linkages between finance and the real economy—between Wall Street and Main Street to use popular parlance, or *macro-financial* linkages in the jargon of economists. Yet in my view, insufficient attention to *macro-distributional* linkages, between the size of the pie and each household's piece of the pie, was just as important. And while economists have emphasized the risk of *secular stagnation* (a prolonged deficiency in aggregate demand and negligible economic growth) in the wake of the crisis, the risk of *secular exclusion* (when growth accrues only to those at the top of the income distribution) in many countries is probably just as salient. If median incomes stagnate, and income polarization intensifies, there is even a risk of a vicious cycle between secular stagnation and exclusion as those at the bottom lack the resources to support demand and growth.

Implications for policy

Economists have generally frowned upon paying attention to distributional issues. This bias dates back at least to the publication in 1942 of Joseph Schumpeter's *Capitalism, Socialism, and Democracy* and is evident also in the modern work of Nobel laureate Robert E. Lucas Jr., who wrote in 2003 that “Of the tendencies that are harmful to sound economics, the most seductive, and in

Rising inequality does not simply fall from the sky, nor is it caused entirely by technological change.

my opinion the most poisonous, is to focus on questions of distribution.” The basis of this view is the so-called trickle-down theory, which holds that a rising tide lifts all boats, so that if growth is assured, there is no need to worry about distribution. But if healthy growth is undercut by excessive inequality, then even the policymaker who has no qualms about the moral or social implications of inequality should be concerned about the *economic* cost. The macro-distributional view has merit independent of the weight placed on inequality in the social welfare function, which links a society’s welfare to the aggregate size of the pie and its distribution.

The macro-distributional view has implications not only for the way economists look at growth but also for the policy advice we give. The reason is simple: rising inequality does not simply fall from the sky, nor is it caused entirely by technological change, which amounts to the same thing, since no one would seriously contemplate rolling back technical progress to curb inequality. Instead, as argued in Ostry, Loungani, and Berg (2018), it is driven to an important extent by the very policies that are the basic tools of the economist’s trade

(Ostry, Berg, and Kotharti 2018). These include not only macroeconomic policies (think of the progressivity of the tax system, or infrastructure spending, or even monetary policy in terms of its impact on the prices of assets held mainly by the rich), but also the kinds of supply-enhancing policies discussed above. The implication is clear: when designing such policies, some assessment of their impact not only on the size of the pie, but on the distributional consequences, should be taken into consideration.

Winners and losers

A counterargument might be that supply-enhancing policy instruments must be geared to their primary targets, which is precisely to expand the size of the pie rather than worry about who wins and who loses. The rub is that such an approach may end up frustrating the very objective its proponents seek. Because reforms inevitably produce winners and losers, it is a fact of life that the opposition of the losers may end up frustrating the ability of politicians to enact reforms intended to boost the size of the pie. As European Commission President Jean-Claude Juncker famously noted, “We all know what to do; we just don’t know how to get reelected after we’ve done it.”

There is a tie-in with debates over globalization. Its goal is also to boost the size of the pie. But if those who face prolonged, unremediated dislocation from globalization end up opposing it and instead support politicians with nativist or protectionist agendas, the likely result will be neither a larger pie nor an equitable distribution. Once again, a macro-distributional view is essential, not only to avoid excessively unequal outcomes for moral or social reasons, but also to ensure that the policies promoting a growing pie aren’t abandoned in favor of protectionism.

If policies have a material impact on inequality, then this impact needs to be taken into account at the policy design phase. Of course, that is not the only solution, since it may be possible to remedy distributional outcomes afterward, with programs



to redistribute income and wealth through taxation and transfers to offset the impact on the less advantaged (Ostry, Berg, and Tsangarides 2014). But history suggests that governments have found it difficult to undertake the needed redistribution in practice and, as a result, distributional effects of certain reforms and globalization policies have not been remedied. Knowing how and what to remedy requires having a handle at the outset on the equity and efficiency effects both of globalization and of reform policies.

Recent work with my colleagues has sought to assess the aggregate and distributional effects of aspects of globalization and structural reforms. We found that some structural reforms give rise to growth-equity trade-offs; for example, opening the economy to cross-border capital flows tends to increase both growth and inequality. The implication is not that distributional consequences should give license to roll back reforms or globalization, given their often-sizable aggregate benefits; rather, distributional effects should inform and ultimately improve the initial design of reform packages to better balance winners and losers. This is essential to give credibility to claims that gains from supply-enhancing reforms and globalization will end up being broadly shared. Policymakers *can* choose to design more inclusive supply-enhancing policies; one way is to ensure that the domestic financial sector is inclusive and well regulated, so that the benefits of external financial liberalization are broadly shared across households and firms.

Urgent priorities

Ongoing work suggests several urgent priorities that seem likely to pay dividends in the form of inclusive growth. Public policies should provide income support for workers displaced by technological change or trade, as well as incentives and opportunities to learn new skills. Fiscal policies should safeguard the political legitimacy of the growth model by ensuring that regulations are not skewed in favor of the wealthy; steps could include increased taxation of rents and estates and cooperative efforts across jurisdictions to stem corporate tax avoidance, tax inversions, and the use of tax shelters. Authorities should also make more aggressive efforts to regulate financial markets to



prevent insider trading and money laundering and ensure that regulations prevent unfair competition and crony capitalism, whether in industry, services, or even the media.

The task of policymakers is to ensure that the disadvantaged also have the opportunity to succeed in the modern, hyperglobalized economy, by designing reforms and globalization with an eye to their distributional effects. If they fail, progrowth reforms will lose political legitimacy, enabling destructive nationalist, nativist, and protectionist forces to gain further traction and undermine sustainable growth. The key to success will be to take preemptive action, rather than focusing solely, or even primarily, on ameliorative measures after the fact. Inclusive globalization need not be the same as unbridled globalization. **FD**

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EPIDEMICS &

New and resurgent infectious diseases can have far-reaching economic repercussions

David E. Bloom, Daniel Cadarette, and JP Sevilla

Infectious diseases and associated mortality have abated, but they remain a significant threat throughout the world. We continue to fight both old pathogens, such as the plague, that have troubled humanity for millennia and new pathogens, such as human immunodeficiency virus (HIV), that have mutated or spilled over from animal reservoirs.

Some infectious diseases, such as tuberculosis and malaria, are endemic to many areas, imposing substantial but steady burdens. Others, such as influenza, fluctuate in pervasiveness and intensity, wreaking havoc in developing and developed economies alike when an outbreak (a sharp increase in prevalence in a relatively limited area or population), an epidemic (a sharp increase covering a larger area or population), or a pandemic (an epidemic covering multiple countries or continents) occurs.

