

F&D

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A robot revolution

Google's Hal Varian

Nancy Birdsall profiled



Smart Technology Takes Flight

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A Tale of Two Tellers

MY mother eases her car into the drive-through lane at our local bank, signs the back of her check, and places it in a metal canister. WHOOSH—the cylinder flies through a pneumatic tube to the teller inside the building.

In a few minutes, the teller squawks her thanks from the intercom speaker nearby. Another WHOOSH, and the canister returns. Inside we find a deposit receipt and a lollipop. Welcome to high-efficiency consumer banking, circa 1973.

Summer 2016. In our kitchen, I watch my oldest son rip open his paycheck and whip out his iPhone. TAP. SWIPE. CLICK. The deposit is made in an instant, thanks to an app that plugs him into an electronic banking network.

Welcome to banking in the second machine age—the era of smart devices and network-connected machines. The difference between the two transactions speaks to the impressive efficiency gains made possible by advances in computing technology over the past four decades.

This issue of *F&D* focuses on how technology is driving growth. We look at the power of smart machines and artificial intelligence to transform economic life.

How can technology drive growth? In our lead article, Google Chief Economist Hal Varian looks at “transmission channels.” As with drive-through tellers, ever-more-powerful technology allows us to streamline, replacing less efficient practices (the drive-through teller) with more efficient ones (smartphone deposits).

Other articles in our cover package chronicle technology’s power to transform: Sanjiv Ranjan Das examines big data’s influence on economics and finance; Aditya Narain documents the rise of a new breed of hybrid financial technology—fintech—firms; and Sharmini Coorey touts distance learning for better policymaking.

We also look at potential downsides. Andrew Berg, Edward Buffie, and Felipe Zanna imagine a future economy dependent on smart machines—or robots. Output and productivity go up, but so does inequality—not a result the authors cheer. And Chris Wellisz probes a dark side—cybercrime and cybertheft—that routinely grabs headlines and reminds us of technology’s capacity to raise the bar on mayhem.

Elsewhere in this issue, we examine the impact of remittances on monetary policy, dedollarization in Peru, and the efficacy of public-private partnerships, among other topics. And we profile Nancy Birdsall, the former head of the Center for Global Development, who has dedicated her career to fighting poverty and inequality through compelling research.

This issue marks my last as Editor-in-Chief. After almost 4 years and 15 issues of *F&D*, I am moving to the job of Publisher of the IMF and passing the baton to Camilla Andersen, who along with Managing Editor Marina Primorac, Creative Director Luisa Menjivar, and our crack editorial team will carry forward *F&D*’s long tradition of publishing accessible, thought-provoking articles on the global economy. I’m proud to have been part of this tradition and am thankful to have worked with such a talented team.

Jeffrey Hayden
Editor-in-Chief

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Swimming Upstream

Alan Wheatley
profiles **Nancy
Birdsall**, founding
president of the
Center for Global
Development

SLIGHT, bespectacled, measured, and reasoned, Nancy Birdsall looks to be someone who would rather play safe than bold. But appearances can be deceptive.

Under her stewardship the Center for Global Development (CGD), the Washington think tank she cofounded in 2001, has carved out a reputation for being innovative, even radical. And though the CGD is now regarded as a leader in its field, Birdsall still likes to portray it as something of an outsider. “We’re swimming upstream all the time to try to push the system to address problems in the way the system works, which tend, in general, to make life more difficult than it ought to be for those who are vulnerable,” she tells *F&D*.

For Birdsall, who recently stepped down as CGD president but remains a senior fellow, development has to encompass much more than aid. Concretely, the goal must be to ensure that the rules of the game on global issues such as trade, migration, and climate change are not rigged against the poor. To that end, the CGD’s research aims to show how the policies of rich-country governments and international financial institutions affect people in the developing world and can be improved to reduce poverty and inequality.

“I think the development community and the international community are moving much more in that direction now,” Birdsall says. “I feel as though we’ve been very important in that respect, in that we have generated ideas. We haven’t just said this policy should be changed or improved. We have come up with new products that address these problems at the global level in ways that are reasonably practical.”

Among the initiatives to the CGD’s name are the Commitment to Development Index, which ranks 27 rich countries on policies that affect the global poor; development impact bonds to catalyze private financing; and an international push for an evidence-based approach to development programs. Its most popular publication is *Millions Saved*, a collection of successful public health case studies now widely used as a teaching aid.

Original thinkers

Kunal Sen, a professor of development economics and policy at the U.K. University of Manchester, calls the CGD’s research thought provoking and says it is required reading for his students. “CGD is distinctive in the way it provides new ideas and thinking on topics,” Sen says. He gives Birdsall credit for bringing in original thinkers including Michael Clemens, Lant Pritchett, and Owen Barder, the CGD’s director for Europe. “In a very short time it’s become one of the leading think tanks on development policy,” says Sen. “They have combined very strong, rigorous research with very effective policy advice and impact.”

Like many things in Washington, the CGD started over lunch. Ed Scott, an entrepreneur and former high-ranking government official, wanted to finance a nongovernmental organization devoted to debt. After consulting such well-known experts as Tim Geithner, Gene Sperling, the late Carol Lancaster, and the IMF’s Masood Ahmed, Scott became convinced that the think tank should also address issues such as governance, health, and education.

But who should head it? Over lunch at the Occidental with Ngaire Woods, whom he knew from studying at Oxford University, Scott went through a list of potential candidates Geithner had compiled. Woods, now the inaugural dean of the Blavatnik School of Government at Oxford and professor of global economic governance, strongly recommended Birdsall. They went to see Fred Bergsten, then head of what is now the Peterson Institute for International Economics, who had agreed to sponsor a research program on debt for Scott. Bergsten told them he had someone in mind to lead the project—Nancy Birdsall.

“So within the course of an hour two independent people coming from two different directions had strongly recommended Nancy,” Scott recalls. At that point, he had never met Birdsall, a veteran of the World Bank and the Inter-American Development Bank. He soon put that right and found they had similar views. So the CGD was born, with Scott, Birdsall, and Bergsten as cofounders.

Birdsall recalls Scott’s insistence that the new center should aim for impact and influence and not be a “sandbox for economists.” This chimed with her view that, while there was no

need for yet another think tank telling developing countries what to do, there was a role for one that focused on how the rich world could improve its policies for the benefit of the poor. “After almost 20 years working the multilateral banks, I thought it was time to scrutinize, watch, monitor, assess, and try to modify the policies of the U.S., Europeans, etc., and of the IMF, World Bank, other multilaterals, the United Nations, the corporate world—to make their policies more development friendly,” she says.

Better than expected

Scott says the CGD has turned out even better than he had expected, employing more research fellows and pursuing a broader scope of inquiry than he had envisaged. “I couldn’t be more pleased. It’s an A-plus institution,” he says. Scott stepped down as CGD chairman last year and handed things over to former Treasury Secretary Lawrence Summers, who knew Birdsall from her days at the World Bank. “He clearly wouldn’t have done that if he did not believe it was an institution worthy of his attention,” Scott says.

“With Nancy’s leadership CGD has emerged as the world’s best example of a ‘think and do tank.’”

Indeed, Summers has praised Birdsall for assembling an exceptional group of scholars who he says make a real difference to development policy. “With Nancy’s leadership CGD has emerged as the world’s best example of a ‘think and do tank.’ From Nigerian debt relief to prizes for successful drug development, from preserving forests to maintaining trade finance, CGD has defined the cutting issues,” says Summers, now an economics professor and president emeritus at Harvard University.

Before setting up the CGD, Birdsall served as director of the Economic Reform Project at the Carnegie Endowment for International Peace. That followed a 5-year stint as executive vice-president at the Inter-American Development Bank and 14 years at the World Bank, where she rose to be director of the policy research department.

Born in New York in 1946, Birdsall did not come directly to economics. After completing a BA in American studies at Newton College of the Sacred Heart in Massachusetts, she went on to earn an MA in international relations at the Johns Hopkins School of Advanced International Studies (SAIS) in Washington. It was there that Birdsall became interested in development—her master’s thesis was on a labor leader engaged in the independence fight in Kenya—but it was not until she was working as a policy analyst for a population program financed by the U.S. Agency for International Development that she had an epiphany on economics. In her job assessing proposals from African scholars, it struck her that the submissions from economists were the most testable.

An economist colleague indirectly mentored her in writing papers on fertility, family planning, and women's employment. Her conviction grew that economists "made the most sense" and that she needed training in the tools of the trade. Five years after her master's Birdsall applied to Yale, earning a PhD in economics.

In addition to her professional experience, Birdsall's personality has helped make the CGD tick, Scott believes. "People like her, she listens to what people have to say, she's extremely articulate, she's a great ambassador of the institution, and she's a very nice person," he says. "Those things have all contributed very much to the success of CGD. But to say only Nancy could have done it—who knows? It's like saying could U2 have been U2 without Bono. Who knows?"

Michele de Nevers, a CGD researcher whom Birdsall first hired at the World Bank, adds: "What is remarkable about her as a leader is that she's driven by a strong and wide-ranging curiosity. That gets people engaged in areas that they might not otherwise have found interesting." In a speech at the CGD to mark its 15th anniversary, IMF Managing Director Christine Lagarde paid tribute to Birdsall for "the way in which, with a smile, with persistence and resilience, you push us to think outside the box."

Reputation for integrity

William Easterly, a professor of economics at New York University, repeatedly returns to Birdsall's integrity to explain how the CGD built a strong reputation. Just as she had not been captured by the Inter-American Development Bank or the World Bank, Birdsall took pains at the CGD to foster intellectual freedom of ideas and not to prejudge the evidence her researchers would unearth. "When she was saying at CGD that aid is good, it was clear that it was coming from her own careful reflection and not serving a political or policy agenda," Easterly says. "That's one of the reasons for CGD's success. The critics of aid and the proponents of aid both equally respected Nancy. She just had this reputation for integrity."

Easterly draws on his own experience to underline the point. Birdsall had been Easterly's boss at the World Bank, and she hired him at the CGD after—in his words—he was "encouraged to go on indefinite leave" by the Bank after airing controversial views. "I really did feel as if Nancy was giving me political asylum," he recalls. "It took some courage on her part to do that because she could potentially be offending the Bank and other parts of the establishment. That's a sign of her integrity."

In the same spirit, Easterly notes, Birdsall has stoutly defended CGD researcher Clemens for his research in support of freedom of migration to rich countries from poor countries. "He's got hate mail, but Nancy has been willing to tolerate the controversy," Easterly says. "A more cautious, bureaucratic think-tank head, of which there are many in Washington, would have told him to shut up."

Having pursued a successful career while bringing up two daughters and a son, it is not surprising that Birdsall identifies with the self-described feminist and Facebook Chief

Operating Officer Sheryl Sandberg. Birdsall has written warmly of Sandberg's book *Lean In*, which is about encouraging more women to seek leadership roles. Sandberg, who used to be on the CGD's board, helped Birdsall see that she had been more ambitious and hard driving than she had admitted to herself, and that there had been no need to feel guilty about traveling a lot when her kids were small. "I was a bit of a Sandberg ahead of my time," she has said. One reason, perhaps, is that Birdsall was educated right through university by nuns who ran their own lives with their own hierarchy. "Even if/when I disdained them, the reality was that they ran their own communities. They were truly independent women, operating as autonomous managers of their own lives," she tells *F&D*. As such, Birdsall reflects, they were for her "an unconscious counterpoint to the very nonfeminist world of postwar, prosperous, suburban New York" in the 1950s.

Birdsall recognizes that only a small minority of women in the world have the opportunities she and Sandberg had. The cards are stacked against poor countries. "The whole process of globalization is asymmetric," she says. The global rules are not neutral because the market is not neutral. "The market tends to favor those who already have some kind of assets, whether it's education or financial assets or, as a country, institutional solidity."

Thus Birdsall sees a need for policies that help level the playing field. She has in mind things such as financing public education and infrastructure. The returns to borrowing to build roads, ports, and public transportation are potentially so huge, especially for the poor, that she would like the World Bank and regional development banks to show more leadership on the issue. The banks' rich-country shareholders worry too much about the reputational risks associated with a loan for, say, a hydroelectric dam, she suggests. "When you borrow to invest, then you generate growth and repay. That's great. That's what development's all about."

Mandate and money

Birdsall would also like multilateral banks to be given an explicit mandate—and money—by their government shareholders to provide global public goods, such as agricultural research, that produce benefits for people in rich and poor countries alike. (See "Knowledge as a Public Good," in this issue of *F&D*.) She is encouraged by a new World Bank initiative to protect the poor against pandemics. But she is frustrated that the Bank has never been formally tasked with addressing global collective action problems and given the tools for the job. Traditional country-based loans are insufficient. "That's something that I've been obsessing about for more than 10 years," she grumbles. "Not enough money is being spent on these global problems."

Besides global public goods, her other self-avowed obsession is outcome-based aid, an approach pioneered by the CGD to increase the effectiveness of aid. Also known as cash on delivery, the idea is to pay for development outcomes rather than inputs. Instead of up-front aid to improve, say, education, the money is not payable until agreed benchmarks are

met. For example, a government might be promised \$100 a year for every extra child who completes primary school and passes a test. It is up to the government how to hit the target. Building schools or raising teachers' pay could be the answer. But the problem could be that muddy roads are impassable for part of the year, and so teachers cannot cycle to school. In that case, the solution would be to build new roads. "Something is missing when you don't give the risk and the responsibility implicitly and explicitly to those on the ground," says Birdsall. It is a lesson she learned in the 1980s when she was working on health and education projects for the World Bank in north-east Brazil. "I was far too concerned with planning inputs, getting projects started, and disbursing money and not with what Brazil wanted to do to get results," Birdsall told a U.S. Agency for International Development conference in 2012.

Birdsall took pains at the CGD to foster intellectual freedom of ideas and not to prejudge the evidence.

In 2010, the U.K. Department for International Development and Ethiopia were the first to implement a pilot aid program based on the cash-on-delivery model. A 2015 CGD paper acknowledged that the idea has been slow to take off, but Birdsall is undeterred. Measuring and verifying outcomes can be difficult in some areas, she recognizes, but not in others. For instance, the CGD has shown how satellite-based data can be used to reward governments that successfully reduce deforestation.

A variation on outcome-based aid, also developed by the CGD, is an incentive plan called Advance Market Commitments. G7 finance ministers in 2009 endorsed the idea and promised to buy a vaccine against a specific disease if such a vaccine was developed. Since then, five countries and the Bill and Melinda Gates Foundation (a CGD funder) have committed \$1.5 billion in a pilot program for a vaccine to prevent the strains of pneumococcal disease common in developing economies. It is hoped the scheme can prevent more than 1.5 million childhood deaths by 2020. More recently, the CGD set out how multilateral development banks could incentivize pharmaceutical companies to combat antimicrobial resistance, a problem rising swiftly up the global agenda.

Consensus defender

If Birdsall is a fierce advocate of spending more money on global public goods, it is because poor people are the most vulnerable to cross-border risks such as infectious diseases and financial crises. By the same token, developing new vaccines and combating climate change help the poor most. Yet the provision of global public goods, or indeed of aid, is

no cure-all. Development begins at home, as the success of China and India shows. Likewise, African countries that have grown rapidly in the past 10 to 15 years have all opened up their economies and shored up their macro fundamentals. "I think it's important to repeat that over and over again," Birdsall says. She is that rare beast—a stout defender of the Washington Consensus, a 10-point list of recommendations for managing a market economy drawn up in 1989 by John Williamson, a colleague of Bergsten's at what was then the Institute for International Economics. In the eyes of critics, the Washington Consensus sowed the intellectual ground for fundamentalist policies that badly damaged developing economies, including the imposition by multilateral lenders of harsh conditionality and premature demands for capital liberalization. But Birdsall says this criticism is to traduce Williamson, whose proposals, she says, are best understood as a program for macroeconomic stabilization and market-based development. "What's been lost in the discussion is that some aspects of the Washington Consensus make a whole lot of sense," she adds. Countries like Ghana, Kenya, Senegal, and Tanzania were doing very well in the past decade—until commodity prices slumped—because they had strengthened their macroeconomic foundations.

The big challenge for such countries is at the micro level, Birdsall argues. Their political institutions are still fragile, and the state is unable to generate enough tax revenue to deliver public services. The goal of development, then, should be to build a middle class that can be taxed, thereby giving it an incentive to hold government to account. "It builds in accountability and transparency at both the global and the country level as being very fundamental to growth—and to growth that is inclusive," she says.

Next chapter

Birdsall intends to make herself scarce at the CGD in the fall to let her successor set the agenda before resuming as a researcher and writer of blogs, columns, and essays. She will work part-time so she can see her grandchildren in Colorado more frequently and spend time at her second home in Vermont gardening, reading more nonfiction, and listening to music—her husband plays guitar and her son is a "struggling" professional pianist/composer. Vermont is handy for Williams College in western Massachusetts, where Birdsall will give a weekly tutorial course in the spring semester as part of a master's program for students from developing economies.

The leadership of the CGD may be changing, but for Birdsall its mission to reduce global poverty remains the same. "There's a long way to go, but there is increasing recognition that we are all in the same boat," she says. "It's about watching and monitoring and reporting and pressuring and coming up with new ideas and new products that make it easier for the good guys to do the right thing." ■

Alan Wheatley is an economics writer and editor, formerly with Reuters, and editor of The Power of Currencies and Currencies of Power.

Intelligent Technology

As digital applications encroach on various aspects of daily life, the impact on the economy will help us live smarter and better



Hal Varian

A computer now sits in the middle of virtually every economic transaction in the developed world. Computing technology is rapidly penetrating the developing world as well, driven by the rapid spread of mobile phones. Soon the entire planet will be connected, and most economic transactions worldwide will be computer mediated.

Data systems that were once put in place to help with accounting, inventory control, and billing now have other important uses that can improve our daily life while boosting the global economy.

Transmission routes

Computer mediation can impact economic activity through five important channels.

Data collection and analysis: Computers can record many aspects of a transaction, which can then be collected and analyzed to improve future transactions. Automobiles, mobile phones, and other complex devices collect engineering data that can be used to identify points of failure and improve future products. The result is better products and lower costs.

Personalization and customization: Computer mediation allows services that were previously one-size-fits-all to become personalized to satisfy individual needs. Today we routinely expect that online merchants we have dealt with previously possess relevant information about our purchase history, billing preferences, shipping addresses, and other details. This allows transactions to be optimized for individual needs.

Experimentation and continuous improvement: Online systems can experiment with alternative algorithms in real time, continually improving performance. Google, for example, runs over 10,000 experiments a year dealing with many different aspects of the services it provides, such as ranking and presentation of search results. The experimental infrastructure to run such experiments is also available to the company's advertisers, who can use it to improve their own offerings.

Contractual innovation: Contracts are critical to economic transactions, but without computers it was often difficult or costly to monitor contractual performance. Verifying performance can help alleviate problems with asymmetric information, such as moral hazard and adverse selection, which can interfere with efficient transactions. There is no longer a risk of purchasing a "lemon" car if vehicular monitoring systems can record history of use and vehicle health at minimal cost.

Coordination and communication: Today even tiny companies with a handful of employees have access to communication services that only the largest multinationals could afford 20 years ago. These micro-multinationals can operate on a global scale because the cost of computation and communication has fallen dramatically. Mobile devices have enabled global coordination of economic activity that was extremely

difficult just a decade ago. For example, today authors can collaborate on documents simultaneously even when they are located thousands of miles apart. Videoconferencing is now essentially free, and automated document translation is improving dramatically. As mobile technology becomes ubiquitous, organizations will become more flexible and responsive, allowing them to improve productivity.

Let us dig deeper into these five channels through which computers are changing our lives and our economy.

Data collection and analysis

We hear a lot about "big data" (see "Big Data's Big Muscle," in this issue of *F&D*), but "small data" can be just as important, if not more so. Twenty years ago only large companies could afford sophisticated inventory management systems. But now every mom-and-pop corner store can track its sales and inventory using intelligent cash registers, which are basically just personal computers with a drawer for cash. Small business owners can handle their own accounting using packaged software or online services, allowing them to better track their business performance. Indeed, these days data collection is virtually automatic. The challenge is to translate that raw data into information that can be used to improve performance.



The challenge is to translate raw data into information that can be used to improve performance.

Large businesses have access to unprecedented amounts of data, but many industries have been slow to use it, due to lack of experience in data management and analysis. Music and video entertainment have been distributed online for more than a decade, but the entertainment industry has been slow to recognize the value of the data collected by servers that manage this distribution (see "Music Going for a Song," in this issue of *F&D*). The entertainment industry, driven by competition from technology companies, is now waking up to the possibility of using this data to improve their products.

The automotive industry is also evolving quickly by adding sensors and computing power to its products. Self-driving cars are rapidly becoming a reality. In fact, we would have self-driving cars now if it weren't for the randomness introduced by human drivers and pedestrians. One solution to this problem would be restricted lanes for autonomous vehicles only. Self-driving cars can communicate among themselves and coordinate in ways that human drivers are (alas) unable to. Autonomous vehicles don't get tired, they don't get inebriated, and they don't

get distracted. These features of self-driving cars will save millions of lives in the coming years.

Personalization and customization

Twenty years ago it was a research challenge for computers to recognize pictures containing human beings. Now free photo storage systems can find pictures with animals, mountains, castles, flowers, and hundreds of other items in seconds. Improved facial recognition technology and automated indexing allow the photos to be found and organized easily and quickly.

Similarly, just in the past few years voice recognition systems have become significantly more accurate. Voice communication with electronic devices is possible now and will soon become the norm. Real-time verbal language translation is a reality in the lab and will be commonplace in the near future. Removing language barriers will lead to increased foreign trade, including, of course, tourism.

Continuous improvement

Observational data can uncover interesting patterns and correlations in data. But the gold standard for discovering causal relationships is experimentation, which is why online companies like Google routinely experiment and continuously improve their systems. When transactions are mediated by computers, it is easy to divide users into treatment and control groups, deploy treatment, and analyze outcomes in real time.

Companies now routinely use this kind of experimentation for marketing purposes, but these techniques can be used in many other contexts. For example, institutions such as the Massachusetts Institute of Technology's Abdul Latif Jameel Poverty Action Lab have been able to run controlled experiments of proposed interventions in developing economies to alleviate poverty, improve health, and raise living standards. Randomized controlled experiments can be used to resolve questions about what sorts of incentives work best for increasing saving, educating children, managing small farms, and a host of other policies.

Contractual innovation

The traditional business model for advertising was "You pay me to show your ad to people, and some of them might come to your store." Now in the online world, the model is "I'll show your ad to people, and you only have to pay me if they come to your website." The fact that advertising transactions are computer mediated allows merchants to pay only for the outcome they care about.

Consider the experience of taking a taxi in a strange city. Is this an honest driver who will take the best route and charge me the appropriate fee? At the same time, the driver may well have to worry whether the passenger is honest and will pay for the ride. This is a one-time interaction, with limited information on both sides and potential for abuse. But now consider technology such as that used by Lyft, Uber, and other ride services. Both parties can see rating history, both parties can access estimates of expected fares,

and both parties have access to maps and route planning. The transaction has become more transparent to all parties, enabling more efficient and effective transactions. Riders can enjoy cheaper and more convenient trips, and drivers can enjoy a more flexible schedule.