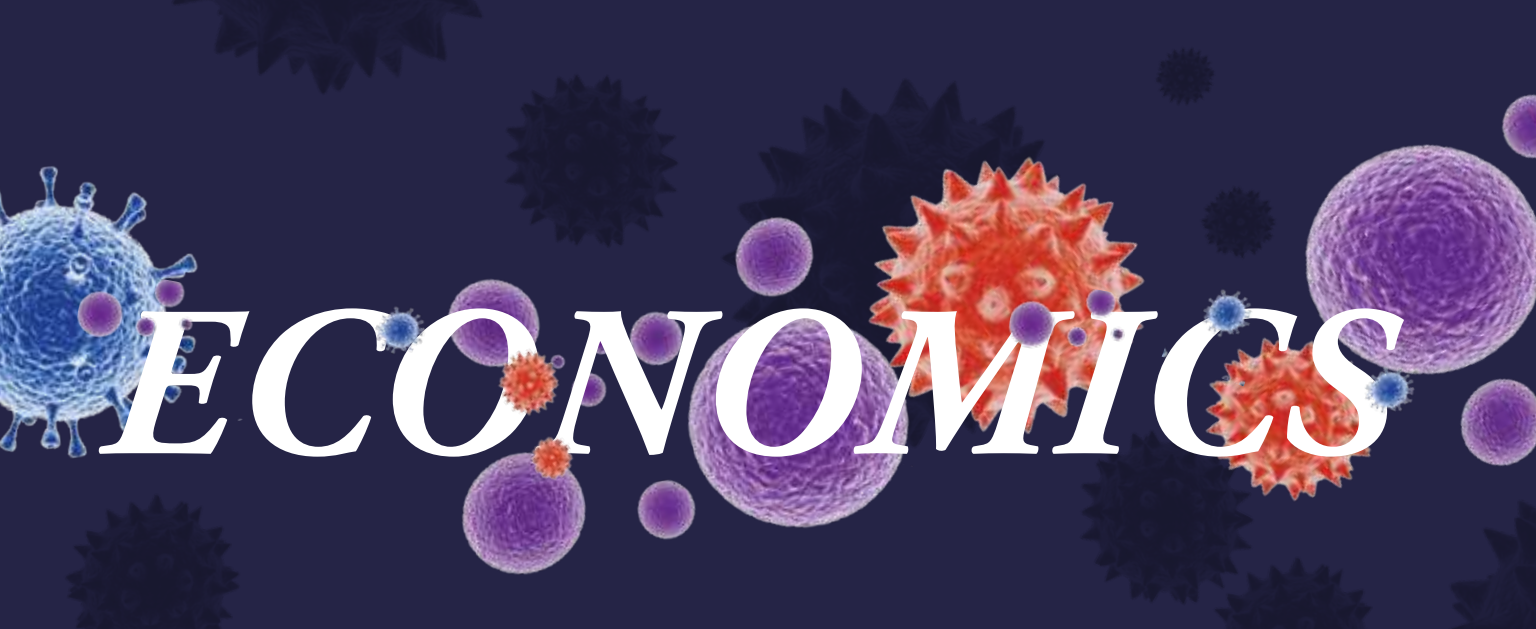
The health risks of outbreaks and epidemics—and the fear and panic that accompany them—map to various economic risks.

First, and perhaps most obviously, there are the costs to the health system, both public and private, of medical treatment of the infected and of outbreak control. A sizable outbreak can overwhelm the health system, limiting the capacity to deal with routine health issues and compounding the problem. Beyond shocks to the health sector, epidemics force both the ill and their caretakers to miss work or be less effective at their jobs, driving down and disrupting productivity. Fear of infection can result in social distancing or closed schools, enterprises, commercial establishments, transportation, and public services—all of which disrupt economic and other socially valuable activity.

Concern over the spread of even a relatively contained outbreak can lead to decreased trade. For example, a ban imposed by the European Union on exports of British beef lasted 10 years following identification of a mad cow disease outbreak in the United Kingdom, despite relatively low transmission to humans. Travel and tourism to regions affected by outbreaks are also likely to decline. Some long-running epidemics, such as HIV and malaria, deter foreign direct investment as well.

The economic risks of epidemics are not trivial. Victoria Fan, Dean Jamison, and Lawrence Summers recently estimated the expected yearly cost of pandemic influenza at roughly \$500 billion (0.6 percent of global income), including both lost income and the intrinsic cost of elevated mortality. Even when the health impact of an outbreak is relatively limited, its economic consequences can quickly become magnified. Liberia, for example, saw GDP growth decline 8 percentage points from 2013 to 2014 during the recent Ebola outbreak in west Africa, even as the country's overall death rate fell over the same period.

The consequences of outbreaks and epidemics are not distributed equally throughout the economy. Some sectors may even benefit financially, while others will suffer disproportionately. Pharmaceutical companies that produce vaccines, antibiotics, or other products needed for outbreak response are potential beneficiaries. Health and life insurance companies are likely to bear heavy costs, at least in the short term, as are livestock producers in the event of an outbreak linked to animals. Vulnerable populations, particularly the poor, are likely to suffer



disproportionately, as they may have less access to health care and lower savings to protect against financial catastrophe.

Economic policymakers are accustomed to managing various forms of risk, such as trade imbalances, exchange rate movements, and changes in market interest rates. There are also risks that are not strictly economic in origin. Armed conflict represents one such example; natural disasters are another. We can think about the economic disruption caused by outbreaks and epidemics along these same lines. As with other forms of risk, the economic risk of health shocks can be managed with policies that reduce their likelihood and that position countries to respond swiftly when they do occur.

A daunting set of threats

Several factors complicate the management of epidemic risk. Diseases can be transmitted rapidly, both within and across countries, which means that timely responses to initial outbreaks are essential. In addition to being exacerbated by globalization, epidemic potential is elevated by the twin phenomena of climate change and urbanization. Climate change is expanding the habitats of various common disease vectors, such as the *Aedes aegypti* mosquito, which can spread dengue, chikungunya, Zika, and yellow fever. Urbanization means more humans live in close quarters, amplifying the transmissibility of contagious disease. In rapidly urbanizing areas, the growth of slums forces more people to live in conditions with substandard sanitation and poor access to clean water, compounding the problem.

Perhaps the greatest challenge is the formidable array of possible causes of epidemics, including pathogens that are currently unknown. In December 2015 the World Health Organization (WHO) published a list of epidemic-potential disease priorities

requiring urgent research and development (R&D) attention. That list has since been updated twice, most recently in February 2018 (see table).

Beyond this list, diseases that are currently endemic in some areas but could spread without proper control represent another category of threat. Tuberculosis, malaria, and dengue are examples, as is HIV. Pathogens resistant to antimicrobials are increasing in prevalence throughout the world, and widespread pan-drug-resistant superbugs could pose yet another hazard. Rapid transmission of resistant pathogens is unlikely to occur in the same way it may with pandemic threats, but the proliferation of superbugs is making the world an increasingly risky place.

Managing risk

Epidemic risk is complex, but policymakers have tools they can deploy in response. Some tools minimize the likelihood of outbreaks or limit their proliferation. Others attempt to minimize the health impact of outbreaks that cannot be prevented or immediately contained. Still others aim to minimize the economic impact.

Investing in improved sanitation, provisioning of clean water, and better urban infrastructure can reduce the frequency of human contact with pathogenic agents. *Building strong health systems and supporting proper nutrition* will help ensure good baseline levels of health, making people less susceptible to infection. Of course, strengthening basic systems, services, and infrastructure becomes easier with economic growth and development; however, policies to protect spending in these areas even when budgets are constrained can help safeguard developing economies from major health shocks that could significantly impinge upon human capital and impede economic growth.

Investment in reliable disease surveillance in both human and animal populations is also critical. Within

Diseases requiring urgent research and development attention, 2018

DISEASE	DESCRIPTION	BIOMEDICAL COUNTERMEASURES
Crimean-Congo hemorrhagic fever (CCHF)	Hemorrhagic fever caused by virus transmitted through ticks and livestock, with case-fatality rate of up to 40%. Human-to-human transmission is possible.	No vaccine available; ribavirin (antiviral) provides some treatment benefit.
Ebola virus disease	Hemorrhagic fever caused by virus transmitted by wild animals, with case-fatality rate of up to 90%. Human-to-human transmission is possible.	Experimental vaccine available
Marburg virus disease	Hemorrhagic fever caused by virus transmitted by fruit bats, with case-fatality rate of up to 88%. Human-to-human transmission is possible.	No vaccine available
Lassa fever	Hemorrhagic fever caused by virus transmitted through contact with rodent urine or feces, with case-fatality rate of 15% in severe cases. Human-to-human transmission is possible.	No vaccine available Vaccine development funded by CEPI
Middle East respiratory syndrome coronavirus (MERS-CoV)	Respiratory disease caused by a coronavirus transmitted by camels and humans, with case-fatality rate of 35%.	No vaccine available Vaccine development funded by CEPI
Severe acute respiratory syndrome (SARS)	Respiratory disease caused by a coronavirus transmitted from human to human and from animals (possibly bats), with a case-fatality rate of 10%.	No vaccine available
Nipah and henipaviral diseases	Disease caused by a virus transmitted by fruit bats, pigs, and humans; can manifest as an acute respiratory syndrome or encephalitis. Case-fatality rate can reach 100%.	Vaccine development funded by CEPI
Rift Valley fever (RVF)	Disease caused by a virus transmitted by contact with the blood or organs of infected animals, or by mosquitos. Up to 50% case-fatality rate in patients with hemorrhagic fever. No human-to-human transmission has been reported.	Experimental, unlicensed vaccine available
Zika	Disease caused by a flavivirus transmitted by mosquitoes. Can result in microcephaly in infants born to infected mothers and in Guillain-Barré syndrome. Human-to-human transmission is possible.	No vaccine available
Disease X (pathogens currently unknown to cause human disease)	N/A	CEPI is funding the development of institutional and technical platforms that allow for rapid R&D in response to outbreaks of pathogens for which no vaccine exists.

Sources: CEPI.net; and World Health Organization website (various pages).

Note: CEPI = Coalition for Epidemic Preparedness Innovations; N/A = not applicable; R&D = research and development.

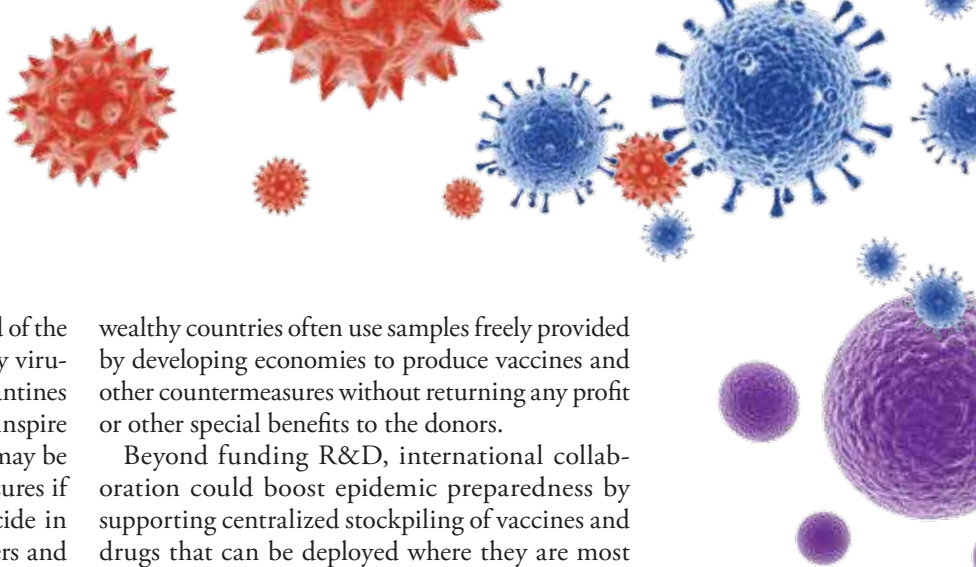
formal global surveillance systems, it may be beneficial to develop incentives for reporting suspected outbreaks, as countries may reasonably fear the effects of such reporting on trade, tourism, and other economic outcomes. The SARS epidemic, for instance, might have been better contained if China had reported the initial outbreak to the WHO earlier.

Informal surveillance systems, such as ProMED and HealthMap, which aggregate information from official surveillance reports, media reports, online discussions and summaries, and eyewitness observations, can also help national health systems and international responders get ahead of the epidemiological

curve during the early stages of an outbreak. Social media offers additional opportunities for early detection of shifts in infectious disease incidence.

Collaborations for monitoring epidemic readiness at the national level, such as the Global Health Security Agenda and the Joint External Evaluation Alliance, provide information national governments can use to bolster their planned outbreak responses. Additional research into which pathogens are likely to spread and have a big impact would be worthwhile.

Countries should be ready to take initial measures to limit the spread of disease when an outbreak does occur. Historically, ships were quarantined in port



during plague epidemics to prevent the spread of the disease to coastal cities. In the case of highly virulent and highly transmissible diseases, quarantines may still be necessary, although they can inspire concerns about human rights. Likewise, it may be necessary to ration biomedical countermeasures if supplies are limited. Countries should decide in advance if they will prioritize first responders and other key personnel or favor vulnerable groups, such as children and the elderly; different strategies may be appropriate for different diseases.

Technological solutions can help minimize the burden of sizable outbreaks and epidemics. Better and less-costly treatments—including novel antibiotics and antivirals to counter resistant diseases—are sorely needed. New and improved vaccines are perhaps even more important.

Collaboration needed

There is a significant market failure when it comes to vaccines against individual low-probability pathogens that collectively are likely to cause epidemics. Given the low probability that any single vaccine of this type will be needed, high R&D costs, and delayed returns, pharmaceutical companies hesitate to invest in their development. The profit-seeking interest does not align well with the social interest of minimizing the risk posed by these diseases in the aggregate.

Farsighted international collaboration can overcome this market failure—for example, the Coalition for Epidemic Preparedness Innovations, which is supported by the governments of Australia, Belgium, Canada, Ethiopia, India, Japan, Germany, and Norway, as well as the European Commission and various nongovernmental funders. Its goals include advancing candidate vaccines against specific low-probability, high-severity pathogens through proof of concept to enable rapid clinical testing and scale-up in the event of outbreaks of those pathogens. It also aims to fund development of institutional and technical platforms to speed R&D in response to outbreaks for which there are no vaccines. Similar funding models could support the development of a universal influenza vaccine.

Of course, new vaccines will be less useful if governments do not ensure that at-risk populations have access to them. Assured access could also motivate developing economies to participate actively in the vaccine R&D process. In 2007 Indonesia withheld samples of the H5N1 influenza virus from the WHO to protest the fact that companies in

wealthy countries often use samples freely provided by developing economies to produce vaccines and other countermeasures without returning any profit or other special benefits to the donors.

Beyond funding R&D, international collaboration could boost epidemic preparedness by supporting centralized stockpiling of vaccines and drugs that can be deployed where they are most needed. Such collaboration has obvious advantages over a system in which each country stockpiles its

The economic risks of epidemics are not trivial.

own biomedical countermeasures. While some countries are more likely to need these countermeasures than others, the global public good of living without fear of pandemics should motivate cooperation and cost sharing. In addition, wealthy countries at relatively low risk of suffering massive health impacts from most epidemics could suffer disproportionately large economic losses—even from faraway epidemics—given the size of their economies and reliance on foreign trade.