When the entire planet is connected, we can expect a dramatic increase in human prosperity.

Smartphones have disrupted the taxi industry by enabling these improved transactions, and every player in the industry is now offering such capabilities—or will soon. Many people see the conflict between ride services and the taxi industry as one of innovators versus regulators. However, from a broader perspective, what matters is which technology wins. The technology used by rideshare companies clearly provides a better experience for both drivers and passengers, so it will likely be widely adopted by traditional taxi services.

Simply being able to capture transaction history can improve contracts (see "Two Faces of Change," in this issue of *F&D*). It is remarkable that I can walk into a bank in a new city, where I know no one and no one knows me, and arrange for a mortgage worth millions of dollars. This is enabled by credit rating services, which dramatically reduce risk on both sides of the transaction, making loans possible for people who otherwise could not get them.

Communication and coordination

Recently I had some maintenance work done on my house. The team of workers used their mobile phones to photograph items that needed replacement, communicate with their colleagues at the hardware store, find their way to the job site, use as a flashlight to look in dark places, order lunch for delivery, and communicate with me. All of these formerly time-consuming tasks can now be done quickly and easily. Workers spend less time waiting for instructions, information, or parts. The result is reduced transaction costs and improved efficiency.

Today only the wealthy can afford to employ executive assistants. But in the future everyone will have access to digital assistant services that can search through vast amounts of information and communicate with other assistants to coordinate meetings, maintain records, locate data, plan trips, and do the dozens of other things necessary to get things done (see "Robots, Growth, and Inequality," in this issue of *F&D*). All of the big tech companies are investing heavily in this technology, and we can expect to see rapid progress thanks to competitive pressure.

Putting it all together

Today's mobile phones are many times more powerful and much less expensive than those that powered Apollo 11, the 1969 manned expedition to the moon. These mobile phone

components have become “commoditized.” Screens, processors, sensors, GPS chips, networking chips, and memory chips cost almost nothing these days. You can buy a reasonable smartphone now for \$50, and prices continue to fall. Smartphones are becoming commonplace even in very poor regions.

The availability of those cheap components has enabled innovators to combine and recombine these components to create new devices—fitness monitors, virtual reality headsets, inexpensive vehicular monitoring systems, and so on. The Raspberry Pi is a \$35 computer designed at Cambridge University that uses mobile phone parts with a circuit board the size of a pack of playing cards. It is far more powerful than the Unix workstations of just 15 years ago.

The same forces of standardization, modularization, and low prices are driving progress in software. The hardware created using mobile phone parts often uses open-source software for its operating system. At the same time, the desktop motherboards from the personal computer era have now become components in vast data centers, also running open-source software. The mobile devices can hand off relatively complex tasks such as image recognition, voice recognition, and automated translation to the data centers on an as-needed basis. The availability of cheap hardware, free software, and inexpensive access to data services has dramatically cut entry barriers for software development, leading to millions of mobile phone applications becoming available at nominal cost.

The productivity puzzle

I have painted an optimistic picture of how technology will impact the global economy. But how will this technological progress show up in conventional economic statistics? Here the picture is somewhat mixed. Take GDP, for example. This is usually defined as the market value of all final goods and services produced in a given country in a particular time period. The catch is “market value”—if a good isn’t bought and sold, it generally doesn’t show up in GDP.

This has many implications. Household production, ad-supported content, transaction costs, quality changes, free services, and open-source software are dark matter as far as GDP is concerned, since technological progress in these areas does not show up directly in GDP. Take, for example, ad-supported content, which is widely used to support provision of online media. In the U.S. Bureau of Economic Analysis National Economic Accounts, advertising is treated as a marketing expense—an intermediate product—so it isn’t counted as part of GDP. A content provider that switches from a pay-per-view business model to an ad-supported model reduces GDP.

One example of technology making a big difference to productivity is photography. Back in 2000, about 80 billion photos were taken worldwide—a good estimate since only three companies produced film then. In 2015, it appears that more than 1.5 trillion photos were taken worldwide, roughly 20 times as many. At the same time the volume exploded, the cost of photos fell from about 50 cents each for film and developing to essentially zero.

So over 15 years the price fell to zero and output went up 20 times. Surely that is a huge increase in productivity. Unfortunately, most of this productivity increase doesn’t show up in GDP, since the measured figures depend on the sales of film, cameras, and developing services, which are only a small part of photography these days.

In fact, when digital cameras were incorporated into smartphones, GDP decreased, camera sales fell, and smartphone prices continued to decline. Ideally, quality adjustments would be used to measure the additional capabilities of mobile phones. But figuring out the best way to do this and actually incorporating these changes into national income accounts is a challenge.

Even if we could accurately measure the number of photos now taken, most are produced at home and distributed to friends and family at zero cost; they are not bought and sold and don’t show up in GDP. Nevertheless, those family photos are hugely valuable to the people who take them.

The same thing happened with global positioning systems (GPS). In the late 1990s, the trucking industry adopted expensive GPS and vehicular monitoring systems and saw significant increases in productivity as a result. In the past 10 years, consumers have adopted GPS for home use. The price of the systems has fallen to zero, since they are now bundled with smartphones, and hundreds of millions of people use such systems on a daily basis. But as with cameras, the integration of GPS with smartphones has likely reduced GDP, since sales of stand-alone GPS systems have fallen.

As in the case of cameras, this measurement problem could be solved by implementing a quality adjustment for smartphones. But it is tricky to know exactly how to do this, and statistical agencies want a system that will stand the test of time. Even after the quality adjustment problem is worked out, the fact that most photos are not exchanged for cash will remain—that isn’t a part of GDP, and technological improvements in that area are just not measured by conventional statistics.

Will the promise of technology be realized?

When the entire planet is indeed connected, everyone in the world will, in principle, have access to virtually all human knowledge. The barriers to full access are not technological but legal and economic. Assuming that these issues can be resolved, we can expect to see a dramatic increase in human prosperity.

But will these admittedly utopian hopes be realized? I believe that technology is generally a force for good—but there is a dark side to the force (see “The Dark Side of Technology,” in this issue of *F&D*). Improvements in coordination technology may help productive enterprises but at the same time improve the efficiency of terrorist organizations. The cost of communication may drop to zero, but people will still disagree, sometimes violently. In the long run, though, if technology enables broad improvement in human welfare, people might devote more time to enlarging the pie and less to squabbling over the size of the pieces. ■

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Robot holds newspaper during 2016 World Economic Forum, Davos, Switzerland.

Robots, Growth, and Inequality

Andrew Berg, Edward F. Buffie, and Luis-Felipe Zanna

The robot revolution could have profound negative implications for equality

SOME say the world is entering a “second machine age.” Every week we read about a new application of artificial intelligence, so-called deep learning, and robotic technology. Automated delivery trucks, electronic teaching and scheduling assistants, computers that replace paralegals, and self-driving cars are just a few. Some seem to approach the “robot” envisioned by Czech science fiction writer Karel Čapek, who coined the term in 1921 to describe an intelligent machine essentially indistinguishable from a human.

No one knows where this technology is headed. Robert Gordon argues that economically meaningful technological change—and productivity growth in the United States—

has slowed since the 1970s, except for a decade-long tech boom ending in 2004 (see the June 2016 *F&D*). But when it comes to intelligent robots, we may be in the early stages of a revolution, and economists should think hard about what it means for economic growth and income distribution.

Competing narratives

Two narratives have emerged in the economic literature on technology, growth, and distribution. One says that technological advances raise productivity and thus output per person. Despite some transitional costs as particular jobs become obsolete, the overall effect is a higher standard of living. The history of this debate since at least the 19th century seems to

yield a decisive victory for technological optimists. The average American worker in 2015 worked roughly 17 weeks to live at the annual income level of the average worker in 1915—and technology was a huge part of that progress (Autor, 2014).

This optimistic narrative points to the many ways that technology does much more than displace workers. It makes workers more productive and raises demand for their services—for example, mapping software makes taxi (and now Lyft and Uber) drivers more efficient. And rising incomes generate demand for all sorts of outputs and hence labor. A wave of fear about the implications of computerization for jobs surged in the United States in the 1950s and early 1960s, but subsequent decades of strong productivity growth and rising standards of living saw roughly stable unemployment and rising employment.

The other, more pessimistic, narrative pays more attention to the losers (see, for example, Sachs and Kotlikoff, 2012; Ford, 2015; Freeman, 2015). Some of the increased inequality in many advanced economies in recent decades may result from technological pressure. The computer revolution has reduced relative demand in developed economies for jobs involving routinized work (physical or mental)—think bookkeeper or factory line worker. Because computers combined with a smaller number of—generally more skilled—workers have been able to produce the goods previously associated with these jobs, relative wages for people with fewer skills have fallen in many countries.

Will robots be different?

Where might intelligent robots fit in? For a bird's-eye view of this question, we designed an economic model that assumes robots to be a different sort of capital, one that is a close substitute for human workers. Macroeconomists usually think of production as resulting from the combination of physical capital stock (comprising machines and structures, both public and private) and labor. But thinking of robots as a new type of physical capital, one that in effect adds to the stock of available (human) labor, is surprisingly instructive. Production will still require buildings and roads, for example, but now people and robots can work with this traditional capital.

So what happens when this robot capital gets productive enough to be useful? If we assume that robots are almost perfect substitutes for human labor, the good news is that output per person rises. The bad news is that inequality worsens, for several reasons. First, robots increase the supply of total effective (workers plus robots) labor, which drives down wages in a market-driven economy. Second, because it is now profitable to invest in robots, there is a shift away from investment in traditional capital, such as buildings and conventional machinery. This further lowers the demand for those who work with that traditional capital.

But this is just the beginning. Both the good and bad news intensify over time. As the stock of robots increases, so does the return on traditional capital (warehouses are more useful with robot shelf stockers). Eventually, therefore, traditional investment picks up too. This in turn keeps robots productive, even as the stock of robots continues to grow. Over time,

the two types of capital grow together until they increasingly dominate the entire economy. All this traditional and robot capital, with diminishing help from labor, produces more and more output. And robots are not expected to consume, just produce (though the science fiction literature is ambiguous about this!). So there is more and more output to be shared among actual people.

However, wages fall, not just in relative terms but absolutely, even as output grows.

This may sound odd, or even paradoxical. Some economists talk about the fallacy of technology fearmongers' failure to realize that markets will clear: demand will rise to meet the

If robots are almost perfect substitutes for human labor, inequality worsens.

higher supply of goods produced by the better technology, and workers will find new jobs. There is no such fallacy here: in our simple model economy, we assume away unemployment and other complications: wages adjust to clear the labor market.

So how can we explain the fall in wages coinciding with the growing output? To put it another way, who buys all the higher output? The owners of capital do. In the short run, higher investment more than counterbalances any temporary decline in consumption. In the long run, the share of capital owners in the growing pie—and their consumption spending—is itself growing. With falling wages and rising capital stocks, (human) labor become a smaller and smaller part of the economy. (In the limiting case of perfect substitutability, the wage share goes to zero.) Thomas Piketty has reminded us that the capital share is a basic determinant of income distribution. Capital is already much more unevenly distributed than income in all countries. The introduction of robots would drive up the capital share indefinitely, so the income distribution would tend to grow ever more uneven.

An economic robot “singularity”?

Remarkably, this process of self-sustained purely investment- (robot plus traditional) driven growth can take off even with a very small increase in robots' efficiency, as long as this increase makes robots competitive with labor. This tiny efficiency boost thus leads to a sort of economic “singularity,” in which capital takes over the entire economy to the exclusion of labor. It is reminiscent of the hypothesis of “technological singularity” publicized by Raymond Kurzweil (2005) in which intelligent machines become so smart that they can program themselves, triggering explosive further growth of machine intelligence. Ours is an economic, not a technological, singularity, however. We are considering how a small jump in the level of robot efficiency could trigger self-sustaining capital accumulation whereby robots take over the economy, not self-sustaining growth in robot intelligence.



Humanoid robot Pepper takes selfie during app contest, Tokyo, Japan.

So far, we've assumed nearly perfect substitutability between robots and workers along with a small increase in robot efficiency. These are robots of the sort featured in the Hollywood movie *Terminator 2: Judgment Day*—such perfect substitutes for humans that they are indistinguishable. Another plausible scenario departs from both these assumptions. It is more realistic, at least for now, to assume that robots and human labor are close *but not perfect* substitutes, that people bring a spark of creativity or a critical human touch. At the same time, like some technologists, we project that robot productivity increases not just a little but dramatically over a span of a couple of decades.

With these assumptions, we recover a bit of the economist's typical optimism. The forces mentioned before are still at play: robot capital tends to replace workers and drive down wages, and at first the diversion of investment into robots dries up the supplies of traditional capital that help raise wages. The difference, though, is that humans' special talents become increasingly valuable and productive as they combine with this gradually accumulating traditional and robot capital. Eventually, this increase in labor productivity outweighs the fact that the robots are replacing humans, and wages (as well as output) rise.

But there are two problems. First, "eventually" can be a long time coming. Exactly how long depends on how easy it is to substitute robots for human labor, and how quickly savings and investment respond to rates of return. According to our baseline calibration, it takes 20 years for the productivity effect to outweigh the substitution effect and drive up wages. Second, capital will still likely greatly increase its role in the economy. It will not completely take over as it does in the singularity case, but it will take a higher share of income, even in the long run when wages are above the pre-robot-era level. Thus, inequality will be worse, possibly dramatically so.

People are different

Readers may be thinking that these scary scenarios will not apply to them, because their jobs as, say, economists or journalists cannot be performed by robots. In our model, we started

with labor and robots as perfect substitutes, then introduced the notion that they may be close but not perfectly the same in production. A further important complication is that not all labor is the same. And indeed, it is plausible that even sophisticated machines combined with advanced artificial intelligence will not replace humans for all jobs. In movies the range of jobs to be replaced is quite broad, from robot hunter (*Blade Runner*) to doctor (*Alien*). And robots have at least taken a stab at replacing teaching assistants and even journalists. Massive online courses may threaten even professors. But in real life, many jobs do seem safe, at least for now.

In our model, we therefore next divide all workers into two categories, which we call "skilled" and "unskilled." By skilled we mean that they are *not* close substitutes for robots; rather, robots may increase their productivity. By unskilled we mean that they are very close substitutes. Thus, our skilled workers may not be the traditionally highly educated; they may be those with creativity or empathy, which is particularly hard for future robots to match. We assume, following Frey and Osborne (2013), that about half of the labor force can be replaced by robots and is thus "unskilled." What happens when robot technology becomes cheaper? As before, output per person grows. And the share of overall capital (robots plus traditional) rises. Now, though, there is an additional effect: the wages of skilled workers rise relative to those of the unskilled—and absolutely. Why? Because these workers are more productive when combined with robots. Imagine, for example, the greater productivity of a designer who now commands an army of robots. Meanwhile, the wages of the unskilled collapse, both in relative and in absolute terms, even over the long run.

Inequality now increases for two fundamental reasons. As before, capital receives a greater share of total income. In addition, wage inequality worsens dramatically. Productivity and real wages paid to skilled labor increase steadily, but low-skilled workers wage a lonely battle against the robots and lose badly. The numbers depend on a few key parameters, such as the degree of complementarity between skilled work-

ers and robots, but the rough magnitude of the outcome follows from the simple assumptions we have laid out. We find that over a period of 50 miserable years, the real wage for low-skilled labor decreases 40 percent, and the group's share in national income drops from 35 percent to 11 percent in our baseline calibration.

Humans' special talents become increasingly valuable and productive as they combine with robot capital.

So far, we have been thinking of a large developed economy, like the United States. And this seems natural given that such countries tend to be more advanced technologically. However, a robot age could also affect the international distribution of output. For example, if the unskilled labor replaced by robots resembles the workforce of developing economies, it could lower those countries' relative wages.

Who will own the robots?

These stories are not destiny. First, we are mainly speculating about the outcome of emerging technological trends, not analyzing existing data. Recent innovations we have in mind have not (yet) shown up in productivity or growth statistics in developed economies; productivity growth has in fact been low in recent years. And technology does not seem to be the culprit for the rise in inequality in many countries. In most advanced economies growth in the relative wages of skilled workers has been smaller than in the United States, even in advanced economies presumably facing similar technological changes. As Piketty and his coauthors have famously emphasized, much of the increase in inequality in recent decades is concentrated in a very small fraction of the population, and technology does not seem to be the main story. But the rising inequality observed in so many parts of the world over recent decades—and perhaps even some of the political instability and populism in the news—underscores the risks and raises the stakes. And it is ominous that the labor share of income in the United States seems to have been falling since the turn of the century, after decades of rough stability (Freeman, 2015).

Science fiction writer Isaac Asimov's famous three "laws of robotics" were designed to protect people from physical harm by robots. According to the first law, "A robot may not injure a human being or, through inaction, allow a human being to come to harm." Such guidance may be fine for designers of individual robots, but it would do little to manage the economy-wide consequences we discuss here. Our little model shows that, even in a smoothly functioning market economy, robots may be profitable for owners of capital and may raise average per capita income, but the result would not be the kind of society most of us would want to live in. The case for a public policy response is strong.

In all these scenarios, there are jobs for people who want to work. The problem is that most of the income goes to owners of capital and to skilled workers who cannot easily be replaced by robots. The rest get low wages and a shrinking share of the pie. This points to the importance of education that promotes the sort of creativity and skills that will complement—not be replaced by—intelligent machines. Such investment in human capital could raise average wages and lower inequality. But even so, the introduction of robots may depress average wages for a long time, and the capital share will rise.

In trying to keep things as simple as possible, we have ignored many of the obligations such a society would face. These could include ensuring sufficient aggregate demand when buying power is increasingly concentrated, addressing the social and political challenges associated with such low wages and high inequality, and dealing with the implications of lower wages when it comes to workers' ability to pay for health care and education and invest in their children.

We have implicitly assumed so far that income from capital remains highly unequally distributed. But the increase in overall output per person implies that everyone could be better off if income from capital is redistributed. The advantages of a basic income financed by capital taxation become obvious. Of course, globalization and technological innovation have made it, if anything, easier for capital to flee taxation in recent decades. Our analysis thus adds urgency to the question "Who will own the robots?" ■

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The Dark Side of Technology

Chris Wellisz

The benefits of the digital age are tempered by the risks

DIGITAL technology has given us comforts and conveniences that could scarcely be imagined even a generation ago. The Internet saves students and scholars hours of tedious research in libraries and enables instantaneous visual, oral, and written communication at virtually no cost. Anyone with a smartphone can use GPS to avoid getting lost in an unfamiliar city or find the nearest Starbucks. There's online shopping and banking for consumers and computer-aided diagnostics for doctors. Such are the wonders of the digital era that scholars Erik Brynjolfsson and Andrew McAfee have dubbed it "The Second Machine Age," declaring that computers are doing for our mental capacity what the steam engine did for muscle power.

But there are drawbacks to progress. Some critics of the digital era lament the power of a few giant social media outlets to shape public opinion. Others raise serious concerns about pathologies such as cyberbullying and Internet pornography. And there are those who worry about the potential loss of privacy, and the danger to civil liberties, at a time when practically every movement, phone call, and email message leaves a digital trail that can be exploited by a nosy neighbor or an intrusive government.

While these are all legitimate concerns, they are impossible to quantify. Yet some aspects of digital technology do impose measurable costs on companies and economies that offset at least part of the efficiency offered by the second machine age.

Hackers can take control of cars or shut down an electric grid. Cyberthieves steal personal information and use it to drain bank accounts or make fraudulent online credit card purchases. Email, mobile phones, and social media, while revolutionizing communication, take a toll on the productivity of office workers mesmerized by their Twitter feeds or addicted to instant messaging.

Cybersecurity Risks

When a group of former officers from Unit 8200, Israel's signals intelligence corps, set out to start a private cybersecurity business, they agreed that Internet-connected cars were the next big thing.

"They just looked at what was going on in the markets and they thought, OK, there are going to be millions of connected cars on the road quite soon," said Yoni Heilbronn, vice president for marketing at Argus Cyber Security Ltd.

Three years later, Tel Aviv-based Argus has added offices in Germany, Japan, and the United States. The company is flourishing as stories about hackers taking control of cars—not to mention accidents, though not hacking, linked to the autopilot feature of Tesla Motors vehicles—focus public attention on the need to improve automotive cybersecurity.

Welcome to the Internet of Things—objects connected to a network that allows them to send and receive data—which is expanding to include devices ranging from diagnostic equipment in hospitals to coffeemakers and other home appliances. This year, the number of Internet-enabled devices will expand 30 percent to 6.4 billion, predicts Gartner Inc., a leading information technology research and advisory firm. Worldwide spending on security for the Internet of Things will jump 24 percent to \$348 million.

A connected world offers new opportunities for cybercriminals to gather personal information that can be used for fraudulent transactions or for ransomware—malicious software that can immobilize devices or encrypt data and demand money in return for a decryption key.

"It's a new point of access for the fraudsters," says Bradley J. Wiskirchen, chief executive officer of Kount, an Internet security firm based in Boise, Idaho. "They don't necessarily have to hack into my computer if they can hack into my printer or refrigerator and collect data on me."

Hacking into Internet-enabled household devices is often easy for the simple reason that they have little, if any, built-in security. Companies like Palo Alto, California-based Nest Labs, a maker of smart appliances with sophisticated security features, are the exception.

"A lot of the others, they get some open-source software and they bolt it onto a device, and that's it—there's not really a lot of thought for security," says Chris King, a vulnerability analyst at CERT Coordination Center, part of Carnegie Mellon University's Software Engineering Institute. Even toys like the Wi-Fi-enabled Hello Barbie doll can be hacked.

The list of vulnerable devices is growing as the wired world expands. Hackers have shut down hospital diagnostic systems to extract ransom, King says. In western Ukraine last year, hackers took down a power grid, leaving more than 200,000 people without electricity. Cybervandals in Germany targeted a steel mill, causing massive damage to a foundry.

Cybercriminals gather personal information for fraudulent transactions or ransomware.

The specter of hackable cars is particularly scary because of the potential for deadly accidents. By 2020, about 250 million cars worldwide will have some form of onboard wireless connectivity, Gartner estimates.

Just about everything in a modern car—brakes, steering, tire pressure, lighting—is mediated by computerized controllers, which are connected to each other via a communication system, or "bus," that was invented 30 years ago, before the Internet age. The bus itself is inherently insecure, as are many of a car's other devices.

"A system that was never designed to be on the Internet is now connected, and suddenly it's vulnerable to all of these things the designers never thought of," says King.

Makers of automobiles and parts are taking the threat seriously and stepping up security measures after a pair of high-profile break-ins.

At Argus, researchers hacked into a device called Zubie, which monitors a car's performance and wirelessly delivers real-time data to the driver's smartphone via the cloud, along with maintenance alerts and tips on improving driving habits. The researchers were then able to control the car's steering, brakes, and engine. Argus informed Zubie of the vulnerability, which the company said it has since fixed.

Last year, Fiat Chrysler Automobiles announced a recall of 1.4 million vehicles after *Wired* magazine reported that researchers had used a laptop computer to seize control of a Jeep Cherokee via its dashboard computer.

"When you have cars that are connected, they will have to be protected," says Heilbronn at Argus. ■

Cybertheft

Magnus Carlsson was in his eighth-floor office overlooking a busy street in Bethesda, Maryland, when an email popped up on his computer. His boss, chief executive of the Association for Financial Professionals, needed help making a funds transfer.

But when Carlsson hit the reply button, an unfamiliar address appeared in his Outlook window. "I knew from the

start it was a textbook scam," said Carlsson. He should know: part of his job as manager for treasury and payments at the global industry group representing finance executives is to warn members around the world of sources of financial fraud, including Internet scams.

The tactic he described, known as "business email compromise," is fast gaining favor among cybercriminals as

Cybertheft (continued)

a way to get company employees to make wire transfers to bogus suppliers or creditors, usually by mimicking an emailed order from a superior. In a survey of the association's members, 64 percent reported having been exposed to compromised business email.

Cybercriminals bent on causing mayhem could bring down the entire global financial system.

It's just one strand of an expanding global web of cyber-fraud that includes tactics and tools with fanciful, if sinister-sounding, names—ransomware, spear phishing, Trojan horses. Cybercriminals are growing more sophisticated, active, and audacious by the day, going after high-profile game, including JPMorgan Chase & Co., British Airways, the Philippines' Commission on Elections, and the U.S. Internal Revenue Service, then moving down the corporate food chain to easier prey when the biggest organizations devote more resources to cybersecurity.

Cybercrime "is growing because it's so easy, and as more countries and companies come online, with just initial approaches to cybersecurity, they're easy targets," says James Andrew Lewis, a senior vice president at the Center for Strategic & International Studies in Washington, D.C., who has written extensively about cyberfraud. "Law enforcement is fabulously uneven across the planet. So if you're a smart hacker, you live in a country that's not going to enforce its laws."

Lewis estimates the global damage wrought by cybercrime at more than \$500 billion a year—exceeding the gross domestic product of Sweden. That figure includes the value of stolen cash and intellectual property, the cost of repairing breaches, and the toll cybercrime takes on innovation, trade, and economic growth.

Financial firms offer a particularly tempting target, as the theft of \$81 million from the central bank of Bangladesh this year showed. In that attack, hackers used the credentials of a bank employee to send more than three dozen fraudulent money transfer requests to the Federal Reserve Bank of New York.

The financial loss was huge for a country like Bangladesh, but regulators worry about a far more serious risk: cybercriminals bent on causing mayhem could bring down the entire global financial system, triggering an economic meltdown to rival the crisis of 2007–08.

"It's about potentially denying market participants access to key parts of the plumbing of our markets," said Greg Medcraft, chairman of the Australian Securities and Investments Commission. "Cyberattacks are probably the next black swan event in the world."

A survey on threats to global financial stability, conducted by the Depository Trust & Clearing Corporation, showed

that a plurality of respondents, 25 percent, put cybercrime at the top of the list. That figure is down from 46 percent last year, in part because financial institutions are investing in protective measures and also because other risks—such as a slowdown in Asia—have gained prominence.

Still, regulators aren't taking any chances. Payment and trade settlement systems, key components of the global financial system, should adopt plans to defend against and react to cyberintrusions and appoint an executive to oversee those plans, according to guidelines issued in June by the Bank for International Settlements and the International Organization of Securities Commissions.

Cybercrime is the second most common type of business crime after asset misappropriation, according to a PwC survey. But while 61 percent of CEOs said they were concerned about cybersecurity, only 37 percent of organizations reported having a response plan.

Internet crime falls into two broad categories. The first is monetizable break-ins, such as identity and payment card theft. The second is cyberespionage: theft of trade secrets, negotiating strategies, and product information.

The number of exposed identities jumped 23 percent last year to 429 million, according to Symantec Corporation's annual "Internet Security Threat Report." The actual number probably exceeded 500 million because many companies don't report breaches.

Following massive data breaches at companies such as health insurer Anthem Inc. and digital marketplace eBay Inc., just about every identity in the United States has been exposed, reckons Bradley J. Wiskirchen, chief executive officer of Kount, a leading provider of digital risk-management solutions based in Boise, Idaho.

"Virtually everyone has been compromised," Wiskirchen says. Stolen identities are traded on a burgeoning electronic black market, where sophisticated international merchants sell their wares on websites to rival the world's best retailers, complete with money-back guarantees, bulk discounts, and tutorials.

The average cost of a data breach has risen to \$4 million from \$3.79 million, according to a recent survey of 383 companies in 12 countries by IBM and the Ponemon Institute. Breaches were most likely to occur in Brazil and South Africa, least likely in Australia and Germany.

The 2014 attack on New York-based JPMorgan Chase & Co. exposed 83 million customer records, including names, email and postal addresses, and phone numbers. It was the largest attack on a financial institution in U.S. history, and while the bank didn't say how much the breach cost, it announced plans to spend an additional \$250 million a year on security measures.

The cost of intellectual property theft is harder to estimate, but the economic toll may be larger. Theft of intellectual property ranging from paint formulas to rockets reduces the profits to be made from innovation, says Lewis at the Center for Strategic & International Studies. "People are incentivized by financial return to invent new things, and if they don't get that financial return, they'll do something else," Lewis says.

The result: underinvestment in new technology and the loss of jobs and economic growth. Even the countries that benefit lose out in the long run because relying on stolen technologies prevents them from learning how to develop their own. “The whole world grows more slowly because of this,” Lewis says.

Lewis’s estimate of the overall cost of cybercrime, including intellectual property theft, is an average of 0.5 percent of GDP globally. In high-income countries, where innovation plays a bigger economic role, the loss may be as

high as 0.9 percent of GDP. For developing economies it’s closer to 0.2 percent. All this is driving dramatic growth in demand for cybersecurity services, which will expand to \$170 billion in 2020 from \$75 billion last year, according to a forecast by Cybersecurity Ventures, a research and market-intelligence firm.

Kount’s annual increase in transaction volume is in the triple digits, “and we have barely scratched the surface of the potential opportunities,” Wiskirchen says. “Unfortunately, I’m in a very big growth industry.” ■

Digital Distraction

Laurie Voss recalls the time when, as a young Silicon Valley programmer, he was given a month to complete an exceptionally dull and unrewarding project. “It was a thankless task,” Voss recalls. “I spent a lot of time on Twitter that month.”

To Voss, who is now chief technology officer at his own startup, NPM, tweeting on the job is the 21st century version of a phenomenon as old as the Dead Sea scrolls: procrastination.

Digital distraction and its cousin, information overload, are taking a growing toll on productivity.

The latest apps and gadgets certainly offer new and irresistible ways to waste time. In cubicles the world over, office workers are bombarded by a relentless stream of blinks and beeps from mobile phones, computers, and tablets. Digital distraction and its cousin, information overload, are taking a growing toll on productivity as new technologies spread across the globe and the knowledge economy expands.

Three in four U.S. employers say that two or more hours a day are wasted because employees are distracted, according to a survey released in June by CareerBuilder, a human resources consulting company based in Chicago.

Employers cited mobile phone use and texting as the biggest time killers, followed by the Internet, office gossip, and social media. Consequences include lower-quality work, reduced morale among workers who must pick up the slack for distracted colleagues, and missed deadlines.

Nathan Zeldes, a Jerusalem-based organizational consultant, identifies email as the biggest waste of time, and he blames employers for failing to limit its use. An office worker can expect to get between 50 and 300 job-related messages a day, he says.

“There’s no way you can read or process that intelligently,” Zeldes says. “And it keeps coming in.”

Useless email and unnecessary interruptions cost the average knowledge worker one day a week in lost productivity, Zeldes says, citing a study he conducted in 2006 while work-

ing as an engineer for computer chip maker Intel Corporation. That comes to about \$1 billion a year for a company with 50,000 workers.

Email is difficult to resist, Zeldes says. Employees feel compelled to read and respond to messages at any time of the day or night for fear of missing out on important communications or out of a desire to impress coworkers or the boss.

“I liken it to the prisoner’s dilemma,” he says. “Everybody would love to send less email and go home early. But nobody dares to be the first to cut back.”

Gloria Mark, a PhD psychologist who teaches at the Department of Informatics at the University of California, Irvine, uses a gambling analogy to describe how people are conditioned to use email.

“I call it the Las Vegas phenomenon,” she says. A slot machine player is rewarded at random intervals by an occasional payout. The prospect of another payout is enough to keep the player pulling the handle.

“Randomly reinforced behavior is the hardest behavior to extinguish,” Mark says.

In a 2012 study, Mark found that workers can concentrate on a computer screen only for an average of 75.5 seconds before switching tasks. By last year, that number was down to 47 seconds.

Workers and their bosses have deployed a variety of strategies to combat distraction and overload. Many set aside specific chunks of time to deal with email and ignore their inboxes the rest of the day.

“I spend a lot of time optimizing my email life,” says Voss at NPM. His solution is to “ruthlessly filter” out any message “that’s repetitive, anything that’s routine, anything that I don’t need to know about or deal with.”

“Turn off all notifications. Don’t let things pop up in your face,” counsels Cliff Williams, senior designer for Nextdoor, a San Francisco-based company that calls itself a “private social network for your neighborhood.”

Still, Williams concedes that avoiding distractions is a “constant struggle.”

“It’s kind of like losing weight,” he says. “You lose some and you gain some back.” ■

Chris Wellisz is a financial journalist based in Washington, D.C.

DIGITAL DIVIDE

Despite the rapid spread of digital technologies, the anticipated benefits of higher growth and more jobs have fallen short

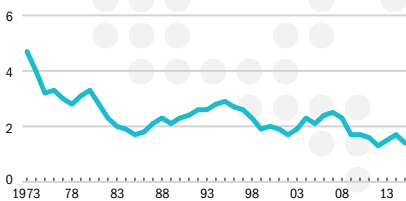
DIGITAL technologies—the Internet, mobile phones, and all the other tools to collect, store, and share information digitally—have spread rapidly in much of the world. The number of Internet users has more than tripled in the past decade—from 1 billion in 2005 to an estimated 3.2 billion at the end of 2015. But the anticipated digital dividends of higher growth, more jobs, and better public services have fallen short.

According to a new World Bank report, *World Development Report 2016: Digital Dividends*, nearly 60 percent of the world's population—or 4 billion people—are still offline and can't fully participate in the digital economy. In addition, some of the benefits of the Internet are being offset by new risks, such as a poor business climate and vested business interests that limit competition and inhibit future innovation.

TECHNOLOGY HAS NOT DELIVERED ITS EXPECTED IMPACT ON DEVELOPMENT

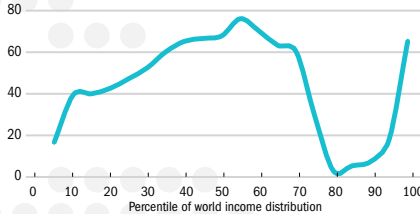
Global productivity has slowed

Five-year moving average of median growth of labor productivity per hour worked, percent



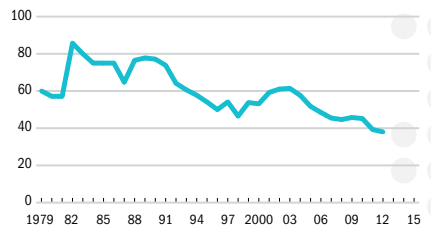
Global inequality remains high

Percent change in real income between 1988 and 2008 at different levels of world income distribution in 2005 prices



Global governance has not spread

Share of elections that are free and fair, percent



A TYPICAL DAY IN THE LIFE OF THE INTERNET*

- 207 BILLION E-MAILS SENT
- 8.8 BILLION YOUTUBE VIDEOS WATCHED
- 4.2 BILLION GOOGLE SEARCHES
- 2.3 BILLION GB OF WEB TRAFFIC
- 803 MILLION TWEETS
- 186 MILLION INSTAGRAM PHOTOS
- 152 MILLION SKYPE CALLS
- 36 MILLION AMAZON PURCHASES

*April 4, 2015.

NUMBER OF INTERNET USERS



1
BILLION
IN 2005



3.2
BILLION
IN 2015

MOBILE PHONE OWNERSHIP



80%
of people in
developing
economies

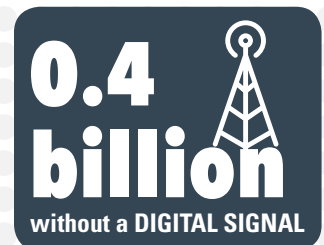
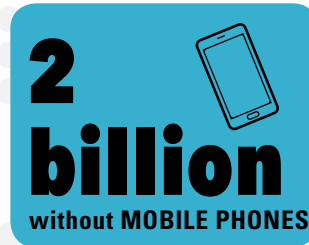
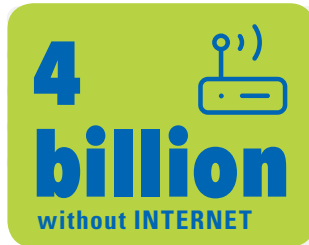
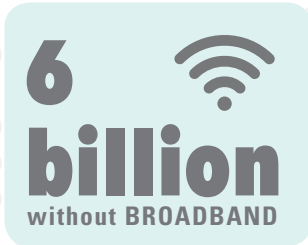


98%
of people in
advanced
economies

Closing the remaining digital divide by making the Internet universally accessible, affordable, open, and safe is vital but not enough. Digital investments also need the support of analog complements—

stronger regulations to ensure competition among firms, action plans to adapt workers' skills to new demands, and more accountable institutions to upgrade public services.

A SIGNIFICANT DIGITAL DIVIDE STILL EXISTS



60% of the world's population is offline



INTERNET ACCESS



31%
of people in developing economies



80%
of people in advanced economies

6 DIGITAL TECHNOLOGIES TO WATCH

- 5G MOBILE PHONES
- ARTIFICIAL INTELLIGENCE
- ROBOTICS
- SELF-DRIVING CARS
- INTERCONNECTED PHYSICAL OBJECTS
- 3D PRINTING



Prepared by Natalie Ramirez-Djumena. Text and charts are based on World Development Report 2016: Digital Dividends, published by The World Bank in January 2016. The report is available at www.worldbank.org/en/publication/wdr2016



Two Faces of CHANGE



Aditya Narain

New financial technologies hold both promise and pitfalls

THE technology and financial sectors have a long symbiotic history. In almost any finance textbook, technology, together with deregulation, is deemed to be the main driver of the exponential growth in finance in the past 50 years. Finance is the biggest focus of technology firms, and technology (particularly information and communication) is a big budget item for banks and other financial sector firms. This is not surprising because finance is ultimately the business of collecting, storing, processing, and trading in information, unbounded by geography.

When the textbooks are revised in the next decade, they will still mention the key role of technology in finance—but with one difference. They likely will highlight how a new breed of hybrid financial technology firms—the so-called fintechs—transformed the financial sector when they went from supplying technology to financial firms to competing against them.

New applications of technology in finance have no doubt made consumers' lives easier in myriad ways—automated teller machines (ATMs), debit and credit cards, and Internet banking, to name a few.

Broad impact

But financial technology affects more than just consumers. Financial firms' entire operations are built around their increased ability to capture and process data thanks to quantum leaps in computing power. These advances have also spawned innovations such as complex options and multilayered securitization—which, for example, package loans into securities that transfer risk from the lender to the securities buyer.

But the most important dividend of the interplay between technology and finance may well be the rise in the number of people around the world who have access to, and use, financial services (often called financial inclusion). The application of existing and widely available technologies such as mobile phones in developing economies has helped them leapfrog market development and bring millions of people into the formal financial system for the first time.

The future promises more change, driven by fintech, a label that is variously used to describe products, product developers, and operators of alternative systems. These fintechs, some owned by tech companies and e-commerce players, have already rolled out applications that propel new ways of making financial transactions. They often come with quirky names—Stripe and Square for payments, Lending Tree and Kabbage for loans, Knip and Zhong An for insurance, and

Betterment and Robinhood for investing are just a few examples of the many fintechs gaining ground.

And there are more in the offing. Many experts have concluded that we are on the verge of a technological revolution in finance that will change the financial landscape and how customers interact with it. That change is being called both disruptive and transformative. Others are skeptical, noting that despite similar fears, earlier major advances in technology were easily absorbed by banks and other financial firms.

But there is a rising consensus that fintech changes are different. First, there's a lot of money flowing into fintech firms, and thousands of companies worldwide are reaching for a slice of the financial sector pie. A recent report by Citigroup suggests that total fintech investment quadrupled between 2010 and 2015 to about \$19 billion annually. Most of that investment went toward developing payment and lending products.

Of course technology firms are merely responding to demand. Consumers were once satisfied with ATMs. Now they carry in their pockets powerful computers, smartphones they use to interact with the world. They are far more trusting of (and dependent on) digital technologies and relationships, which has influenced their expectations of the speed and ease of commerce and finance.

Financial inclusion

At the same time, global efforts toward large-scale financial inclusion have motivated policymakers to encourage fintechs to develop technology that taps into these new market segments, and countries are competing to get fintech start-ups to join their innovation hubs.

Moreover, just as deregulation cleared a path for technology-driven financial innovation in the 1970s, stronger regulation following the global financial crisis may have driven the new wave of fintechs. Regulators have set higher standards for banks to manage their risk, paving the way for nonbanks and fintechs, which are not regulated as banks are, to offer bank-like services. The most visible developments are in the way payments between parties are conducted, recorded, and settled. Banks—the linchpin of the payment system—still have a role in these transactions, albeit reduced. But new technologies (such as bitcoin's underlying blockchain) could soon spawn applications that permit direct transfers between market participants rather than through a third-party central ledger, currently the role of banks and central banks (see “The Internet of Trust,” in the June 2016 *F&D*).

Another growing application is lending—long the preserve of banks, which channel deposit funds to borrowers. Peer-to-peer platforms allow those depositors to lend directly to borrowers. And projects seeking capital can use crowdsourcing platforms that allow investors to pick up equity directly, sidestepping the usual chain of intermediaries, such as investment firms.

Big data-based applications allow for increasingly powerful search techniques to support behavioral analytics and collect and manipulate information from many different sources to identify and measure risks, trends, and customer preference more comprehensively than ever.

These are only some examples. Change also permeates the insurance, savings, and investment spheres. Yet the promise of many more efficient and possibly cheaper ways to conduct financial transactions is not without potential pitfalls. That is why banks and other financial firms are looking warily at this wave of innovation and why regulators are debating how they should respond.

Technology risks

Some of the vulnerabilities of any technology application in finance are well known. For consumers, these include breached personal data, potential electronic fraud committed remotely, still evolving consumer protection frameworks, and nonbanks' and unregulated providers' lack of safety nets such as deposit insurance. The failure of several peer-to-peer platforms in Asia hurt many lenders and led to calls for stricter regulation. Technology can also promote inequities even as it promotes inclusion. For example, high-frequency traders use complex programs driven by massive computing power located near stock exchanges to take advantage of millisecond-long price differences, giving them what many believe is an unfair advantage over other investors.

For financial institutions, fintech products pose the usual set of operational risks that arise from the failure of systems and processes and risks posed by dependence on third-party technology and service providers. Cyber risk—as a result of interconnected computer-based systems vulnerabilities that can be exploited by hackers for fun or criminal intent—is the most talked about technology-related risk (see “The Dark Side of Technology,” in this issue of *F&D*). Banks and other financial institutions are increasingly reporting heavy losses from cyber risk incidents that require them to make major investments.

But the fintech-related risk that threatens to be the most disruptive, especially for banks, is new providers' growing ability to eat away at their revenues when bank profitability is already strained. For example, among a sample of the top 300 advanced economy banks, one-sixth needed to revamp their business model to post sustainable profits (IMF, 2016). The right investments in fintech could well make the difference between their survival and demise.

Regulators have a key role. Their job is to design and enforce rules for prudent behavior and market conduct for licensed banks and other financial firms, manage their orderly entry and exit, and minimize the potential for major disruptions in the financial system. Regulators set minimum

standards, provide guidance on managing risk, and define penalties for noncompliance. Depositors and investors in turn gain access to safety nets such as deposit insurance.

Fintechs, on the other hand, may often be in regulatory gray zones. They may perform some activities that banks do, without being subject to similar licensing and regulatory regimes. Regulators, more comfortable dealing with entities than activities, may respond by subjecting them to prudential regulations after the fact, thus affecting the fintech's business model.

Many fintech products are digital and cannot be contained within national borders.

One major issue that worries national authorities is regulatory arbitrage. Many fintech products are digital and cannot be contained within national borders, so international coordination is needed to ensure that these activities don't move to less regulated jurisdictions. For example, countries have taken very different approaches to regulating virtual currencies such as bitcoin. Some have banned them, others allow them for limited purposes, and some have not yet given them a thought.

Regulators understand well the risks of established technologies but struggle to grasp the risks that new entrants and new technologies may pose to the financial system. They don't want to stifle innovation by restricting the use of new technologies, but regulators also do not want such innovations to spread so widely that they can't be easily rolled back in the event of unanticipated risks.

So regulators are looking for new ways to manage the transition to a new landscape. They are promoting the concept of “regulatory sandboxes” or “safe zones.” In the past year, regulatory agencies (for example, in Australia, Singapore, and the United Kingdom) have issued guidelines on sandboxes that will allow selected products of approved fintechs to go live for a defined period. Only if the product succeeds will the full suite of regulatory requirements become applicable.

This sandbox approach should help regulators understand the risks a product might pose if widely used, but in a controlled environment. It will help fintech firms, especially start-ups, test their products without having to bear the full cost of regulation or face enforcement action.

Of course, sandboxes pose risks of their own. Regulators are not experts on promoting products and will be put in the position of selecting winners and losers, something markets do best. Only time will tell how successful sandboxes are, but until then finance and technology will play together to develop useful products under the watchful eye of regulators. ■

Aditya Narain is a Deputy Director in the IMF's Monetary and Capital Markets Department.

Reference:

International Monetary Fund (IMF), 2016, Global Financial Stability Report (Washington, April).

Knowledge as a Public Good

The IMF is using technology to boost understanding of economic policy issues



Sharmini Coorey is the Director of the IMF's Institute for Capacity Development.

YOU may be surprised to learn that the IMF is in the business of delivering massive open online courses, also known as MOOCs. In fact, you may not even be aware that it is in the business of teaching at all.

Our lending operations and monitoring of member countries' economies certainly grab more headlines. But over a quarter of the IMF's work involves capacity development—that is, helping member countries build strong economic institutions and boost skills to implement sound macroeconomic and financial policies. The IMF provides quite a lot training and technical assistance behind the scenes to help countries better withstand shocks and avert crises—precisely so they *won't* be in the news.

My department, the IMF Institute for Capacity Development, runs a training program for country officials on applied macroeconomics, financial issues, and related statistical and legal frameworks. Our courses use the same rigorous analytical approach as macroeconomics and finance courses taught at universities, but they differ in that they are short and policy oriented, drawing lessons from the experiences of our 189 member countries. They try to bridge the gap between economic theory and practical policy implementation using case studies and workshops based on actual country data.

Expanded potential

I first heard about MOOCs through a TED talk by Daphne Koller, founder of Coursera, a pioneer of the concept of free online courses for the public. I was fascinated by the possibilities MOOCs presented. Our traditional classroom training—on topics such as economic forecasting and debt sustainability analysis—was reaching 30 government officials at a time. Although we were delivering courses at several training centers across the globe and training 7,000–8,000 officials

a year, it wasn't enough to meet the demand from our member countries. With online learning, not only would we be able to reach more people, we could also deliver training at a much lower cost, unconstrained by the need for physical facilities and complex logistical arrangements.