If outbreaks do occur and impose a substantial health burden, there are tools to limit the risk of economic catastrophe. As with natural disasters, insurance can help distribute the economic burden across sectors of the economy and regions. Prioritizing personnel such as health care workers, members of the military, and public safety employees for distribution of biomedical countermeasures during an outbreak can help protect critical economic resources.

We cannot predict which pathogen will spur the next major epidemic, where that epidemic will originate, or how dire the consequences will be. But as long as humans and infectious pathogens coexist, outbreaks and epidemics are certain to occur and to impose significant costs. The upside is that we can take proactive steps to manage the risk of epidemics and mitigate their impact. Concerted action now at the local, national, and multinational levels can go a long way toward protecting our collective well-being in the future. [FD](#)

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PIERCING THE VEIL

Some \$12 trillion worldwide is just phantom corporate investment

Jannick Damgaard, Thomas Elkjaer, and Niels Johannesen

New research reveals that multinational firms have invested \$12 trillion globally in empty corporate shells, and citizens of some financially unstable and oil-producing countries hold a disproportionately large share of the \$7 trillion personal wealth stashed in tax havens.

Although Swiss Leaks, the Panama Papers, and recent disclosures from the offshore industry have revealed some of the intricate ways multinational firms and wealthy individuals use tax havens to escape paying their fair share, the offshore financial world remains highly opaque. Because of the secrecy that lies at the heart of the services offered by offshore banks, lawyers, and domiciliation companies, it is hard to know exactly how much money is funneled through tax havens, where the money is coming from, and where it is going.

These questions are particularly important today in countries where policy initiatives aiming to curb the harmful use of tax havens abound. The policies, with acronyms such as FATCA (Foreign Account Tax Compliance Act), CRS (Common Reporting Standard), and BEPS (base erosion and profit shifting), introduce a variety of new reporting requirements: multinational firms must report country-by-country information about their economic activity; banks must conduct

thorough background checks of customers to identify foreign-owned accounts and report detailed account information to the tax authorities; and the tax authorities must share tax-relevant information with their foreign counterparts through comprehensive information exchange agreements.

This new wave of tax enforcement policies is controversial. Some welcome the ambitious attempts to fix what is perceived as a broken international tax system that allows global elites to get away with low effective tax rates. Others argue that the cost of enforcement could dwarf the benefits. Determining which view is closer to the truth is impossible without reliable measures of the scale of this offshore challenge. Fortunately, recently released statistics from the Organisation for Economic Co-operation and Development (OECD) and the Bank for International Settlements (BIS) on cross-border financial positions have allowed researchers to begin to pierce the veil of offshore secrecy.

Offshore shell games

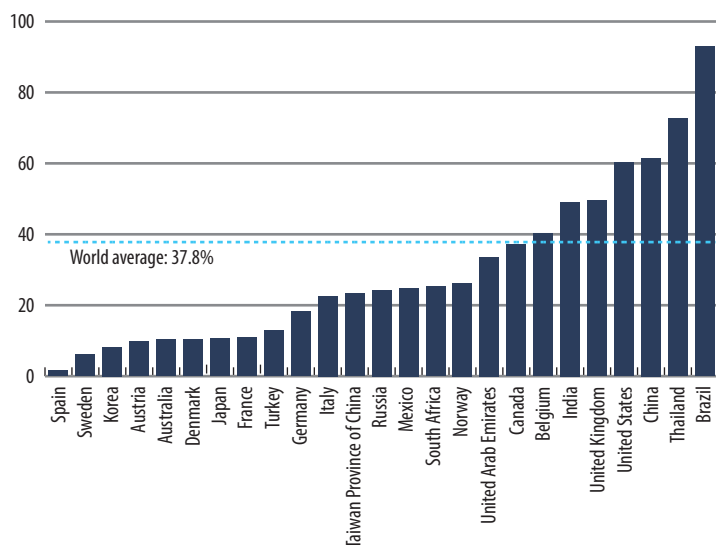
Foreign direct investment is usually perceived as long-term strategic and stable investment reflecting fundamental location decisions of multinational firms. Such investment is often thought to bring job creation, production, construction of new factories, and transfer

Chart 1

Offshore shell games

More than half of outward FDI goes through foreign shell companies.

(FDI that passes through SPEs as percent of total outward FDI)



Source: Calculations based on Damgaard and Elkjaer (2017).

Note: FDI = foreign direct investment. Includes non-tax-haven countries with GDP greater than \$300 billion and a ratio of outward FDI to GDP greater than 3 percent in 2015. SPE = special purpose entity, a legal entity often set up for tax reasons.

of technology. However, a new study (Damgaard and Elkjaer 2017) combines detailed statistics on foreign direct investment published by the OECD with the broad coverage of the IMF's Coordinated Direct Investment Survey and finds that a stunning \$12 trillion—almost 40 percent of all foreign direct investment positions globally—is completely artificial: it consists of financial investment passing through empty corporate shells with no real activity.

These investments in empty corporate shells almost always pass through well-known tax havens. The eight major pass-through economies—the Netherlands, Luxembourg, Hong Kong SAR, the British Virgin Islands, Bermuda, the Cayman Islands, Ireland, and Singapore—host more than 85 percent of the world's investment in special purpose entities, which are often set up for tax reasons. The characteristics of these entities include legal registration subject to national law, ultimate ownership by foreigners, few or no employees, little or no production in the host economy, little or no physical presence, mostly foreign assets and liabilities, and

group financing or holding activities as their core business. The significance of such offshore investment is growing. Foreign direct investment, unlike portfolio and other investment, has continued to expand in the aftermath of the financial crisis, driven primarily by its positions vis-à-vis financial centers as a result of the growing complexity of the corporate structures of large multinationals (Lane and Milesi-Ferretti 2018).

The use of pass-through entities in tax havens does not in itself imply tax avoidance, but it certainly implies more opportunities for tax avoidance and even tax evasion. Many of the most aggressive tax minimization strategies require that investments be structured in precisely this way, and it is well documented that multinational firms with a nominal presence in tax havens effectively pay lower taxes on their global profits.

This type of financial tax engineering is a worldwide phenomenon that cuts across advanced and emerging market economies. In emerging market economies such as India, China, and Brazil, 50 to 90 percent of outward foreign direct investment goes through a foreign entity with no economic substance; the share is 50 to 60 percent in advanced economies such as the United Kingdom and the United States (see Chart 1). Globally, the average is close to 40 percent. Even though the special purpose entity share is relatively low in some OECD countries, the tax challenge can still be significant, given developed economies' generally relatively high outward foreign direct investment relative to their economic size.

Hidden wealth

In many parts of the world, private individuals also use tax havens on a grand scale, as evidenced in a new study by Alstadsæter, Johannesen, and Zucman (forthcoming). Analyzing recently released statistics from the BIS on cross-border bank deposits, the study documents distinct differences across countries in the amount of wealth held in personal offshore accounts. Globally, individuals hold about \$7 trillion—corresponding to roughly 10 percent of world GDP—in tax havens. However, the stock of offshore wealth ranges from about 4 percent of GDP in Scandinavia to about 50 percent in some oil-producing countries, such as Russia and Saudi Arabia, and in countries that have suffered instances of major financial instability, such as Argentina and Greece (see Chart 2).