So we joined forces in 2013 with edX, a consortium that provides MOOCs started by Harvard University and the Massachusetts Institute of Technology, and produced our first MOOC. It was on Financial Programming and Policies, our flagship course for policymakers in finance ministries and central banks all over the world, a version of which is also our “boot camp” course for new IMF economists. We've since developed five other MOOCs, with some available not only in English, but also in French, Spanish, Russian, and Arabic.

Has this joint venture worked out the way we thought it would? I would say it has been better than expected—not that we knew precisely what to expect at the time. One felicitous surprise is that low Internet connectivity and power interruptions have not been a major obstacle to reaching people in poor countries. Some 28 percent of officials earning online certificates have been from sub-Saharan Africa and 38 percent from low-income countries. The top countries where our participants are located, besides Brazil and India, are Cameroon, Uganda, and Zimbabwe.

And online training has taken off in an impressive way; it now accounts for about a third of all IMF training for officials. Since the launch of our first MOOC in late 2013, online courses have attracted 21,000 active participants. Of those, 6,300 government officials and 6,000 members of the general public from 183 countries have successfully completed a course—a sign of good progress toward our dual goal of scaling up training for policymakers and sharing knowledge with the general public. Although it's difficult to gauge just how much participants

absorb, retain, and later apply that knowledge, we do see evidence of learning—on average participants score 16 percentage points higher on end-of-course tests compared with pre-course tests.

Another revelation was that the design of the MOOCs—which include video lectures that can be paused and replayed, Excel spreadsheets, discussion forums with other students, and opportunities for online interactions with an instructor—makes for a remarkably personalized experience. It is almost like working with a tutor, some online students tell us, even though the number of participants in a given course has jumped from about 30 to some 3,000 at times.

Finally, we've learned that online training is also a complement to face-to-face training. It is more effective than classroom training in transmitting information and building focused skills. However, it is less effective when it comes to delving into the nuances and complexities of real-life policymaking and allowing peer-to-peer interactions. We need to do both so that the relative strengths of technology and human interaction can be deployed to maximize the impact on learning while making our training available to as many people as possible. So we are moving to make some online courses and modules prerequisites for classroom training and are adapting our classroom material to complement our online offerings.

The IMF as a knowledge hub

Training is just one aspect of our capacity development work. If we can bring about such dramatic change with online learning, can we not leverage technology to increase the impact of the IMF's capacity building work more generally?

Here are some quick ideas, although no doubt practitioners will have many more:

- **Build a searchable repository of technical assistance reports available to all officials.** The IMF's vast pool of technical knowledge is the lifeblood of the institution. We could create a database of technical assistance reports that other countries could draw on when considering reforms or implementing specific policy initiatives. Technical assistance reports may need to be written differently, particularly to separate out confidential material into annexes that are not included in the database. There may be some transitional costs, but these are likely to be well worth the benefit. A searchable repository will not only increase the knowledge available to governments, but also make technical assistance more effective by better focusing country requests and better preparing officials to receive technical advice.

- **Arrange peer-to-peer learning via video chats.** The IMF doesn't always have to be the purveyor of technical knowledge and policy experience—we could also serve as a broker to match officials who have the relevant knowledge and experience with those who are seeking it. If you're a policymaker in a low-income country, what an advanced economy does is less interesting than what policymakers who are going through—or who have just been through—your experience did. Using video chat software that allows people around the world to communicate with each other at no cost, we could

arrange conversations between, say, a policymaker in Samoa and his or her counterpart in Mauritius, much like we do in the peer-to-peer workshops the IMF organizes from time to time—but with fewer logistical complications and resource costs. These arrangements would allow for an informal dis-

The IMF's vast pool of technical knowledge is the lifeblood of the institution.

cussion of not just the nuts and bolts of a particular economic reform, but also the “softer” aspects of implementing it—such as how to overcome political obstacles or how best to communicate with the public.

- **Form “communities of practice.”** Serving as a convener, the IMF could facilitate the formation of online groups on social media for purposes of professional development and information sharing. Officials come together from time to time for conferences, workshops, and courses, but may never see each other again. Or they may be receiving technical assistance on similar topics and never meet each other. IMF experts could “curate” online communities that link up officials working in a particular area—for example, economic modelers in central banks—using various social media platforms. Members could disseminate the latest professional materials, compare experiences, and share solutions to problems they encounter in their day-to-day work. Such cross-country communities could be particularly useful for developing economies with few highly specialized staff, who may not have many colleagues in their organization to consult and may thus be somewhat isolated.

Continuous learning

All of these ideas are feasible; we have the technology. It's not the technology that is an obstacle; it's the adoption of new work practices that presents the more formidable challenge. There is a natural reluctance to take risks to try new things, and people may even feel that freely disseminating their knowledge could diminish the value of their individual expertise. But we shouldn't see it as a zero sum game.

Leveraging technology to transfer knowledge in innovative ways would not eliminate traditional ways of developing capacity in countries any more than online learning has rendered our face-to-face courses obsolete. These complementary methods will allow us to be more effective. We need to keep adapting our methods to exploit the full potential of changing technology.

Everyone stands to benefit if we are able collectively to raise the caliber of economic policymaking. There will always be more to learn, because the global economy—and thus our policymaking challenges—is continuously evolving. This is all the more reason to use every tool we have at our disposal to help policymakers grow in sophistication and knowledge. As an international organization, we have an obligation to do so. ■

Game Changer

Technology is transforming the way development agencies work

IN health, education, energy, finance, agriculture, and other areas, technology is transforming international development. *F&D* asked a few leading development agencies to describe innovative technology projects they are funding in developing economies. These agencies are not just providing financing, they are also making use of local talent, transferring knowledge, and achieving durable change. Here are their stories.

Leading change through social entrepreneurship Global Affairs Canada



Global Affairs
Canada Affaires mondiales
Canada

Global Affairs Canada, which leads Canada's international development and humanitarian assistance, aims to help those most in need, building more resilient communities and stimulating sustainable economies. We work in partnership with the private sector, civil society, and others to maximize the impact of our development investments.

One of our partners is Digital Opportunity Trust (DOT), a Canadian social enterprise working in international development. DOT's youth-led movement of daring social entrepreneurs is transforming communities across Africa and the Middle East.

Through DOT's digital livelihoods program, young people like Ajra Mohammed in Kenya are using their deep understanding of local needs to build social impact initiatives that create opportunities, shape local economies, and make technology locally relevant.

Mohammed was a recent university graduate struggling to find meaningful employment when she joined DOT. After participating in business and technology training and connecting with DOT's network of young leaders, she began delivering entrepreneurship and digital skills training to peers in her community. Having gained insight into the needs of her own community, she has now launched a successful social enterprise—the first women-focused technology innovation hub in Kenya.

Mohammed has transformed the lives of hundreds of people who are now taking advantage of educational opportunities, starting businesses, and finding jobs because of the digital networks she has created.

DOT has supported more than 5,000 young people like Mohammed, who have in turn transformed the lives of nearly a million others through digital social impact initiatives.

DOT's program is a powerful model for sustainable, technology-enabled, youth-led change. It recognizes that youth are natural adopters of technology who have powerful insight

into the needs of their communities. Equipped with the tools for positive social impact, young people can launch initiatives that promote community well-being, create jobs, and shape local economies. Global Affairs Canada and other stakeholders have helped DOT scale up its development impact over the past 15 years.

Mobile money's momentum U.S. Agency for International Development (USAID)



USAID
FROM THE AMERICAN PEOPLE

Advances in mobile technology and digital connectivity have reshaped our lives in the United States and can transform the lives of millions in low-income countries. According to strategy& (formerly Booz & Company), the digitization of developing economies could yield a \$4.4 trillion increase in GDP among countries at the bottom of the pyramid.

We're already seeing promising signs. In parts of Africa, mobile money has completely changed the way people save, send, and receive money. When a mobile phone replaces cash hidden at home, people are less vulnerable to theft. It becomes easier for them to send money to family members or to save it securely and harder for their bosses to skim a little off the top on payday.

That's why we are working to strengthen the ecosystem for mobile money and other digital financial services. USAID is a cofounder of the Better Than Cash Alliance (BTCA), a group committed to digitizing payment flows and creating pathways toward more inclusive growth.

At the height of the Ebola crisis, Sierra Leone, also a member of the BTCA, digitized hazard payments to more than 15,000 response workers over the course of just two weeks.

Before the change, workers had received their pay in cash, making them vulnerable to corruption and theft and delaying receipt by more than a month. This bitter combination caused an average of eight strikes a month.

Digitization ensured that the health workers were paid within a week, putting an end to the strikes. At the same

time, mobile money saved more than \$10 million by ending double payment, reducing fraud, eliminating the costs of cash transportation, and reducing travel costs for response workers. It strengthened Sierra Leone's capacity to contain the Ebola epidemic.

Two billion people still don't have access to financial services, and a disproportionate number of them are women. But mobile money has strong momentum. It is now available in 85 percent of the countries that need it most—those where the vast majority of people don't have access to traditional banks.

Technology is transforming the way we pursue international development, and it presents a tremendous opportunity to help the 700 million people who still live on less than \$1.90 a day.

Digital for development

Belgian Development Cooperation



No one can ignore how the digital revolution is changing the world. Digitization is proceeding much faster than development in other sectors; the number of people who own a mobile phone is far larger than those with access to electricity or clean water.

We see digitization not as a goal in itself, but rather a tool to be systematically explored for improving people's living standards and making progress toward the United Nations' Sustainable Development Goals.

Our "digital for development" strategy focuses on two areas: ensuring that digital benefits are benefits for all and promoting better-informed decision making through publicly accessible big data. A massive amount of data is produced daily and, when put to good use, it can help policymakers gain potentially lifesaving insight. This is especially true in low-income countries, where governments generally lack good data to inform their policies.

We are funding a project in Uganda to develop tools to help the government monitor and prioritize policy measures. This project—to be implemented by the United Nations Capital Development Fund (UNCDF) and a private partner—develops mobile phone applications for data analytics. One such app helps identify urban mobility patterns through mobile phone data; another is a financial inclusion app that allows the UNCDF and other development actors to monitor the use of digital financial services.

We also support a digital teachers' platform in the West Bank and Gaza, a peer-to-peer site where teachers share tips and experiences. The portal has 6,500 active users and more than 2 million hits.

These are just a few projects currently in progress—but in the digital world, innovation is the name of the game. To generate new ideas, we launched a biennial prize this spring with the Royal Museum of Central Africa to reward outstanding initiatives that use digitization as a lever for development.

Of course, digital dividends are not automatic and often not equally distributed. And we must also take into account the potential risks of digitization, such as increased vulnerability to cybercrime and the emergence of new or deeper inequalities.

But digitization in development is a fundamental game changer, especially in poor countries and fragile states, where Belgium has committed to focus at least 50 percent of its official development assistance.

Combating climate change

Japan International Cooperation Agency



The Japanese government promotes joint research projects between scientists from Japan and developing economies through the Science and Technology Research Partnership for Sustainable Development (SATREPS). These projects provide an avenue for universities and research institutes in those countries not only to boost their technical capacity, but also to apply this knowledge to a host of universal real-world challenges such as global warming, infectious diseases, and natural disasters. The initiatives born of these scientific partnerships also spur progress toward the United Nations' Sustainable Development Goals.

Since 2008, our agency, in partnership with the Japan Science and Technology Agency and the Japan Agency for Medical Research and Development, has implemented more than 100 SATREPS projects. One of these, the Carbon Sequestration and Monitoring Project, began in 2012 in the Gunduh gas field of Indonesia's Central Java province.

This project brings together researchers from Japanese universities and local counterparts from the Bandung Institute of Technology, Pertamina Oil of Indonesia, and others. Our mission is to develop a system for carbon dioxide capture and sequestration—the first attempt to do so in southeast Asia.

Natural gas production in the East Java Basin, where the Gunduh gas field is located, results in high carbon emissions. Our project seeks to reduce these emissions by separating carbon dioxide from the gas during the production phase and then injecting it into underground sand layers for safe storage. Up to 30 tons of carbon emissions could be sequestered underground each day as a result of this project, potentially setting Indonesia on a course to reach its goal of reducing total carbon emissions by 26 percent by 2020.

The first phase of the project entails determining the amount of carbon dioxide emissions that can be safely injected underground. Simulations and tests ensure that pressure outside the injection layer will not cause fault instability. Meanwhile, the scientists monitor the movement of injected carbon gas through changes in gravity.

This advanced technology—which sets the stage for large-scale carbon sequestration—has already attracted donor attention, including from the Asian Development Bank. We are proud to be a part of the efforts to make carbon sequestration a reality in southeast Asia and help reduce carbon emissions on a global scale. ■

Big Data's **Big Muscle**

Computing power is driving machine learning and transforming business and finance

Sanjiv Ranjan Das

THE world has access to more data now than was conceivable even a decade ago. Businesses are accumulating new data faster than they can organize and make sense of it. They now have to figure out how to use this massive amount of data to make better decisions and sharpen their performance.

The new field of data science seeks to extract actionable knowledge from data, especially big data—extremely large data sets that can be analyzed to reveal patterns, trends, and associations. Data science extends from data collection and organization to analysis and insight, and ultimately to the practical implementation of what was learned.

This field intersects with all human activity—and economics, finance, and business are no exception.

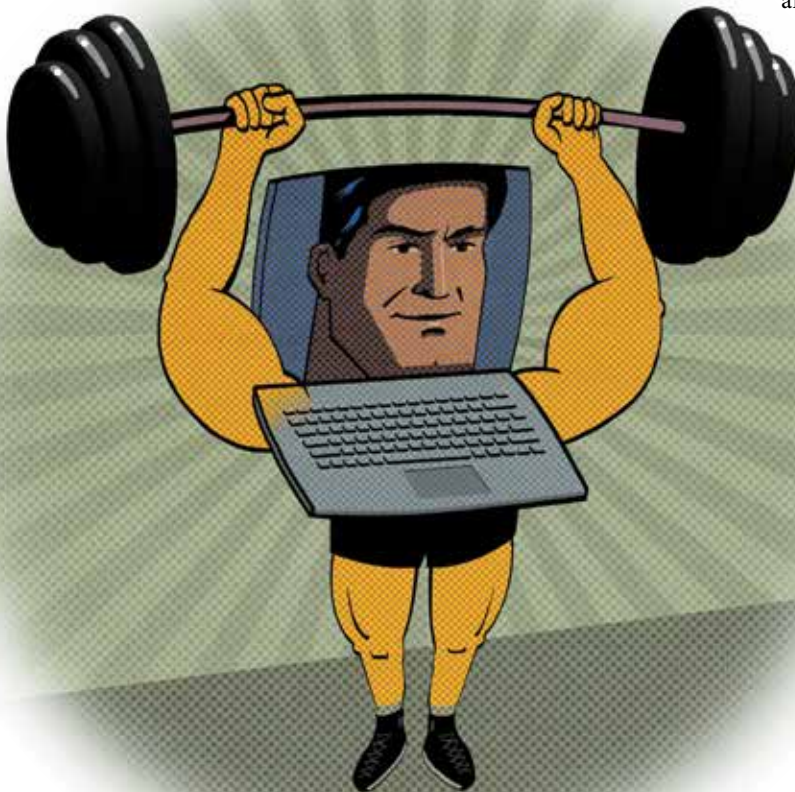
Data science brings the tools of machine learning—a type of artificial intelligence that gives computers the ability to learn without explicit programming (Samuel, 1959). These tools, coupled with vast quantities of data, have the potential to change the entire landscape of business management and economic policy analysis.

Some of the changes offer much promise.

Consumer profiling

The rapid growth in the adoption of data science in business is no surprise given the compelling economics of data science.

In a competitive market, all buyers pay the same price, and the seller's revenue is equal to the price times the quantity sold. However, there are many buyers who are willing to pay more than the equilibrium price, and these buyers retain consumer surplus that can be extracted using big data for consumer profiling.



Charging consumers different prices based on their analyzed profiles enables companies to get the highest price the consumer is willing and able to pay for a specific product. Optimizing price discrimination or market segmentation using big data is extremely profitable. This practice was the norm in some industries—for example, the airline industry—but is now being extended across the product spectrum.

Moreover, the gains from price targeting also enable firms to offer discounts to consumers who would not otherwise be able to afford the equilibrium price, thereby increasing revenue and expanding the customer base, and possibly social welfare. Consumer profiling using big data is an important reason for the high valuations of firms such as Facebook, Google, and Acxiom, which offer products and services based on their customers' data.

While big data may be used to exploit consumers, it is also changing business practices in a way that helps those same consumers. Firms are using the data generated from people's social media interactions to better understand their credit behavior. Relating people's past credit history to their social media presence leads to improved credit-scoring systems. It also allows lenders to extend credit to people who might otherwise be turned down.

In particular, big data eliminates the biases that arise when people make decisions based on limited information. This absence of fine-grained individual data led to redlining in loan applications, a practice dating to the 1930s. Mortgage lenders would draw red lines around areas on a map to indicate that they would not make loans there because of the racial or ethnic composition. This stereotyping practice denied credit to entire segments of society.

Big data, however, does away with stereotyping. Coarse subjective data can now be replaced by finer, more individualized data. Credit-scoring firms can exploit the heterogeneity detectable from people's social media interactions, texting streams, microblogs, credit card patterns, and profiling data—in addition to such typical demographic data as income, age, and location (Wei and others, 2014). The use of finer-grained data facilitates better classification of individuals by credit quality.

Forecasting and risk analysis

Economic forecasting has changed dramatically with data science methods. In traditional forecasting, key statistics about the economy—such as the quarterly GDP report—are available only with considerable delay. Data science can get around these delays by relying on information that is reported more frequently—such as unemployment figures, industrial orders, or even news sentiment—to predict those less frequently reported variables.

The collection of approaches engaged in this activity is known as “nowcasting”—also termed the prediction of the present—but is better understood as real-time forecasting (see “The Queen of Numbers,” in the March 2014 *F&D*).

Data science is also making inroads when it comes to analyzing systemic financial risk. The world is more interconnected than ever, and measuring these ties promises new insight for economic decision making.

Looking at systemic risk through the lens of networks is a powerful approach. Data scientists now use copious data to construct pictures of interactions among banks, insurance companies, brokers, and more. It is obviously useful to know which banks are more connected than others. So is information about which banks have the most influence, computed using a method based on eigenvalues. Once these networks are constructed, data scientists can measure the degree of risk in a financial system, as well as the contribution of individual financial institutions to overall risk, offering regulators a new way of analyzing—and ultimately managing—systemic risk. See Espinosa-Vega and Solé (2010); IMF (2010); Burdick and others (2011); and Das (2016).

These approaches borrow extensively from the mathematics of social networks developed in sociology, and they are implemented on very large networks using advanced computer science models, culminating in a fruitful marriage of several academic disciplines.

More than words

Text analytics is a fast-growing area of data science and is an interesting complement to quantitative data in the area of finance and economics (see “Two Faces of Change,” in this issue of *F&D*). Commercial applications based on text mining abound: firms like iSentium extract long- and short-horizon sentiment from social media using Twitter; StockTwits provides sentiment indicators through a mobile-enabled Web application.

Big data eliminates the biases that arise when people make decisions based on limited information.

It is now possible to rank a firm by quarterly earnings outcomes in its 10-K, an annual report on a company's financial performance filed with the U.S. Securities and Exchange Commission (SEC). A tally of risk-related words in quarterly reports offers an accurate ranking system for forecasting earnings. Firms whose quarterly reports are harder to read tend to have worse earnings—most likely because they attempt to report bad news using obfuscating language (see Loughran and McDonald, 2014). Using an age-old metric for readability, the Gunning Fog Index, it is easy to score financial reports on this attribute, and regulators such as the Consumer Financial Protection Bureau are looking into establishing readability standards.

Studies have even found that the mere length of the quarterly report is sufficient to detect bad news (longer reports presage earnings declines), again because obfuscation is correlated with verbiage; as an ultimate extension, the file size alone of companies' filings uploaded to the SEC's website signaled quarterly earnings performance. Much more is expected to emerge from this rapidly evolving area of work.

A new field known as “news analytics” mines the news for data. Services provided by companies such as RavenPack are growing. These services range from sentiment scoring and predictive analytics for trading to macroeconomic forecasting. RavenPack mines vast quantities of unstructured data from news and social media and converts it into granular data and indicators to support financial firms in asset management, market making, risk management, and compliance.

Studies have found that the mere length of the quarterly report is sufficient to detect bad news.

Within this category, news flow analysis is especially interesting. Hedge funds mine thousands of news feeds a day to extract the top five or ten topics and then track the evolution of the proportion of topics from day to day to detect tradable shifts in market conditions. A similar analysis would be useful to policymakers and regulators, such as central bankers. For example, it might be time to revisit interest rate policy when the proportion of particular topics discussed in the news (such as inflation, exchange rates, or growth) changes abruptly.

Topic analysis begins with construction of a giant table of word frequencies, known as the “term-document matrix,” that catalogs thousands of news articles. Terms (words) are the rows of the table, and each news article is a column. This huge matrix can uncover topics through mathematical analysis of the correlation between words and between documents. Clusters of words are indexed and topics detected through the use of machine learning such as latent semantic indexing and latent Dirichlet allocation (LDA). LDA analysis produces a set of topics and lists of words that appear within these topics.

These modeling approaches are too technical to be discussed here, but they are really just statistical techniques that uncover the principal word groupings in a collection of documents (for example, in the news stream). These language clues are likely to be widely used by economic policymakers and in political decision making—for example, in redefining the message in a political campaign.

Artificial intelligence and the future

Computers are more powerful than ever, and their ability to process vast amounts of data has stimulated the field of artificial intelligence. A new class of algorithms known as “deep-learning nets”—inspired by biological neural networks—has proved immensely powerful in mimicking how the brain works, offering many successful instances of artificial intelligence.

Deep learning is a statistical methodology that uses artificial neural networks to map a large number of input variables to output variables—that is, to identify patterns.

Information is dissected through a silicon-and-software-based network of neurons. Data are used to strengthen the connections between these neurons, much as humans learn from experience over time. The reasons for the stunning success of deep learning are twofold: the availability of huge amounts of data for machines to learn from and the exponential growth in computing power, driven by the development of special-purpose computer chips for deep-learning applications.


Deep learning powers much of the modern technology the world is beginning to take for granted, such as machine translation, self-driving cars, and image recognition and labeling. This class of technology is likely to change economics and policy very soon. Credit rating agencies are already using it to generate reports without human intervention. Large deep-learning neural networks may soon provide forecasts and identify relationships between economic variables better than standard statistical methods.

It is hard to predict which domains in the dismal science will see the biggest growth in the use of machine learning, but this new age has definitely arrived. As noted science fiction writer William Gibson put it, “The future is already here; it’s just not very evenly distributed.” ■

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Protecting creative content could promote development in the digital age

Music Going for a Song

Customers at the Apple store in Dalian, Liaoning Province, China.

Patrick Kabanda

INTELLECTUAL property rights date to ancient Egypt. In an inscription on a rare Egyptian tablet from 2000 BCE displayed at the Louvre in Paris, Irtyesen, a master craftsman, scribe, and sculptor, boasts about his trade secrets. How would he maintain ownership of his techniques and make a decent living in today's digital world?

Technology occupies us in ways that would baffle Irtyesen. Rush hour subway riders swipe and text away while digital music blasts through their earphones. Whether they're consuming this music legally or illegally, who knows? What's clear is technology makes it easy to copy and transmit creative work: capture and share are the order of the day.

Cheap singles

When Apple's iTunes debuted in 2001, it ushered in the cheap digital single. In about a decade, music sales plunged to \$7.1 billion in 2012 from \$11.8 billion in 2003 (Covert, 2013). At the same time, world trade in creative goods and services totaled a record \$624 billion in 2011, according to the United Nations Conference on Trade and Development. To protect creative workers' incomes and boost creative economies, protection and fair compensation are essential.

Digital music generated more revenue than physical formats for the first time in 2015—it was up 3.2 percent to \$15 billion, the industry's first significant year-over-year growth in nearly 20 years (IFPI, 2016). The International Federation of the Phonographic Industry (IFPI) notes that digital revenue rose 10.2 percent, to \$6.7 billion. A 45.2 percent rise in streaming revenue more than offset

fewer downloads and physical sales. This is welcome news. But the industry is trapped in a so-called value gap—a mismatch between music that makes money and a lot that doesn't parlay into meaningful revenue for artists and creative businesses.

If developing economies could reap earnings from their cultural wealth it could unleash development, help solve youth unemployment, and promote diversification. But piracy, endemic in both developing and developed economies, poses a threat.

Digital piracy is constantly changing, which makes it hard to eradicate. Unauthorized music is distributed through platforms such as Tumblr and Twitter, unlicensed cyberlockers (online data hosting services), and BitTorrent file sharing. The IFPI estimates that “in 2014 there were four billion music downloads via BitTorrent alone”—most were unlawful (IFPI, 2015). The Chinese “Special Campaign” focused on cracking down on infringement and urged businesses to raise awareness of intellectual rights. Although imperfect, it's one example of how to tackle this problem (Brodbeck, 2015).

Unfair ad rules?

Today's iPhone is like a mini pocket studio, whose users can easily make videos and post them on YouTube. Whether it's a cat tapping out an approximation of “Für Elise” on the piano as it meows off-key or a concert pianist, footage that goes viral can turn into cash. One path to success for an artist is to partner with YouTube and give the company a share of advertising revenue (Johnston, 2013).

But sometimes advertisers, including well-known brands, wind up on sites that infringe on copyright. A 2014 study by MediaLink found that “596 infringing sites generated US\$227 million a year in advertising revenue.” Those involved benefit, but those who wrote, performed, and produced the music get nothing (IFPI, 2015).

Leveraging intellectual rights to expand the creative sector is a huge development opportunity.

Copyleft

Piracy losses are hard to pin down. The economy does not necessarily suffer—consumers may just spend their money elsewhere. “If a person illegally downloads a movie or song that he never would’ve downloaded otherwise, then it’s not clear what the losses actually amount to (the benefits, by contrast, are fairly clear).” (Plumer, 2012)

Stringent intellectual property protection can also worsen the knowledge gap between rich and poor countries. The rules in the World Trade Organization’s Trade Related Aspects of Intellectual Property Rights Agreement (TRIPS), which “promote stricter intellectual property protection were clearly a response to lobbying by Western companies that owned and developed intellectual property, such as pharmaceutical, entertainment and software companies.” (Lester and others, 2008) The agreement aims to help all countries facilitate international trade through protection of intellectual property rights, but even if some developing economies have asked to be excused from some of the obligations, many have yet to see meaningful benefits from the system.

And then there’s cost. Property rights may encourage businesses to invest in intellectual products, but costs such as litigation and enforcement can undercut these efforts, as well as governments’ incentive to invest in strong intellectual rights regimes—especially in developing economies.

Copyright for development

The benefits to development and the costs deserve a close look. The often-cited knowledge gap (with respect to TRIPS) is the West versus the rest. But there’s another side. When creative and traditional knowledge from developing economies is exploited in Western branding or copyright infringement, for example, the implications for development are largely ignored. And although an economy as a whole may not suffer, impoverished artists do.

Constructive policymaking must consider how TRIPS can benefit both developed and developing economies and distinguish between protecting creative work and protecting pharmaceuticals, for example.

And it’s more than just carrots and sticks. Many creative workers struggle to survive despite contributing to others’ economic and social welfare. Some tech companies and

superstars have made a killing in the Internet age, but, according to economist and singer Jason Shogren, it takes more than 4 million hits on Spotify just to earn the minimum wage (Timberg, 2015).

Meanwhile, an artist who sold 150 self-pressed CDs for \$9.99 each would take in almost \$1,500. That beats aiming for 4 million plays. The average per stream payout to rights holders is somewhere between \$0.006 and \$0.0084 on Spotify (Plaugic, 2015). Shogren says that after management fees and other costs, few but the most famous artists see any real money. “The most popular artists on Spotify are racking up millions of streams worldwide, which actually does translate into a lot of money. Drake was Spotify’s most streamed artist in 2015”—with about 1.8 billion streams, which earned him close to \$15 million (Plaugic, 2015).

Leveraging intellectual rights to expand the creative sector is a huge development opportunity and calls for development financing and a new mind-set. Developing economies must jettison the assumption that there’s no money or developmental value in creative work.

As Irtyzen might remind us, extractive industries—which often get all the attention—are not the only ones that need infrastructure, tax breaks, foreign and domestic direct investment, and the like. Our increasingly knowledge-based economy must harness people’s teeming creative wealth to drive development. The tools include allocation of scarce resources to build infrastructure, attractive loans and tax breaks, structures for local and global fee collection, and fair distribution. International development organizations can also chime in with financial and technical leverage to support creative work for development in the digital age. ■

Patrick Kabanda is a consultant for the Office of the Senior Vice President and Chief Economist at the World Bank and is writing a book based on his working paper “The Creative Wealth of Nations.”

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Pupils from different countries attend a German language class for immigrant children in Berlin, Germany.

TONGUE TIDE

Barry R. Chiswick

EUROPEAN countries admitted more than a million migrants from North Africa and the Middle East in 2015, primarily from the conflicts in Syria and Iraq. Some are refugees fleeing civil war, discrimination, and chaotic situations. Others are economic migrants seeking better opportunities. The vast majority of both types of predominantly Arabic speakers will settle permanently in Europe, where Arabic is not the dominant language but where substantial enclaves of Arabic speakers live. Although some of these immigrants will be proficient in their host country's language, most will not.

The recent surge in international migration has focused attention on the economics of language: the determinants and consequences—including prospects for employment and earning potential—of migrants' proficiency in their host country's language. The economic success of migrants depends heavily on how

well and quickly they learn the language of their new country.

Theoretical and empirical research, both my own and by colleagues in the field, has benefited from the relatively recent release of large microdata sets in the major immigrant-receiving countries, which identify immigrants, their original language, and their proficiency in the host country's main language, along with other relevant social, demographic, and economic characteristics.

Picking it up

Language proficiency is a form of human capital, just like other skills acquired in school or on the job. It is an economic good that is useful professionally, personally, and socially and is acquired at a cost to individuals—in the case of children, to parents or caregivers—of time and financial outlay. Although the effects vary somewhat across

The economics of language offers important lessons for how Europe can best integrate migrants

countries, immigrants who are more proficient in the host country language are more likely to be employed, when employed earn more, are more likely to become citizens, and have a higher propensity to marry someone born outside of their country of origin or ethnic group.

Research on the determinants of immigrants' proficiency in the host country language—conducted for several migrant-receiving countries, including Australia, Canada, Germany, Israel, the United Kingdom, and the United States—has focused on the “four E’s”: exposure, enclaves, efficiency, and economic incentives.

Exposure to the host language can occur before or after migration. People may learn a language before migrating through formal or informal language training programs or via media and Internet exposure. Exposure after migration might also include formal or informal language training programs, but learning by living, typically measured by how long a person has lived in a new country, is the most effective method of language acquisition. An interrupted stay, perhaps from migrating to and fro (by sojourners or so-called birds of passage, who return home with their savings every year or so), or the expectation of only a temporary migration dulls the incentive to acquire proficiency. Mexican migrants in the United States, for example, tend to be less proficient in English than similar migrants, in part because they are more likely to migrate to and fro.

Enclaves: Living and working within an ethnic enclave and associating with people who speak their language eases the transition for newly arrived immigrants but comes at a cost. Linguistic, networking, and other adjustments to the new country take longer. What may be a benefit in the short run can become a disadvantage over time.

Language is often closely connected to cultural preferences or ethnic goods consumed primarily by members of an ethnic community and seldom by others. These include ethnic foods (halal meats, for example) and clothing (sarīs). Language binds those who belong to ethnic houses of worship, social clubs, friendship networks, and marriage markets. Living among others with a similar linguistic background and a demand for similar ethnic goods lowers the cost of living and encourages the emergence of ethnic communities or enclaves. For immigrants from India, for example, the cost in terms of money or time of buying a sari or attending a Hindu temple is lower the more competition there is among providers and the greater the number and variety of choices. Yet ethnic enclaves often suffer disadvantages in housing, sanitation, and security due to limited host government spending.

The emergence of such enclaves among immigrants depends not only on the *number* of migrants relative to the native population and their geographic concentration, but also on how *diverse* their languages are. A linguistically homogenous migrant inflow is more likely to generate a linguistic enclave than a similarly sized stream of migrants speaking a variety of languages. And living and working in a linguistic enclave is easier if the migrant's language is spoken by many in the destination. It is much easier to avoid or minimize contact with the destination language if neighbors and colleagues speak the

new migrant's language and if media, social contacts, and job networks are available in that language as well. For example, a newly arrived migrant Basque speaker in Germany would find few people to communicate with in Basque, but a newly arrived migrant Turkish speaker would find a large, well-established community of Turkish speakers.

Efficiency is the ability to convert exposure to a new language into greater proficiency. Age is a primary determinant of efficiency. Young migrants can acquire host country language skills more quickly and precisely than older migrants. Education increases efficiency in acquiring new languages, as it does with other skills. Another efficiency factor is linguistic proximity—

The probability of being employed increases with migrants' proficiency in the host country language.

how close the person's original language or mother tongue is to the destination language. For example, Italian is linguistically closer than Chinese to French, so Italian immigrants to France have an easier time than Chinese immigrants learning French.

Economic incentives are the final important factor affecting whether or how quickly a migrant becomes proficient in the host country language. The economic incentives to learn a language are stronger if a person expects a long and uninterrupted stay. Tourists and sojourners are less motivated than permanent immigrants to learn the destination language. The benefits from learning the destination language also vary by skill or schooling level. More highly skilled people tend to work in jobs that require destination language proficiency, but this is less important for those in many low-skill jobs. Immigrant engineers and technicians generally need a degree of proficiency in the destination language for their skills to be productive, but janitors and porters may not.

A first-generation problem

Fortunately, limited proficiency in the host country language is primarily a first-generation-immigrant problem. The use of the heritage language tends to disappear in successive generations, for better or for worse. Attending school and exposure to media in the host language, and playing with other children who don't speak the heritage language, hasten both the acquisition of the new language and the loss of the heritage language by the second or third generation. The disadvantage is that this decreases ties to a person's heritage and to relatives who did not migrate.

The children and grandchildren of immigrants can become fully proficient in the host country language while maintaining the heritage language. This is more likely if they grow up among family members and neighbors who speak the heritage language, if print and electronic media are available in that language, and if they stay in touch with relatives left behind. When children born in the new country live in enclaves, whether defined by geography or language, heritage languages tend to persist longer.

The downside is that these speakers often have lower earnings than monolingual English speakers. This has been found, for example, among men born in the United States who speak Spanish, Yiddish, Pennsylvania Dutch, or Native American languages at home as their second language in addition to English. The Spanish speakers have 20 percent lower earnings overall, and when other determinants of earnings—including schooling, age, and weeks worked—are the same, they still make 7 percent less.

Languages closely associated with the practice of a religious minority tend to persist longer in the destination country, even among second- and subsequent-generation descendants whose mother tongue is that of the host country.

The worth of a language

How important is it for labor market success to learn the language of the host country? The short answer is it matters a lot. The probability of being employed—and their earnings when employed—increases with migrants' proficiency in the host country language, along with how long they have lived in the country and their level of schooling, among other things. Proficiency's effect on earnings is estimated to equal about three additional years of schooling.

The more the skills—acquired in their country of origin—migrants bring with them match those needed for jobs in their new country, the higher their earnings. Earnings increase with length of time in the country, rapidly at first and then more slowly. This happens partly because migrants acquire credentials, networks, and experience relevant to their new labor market, but also because of improved language skills. Migrants might find employment in a linguistic enclave, but because there are fewer job opportunities their earnings tend to be much lower than in the general job market.

Tools for change

Public policy can influence a migrant population's language proficiency. It can do this by favoring the applications of immigrants who have already mastered the host country language, as in the case, for example, of English and French in Canada.

Policies that favor young adult and more highly educated immigrants who are not geographically isolated in migrant enclaves but live among the general population result in a more proficient and higher-earning immigrant population. Such policies have been successful in Australia and New Zealand. Policies that encourage permanent, rather than back-and-forth, migration—perhaps by encouraging immigration of entire families, promoting citizenship, or facilitating employment of the primary migrant's spouse—can enhance family income and discourage return migration.

Encouraging immigrant flows among migrants with exposure to the destination culture and language, such as residents of former colonies (as the United Kingdom has done), and with languages linguistically close to that of the destination also promotes proficiency.

In refugee immigration flows, the destination country may have little say in the choice of migrants, but public policy can still influence their language skills. Postmigration provision of

subsidized training in the destination language, emphasizing both speaking and literacy, naturally enhances the skills of new arrivals. The Israeli *ulpan* system of subsidized language training for the intensive study of Hebrew has been particularly successful. Such language training is voluntary, free of charge, and accompanied by stipends to support the enrollees and their families. It focuses on speaking and literacy skills for everyday living as well as employment-related skills and cultural acclimatization. The *ulpan* program is relatively expensive, but the payoff is large both for participants and for society as a whole.

Lessons for Europe

These policy recommendations are supported by numerous empirical studies for a variety of immigrant-receiving developed economies and have significant implications for the European countries accepting migrants today. The challenge to Europe is intensified by high unemployment rates and labor market restrictions.

Compared with North America and Australia, Europe does not have a particularly good track record when it comes to integrating migrants into its linguistic, social, and economic life. If the recent wave of newcomers from North Africa and the Middle East join linguistically homogenous enclaves, whether by choice or by government settlement policy, their linguistic isolation will persist. This has negative implications for people's economic prospects and raises the potential for criminal activity and radicalization.

Two types of training programs are needed: general training in the host country language and culture and job training to give migrants the linguistic skills and credentials they need in order to use previously acquired skills. Host countries need policies that validate previously acquired job-related credentials and reduce other barriers to employment without weakening domestic health and safety standards.

Many migrants will still lack the relevant skills for the technologically advanced economies of Europe and many will struggle to acquire the host country language. These difficulties increase with the age of migrants when they reach their final destination and the greater their geographic and social isolation from the job market—important considerations for policymakers.

Linguistic assimilation—acquiring proficiency in the destination language without necessarily abandoning one's heritage language and culture—is critical for the social, cultural, political, and economic integration of migrants, including refugees. And Europe can be more successful than it has been in promoting linguistic assimilation—if it has the will to do so. ■

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Ford workers producing new cars at plant in São Paulo, Brazil.

A RIDE in ROUGH WATERS

Raju Huidrom, M. Ayhan Kose, and Franziska L. Ohnsorge

Emerging markets buoyed the world after the global financial crisis, but are now in a major slowdown

EMERGING market economies were once conferred darling status. And seemingly rightly so. In the two decades after the mid-1980s, emerging markets, with their record-high growth, transformed the global economic landscape. Their resilience during the global financial crisis provided a much-needed anchor for the world economy. Emerging markets bounced back from the crisis when the majority of advanced economies went through historic recessions.

This striking story, however, has taken a somewhat different turn of late. Since 2010, growth in emerging market economies has slowed and, at 3.8 percent in 2015, is below its long-term average (see Chart 1). The current slowdown in emerging market economies is unusually synchronous and protracted and is comparable to earlier episodes of global turmoil. In particular, the current slowdown affects some of the

largest emerging markets—the diverse group of countries dubbed BRICS (Brazil, Russia, India, China, and South Africa)—with India the notable exception. The slowdown reflects easing growth in China, persistent weakness in South Africa, and steep recessions in Russia since 2014 and in Brazil since 2015.

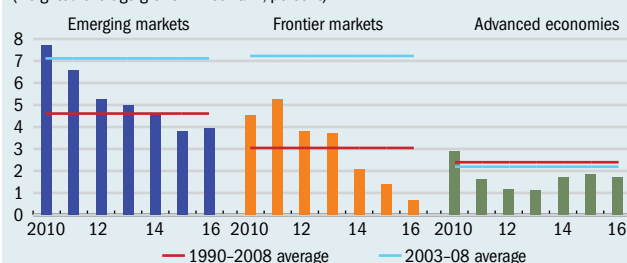
External and domestic as well as cyclical and structural factors have contributed to the slowdown in emerging markets. The growth

Chart 1

Heading down

Growth in emerging market economies began to slow in 2010.

(weighted average growth in real GDP, percent)



Source: World Bank, World Development Indicators, *Global Economic Prospects* (June 2016).

Note: Long-term average for frontier markets begins in 1993 because of lack of data before then. Countries categorized as emerging markets, frontier markets, and advanced economies can be found in World Bank (2016). GDP numbers for 2016 are forecasts.

slowdown, which began in 2011, was initially driven by external factors, such as weak world trade, low commodity prices, and tightening financial conditions. But since 2014 domestic factors—including a steady slowdown in productivity growth, bouts of policy uncertainty, and tighter government budgets that have made it difficult to stimulate economic activity—have become increasingly important. Decelerating potential growth—that is, the speed at which an economy could grow—accounts, on average, for one-third of the slowdown in emerging market growth since 2010. Much of the decline resulted from a slowdown in productivity growth, which, in part, reflects an aging population.

Widespread effects

The slowdown in major emerging markets could significantly hurt the rest of the world. An important reason is their size—these economies now account for a sizable share of global output and growth. During 2010–14, even though their economies were slowing, the BRICS accounted for about 40 percent of global growth, up from about 10 percent during the 1990s. They now represent more than one-fifth of global economic output—as much as the United States and more than the euro area. In 2000, they were responsible for about a tenth of global activity. China is by far the largest emerging market, twice as large as the other BRICS economies combined and two-thirds the size of the other emerging markets combined.

The rising importance of the BRICS in the global economy is also reflected in their increased participation in international trade and finance. In particular, cross-border economic links between BRICS and other emerging and frontier markets (those slightly less developed than emerging markets) have grown significantly since 2000 (World Bank, 2016). In addition to trade, the BRICS have begun to play a major role in a wide range of global financial flows—including foreign direct investment, banking and portfolio investment, remittances, and official development assistance. Furthermore, the BRICS—in particular China, and to a lesser extent India—are major sources of demand for key commodities. Slower growth in the BRICS could therefore affect other economies through trade and financial channels and through commodity prices.

We examine the extent of economic effects on other countries (or spillovers) from the current slowdown in the BRICS by looking at the size of global spillovers, the effect of individual BRICS on countries in their respective regions, and the implications of a slowdown that coincides with financial stress.

Global spillovers from the BRICS: We employ a set of simple economic models to quantify growth spillovers from the BRICS (Huidrom, Kose, and Ohnsorge, forthcoming). Our models trace the responses of growth in other economies to declines in growth in BRICS economies, after controlling for global activity and financing conditions and commodity prices. We use quarterly data from the second quarter of 1998 through the second quarter of 2015.

On average, a 1 percentage point decline in growth in the BRICS could, over the subsequent two years, reduce global growth by 0.4 percentage point, growth in non-BRICS emerging markets by 0.8 percentage point, and growth in

frontier markets by 1.5 percentage points (see Chart 2, top panel). Specifically, between 2010 and 2015, the slowdown in the BRICS accounted for a sizable share of the growth slowdown in other emerging and frontier markets.

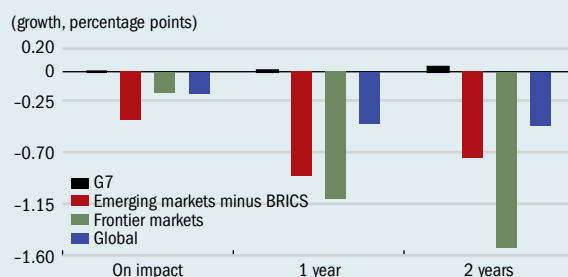
In contrast, the estimated impact on growth of the BRICS slowdown was on average negligible in the so-called Group of Seven (G7) countries—Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States. This reflects both policy actions to fight economic slowdown taken by G7 countries and their net oil-importing status. G7 central banks tend to respond to external shocks, including those from the BRICS, with accommodative monetary policies to encourage spending. Furthermore, as net oil importers, G7 economies tend to benefit from the lower oil prices induced by a BRICS slowdown.

Sizable as they are, spillovers from the BRICS affect other emerging and frontier markets less than spillovers from major advanced markets (see Chart 2, bottom panel). Stronger spillovers from G7 economies reflect their larger economic size. While the BRICS account for one-fifth of global GDP, G7 economies account for almost half. In addition, G7 countries account for a larger share of global trade and play a central role in global finance. Financial flows can quickly transmit shocks originating in G7 economies around the world. Thus, despite the rise of the major emerging markets, advanced economies remain the dominant player in the global economic arena.

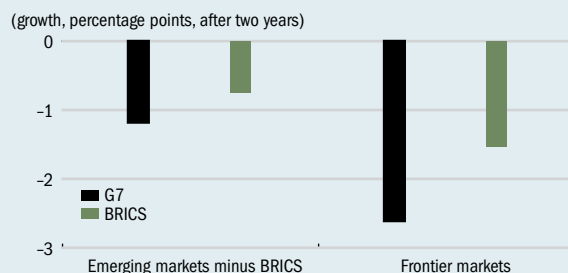
Chart 2

Hurting the world

A 1 percentage point decline in BRICS growth is felt in other countries.



But a 1 percentage point decline in G7 economies is more harmful.



Source: World Bank staff estimates.

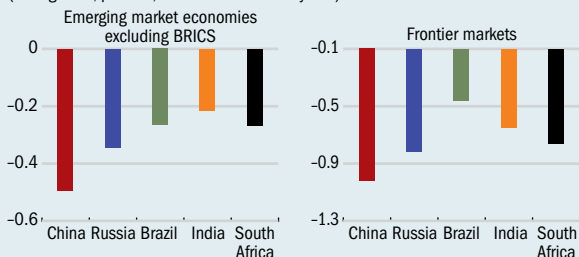
Note: BRICS = Brazil, Russia, India, China, and South Africa. G7 = Canada, France, Germany, Italy, Japan, United Kingdom, and United States. In the top panel, Global is the weighted average of all emerging market economies, frontier economies, and G7 economies. In the bottom panel, growth response is the cumulative response after two years. Estimates are based on data from 1998:Q2 to 2015:Q2.

Chart 3

Country by country

A 1 percentage point decline in China's growth hurts other emerging market and frontier economies more than declines in other BRICS economies.