These patterns suggest that high taxes are not necessarily associated with high levels of offshore

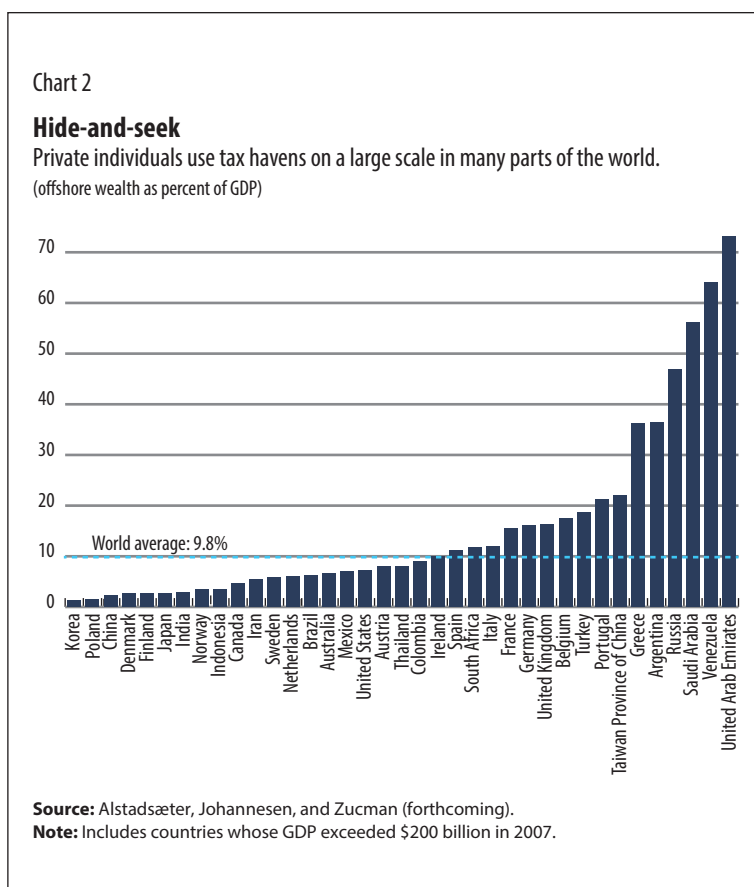
tax evasion: the Scandinavian countries have some of the highest income tax rates in the world, but at the same time have relatively little offshore personal wealth. The findings also suggest that individuals sometimes stash money in offshore accounts for reasons entirely unrelated to tax evasion, particularly in the context of emerging market economies. For instance, tax haven banks may serve to circumvent capital controls during a currency crisis, as suggested by the exceptionally high levels of offshore personal wealth in Argentina, and to launder the proceeds from corruption in resource-extraction industries, as suggested by the statistics for countries such as Russia and Venezuela.

The study also highlights dramatic changes in tax havens' share in the global wealth management market: the proportion of the world's hidden wealth managed by Swiss banks has dropped from almost 50 percent on the eve of the financial crisis to about 25 percent today with the expansion of Asian tax havens such as Hong Kong SAR, Macao SAR, and Singapore. This development may indicate that international cooperation on tax matters by Switzerland and other European tax havens is deterring tax evaders. Alternatively, it may be a sign that a larger share of the world's superrich are Asians who do offshore banking in nearby tax havens.

Out of the shadows

The international tax challenge will grow in the coming years because of increased digitalization and mobility of assets (think Facebook, Google, Tencent). New studies shed light on the money passing through tax havens and reveal striking cross-country differences in exposure to the offshore challenge, but these analyses are based on incomplete evidence, since multinational firms and private individuals can also use other methods to shelter wealth abroad. For this reason, even more data are needed to fully pierce the veil of offshore financial secrecy.

First, more countries should begin regularly reporting detailed financial data broken down by instrument, domestic sector, counterpart sector and country, currency, and maturity. Second, traditional macroeconomic statistics, which are based on the concept of a national economy as the only relevant boundary, are increasingly challenged by financial globalization. These statistics should be supplemented with data on global interconnection that look beyond holdings of financial wealth



across borders to find their ultimate owners. Such data will make it possible to weigh the costs and benefits of various policy initiatives: informed decisions must be based on rich, detailed, and reliable evidence. **FD**

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The views expressed here are those of the authors; they do not necessarily reflect the views of the institutions with which they are affiliated.

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MIND THE GAP

Differing perspectives of men and women economists may affect policy outcomes

Ann Mari May, David Kucera, and Mary G. McGarvey

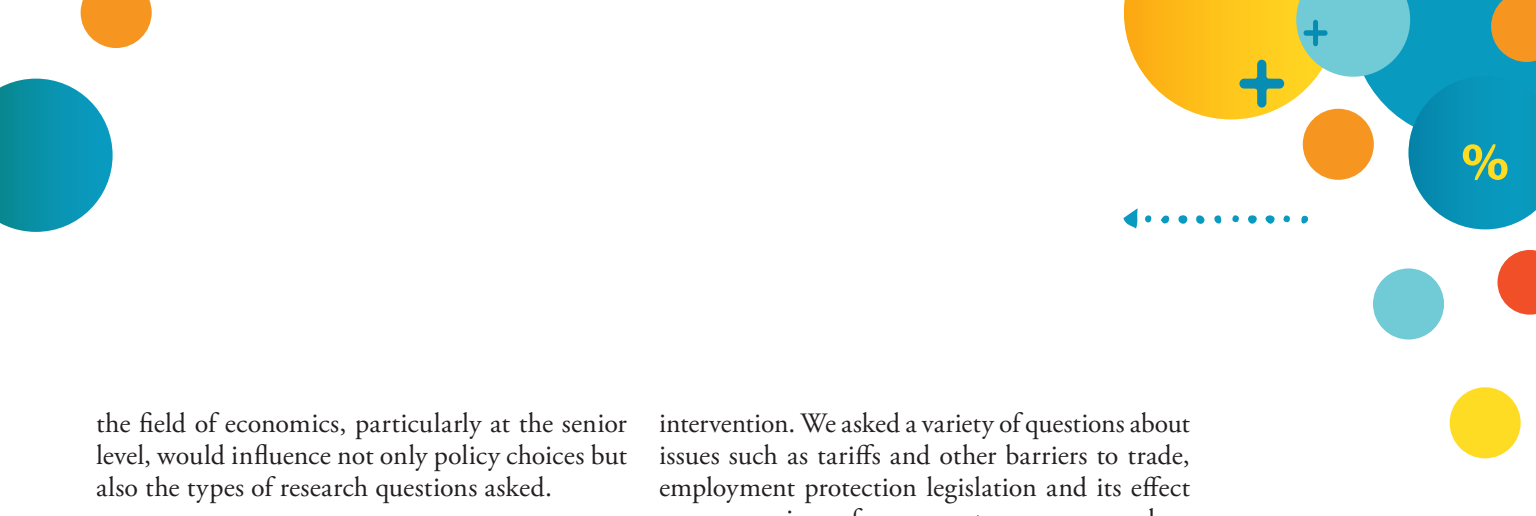
Female economists place much less confidence in the market than their male counterparts do when it comes to solving problems in the economy and society.

Compared with male economists, women in the field have a greater tendency to look to government intervention for solutions, to support increased environmental regulation, and to perceive a gender gap in wages and other labor market conditions.

These are some of the most important findings of our survey of male and female economists at universities in 18 European Union countries that grant PhDs in economics. Controlling for where these economists reside and when and where their

PhDs were earned, we analyzed their responses to a wide variety of questions concerning contemporary policy, including support for austerity measures, regulation of high-risk financial transactions, deflationary policies, renewable energy and hydraulic fracturing, drilling in the Arctic, and genetically modified crops.