(GDP growth, percent, cumulative over two years)



Source: World Bank staff estimates.

Note: BRICS = Brazil, Russia, India, China, and South Africa. China decline is 1 percentage point; other BRICS are calibrated such that their growth declines by exactly the same amount as China's at the end of two years. Estimated spillovers from India and South Africa to non-BRICS emerging market economies are insignificant. Estimates are based on data with a maximum coverage from 1998:Q2 to 2015:Q2.

Spillovers from individual BRICS: The magnitude of spillovers varies across the BRICS, but those from China are the largest (see Chart 3). On average, a 1 percentage point decline in China's growth could reduce growth in other emerging market economies by 0.5 percentage point and in frontier markets by 1 percentage point over two years. A similar shock in Russia would reduce growth in other emerging markets by 0.3 percentage point. Spillovers from Brazil to other emerging markets would be much smaller, and negligible to frontier markets. In general, estimated spillovers from India and South Africa to other emerging markets and frontier markets would be mostly negligible.

The BRICS include some of the largest and most regionally integrated emerging markets in their respective regions.

The difference in the magnitude and reach of spillovers from the individual BRICS reflects their size and integration. In current dollar terms, China's economy is more than four times the size of the next largest BRICS economy (Brazil); its imports are six times the size of Russia's; and its demand for key primary energy and metals is four to ten times that of India. The rapid rise in China's participation in global trade since it joined the World Trade Organization in 2001 has increased its potential to generate global spillovers.

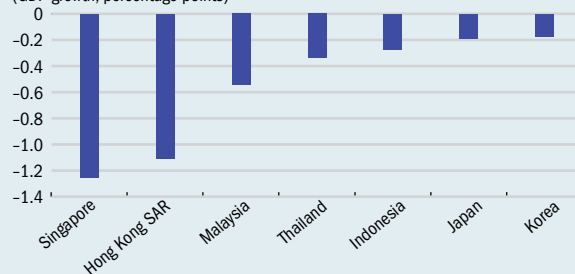
Commodity markets are a key avenue for transmission of spillovers from China to other emerging market and frontier economies. A growth slowdown in China, by reducing global commodity demand, could have adverse effects on commodity prices. As a result, growth in commodity exporters could slow by somewhat more than in commodity importers in response to a slowdown in China.

Chart 4

Regional punch

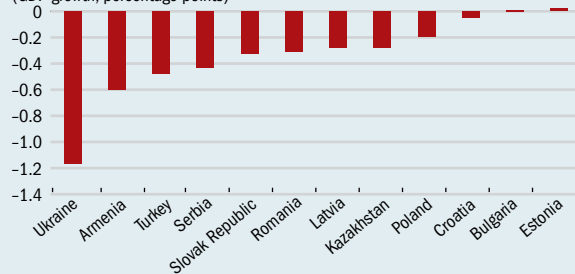
A 1 percentage point decline in Chinese growth hits its east Asian and Pacific neighbors hard.

(GDP growth, percentage points)



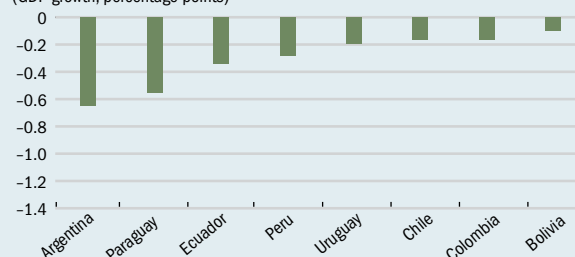
A 1 percentage point decline in Russian growth hurts economies in Europe and central Asia.

(GDP growth, percentage points)



But a similar decline in Brazil is less harmful to Latin American economies.

(GDP growth, percentage points)



Source: World Bank staff estimates.

Note: Bars represent cumulative growth declines at the end of two years in individual economies. Estimates are based on data with a maximum coverage from 1998:Q2 to 2015:Q2.

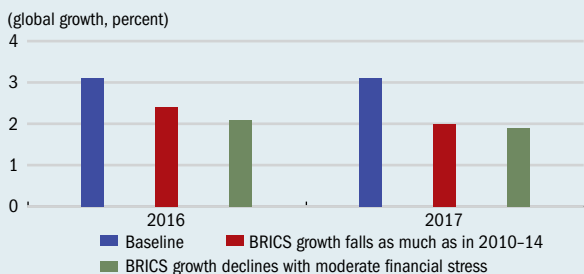
Despite the sizable spillovers from China, a simultaneous slowdown in the BRICS would have larger negative spillover effects than a slowdown in China alone and would deal a sharper blow to emerging market, frontier market, and global growth. Compared with China alone, these effects reflect the special role the broader group of BRICS plays. The BRICS include some of the largest and most regionally integrated emerging markets in their respective regions. Activity in trading partners of China that are also closely linked to BRICS in their region would face a double whammy.

Spillovers from individual BRICS within their respective regions: The BRICS drive much of the intraregional trade and are important sources of remittances from workers who migrate to the regional giant and send some of their earnings back home. As such, spillover effects from a growth slow-

Chart 5

Financial stress

Global growth could slow sharply in 2016 and 2017 if BRICS growth declines by as much as it disappointed during 2010–14 and global financial conditions tighten moderately.



Source: World Bank staff estimates.

Note: The baseline represents forecasts from World Bank (2016). Moderate financial stress is represented by the harsher conditions in financial markets during summer 2013, when investors worried about an increase in interest rates by the Federal Reserve, the U.S. central bank.

down in the BRICS could be particularly large within their respective regions:

China: Spillovers from growth fluctuations in China are sizable and affect a wide range of economies in the east Asia and Pacific region. A one-time 1 percentage point decline in China's growth is particularly harmful to growth in the trading hub of Singapore and in Hong Kong SAR (see Chart 4). Strong spillovers from China are transmitted primarily through trade channels: China is now the top trading partner of most major economies in the region.

Russia: In Europe and central Asia, there are strong regional trade and financial links, including through remittances, that are reflected in sizable spillovers from Russia. The estimates suggest that a 1 percentage point decline in Russian growth reduces growth in other countries in Europe and central Asia on average by 0.3 percentage point over two years (see Chart 4, middle panel). The estimated impact is larger in neighboring countries and countries in the South Caucasus.

Brazil: Spillovers from Brazil to neighboring countries in Latin America and the Caribbean are moderate. Growth declines in Brazil tend to have measurable or statistically significant spillovers in its South American neighbors (see Chart 4, bottom panel). Spillovers from Latin America's main trading partners outside the region, however, tend to be considerably larger than those within the region.

India and South Africa: Within-region spillovers in south Asia are generally small. Its integration with the global economy is low, and integration within the region is even more limited. Although within-region spillovers in sub-Saharan Africa are generally small, South Africa can significantly affect immediate neighbors that are tightly integrated through currency and customs unions.

In other words, the potency of spillovers varies across regions. In some, strong regional trade and financial links are reflected in sizable spillovers—for example, in Europe and central Asia from lower growth in Russia and in east Asia and the Pacific from a slowdown in China. Spillovers from Brazil, India, and South Africa to other economies within their respective regions are generally insignificant. For many coun-

tries, spillovers originating in distant major advanced economies overshadow within-region spillovers from their large emerging market neighbors.

Financial stress and the BRICS slowdown: Slower-than-expected growth in the BRICS could coincide with bouts of global financial market volatility. Even though any interest rate increases from the Federal Reserve are expected to proceed smoothly, have long been anticipated, and are associated with a robust U.S. economy, they nonetheless carry significant risk of financial market turmoil. Investor sentiment could deteriorate sharply on weakening emerging and frontier market growth prospects. As a result, risk spreads for emerging and frontier market assets could widen steeply and raise overall financing costs for those markets, further dampening growth.

A synchronous slowdown in the economies of the BRICS could have much more pronounced spillover effects if it is accompanied by such financial market stress. If BRICS growth slows further, by as much as it disappointed on average during 2010–14, and if financial conditions tighten moderately—as during summer 2013, when financial markets were upset by potential Federal Reserve tightening of monetary policy—global growth could shrink by about a third in 2016 (see Chart 5).

Mitigating spillovers

If the largest emerging markets sneeze, the rest of the world could catch a cold. The current slowdown in major emerging market economies could spill over significantly to the rest of the world through trade and financial channels given those economies' size and connection to the global economy. The spillovers would be more pronounced in a slowdown accompanied by financial market stress.

Policymakers must be ready to counteract painful spillovers from the slowdown in the largest emerging market economies. The appropriate policy response depends on country-specific features and the nature of the shock and spillovers: a cyclical downturn in the BRICS would generate temporary harm that could be mitigated by countercyclical fiscal and monetary policies such as spending increases and interest rate cuts.

A structural downturn in potential BRICS growth would require more permanent reforms. Because the recent slowdown in the BRICS was partly cyclical and partly structural, both countercyclical fiscal or monetary policy and structural reforms—in the BRICS and in other countries—could support activity. A fresh structural reform push focused on governance and labor and product markets could help lift growth prospects. ■

Raju Huidrom is an Economist, M. Ayhan Kose is a Director, and Franziska L. Ohnsorge is a Lead Economist, all in the Prospects Group of the Development Economics Vice Presidency of the World Bank.

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A Winning NOTE

Kazakhstan's tenge has won several awards for best currency design

Niccole Braynen-Kimani



Front of winning commemorative T 1,000 note.

MANY countries claim that their currency is appealing, but Kazakhstan has awards to back it up. In the two decades since the country introduced its own currency, the Kazakhstani tenge has won four first places and one runner-up in contests for the world's prettiest banknotes.

Kazakhstan declared its independence in December 1991, the last of the former Soviet republics to do so. But it did not create its own currency until two years later. It was still using the ruble in July 1993 when Russia abruptly issued a new national currency and old Soviet banknotes flooded Kazakhstan, driving up prices and creating shortages of products. To regain control of its economy, Kazakhstan issued its own currency in November 1993, at a rate of 500 rubles to the tenge.

Vertical appeal

The look of the national currency changed several times after 1993, and in 2006 the National Bank of Kazakhstan launched a new series that also became recognized as one of the most secure in the world. Designed by Mendybay Alin, the central bank's senior designer, the series was intended to

reflect the young country's growing self-confidence, a link between its past and future. The vertical orientation of the notes was dictated by the inclusion of the Bayterek tower in the new capital city of Astana. "Bayterek" comes from a Kazakhstani legend and means "tree of life." The notes in the Bayterek series also include an open palm to show the country's openness to the world, Alin says.

The T 10,000 note from the 2006 series started the winning streak when it was named best new banknote by the International Association of Currency Affairs (IACA) in 2007. Four years later the International Bank Note Society (IBNS) named the T 10,000 commemorative note—issued to celebrate 20 years of Kazakhstani independence—banknote of the year. In 2012, the new T 5,000 note won best in show, and again in 2013 the tenge took the top IBNS award, for a commemorative T 1,000 note.

The commemorative T 1,000 banknote stands out for its rich, warm-color hues and an elegant image of General Kul Tigin of the Second Turkic Kaganate, or empire, on the vertical front. On the horizontal back, a drawing of Turkic warriors on horseback is set against a monument with Turkic writing at Kul Tigin's memorial complex.



Reverse of the winning and runner-up tenge notes.



Front of the winning notes: T 10,000 (2006), T 10,000 (2011), T 5,000 (2012), and runner-up T 20,000 (2015).

In 2015, Kazakhstan's T 20,000 note had to settle for runner-up behind New Zealand's \$5 polymer note (see "Paper or Plastic," in the June 2016 *F&D*).

Kazakhstan's current series of banknotes carries a common theme. The front includes a gilded figure of the mythical bird *Samruk* atop Astana's Kazakh Eli monument, meant to depict the country's desire to develop and prosper. Each

note features doves, a universal symbol of peace, on the front; various depictions of national landmarks appear on the back. All notes carry images of the state flag and emblem and are printed in Kazakh and Russian.

Safety first

Not only are the Kazakhstani banknotes attractive, they are more secure than most.

A T 5,000 note issued in 2008 to commemorate the currency's 15th anniversary was the first to use color-shifting ink. The ink, developed by the Swiss firm SICPA Holding SA, is embedded as a flying eagle printed over a contrasting image of the sun. Microtext provides added security. Printed across an open palm, it reads *Қазақстан* (Kazakhstan) and bears a facsimile of the signature of Nursultan Nazarbayev, who has been president since independence.

Kazakhstan's T 20,000 note was the first banknote in the world printed on composite paper, which is stronger and more secure than standard note paper. It is produced by Landqart AG of Switzerland and was also used for the Swiss 50 franc note issued in 2016. ■



Other distinctive tenge notes.

Nicole Braynen-Kimani is on the staff of F&D.



WESTERN UNION



Western Union, Frankfurt, Germany: remittances from advanced economies like Germany often complicate monetary policymaking in recipient countries.

Transmission Troubles

Adolfo Barajas, Ralph Chami, Christian Ebeke, and Anne Oeking

Heavy inflows of remittances impair a country's ability to conduct monetary policy

MANY developing and emerging market economies are modernizing the way they conduct monetary policy to make it more transparent and forward looking, with more emphasis on exchange rate flexibility, an explicit inflation objective, and greater reliance on a short-term interest rate as the policy instrument.

But to be successful these countries must have an operable “transmission mechanism” that permits changes the central bank makes in the policy rate to propagate through the economy and ultimately affect spending decisions by households and firms. Several recent studies find that this transmission mechanism is missing or severely weakened in lower-income countries.

We have found the same weakened transmission mechanism in middle-income and emerging market economies that are major recipients of remittances—that is, money citizens living abroad send home to their families. That means policymakers in those economies should be aware of the difficulties they face in pursuing a fully modern monetary policy, and they may want to consider measures to strengthen the transmission mechanism or other approaches to help them conduct monetary policy.

Remittances are large and growing

International inflows of workers' remittances are a fixture in many developing and emerging market economies. Worldwide, official measures of these flows have been on a steady

upward trend, from negligible amounts in 1980 to approximately \$588 billion in 2015—\$435 billion of which were received by developing economies. As a source of foreign funds in recent years, workers' remittances have amounted to close to 2 percent of GDP on average for all emerging market and developing economies, while foreign direct investment (FDI) represented 3 percent, portfolio investment amounted to nearly 1 percent, and official transfers (foreign aid) were just over ½ percent. In 2014, some 115 countries received remittances equivalent to at least 1 percent of GDP, and 19 countries received 15 percent or more. Compared with private capital or official aid flows, remittances have been more stable—their cyclical volatility has proved to be appreciably lower—and they suffered a much milder contraction following the global financial crisis that started in 2008.

In some countries, remittances dwarf other external flows. For example, in 2015 in Jordan—among the top 30 recipients in recent years—remittance inflows amounted to about 9 percent of its GDP, more than 4 times FDI inflows and 3½ times private Eurobond placements.

While it is undeniable that remittances bring tangible benefits to the receiving country, supporting income and consumption of remitters' families back home, it is also to be expected that flows of this magnitude year after year would have sizable effects on the overall economy—not all of them necessarily beneficial. A survey of economic research (Chami and others, 2008) found that remittances have measurable effects on exchange rates, the sustainability of tax and spending (fiscal) policy, institutions and governance, long-term economic growth, and monetary policy. Several studies have shown that persistent inflows of remittances exert upward pressure on the long-term real exchange rate, which makes the goods that the recipient economy exports more expensive. Beyond their effect on exchange rates and tradable exports, these flows are a channel that can transmit shocks from remittance-sending to remittance-receiving countries, which links their business cycles. During the recent global crisis, for example, sharp downturns in advanced (sending) economies were transmitted to low- and middle-income (recipient) economies as workers were forced to cut back on the funds they could send to their families (Barajas and others, 2012). More recently, the decline in oil prices has resulted in similar transmission from oil-producing countries in the Persian Gulf to their corresponding recipient countries, mainly oil importers of the Middle East and North Africa region.

When it comes to fiscal policy, there can be both positives and negatives for a country that receives a large and steady stream of remittances over time. Remittances directly expand the tax base, which makes it easier for countries to maintain fiscal sustainability, in the sense of avoiding a situation of ever-expanding public debt. However, remittances can also skew the behavior of governments, in undesirable ways. First, and somewhat paradoxically, the very expansion in the revenue base could distort government incentives, lowering the costs of engaging in wasteful spending. Second, the supplemental income that remittances provide to households

increases their ability to purchase goods that substitute for government services and reduces their incentive to hold the government accountable.

Effect on monetary policy

Most studies exploring remittances presume a well-functioning financial system and an operable transmission mechanism, conditions that may not exist in those countries. In other words, the studies assume that when policymakers change a policy interest rate, the change is passed on effectively to other rates in the economy, ultimately affecting lending behavior by financial intermediaries and spending decisions by households and firms.

We explored whether this is an accurate representation of the monetary policy environment in countries that are major recipients of remittances. If the transmission mechanism is absent in recipient countries, then policymakers will face an additional difficulty in conducting independent and forward-looking monetary policy using an interest rate instrument (Barajas and others, 2016).

Remittance flows may have a hand in weakening governance.

For low-income countries, there is growing evidence that monetary policy transmission is substantially weaker than in advanced economies. While a variety of transmission channels may operate, Mishra, Montiel, and Spilimbergo (2012) argue that weak securities market development, imperfect integration with international financial markets, and highly managed exchange rates are likely to leave poorer countries with only one operable channel—bank lending. A change in the policy rate ripples through markets for short-term securities, ultimately affecting banks' cost of funds at the margin and thus their ability to lend to private entities, whether people or firms.

However, even the bank-lending channel may be seriously weakened if there is little banking competition, the quality of institutions is poor, interbank markets in which banks deal with each other are underdeveloped, and information is lacking about the quality of borrowers. These factors conspire to short-circuit the transmission of moves in the short-term policy rate to banks' cost of funds.

Remittances, which are common not only in low-income but also in a variety of middle-income and emerging market economies, can also affect the conduct of monetary policy, in two ways. First, remittances expand bank balance sheets by providing a stable and essentially costless source of deposits—because they are largely insensitive to interest rates. All other conditions equal, recipient countries tend to have larger banking systems. Thus, because the remittance deposits increase the amount of financial intermediation (the process of banks matching up savers and borrowers), remittances might be expected to contribute to stronger monetary policy transmission. After all, the more financial services are used

throughout an economy, the stronger the expected effect of fluctuations in bank credit on economic activity.

On the other hand, although banks might receive ample and virtually costless additional funding year after year from deposited remittances, that does not mean they will increase lending to the private sector one for one. Remittance-recipient economies—such as economies in most of the developing world—are often plagued by a number of problems, including a weak institutional and regulatory environment and a dearth of creditworthy borrowers. In fact, as we said, remittance flows may have a hand in weakening governance. This fragile lending environment reduces banks' willingness to lend beyond a very limited pool of "qualified" borrowers, a reluctance that the additional lendable funds do nothing to counteract. Banks in recipient countries, then, tend to hold larger shares of liquid assets, excess reserves, and government securities than banks in nonrecipient countries (see Chart 1). As a result, because banks are flush with liquidity, an interbank market—in which institutions in need of short-term funds borrow from those with excess balances—fails to develop. Because the policy rate is designed to affect the marginal cost of funds for banks, when there is virtually no interbank market, the effect of policy rate movements is weakened or nonexistent. The bank lending channel becomes impaired.

Weaker monetary transmission

Our empirical analysis confirms that, as remittances increase, monetary transmission through the bank lending channel weakens notably. Based on a sample of 58 countries worldwide between 1990 and 2013, we find that the strength of transmission, measured as the direct effect of a change in the policy rate on changes in bank lending rates, declines continuously as the size of remittances increases. In countries that do not receive remittances and have competitive banking

systems, nearly 90 percent of a change in the policy rate is transmitted to the bank lending rate. In contrast, in an economy that receives 5 percent of GDP annually in remittances, only about 4 percent of the same change to the lending rate is transmitted, even when banking systems are competitive. In fact, when remittances reach 7.6 percent of GDP, the policy rate has no effect on bank lending rates. If the banking system is not competitive, the turning point occurs at a much lower level of remittances—1.2 percent of GDP (see Chart 2).

The so-called trilemma policy framework posits that when a country freely allows capital to flow in and out of its economy and maintains a fixed exchange rate, its ability to conduct an independent monetary policy is seriously impaired. Attempts by policymakers to affect the domestic interest rate tend to induce rapid and large capital flows (either into or out of the country, depending on whether interest rates are raised or lowered) that ultimately undo the policy action. Our results suggest that a parallel trilemma may arise when remittances are present, but for a different reason. Unlike capital flows, remittances do not respond to changes in domestic interest rates. Their continued presence weakens monetary policy, not because policymakers cannot affect domestic interest rates, but because the authorities' policy rate is unlikely to be transmitted to decisions affecting domestic economic activity. Thus, remittance-recipient countries may opt to scale back plans for full monetary policy independence. In fact, research suggests that greater remittance inflows are indeed associated with greater intervention in foreign currency markets, whether to fully fix the exchange rate or manage its fluctuations.

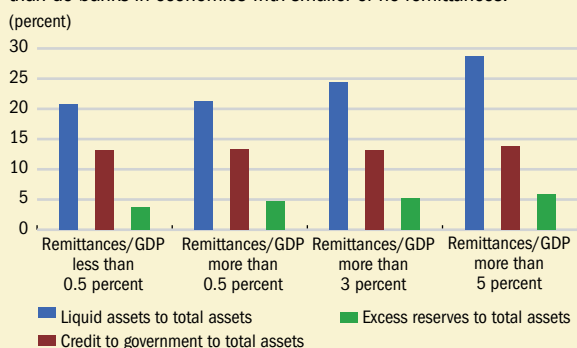
Policy options

This finding may lead to the conclusion that, short of abandoning monetary independence, a recipient country should target remittances, given that their continued presence is at

Chart 1

Cash flush

Banks in economies with large amounts of remittances tend to hold more liquid assets, government securities, and excess reserves than do banks in economies with smaller or no remittances.



Sources: IMF, *International Financial Statistics*; survey of central banks; and authors' calculations.

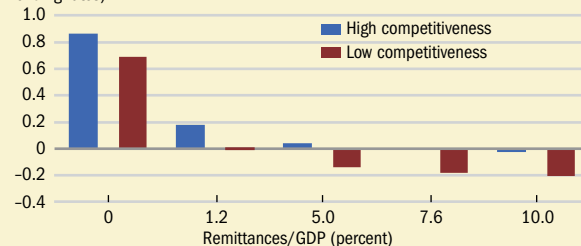
Note: Data cover the period from 1997 to 2007. Sample size varies from 101 countries for excess reserves to 112 countries for credit to government to 123 countries for liquid assets.

Chart 2

Stifling the signal

The greater the remittances and the less competitive the banking system, the less a change in the policy interest rate affects bank lending rates.

(amount of a 1 percentage point change in policy rate that flows through to lending rates)



Source: Authors' calculations.

Note: The results are based on a sample of 58 countries between 1990 and 2013. Competitiveness is based on the so-called Lerner index, which measures bank markup—the difference between bank output price and marginal costs. The higher the index value, the less competitive the banking system. Low competitiveness indicates country-years in which the Lerner index for the banking system was above the cross-country median, and high competitiveness indicates times when the Lerner index was below the median.

least partly responsible for weakening the impact of monetary policy. In particular, there might be a temptation to try to control or curtail remittance inflows. However, it would be impractical to enforce reductions in remittance inflows—transfers would not stop but would move to the parallel market—and curtailment would rob the economy of the poverty-reduction and insurance effects of remittances on the recipient households.