The gender gap in views on the economy has important implications for policymaking and the outcomes of decisions that are pursued. Despite an increase in the number of women entering economics from the 1970s to the 1990s, the profession remains predominantly male. Our study suggests that greater representation of women in



the field of economics, particularly at the senior level, would influence not only policy choices but also the types of research questions asked.

Why gender balance matters

Gender balance has particular significance in Europe, where it's common for economics professors to serve in high-level policymaking roles in government, such as prime minister, cabinet-level positions, and heads of central banks. In the United States, by contrast, economics professors more typically serve in advisory roles, according to research by Bruno S. Frey and Reiner Eichenberger of the University of Zurich.

The European Commission has made greater gender balance in economic decision-making a priority in recent years, as expressed in several high-profile reports and declarations. The Commission has argued that achieving greater gender balance is not just a question of fairness, but that it contributes to greater productivity and innovation, better company performance, and improved public policy.

Does the gender makeup of economics affect policymaking and outcomes? Specifically, would greater representation of women lead to a more diverse set of policy questions being asked and perhaps to an alternative set of conclusions?

The answers to these questions depend, of course, on whether men and women economists really do have different views on matters of economic policy. Until recently, the only study that systematically looked at such gender differences was for economists based in the United States (2014). Our new study set out to understand if there is a gender gap in views of economists working in the European Union on a wide variety of economic policy issues as well as differences in views of core economic principles and methodology.

We found statistically significant differences in opinions between men and women economists in all five topic areas we examined: (1) core economic principles and methodology; (2) market solutions versus government intervention; (3) government spending, taxation, and redistribution; (4) environmental protection; and (5) gender and equal opportunities.

The largest gender difference involved choices between market solutions and government

intervention. We asked a variety of questions about issues such as tariffs and other barriers to trade, employment protection legislation and its effect on economic performance, temporary employment contracts, government austerity measures and economic performance, regulation of high-risk financial transactions, and youth unemployment.

Here, the average female economist was less likely than the average male economist to prefer market solutions over government intervention. The largest difference in views concerned the notion that stronger employment protection legislation results in weaker economic performance. On this

Greater representation of women in economics would influence not only policy choices but also the types of research questions asked.

issue, men were more likely than women to believe that this type of government intervention would weaken the economy.


Questions on environmental protection revealed the second-largest gap in views between male and female economists. This group included questions about policies to provide for a lower value-added tax rate on eco-friendly products to encourage their use, to increase energy taxes on carbon dioxide emissions, to promote renewable energy, to limit hydraulic fracturing and drilling in the Arctic, and to ban genetically modified crops.

Overall, women economists were more likely to support increased environmental protection than their male counterparts. The largest difference in views centered on whether the European Union should continue the ban on planting genetically modified crops. Women were more likely to agree with continuing this ban.

We found a small, though statistically significant, difference between the genders on questions about government spending, taxes, and redistribution. Included in this group are questions about the level of military spending, import openness, the impact of increases in the



It is important to include both men and women economists at the table when formulating and debating economic policy.



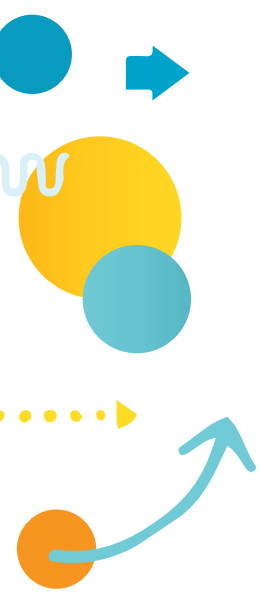
minimum wage on unemployment, the effect of moderate inflation, European Central Bank policy, deflationary policies, and deficit and debt limits.

In this group of questions, we found that disagreements over the appropriate level of military spending accounted for the largest difference in views. Women were more likely to see military spending as too large, while men were more likely to take the opposite view.

We also posed questions related to core principles in economics and methodology and found disagreement between the views of male and female economists. In the greatest contrast, we found that women economists were more likely than men to support the notion that interdisciplinary research teams would improve economic knowledge.

A question of equity

Finally, we asked specifically about equal opportunity in society and gender equality in higher education. The questions in this group provide a window into some of the more important issues facing women today. We included questions about the gender wage gap, policies promoting gender balance on boards of directors of privately held companies, affirmative action, perceptions of opportunities for faculty and graduate students in the European Union, the potential benefits of gender balance in research teams, and the role of housework and the importance of affordable childcare in women's labor force participation.



It was interesting to us that this group of questions did not produce the largest or even second-largest difference in views between men and women. Perhaps not surprisingly, the largest difference in views in this group of questions centered on opportunities for men and women in economics in most universities in the European Union. Here women were more likely to believe that opportunities in economics favor men a bit more, whereas men believed that opportunities favor women a bit more, or are approximately equal.

The differences in views between male and female economists on important policy issues suggest that changes in the makeup of the economics

profession may indeed affect policy outcomes and influence the types of research questions that are asked. This may be especially important in the European Union, where evidence suggests that economic knowledge in higher education is more readily transformed into policy than in the United States (Frey and Eichenberger 1993).

Stalled progress

The results also provide an important clue as to why there may be fewer women in economics than in other STEM (science, technology, engineering, and mathematics) fields. If women hold views at odds with the perspectives of more senior male colleagues on research and policy questions, women might be less likely than men to be hired, promoted, and have their work published in top journals.

Such barriers may help explain why progress in female representation in the economics profession stalled around 2000, as reported by the American Economic Association's Committee on the Status of Women in the Economics Profession.

Our study provides evidence that it is important to include both men and women economists at the table when formulating and debating economic policy. If demographic differences such as sex help to shape our views on policy questions, the inclusion of women will expand the debate and enlarge the scope of perspectives. **FD**

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This article draws on May, McGarvey, and Kucera (2018).

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Happiness When Growth Is Weak

WEALTH DOES NOT bring happiness, according to the Easterlin Paradox. Rapid economic growth allows people to think this might be so, but when growth turns weak and wealth decreases for many, the illusion is shattered. *The Infinite Desire for Growth*, by renowned French economist Daniel Cohen, aims to offer an alternative to this outcome.

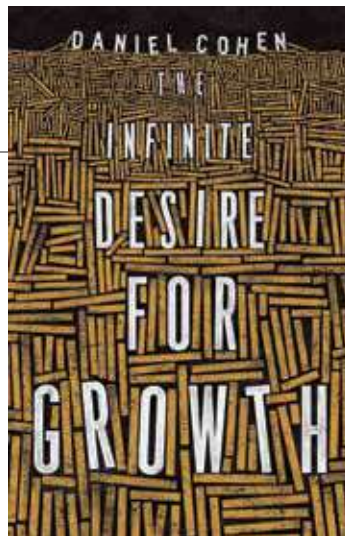
In the first part of his book, Cohen examines the origin of growth in terms of millennia rather than centuries or decades. In a creative but somewhat speculative way, he associates the origin of growth with the beginning of agriculture in far apart geographic locations and with the population expansions that followed as a result. A watershed moment occurred at the turn of the 17th century as the scientific revolution began to replace religion with the idea of material progress, generating modern economic growth through the industrial revolution. This event Cohen associates implicitly with the emergence of a permanent desire for rapid growth.