Instead countries could explore alternatives to short-term interest rates, while still moving to a more transparent and forward-looking framework. An option might be to require that the deposits (reserves) banks maintain with the central bank be high enough to become binding, thereby restoring some control over bank lending. Of course, this would come at the cost of a reduction in private sector credit. Another option might be to tax banks' excess liquidity (cash or assets that can easily be converted to cash, such as government securities), which would encourage them to lend more. However, such an approach might increase credit risk—what banks were trying to avoid by restricting their pool of borrowers.

The best approach would be to target the root factors—such as low institutional quality and lack of complete information about the dependability of borrowers—that cause banks to accumulate excess liquidity rather than expand private sector credit beyond their well-known borrowers. Realistically, however, this would take a long time to achieve. Structural reforms—such as enforcing property rights, enhancing the

rule of law, and combating corruption—could also play an important role. These measures would also help rein in fiscal deficits—reducing the need for governments to borrow from banks, which would free up resources to finance the credit-strapped private sector. ■

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Capital Buffers

Jihad Dagher, Giovanni Dell’Ariccia, Lev Ratnovski, and Hui Tong

How much capital banks need is an important public policy question

THE recent global financial crisis demonstrated how distressed banks can undermine the real economy that produces goods and services. What started as a financial sector problem—real-estate-related losses at banks and other financial intermediaries—quickly turned into an economy-wide problem, at first in the United States, then in other advanced economies.

The large losses banks incurred stirred fear about their soundness and led to the modern version of a bank run: large uninsured depositors and bank creditors running for the exit (Huang and Ratnovski, 2011). Governments had to inject massive amounts of cash and capital into the banking system to ensure that

the institutions had the funds needed to meet their obligations and a big enough buffer to keep them solvent.

Policymakers, economists, and regulators have long grappled with what steps could have been taken before 2007 that would have attenuated or even prevented the crisis—which triggered a global recession whose effects are felt even today. One possible measure would have been to require banks to have more capital.

Why banks need capital

A bank’s capital is the difference between the value of its assets and that of its debt liabilities (including deposits). In other words, it is the portion of the bank’s assets that belongs

to its shareholders. A bank's creditors and depositors are better protected from bank distress when the ratio of capital to total assets is high. There are a number of reasons for this. First, because equity holders are the most junior stakeholders in the bank, capital serves as a buffer that can absorb possible bank losses. Second, because equity holders indirectly control a bank's behavior, the bank is more likely to invest prudently when they have more at stake.

From an aggregate welfare standpoint, an optimal capital level is one that takes into account the cost and benefit of capital not just to banks but to the overall economy. Market forces provide incentives for banks to maintain a positive

A bank's creditors and depositors are better protected from bank distress when the ratio of capital to total assets is high.

level of capital. However, because bank shareholders do not internalize the bad effects a bank's failure might have on bank creditors, depositors, and the overall economy, they tend to want to hold far less capital than is seen as optimal from the society's point of view (De Nicolò, Favara, and Ratnovski, 2012). Accordingly, bank capital levels have long been subject to regulations that aim to bring them closer to the social optimum.

Early bank regulation—so-called Basel I, after the Swiss city where the international group of central bankers and bank supervisors convenes—required banks to have capital ratios of at least 8 percent. Capital ratios are computed by dividing capital—which includes shareholder equity, earnings banks retain rather than pay out to shareholders, and some forms of debt that can absorb losses—by assets that are weighted for risk. Weights are low, meaning less capital is required, for relatively safe assets such as government bonds and high for risky loans. In the early 2000s, bank regulation switched to Basel II, which enabled banks to use advanced customized risk weights for assets, rather than standardized ones, when determining how much capital they needed to hold. Basel II was agreed to several years before the global crisis, but had not yet gone into effect when the crisis spread globally in 2008. The crisis spawned yet another round of capital regulations, Basel III, which required banks to hold substantially more capital than under previous rules—at least 11.5 percent and up to 15.5 percent of risk-weighted assets. As an additional safeguard, Basel III introduced a simple leverage ratio (the relationship between core capital and total assets) and increased the required quality of bank capital (more reliance on equity and less on less tangible assets such as tax credits). Since Basel III was proposed in 2010, banks around the world have increased their Tier 1 capital ratio (the relationship between stockholder equity and retained

earnings to total assets) as well as the total capital ratio, which includes other forms of capital, such as subordinated debt (see Chart 1).

How much to hold

The postcrisis increase in required bank capital better equips banking systems to deal with losses. But there is an ongoing debate over the optimal level of capital.

Proponents of higher bank capital requirements emphasize the financial stability risks associated with high bank leverage (when banks fund themselves too much through debt and too little through equity) and the exorbitant costs of the crisis that need to be avoided in the future. They argue that requiring more shareholder equity would have little social cost (Admati and Hellwig, 2014). Opponents believe that higher capital standards would increase banks' funding costs and as a result the cost of bank credit, thus hindering economic activity (IIF, 2010).

We explored how much capital it would have taken to absorb bank losses entirely through bank equity and how much would have been required to avoid public recapitalization of banks (Dagher and others, 2016). The two concepts are different. Government intervention does not hinge on whether a bank fully depletes its capital, and governments often allow regulators to close failing banks, particularly smaller ones.

To figure out how much capital banks would have needed to absorb losses in past banking crises, we compiled data on the ratio of nonperforming loans, those that are not being repaid on time, to total loans in 105 banking crises since 1970 (based on data from Laeven and Valencia, 2013). We further used historical data on loan losses, provisions banks made to prepare for losses, and bank risk weights on those loans to determine how much bank capital would have been needed to absorb them.

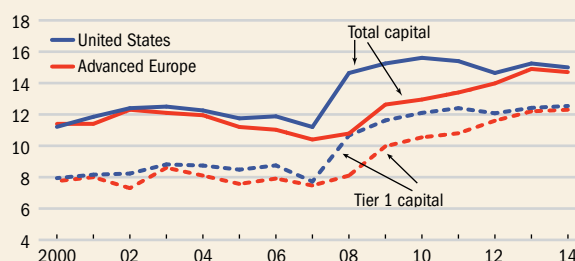
Chart 2 shows nonperforming loans as a percentage of bank assets during banking crises in advanced and emerg-

Chart 1

Bulking up

In recent years, banks in advanced Europe and the United States have been adding to their capital, especially Tier 1 capital—mainly shareholder equity and retained earnings.

(capital, percent of risk-weighted assets)



Source: Authors' calculations.

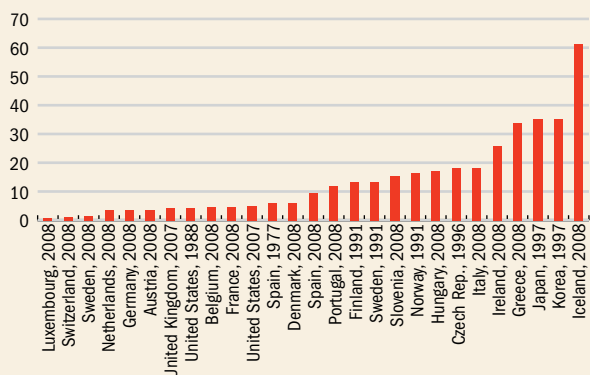
Note: Tier 1 and total capital ratios are year-end median values. The sample includes all listed banks whose total assets exceeded \$50 billion in 2006. Advanced Europe = Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom.

Chart 2

Potential problems

Nonperforming loans, those not being paid on time, represented a significant portion of bank assets in some advanced economies during financial crises.

(nonperforming loans, percent of total loans)



Source: Authors' calculations.

Note: The data cover countries that are members of the Organisation for Economic Co-operation and Development.

ing market economies that are members of the Organisation for Economic Co-operation and Development (OECD). Chart 3 shows the share of banking crises during which banks could have absorbed all losses through equity for various levels of hypothetical bank risk-weighted capital ratios. The blue line is a benchmark case in which 50 percent of the value of nonperforming loans ends up as loss; on the red line 75 percent turns into losses. What becomes apparent is that the marginal benefit of bank capital is initially high—up to 15 to 23 percent of risk-weighted assets for the blue and red line cases, respectively—but it declines rapidly after that. That is, additional capital is beneficial at first, but becomes almost meaningless above a bank capital ratio of between 15 and 23 percent—largely because extreme crises with substantially higher nonperforming loans are rare. For example, when capital ratios are at 23 percent or so, nearly the same percentage of crises are avoided as when capital is at 30 or even 40 percent.

Avoiding public recapitalization

Policymakers have learned that when it comes to financial crises inaction is not an option. History provides painful examples of the large economic costs of inaction or delay—such as in the United States during the Great Depression of the 1930s or during the Japanese crisis in the 1990s. That is why governments have often injected money into the banking sector during a banking crisis to improve bank capital ratios.

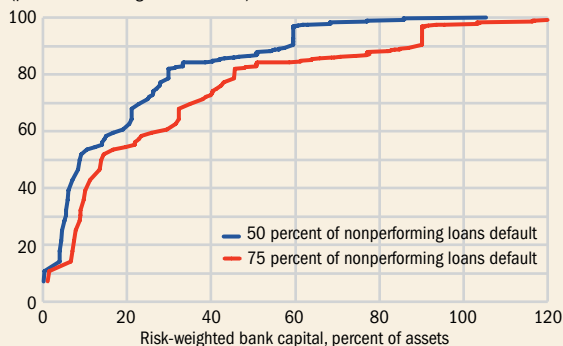
To assess how much capital would have been needed prior to a crisis to avoid having to use public funds to recapitalize banks, we assumed that recapitalization brought banks only to the minimum level of capital needed to restore viability. The level of precrisis bank capital that would have forestalled bank recapitalization is then the sum of the capital in place before the crisis and the postcrisis public capital injection

Chart 3

Crises avoided

Up to a point, higher levels of bank capital forestall banking crises, but after that point whether loan losses are 50 percent or even 75 percent of the value of total loans, higher capital levels have a marginal effect.

(percent of banking crises avoided)



Source: Authors' calculations.

Note: The data cover countries that are members of the Organisation for Economic Co-operation and Development. In risk-weighted capital, riskier assets, such as some types of loans, require a higher level of capital than relatively secure assets, such as government securities. The blue line represents a scenario in which 50 percent of nonperforming loans ultimately default. The red line represents a scenario in which 75 percent of nonperforming loans ultimately default.

tion (expressed in percentage points of bank capital ratios).

Chart 4 shows bank recapitalization expenditures during banking crises in OECD economies since 2007 as a percentage of risk-weighted assets. Chart 5 depicts the share of banking crises during which bank recapitalizations could

The marginal benefit of bank capital in terms of avoiding public recapitalization declines quickly after a certain level.

have been avoided for each level of hypothetical bank risk-weighted capital ratio. Strikingly consistent with our previous findings, we find that the marginal benefit of bank capital in terms of avoiding public recapitalization declines quickly after a certain level—in this case 15 to 17 percent of risk-weighted bank capital.

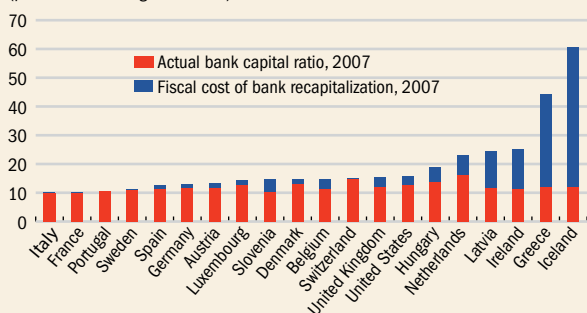
Our results suggest that bank capital in the range of 15 to 23 percent of risk-weighted assets would have been sufficient to prevent a large majority of past banking crises—at least for advanced economies. There are, of course, a number of caveats to our analysis. Notably, our results relate to levels of bank capital rather than minimum capital requirements. Banks tend to maintain buffers above minimum capital requirements and draw on those buffers during periods of stress. Moreover, although we focus on bank

Chart 4

Costs of crises

In some crises governments had to use public funds to put capital into banks to keep them from failing.

(percent of risk-weighted assets)



Sources: Bankscope; Laeven and Valencia (2013); and authors' calculations.

Note: The data cover countries that are members of the Organisation for Economic Co-operation and Development. Risk weighting requires assets that carry more risk, such as some types of loans, to have a higher level of capital than relatively secure assets, such as government bonds.

capital as a means to absorb losses, other instruments (such as debt that can be converted to equity) are also available to absorb bank losses during crises. Finally, we have focused on risk absorption, but more bank capital would also deter banks from taking risks in the first place, because potential losses for equity shareholders would encourage them to pressure management to behave prudently. These factors suggest that the desirable capital requirement level is lower than the range identified in our analysis.

Emerging market and developing economies

Emerging market and developing economies have, on average, suffered greater bank losses than those incurred in advanced economies during past banking crises. This is not surprising because macroeconomic shocks tend to be larger in these economies and credit less diversified, and institutional factors (such as weaker bank regulation and supervision) lead to higher levels of nonperforming loans and loan losses. On one hand, higher bank losses, all else equal, call for more capital to absorb them in these economies. On the other hand, emerging market and developing economies tend to have much smaller banking systems relative to GDP. So when bank losses exceed banks' ability to absorb them, the direct impact on the economy (and on sovereign spending accounts) might also be smaller. We find that if non-OECD countries had imposed capital ratios in the 15 to 23 percent range, losses exceeding the absorption capacity of capital would have been within 3 percent of GDP in 80 percent of banking crises.

Compared with Basel

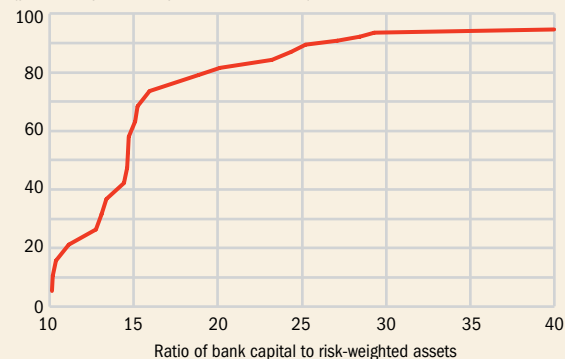
Although our ratios are slightly higher than the current Basel standards, they are broadly in line with the wider measure of *total loss-absorption capacity* for globally systemically important banks set by the multinational Financial Stability Board

Chart 5

Protecting the public purse

When bank capital reaches 15 to 17 percent of risk-weighted assets, the marginal benefits of additional capital diminish quickly.

(percent of public recapitalizations avoided)



Sources: Bankscope; Laeven and Valencia (2013); and authors' calculations.

Note: The data cover countries that are members of the Organisation for Economic Co-operation and Development. Risk weighting requires assets that carry more risk, such as some types of loans, to have a higher level of capital than relatively secure assets, such as government bonds.

for institutions that are so big and so intertwined with other major financial entities that their failure would have global consequences. It is up to bank supervisors in individual countries to judge the adequacy of the instruments added to Tier 1 bank capital to make up the total loss-absorption capacity—such as subordinated and convertible debt. If they determine that these additional instruments cannot provide robust loss absorption in crises, they may have to emphasize higher levels of bank capital. ■

Jihad Dagher is an Economist, Giovanni Dell'Ariccia is a Deputy Director, and Lev Ratnovski and Hui Tong are Senior Economists, all in the IMF's Research Department.

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Dollar Dependence

The move away from domestic dollar use ended in most emerging markets after the global crisis, but not in Peru

Luis A.V. Catão and Marco E. Terrones



People walking past Government House, Plaza de Armas, Lima, Peru.

DOLLARIZATION, the partial or full replacement of a country's domestic currency with a foreign currency, spread widely in the 1970s in Latin America, when high and hyperinflation robbed national currencies of their traditional roles as a stable medium of exchange and store of value. Households and firms in these countries began to use foreign currencies—typically the dollar—to save and to buy and sell big items like real estate.

The phenomenon eventually spread far beyond Latin America to become a generalized feature of financial sectors in many emerging market economies. By the early 1990s, the banking systems in Turkey and several economies in Africa, Asia, and eastern Europe routinely accumulated substantial dollar-denominated assets and liabilities. The possibility of dollar-denominated bank liabilities substantially exceeding dollar-denominated bank assets presented a serious risk to financial systems in the event of a large and sudden exchange rate devaluation or depreciation. Regulators and policymakers worried, rightly it turned out, that because dollars would be much more expensive after a devaluation or depreciation, the imbalance between banks' dollar-denominated liabilities and assets could trigger large losses and cause systemic financial instability. This asset-liability mismatch was behind some of the gravest financial crises in emerging market economies during the mid-1990s and early 2000s—including Turkey in 1994, Argentina in 1995, Russia in 1998, and Argentina again in 2001.

Dollarization began to subside in the early years of this century as economic conditions improved in many emerging market economies. Favorable terms of trade, more flexible exchange rates, and better economic policies—including the adoption of inflation targeting and greater fiscal discipline—helped keep inflation low and reduced the risk of abrupt currency devaluations in many of these economies. In recent years, however, large currency depreciations coupled with less-well-anchored inflation expectations and companies' greater exposure to dollar-denominated debt made it less likely that the move away from the dollar would continue, which appears to be what is happening. A broad look at international data since the global financial crisis shows that dedollarization has halted and even reversed in many emerging market countries. But notable exceptions are found precisely in the birthplace of modern financial dollarization—Latin America, where movement away from the dollar has continued. We look at the Peruvian experience in detail and find some key policy lessons that may be relevant for many other countries.

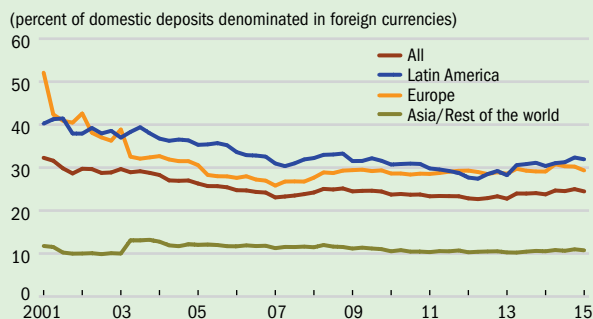
A global look

An examination of 28 emerging market economies over the past 15 years found moderately high financial dollarization in Europe and Latin America but relatively little in Asia and the rest of the world (see Chart 1). There are two common and diverging trends. The first is the persistent decline in dollarization (bank deposits in dollars or euros as a percentage of total deposits) from the beginning of the century until the eve of the global financial crisis in 2007; the second is the increase in dollarization in emerging Europe and a turnaround in dedollarization in Latin America starting in 2012.

Chart 1

A long farewell

From the start of the century until the global financial crisis, financial systems in emerging market economies moved away from using foreign currencies in place of domestic ones—a phenomenon that has ended but not fully reversed.

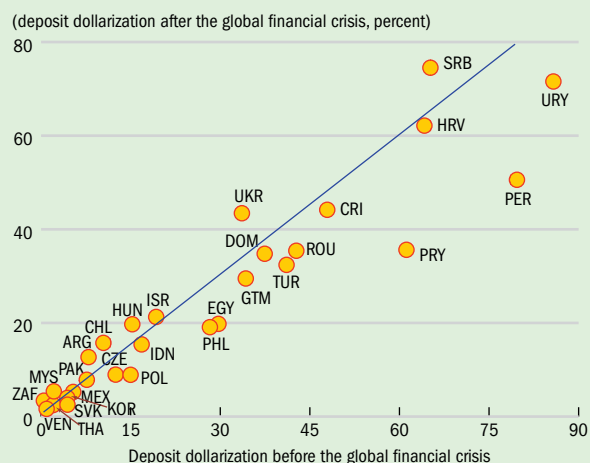


Source: Authors' calculations.
Note: Data cover 28 emerging market economies in Asia and the rest of the world, Europe, and Latin America.

Chart 2

Still ahead

The move away from foreign currencies that dominated the years before the crisis in emerging market economies exceeds the reversal that occurred after the crisis.



Source: Authors' calculations.
Note: Deposit dollarization is the percentage of deposits in a country's financial system that are denominated in a foreign currency. The period before the global crisis is 2000:Q1 through 2006:Q3; the period after the crisis is 2010:Q1 through 2015:Q4. Data labels in the chart use International Organization for Standardization (ISO) country codes.

Yet the regional averages mask considerable variation across countries. To unearth some of those differences, in Chart 2 we plotted the country-by-country breakdown before and after the global crisis. Countries that experienced increases in financial dollarization sit above the 45-degree line; those with declines sit below it. Most countries sit below the line, meaning that the dedollarization that occurred immediately after the crisis still exceeds any reversal after 2012.

Moreover, although there was little change in either the level or dispersion of dedollarization in Europe and Asia

and the rest of the world in the seven years before 2007 and the period after the crisis—2010 through 2015—this is not true in Latin America. Dedollarization continued there in the years after the global financial crisis, mainly because of continuing and sizable dedollarization in Paraguay, Peru, and Uruguay. These three countries were highly dollarized before the 2000s and experienced remarkable dedollarization in the run-up to the crisis. We will examine the experience of Peru, where the pace of financial dedollarization has been especially noteworthy.

Curbing Peru's dollar addiction

Peru's high dollarization in the 1990s was surpassed only by countries such as Ecuador and El Salvador that officially replaced their domestic currencies with the dollar. As shown in Chart 3, nearly 85 percent of bank deposits and 80 percent of bank loans in Peru were denominated in dollars by the late

By 2012, dollar-denominated bank deposits fell below 50 percent and dollar-denominated loans below 45 percent.

1990s. Although bank deposits in dollars were consistently higher than bank loans, both types of dollarization showed similar trends until about 2000. Then dedollarization proceeded spectacularly fast. By 2012, dollar-denominated bank deposits fell below 50 percent and dollar-denominated loans below 45 percent. Loan dollarization has continued to fall and reached 30 percent by the end of 2015, although dollar-denominated deposits have increased somewhat.

The important question for policymakers interested in engineering reduced dollar dependence in their countries is how to accomplish it. In the case of Peru, which can be used

as a guide, we found four main factors in the dedollarization process: the introduction of inflation targeting, the implementation of regulations that make it more expensive for banks to manage dollar deposits and make dollar loans, persistent real exchange rate appreciation, and favorable external conditions, such as high global commodity prices and low global risk aversion (Catão and Terrones, 2016).

Peru introduced *inflation targeting* in early 2002 in an attempt to control domestic inflation when much of the country's monetary aggregates was dollar denominated. The approach was to target inflation by setting a short-term policy interest rate for the domestic currency (the sol) while using unconventional instruments to control overall credit (much of which was dollar denominated) and dampen exchange rate volatility—which can be especially destabilizing in highly dollarized economies such as Peru's. Tax and spending (fiscal) policy was consistent with the implementation of these policies. Inflation targeting has done much to reduce loan dollarization in Peru because it helped bring low and stable inflation. Inflation averaged about 3 percent during the period 2002 to 2015 compared with 55 percent from 1991 to 2001. With adjustable interest rate loans, debt repayment in domestic currency is then more predictable than in foreign currency because inflation targeting is aimed at domestic inflation, not inflation in dollars. By the same token, to the extent that inflation targeting allows greater exchange rate volatility with respect to changes in inflation, it discourages foreign borrowing by firms whose revenue is not denominated mainly in dollars.