The most innovative and thought-provoking segment of the book is its middle. Titled “The Future, the Future!” it presents a coherent argument for weak growth in the future. Starting from an overview of forthcoming technological advances,

A cloud hangs over this paradise: the possible elimination of middle-class jobs.

it raises the possibility of perpetual growth. Yet a cloud hangs over this paradise: the possible elimination of middle-class jobs.

Rain begins to fall through a thorough discussion of Robert Gordon’s questioning of the depth of modern inventions’ effect on mass welfare. It intensifies with a mechanical display of how a very productive, fully automated goods-producing sector alongside a highly inefficient services sector yields lower growth and rising inequality for the economy as a whole. This abstraction is broadly consistent with some features of developed economies in theories advanced by such prominent



Daniel Cohen

The Infinite Desire for Growth

Princeton University Press,
Princeton, NJ, 2018, 184 pp., \$24.95

economists as William Baumol, Thomas Piketty, and Lawrence Summers. The segment concludes by arguing that the failure—because of collective action problems—to halt global warming will prevent rapidly growing developing economies from doing anything about the weak economic growth generated by advanced economies.

The last part of the book is an unconvincing attempt at dealing with weak economic growth’s implications for well-being. Cohen argues that an acceptable level of happiness is achievable only if societies hit by weak economic growth are transformed. This transformation would have to be profound as it requires new attitudes toward material progress, work, and hierarchy.

Furthermore, key arguments are based on data from the United Nations *World Happiness Report*, which implies reliance on a relative measurement of happiness to draw conclusions about absolute levels of well-being. The French may on average score low on happiness, but it is hard to convince me that their well-being is the same as that of people in most African or Central American and Caribbean countries—even if their average happiness scores are the same or similar.

I found the initial part of the book interesting and the middle part excellent and enjoyable to read, whether or not I agreed with its arguments. The book’s final section, by contrast, was a letdown. **FD**

ROGER R. BETANCOURT, professor emeritus of economics, University of Maryland

The Importance of Data

STATISTICS AND DATA are often seen as important but dry subjects. William Deringer's book on the use of calculated values in late 17th and 18th century Britain challenges this image with a story of remarkable events in which data plays a central role.

The "Glorious Revolution" of 1688 brought William of Orange to the English throne. The subsequent increased authority of Parliament over budgetary measures, the development of a two-party system, and the freeing of the press created an environment in which politically motivated individuals (dubbed "calculators" by Deringer) used calculated values to publicly hold the government

data widened from financial and economic affairs to social and geographic settings, including in the British colonies. Indeed, the author considers that the period left its greatest legacy in the United States, with its heavy reliance on quantitative modes of accounting, evaluation, and decision-making.

The book highlights the use of a number of emerging statistical techniques. The South Sea Bubble—a

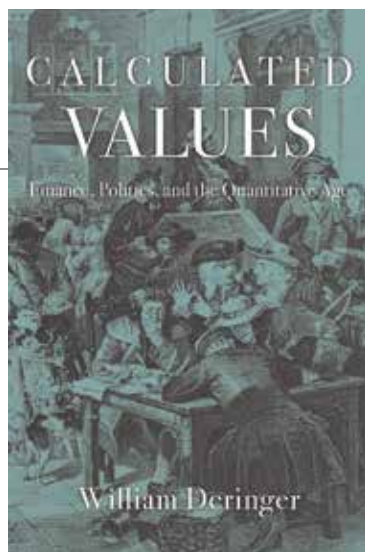
Data can often be a tool for generating debate.

story of asymmetric information, misaligned incentives, and misled investors in a period of financial innovation—showcases the use of plausibility analysis to depict the absurdity of the share price at its height. The story of the "Equivalence" exemplifies the use of present value techniques to make a precise estimate of England's payment to Scotland at the time of their unification. There are also examples of scenario building, early forms of regression analysis, and the introduction of actuarial calculations. Measures of social happiness emerged.

The competitive nature of the calculators highlighted measurement issues, some of which remain to this day. The measurement of bilateral trade between England and France in a mercantile environment of winners and losers raised issues, as it does today, regarding the recording of reexports, the reliability of reported customs data, and the valuation of goods. Partisan debate over the size of government debt and whether it was increasing or decreasing raised the efficacy of using market value. The calculators also drew attention to the importance of identifying the hidden assumptions behind calculations.

Deringer tells these vivid stories with a richness of research that brings to life not only the events surrounding them but also the many famous characters involved. We can learn from the 18th century debate, he says, by promoting new and diverse computational approaches to stimulate public debate and offset what he fears is growing anti-quantitative sentiment. As Deringer notes, data can often be a tool for generating debate as much as for providing definitive answers. **FD**

ROBERT HEATH, former deputy director of the IMF's Statistics Department



William Deringer
Calculated Values:
Finance, Politics, and the
Quantitative Age
 Harvard University Press,
 Cambridge, MA, 2018, 440 pp., \$45

and government-supported companies to account. The public use of data in this way distinguished Britain at the time. Calculators competed and challenged each other's calculations to prove political points. By the 1720s, the government under Robert Walpole increasingly relied on calculators to support policy decisions.

The book focuses on the early 18th century, with its increasingly vitriolic debates over government expenditure, taxation, and debt as well as the trade balance. As the century wore on, the role and authority of

An Indonesian Story

THE COVER OF Vasuki Shastry's *Resurgent Indonesia* shows a Phoenix rising from the ashes—an apt metaphor for Indonesia's remarkable transformation since its catastrophic financial, economic, and political crisis in 1997–98. The book's release coincides with a gathering of the world's financial elite at the IMF–World Bank Annual Meetings in Bali later this year. It will serve as a useful reminder of how far Indonesia has traveled from the dark depths of the crisis to a stable, democratic, and decentralized country with a vibrant economy.

The book's broad sweep of Indonesia's spectacular crash and subsequent rise is really an account of three crises—financial, agricultural, and political—that serendipitously occurred at about the same time and interacted in complex ways. A journalist by training, Shastry uses anecdotes, personal reflections, and interviews to illuminate the complicated causes and consequences of the crisis and the factors behind the country's resurgence.

The first half of the book examines the unfolding of the 1998 crisis. Shastry's account makes vivid how a multitude of interests intersected to shape events during that fateful period: those of international and Indonesian technocrats with little understanding of the political ramifications of their policies; the political, military, and commercial elites intent on defending their interests; and ordinary workers, peasants, and students who bore the brunt of the crisis and demanded a change in the status quo, including a greater voice in government. Over just one week in May 1998, the crisis came to a sudden and unexpected climax with riots in the streets, the killing of four students at Trisakti University, and the eventual departure of President Suharto.

The second half of the book focuses on the noisy, often chaotic post-Suharto transition toward democracy, a free press, and increased emphasis on human rights and the rule of law. Shastry rightly points to the pivotal role of Habibie's 18-month presidency during which he trimmed the powers of the presidency, enhanced the role of local governments, restored basic freedoms, and allowed the East Timorese to



Vasuki Shastry
**Resurgent Indonesia:
From Crisis to Confidence**
Straits Times Press Books,
Singapore, 2018, 248 pp., \$35

vote for independence—all the while protecting the country's key institutions and the interests of the elites.

Unfortunately, the book gives scant attention to the next three presidents—Abdurrahman Wahid (Gus Dur), Megawati, and Susilo Bambang Yudhoyono (SBY)—but gives a glowing account of President Joko Widodo (Jokowi)'s meteoric rise. Disregarding SBY's 10-year administration (2004–14) is particularly unfortunate, as it would have helped explain why Jokowi inherited a country with rampant corruption, a large infrastructure deficit, unsustainable fuel subsidies, and growing intolerance toward minorities.

Shastry, a self-confessed optimist, correctly describes Indonesia as “an archipelago of possibilities,” but in doing so glides over the country's many deep social, economic, spatial, and religious fault lines. To compound matters, the book's discursive style is often as choppy and turbulent as the events it describes, and periodic digressions describing the challenges of other countries, especially India and China, do not help.

Its shortcomings notwithstanding, *Resurgent Indonesia* is a useful addition to the literature on an important country during a critical part of its history. **FD**

VIKRAM NEHRU, distinguished practitioner-in-residence,
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Striking the Right Note

An inside look at paper money around the world

Tadeusz Galeza and James Chan

FROM STRINGS OF SHELLS in the Solomon Islands to large stone disks on the Micronesian isle of Yap or wheels of Parmigiano-Reggiano cheese in Italy, money has taken many forms throughout history. Today, banknotes are an artistic expression of national sovereignty, with many countries choosing to immortalize famous authors and activists, local wildlife, and iconic national landmarks. In other words, modern paper money represents the essence, history, beauty, and ideals to which each country

aspires. To see this diversity in action, we need look no further than the 189 member countries of the IMF that churn out 136 unique national currencies and form four currency unions.

Standouts include the Malawian kwacha, the smallest banknote in our study at about 87 percent the size of the US dollar bill. At the other end of the spectrum are the Brunei and the Singapore dollars, the largest banknotes in circulation, each with a total area of more than 150 percent of the US dollar bill—calling for a really deep wallet. Banknotes across the world are rectangular, but most are wider rather than they are tall. Swiss francs, for example, tend to be very slender, while British pounds and Kenyan shillings are more square.

Yet despite the variations in design, the properties that define currency are the same: they are a unit of measure, a store of value, and a medium of exchange. Paper bills, or “fiat” money, also have no intrinsic value; their worth is determined solely through supply and demand, and they are declared legal tender by government decree.

The most important element that separates one national currency from another is its value. Central banks decide what the largest note in circulation should be, and its nominal value is determined by the number of zeros—this indicates the purchasing power of the note within the country. Currently, the largest bills changing hands range from 20 Bahrain dinars to 500,000 Vietnamese dong. Historically, because of hyperinflation, many countries printed banknotes with a cartoonish number of zeros: Yugoslavia issued a 500 billion dinar bill in 1991, and Zimbabwe a 100 trillion dollar bill in 2009. Today, a hundred units of currency (for example, 100 US dollars) is most commonly the highest available banknote in each country. But the real value (proxied here

Hyperinflation Bills



500 billion Yugoslav note



100 trillion Zimbabwe note

Comparing Real Value Based on Largest Banknotes



Three **100 South Sudanese pound notes** buy a cup of coffee.

Two **10,000 Brunei dollar notes** buy a Toyota Yaris sedan.

by its worth in US dollars) is where the rubber hits the road.

On average, the largest banknote in circulation across countries is equivalent to 33 US dollars, but the difference in real value from country to country could not be more stark. It takes three 100 South Sudanese pound notes (their largest in circulation) to purchase a medium coffee at Starbucks. At the opposite end, it takes only two of Brunei's largest bills—10,000 dollar notes—to buy a 2018 Toyota Yaris sedan.

Cash, nevertheless, may not be king forever.

With digital currencies and online transactions gaining steam worldwide, the future of paper money may be in jeopardy. What was once valued precisely because of its physicality is giving way to a new global economy where more and more transactions—big and small—are processed electronically. Perhaps one day countries will design and issue banknotes of the virtual kind, embedded with even richer features to celebrate all they hold dear. Until then, however, paper banknotes will retain an undeniable appeal. **FD**

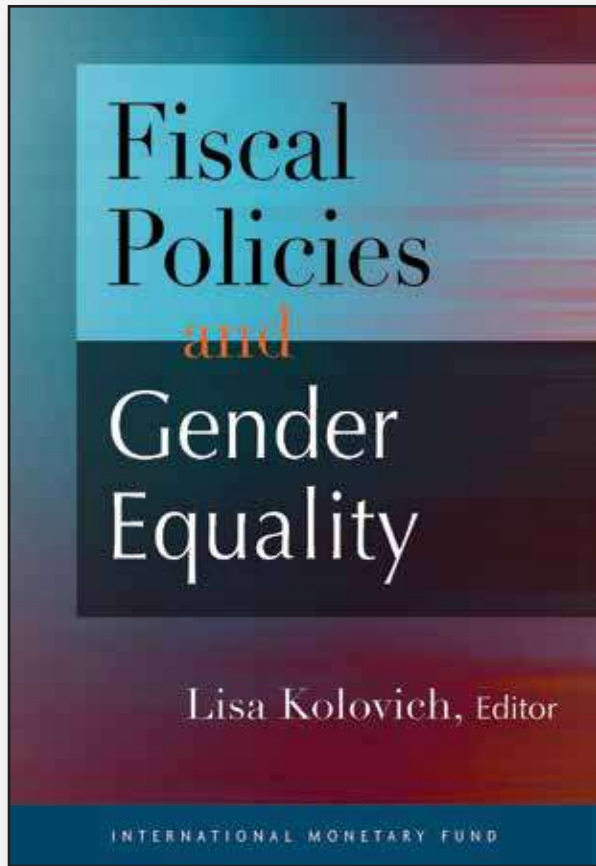
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If you had the equivalent of \$1 million, how much of a briefcase would it fill?



Recommended Reading from IMF Publications

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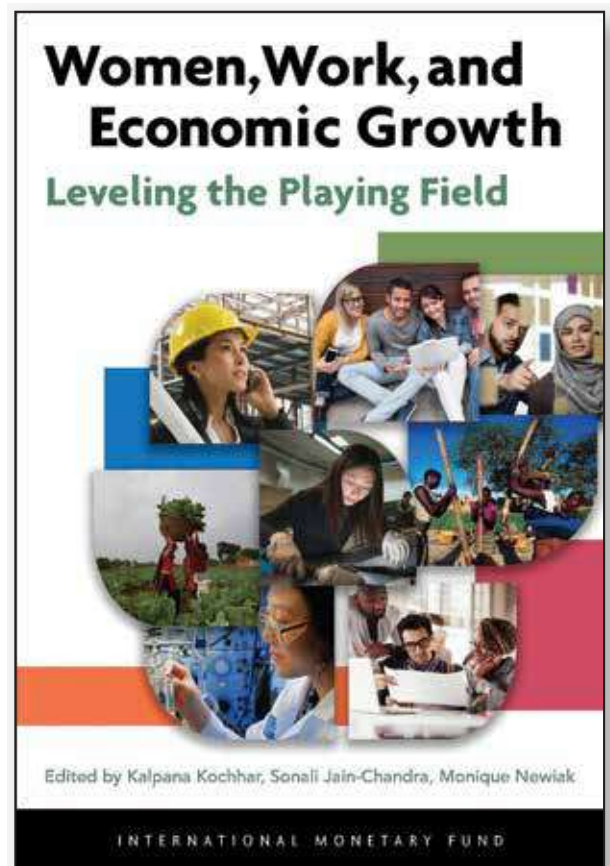


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