Higher reserve requirements

The second important element in dedollarization is *regulation*. Financial dollarization can be discouraged by taxing dollar lending and dollar deposits. One way to do that is to differentiate between dollar- and sol-denominated deposits and increase the amount of funds banks must maintain with the central bank (reserve requirements) for deposits in dollars. Because reserves generally earn below-market interest from the central bank, requiring banks to maintain them is equivalent to imposing a tax on these institutions equal to the interest forgone. On the lending side, regulations can also require banks to put aside more reserves to provide for losses from dollar-denominated loans than for those in domestic currency. The higher loan-loss provisions raise the marginal cost of dollar loans and should decrease new lending in dollars.

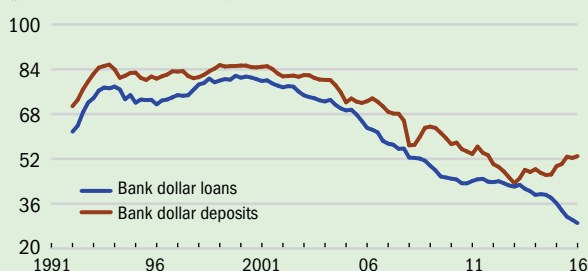
An economic analysis of the 1990 to 2014 period indicates that higher reserve provisions for dollar loans in Peru were especially effective at reducing both deposit and loan dollarization; in contrast, marginal reserve requirements on dollar deposits played a smaller, though still significant, role. In 2015, the Peruvian central bank pursued an aggressive program of loan dedollarization, including not only an additional increase in the marginal reserve requirements on dollar deposits but limits on car and mortgage loans in dollars as well. Those limits help explain the continuous decline in dollar loans relative to dollar deposits that started in 2015.

Chart 3

Shedding dollars

In the late 1990s nearly 85 percent of Peru's bank deposits and 80 percent of loans were dollar denominated. Dollar loans are now less than 30 percent. Dollar deposits have grown a bit since 2012 and are now about 50 percent.

(percent denominated in dollars)



Source: Authors' calculations.



Museum of the Central Reserve Bank, Lima, Peru.

Third, *allowing real exchange rate appreciation* appears to be an important step in reducing reliance on dollars, particularly when justified by economic fundamentals. To be sure, the decrease in dollarization as a result of appreciation of the local currency may be simply arithmetic: the ratio of dollars to total deposits tends to shrink when the exchange rate of the local currency appreciates. But there are likely some economic factors at work too. When the real exchange rate appreciates, the prices of goods that are traded internationally fall relative to prices of goods that are not tradable. Since nontradable goods earn revenue in domestic currency, purveyors of those goods typically prefer to borrow in local currency. This is not always the case, though, in emerging market economies, where an increase in the relative price of nontradable goods can lead to more dollar loans to the nontradable sector—real estate, for instance. But as inflation targeting stabilizes domestic inflation it becomes less attractive for banks to index those loans to the dollar.

We found that some of the Peruvian dedollarization of the 2000s was fostered by long-term appreciation of the real exchange rate. The reversal of deposit dedollarization observed since the end of 2014 is attributable in part to the depreciation of the Peruvian currency and to strong depreciation expectations in anticipation of normalization of monetary policy in the United States.

External forces

The fourth set of factors that mattered in Peruvian dedollarization concern *external forces*, such as higher commodity prices, which encouraged a shift to local currency loans and deposits for a variety of reasons. These include the boost that higher commodity prices give to economic growth. That boost to growth stimulates loan demand from the nontradable goods sector as it seeks to expand operations and also encourages confidence in domestic policies.

In a nutshell, domestic firms and consumers feel more confident about holding domestic currency.

But other external forces weigh against dedollarization. For example, bouts of risk aversion in world capital markets and higher external interest rates tend to be associated with an increase in financial dollarization. The prod for increased dollarization from such higher risk aversion is to be expected and works against the confidence engendered by high commodity export prices. To the extent that these global factors explaining dedollarization in Peru in the 2000s are also observed in other countries, they help shed light on the common emerging market trend since 2000 and the global slowdown in dedollarization after the crisis.

The significant *positive* effect of world interest rates on dollarization, however, is more puzzling. By lowering the cost of borrowing in dollars, the current low interest rate environment might be expected to boost the supply of dollar loans at home. But lower interest rates abroad might motivate firms that buy and sell tradable goods to borrow abroad rather than domestically, reducing demand for domestic dollar borrowing and lowering dollarization. In theory, the net effect of higher world interest rates on both deposit and loan dollarization is ambiguous. It depends on how high dollarization is to begin with and on the marginal costs of administering dollar and local currency accounts (Catão and Terrones, 2000). In a country like Peru, where initial dollarization was high, a reversal might be expected as global interest rates decline. Our economic analysis suggests that this effect has dominated in recent years.

The Peruvian experience highlights the importance of four factors in dedollarization—inflation targeting, regulatory requirements that make it more expensive for banks to take dollar deposits and make dollar loans, persistent real exchange rate appreciation, and favorable external factors, such as high global commodity prices and low global risk aversion. While some factors are particular to Peru, others seem to have broader significance (García-Escribano and Sosa, 2011; Mecagni and others, 2015). This evidence should be valuable to the design of policies aimed at reducing the dependence of a country's financial sector on foreign currency. ■

Luis A. V. Catão is a Senior Economist and Marco E. Terrones is a Deputy Division Chief, both in the IMF's Research Department.

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HIDDEN VALUE



Henri Konan Bédié Bridge, a public-private partnership, links the north and south of Abidjan, Côte d'Ivoire.

*Edward F. Buffie, Michele Andreolli, Bin Grace Li,
and Luis-Felipe Zanna*

Public-private partnerships have been criticized as too costly, but when the whole economic picture is considered, they look much better

PUBLIC-private partnerships to build and operate infrastructure assets are increasingly common in less developed economies (see chart). But they are also highly controversial. Case studies warn that public-private partnerships may be much more expensive than traditional procurement in which public agencies build infrastructure assets on their own (or outsource construction to a private supplier). Traditional procurement is commonly called *own investment* by the public sector.

The list of extra expenses incurred in public-private partnerships is quite long:

- The partnerships assign construction risk to the private partner to exploit the tight relationships between asset construction, quality of services, and the revenue the partner earns after operations commence—frequent blackouts, for example, reduce sales at poorly built power plants. But the private sector cannot spread risk as widely as the public sector; consequently, the return paid to the private partner is usually several points above the interest rate on government debt.

- The administrative costs of writing and tendering bids for complicated long-term contracts are often substantial, while limited competition and the difficulty of designing auctions that prevent collusive behavior are apt to result in inflated bid prices.

- Complex contracts, the impossibility of enumerating all contingencies in partnerships that last 20 to 30 years, and cumbersome legal systems often lead to repeated, costly renegotiations of the original contract.

- Even if the government bargains exceptionally well and minimizes bid, tendering, and renegotiation costs, it cannot avoid the extra cost of monitoring compliance by the private partner.

Half a picture

But the comparison of costs presents only half of the picture. The other half contains everything the private partner brings to the table: superior technical expertise, greater implementation capacity, and less pressure to meet political objectives—such as hiring more workers than needed and purchasing

from favored suppliers—that hinder efficiency (de Bettignies and Ross, 2004; Valila, 2005; Grimsey and Lewis, 2005). These advantages translate into shorter construction time (Monteiro, 2005; Sarmiento, 2010) and better, more productive infrastructure—power plants that supply electricity without spikes and frequent blackouts, roads that are usable year-round, and ports where cargo can be loaded and unloaded quickly. The critical issue is whether the gains in speed and efficiency compensate for the higher cost. In the language favored by government bureaucrats, do public-private partnerships offer enough “value for the money”? More precisely, do such partnerships offer better value for money than own investment by the public sector?

Typically, policymakers answer this question by calculating the direct return in the two investment programs. The *direct* return is simply the return on infrastructure (the increase in real GDP, holding other inputs constant, divided by the capital cost of the project) minus either the return paid to the private

If the difference in costs is not too great, public-private partnerships are preferable.

partner (including transaction and administrative costs) or the interest rate paid on external debt. In a head-to-head matchup, the comparison of direct returns often picks own investment as the winner—the higher-quality infrastructure available in the public-private partnership is not worth the extra cost.

The direct return is easy to understand and easy to calculate. For two reasons, however, it is rarely an accurate predictor of relative social returns. First, *higher on-time completion* by public-private partnerships is a big plus in low-income countries plagued by acute bottlenecks in transportation, power, telecommunications, and irrigation. When projects pay a 25 percent return and can be financed at 10 percent, it is best to complete them as fast as possible. Second, in most investment programs, *the government aims not only to improve the country’s infrastructure but also to stimulate private investment*

and to reduce unemployment, underemployment, and poverty. When these additional objectives are taken into account, the social returns to public-private partnerships and own investment diverge dramatically. (The social return is the increase in national income adjusted to reflect the value policymakers place on poverty reduction.) Because public-private partnerships generally build better, higher-quality infrastructure than own investment, they raise the return on private capital more and increase the demand for labor more. Consequently, *if* the difference in costs is not too great, public-private partnerships are preferable because they are more effective in reducing underinvestment, unemployment, and poverty.

Choosing the right approach

But it is difficult for policymakers to assess whether the social returns from faster construction and better-quality infrastructure outweigh the higher costs of public-private partnerships.

We built a dynamic macroeconomic model that helps them do that. The model tracks the interactions between public investment in infrastructure, private capital accumulation, unemployment, and real wages. Growth in the stock of infrastructure—whether an airport, a power plant, or an irrigation project—raises social welfare *directly* by increasing total factor productivity (the rise in output not directly attributable to increases in inputs such as labor and capital) and *indirectly* by stimulating private investment and creating more and better jobs. The model uses empirical estimates for developing economies to determine the impact of infrastructure on total factor productivity and how much the real wage rises when unemployment falls.

Welfare depends on consumption today, tomorrow, and in the distant future. To measure the overall welfare gain, we calculate the permanent increase in consumption that yields the same increase in welfare as the actual path of consumption in the investment program. A welfare gain of 10 percent, for example, means that the fluctuating path of consumption in the investment program increases welfare by the same amount as a permanent increase in consumption of 10 percent starting today.

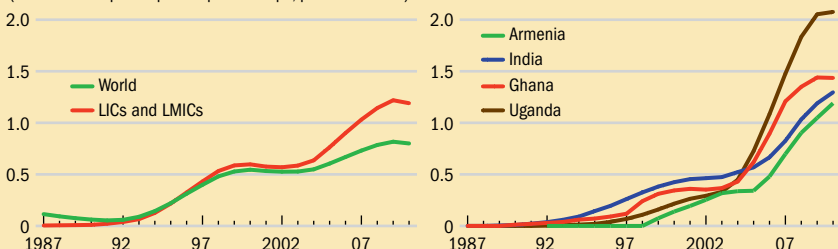
Policymakers must determine the point at which the welfare gain from the public-private partnership exceeds that of own investment. The break-even point depends on numerous factors, including policymakers’ social objectives.

The table illustrates how the model can help policymakers make the right choice. It shows the welfare gain from public-private partnership divided by the welfare gain from own investment under alternative assumptions about the labor market, the speed of construction, and the importance of wage income relative to increases in income per capita. In the case of own investment, we assumed that the government borrows in the Eurobond market at 6 percent and that infra-

Growing apace

Investments in public-private partnerships have risen sharply in the past two decades, especially in developing economies.

(investment in public-private partnerships, percent of GDP)



Source: IMF, Investment and Capital Stock Dataset.

Note: All data are in five-year moving averages. LIC = low-income country. LMIC = lower-middle-income country.

How to choose

When the ratio of the welfare gain from a public-private investment to that from own investment on an infrastructure project exceeds 1, policymakers should choose the partnership, even though on a direct-return basis the return from traditional procurement is higher.

	Difference in direct return between own investment and public-private partnership, percentage points					Break-even ratio
	0	0.02	0.04	0.06	0.08	
Scenario 1: Ratio when there is full employment but speedier construction by public-private partnership	2.20	1.82	1.45	1.07	0.69	0.064
Scenario 2: Ratio when there is unemployment	1.27	1.13	1.00	0.87	0.73	0.040
Scenario 3: Ratio when the welfare weight on wage income is 50 percent higher than the weight on average income	1.35	1.23	1.11	1.00	0.88	0.060
Scenario 4: Ratio when the welfare weight on wage income is 100 percent higher than the weight on average income	1.38	1.28	1.17	1.06	0.96	0.072

Source: Authors' calculations.

Note: Direct return is assumed to be 10 percent for own investment. It varies from a net of 10 percent to 2 percent for the public-private partnership. The direct return is the net increase in GDP divided by the capital cost of an infrastructure project minus either the return paid to the private partner (including transaction and administrative costs) or, in own investment, the interest paid on external debt. Welfare gain is the permanent increase in consumption generated by an investment program. The break-even ratio is the point at which the welfare gain from public-private partnership exceeds that of own investment, even though the direct return seems to favor own investment.

structure earns a return of 16 percent. The direct return, then, is 10 percent for all own investment.

In the competing public-private partnership, the *borrowing rate*—the annual return paid to the private partner plus all transaction and administrative costs—is 15 percent, while the return on infrastructure ranges from 17 percent to 25 percent. The corresponding range for the direct return, then, is 2 percent to 10 percent. With own investment assumed to return 10 percent, the comparison of direct returns alone strongly favors own investment: the *direct return gap*, the difference between the direct return from own investment and the direct return from the public-private partnership, ranges from zero—when the direct return from both is 10 percent—to as high as 8 percentage points—when the direct return from public-private partnerships is 2 percent. The case for choosing public-private partnerships over own investment therefore rests entirely on more favorable effects on completion time, private investment, job growth, and real wages that offset its lower direct return.

Several scenarios

The table reports results for four different scenarios. In the first, there is full employment but investment projects in the public-private partnership reach the 50 percent completion point in 25 percent less time than own-investment projects. The other three scenarios assume the same speed of construc-

tion in public-private partnerships and traditional procurement, but allow for unemployment and different welfare weights for wage income and average income. In the unemployment scenario, the government ignores effects on income distribution; in the third and fourth scenarios, it values a dollar increase in wage income 50 to 100 percent more than a dollar increase in average household income.

What is striking is that many of the ratios exceed 1, meaning that public-private investment increases social welfare more than own investment, *even when the direct-return gap is large*. Faster construction speed alone increases the break-even value of the direct-return gap—that is, the point at which a government would have no preference between investment approaches—from zero (the value in the comparison of direct returns when both return 10 percent) to 6.4 percentage points. In other words, a public-private partnership with a direct return greater than 3.6 percent generates a larger welfare gain than own investment with a direct return of 10 percent, once the difference in speed of construction is taken into account.

In the model with unemployment and the same speed of construction, the break-even value ranges from 4 to 7.2 percentage points depending on the weight of wage income relative to average income.

The lesson is that policymakers ought to look beyond direct returns when evaluating the merits of public-private partnerships versus own investment. Public-private partnerships are undeniably expensive. But they are competitive with traditional procurement if they enable the public sector to build infrastructure faster and of higher quality. A public-private partnership that pays a modest direct return of 2 to 5 percent may generate a higher social return than own investment that pays a direct return of 10 percent. ■

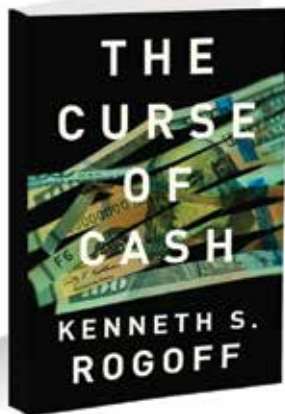
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This article is based on the authors' 2016 IMF Working Paper, No. 16/78, "Macroeconomic Dimensions of Public-Private Partnerships."

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A Barbaric Relic



Kenneth S. Rogoff

The Curse of Cash

Princeton University Press, Princeton, New Jersey, 2016, 248 pp., \$29.95 (cloth).

The Johns—Law and Keynes—strove to defenestrate gold, and they rather liked fiat paper. But advances in payment technology have always driven both new payment media and monetary theory. Technology is such that physical media *can* now mostly be abandoned in wired societies. In *The Curse of Cash*, Kenneth Rogoff passionately presses the case that they *should* be eliminated because the social ravages of paper currency far outweigh the benefits.

If such a plan is ever fully implemented, this book will have been at least its initial, if not ultimate, blueprint. Meticulously written, it covers everything needed for such a monetary reform. But the book is not excessively polemical. Rogoff details almost all the arguments against tinkering with paper currency, then labors to refute or defuse them.

The plan allows for both macroeconomic reform and possibly massive confiscation of illicit cash. Its boldness in these dimensions reminds me most of the Colm-Dodge-Goldsmith Plan of 1946 for German monetary reform. But, to state my doubts up front, given that precursor, I am skeptical that it can ever be implemented without an occupying army or a totalitarian regime that forecloses the issuer's geopolitical aspirations.

Critiques against today's currency denominations have become a cause célèbre for senior academic economists. Foremost, high denominations are the lifeblood of the underground economy. At a minimum, Rogoff and others want to eliminate large denominations like \$100, €500, and Sw F 1,000 notes.

Eliminating paper currency would have numerous desirable effects, including reduced tax evasion for high-volume cash and off-book businesses and unreported wages. Terrorists, human traffickers, drug dealers, gunrunners, corrupt politi-

Rogoff and others want to eliminate large denominations.

cians, and dictators would risk confiscation of their cash or at least disruption of their activity.

What of lost privacy in personal transactions? That ship has already sailed in a society with ubiquitous video surveillance, U.S. National Security Agency snooping, and massive data gathering by social media and other hackers. Will the illicit activities simply find alternative mechanisms? What of the socially positive uses of underground cash? People in egregiously run economies would lose an avenue to escape hyperinflation. A large unbanked population needs physical money, and people need cash when power outages disrupt electronic transactions.

To address these objections, Rogoff suggests workarounds. He compiles evidence that the social gain to currency elimination would outweigh the loss, but concedes that it is a judgment call. A relentless prosecutor, he loads the indictment with every conceivable crime: paper currency is a vector for disease!

But he neglects a crucial rationale for high denominations. Great-power currency and financial instruments play a dual role: they are tools of economic and financial policy and conduits of geopolitical power. There is

tension between them. Maintained at great economic cost, the euro makes little sense outside the geopolitical sphere. Disadvantaging itself economically, the dollar system, including paper currency policies, has focused ever more on geopolitical goals. For example, to overthrow the Taliban, U.S. agents delivered blocks of \$100 notes to mercenary tribal armies to get them to switch sides. Stanford University economist and former Treasury Under-Secretary John Taylor has recounted how the United States flew in bales of \$100 notes to pay the Iraqi bureaucracy prior to currency reform. Sometimes dictators are paid to support the interests of high-denomination issuers. If the United States and Europe eliminated their currencies, they would have to buy even larger plane loads of 100 yuan notes for such national security operations. This is enough to convince me that paper denominations high in real value will endure.

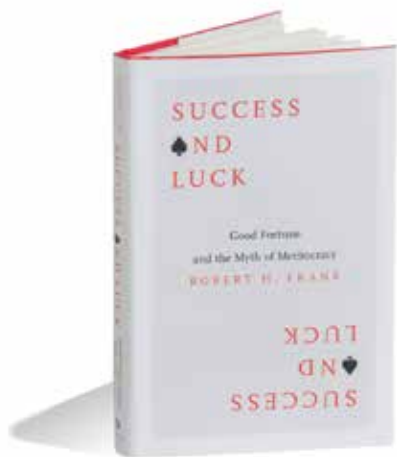
Even the European Central Bank's plan to stop issuing €500 notes will do little to reduce the outstanding stock in the near future and seems geared to increase it. On a contrary tack, the United States ceased issuing denominations higher than \$100 in 1969 to preclude their illicit use. Subsequent inflation has increased by sevenfold the weight of \$100 notes needed to service a kilo of cocaine. Inflation is doing Rogoff's work without requiring explicit action!

But if a logistical headache for money launderers is Rogoff's true goal, why not simply increase the physical dimensions of high-denomination notes without jumping through the flaming hoop of elimination? Before 1929, U.S. currency was 40 percent physically larger than it is now. Restoring that size or making it even larger would instantly work the wonders of decades of inflation. The iron law for subverting illicit economies: a percentage increase in physical note size is equivalent to the same percentage increase in the price level.

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When Winners Don't Take All



Robert H. Frank

Success and Luck

Good Fortune and the Myth of Meritocracy

Princeton University Press, Princeton, New Jersey, 2016, 187 pp., \$26.95 (cloth).

In their 1995 book, *The Winner-Take-All Society*, Philip Cook and Robert Frank looked at the competition for fewer and larger rewards in winner-take-all markets. They postulate that these markets—in which the best performers capture the most rewards, leaving remaining competitors with very little—have led to spiraling income inequality, higher consumption spending, and perhaps, with their emphasis on winners only, a dilution of culture itself. Since that book's publication, Frank has been a strong proponent of the idea that a progressive consumption tax might end the income inequality spiral and divert funds from consumption spending to saving and investment.

His latest book, *Success and Luck*, follows naturally from his earlier work. It is a compelling discussion of how winner-take-all markets work, the rising income inequality and “expenditure cascades” in these markets, the economic need for winners to acknowledge the role of luck in such markets and thereby be willing to share their winnings for the common good, and how a change in tax policy might ameliorate some of these problems.

Frank, a professor of management and economics at Cornell University, argues that talent and hard work alone do not necessarily lead to proportional success in the market. Chance events such as being born into the right family (the influence of genes and early family advantage) or the right country (the influence of the physical, financial, cultural, and educational environment) also contribute greatly to success.

The effect of these chance events, or luck, is magnified in winner-take-all markets, he says. The winner, who may be only slightly better than the second best, takes all, thanks to open markets, most people's inability to choose among competing options because of a lack of time and energy, and the network effects of social media. Thus, rewards depend more on relative than absolute performance (think of the incentives for athletes to dope!), and rewards are highly concentrated in the hands of a few. Winners then lobby government to lower top tax rates and reduce regulations, which leads to spiraling income and wealth inequality.

One interesting implication is that as the wealthy spend more, those in lower income tiers also spend more—what Frank terms the positional arms race. The idea of what is “adequate” keeps changing with rising income inequality (reminiscent of Amartya Sen's influential essay *Poor, Relatively Speaking*). For those with lower incomes, this creates inordinate financial distress.

Frank then introduces the role of luck in winner-take-all markets. Using simulations, he illustrates why the biggest winners are almost always lucky—when all competitors are extremely talented and hard-working, winning requires almost everything to go right. Drawing on behavioral economics and experiments in psychology, Frank shows that winners themselves tend to downplay the role of luck. The notion that they worked hard is cognitively more “available” than

the notion that they were lucky. And downplaying the role of luck encourages more hard work and effort.

Frank claims that there is an economic cost to underestimating the importance of luck. Winners who believe they have a legitimate claim to their winnings become reluctant taxpayers, making it more difficult to raise revenue for economic invest-

There is an economic cost to underestimating the importance of luck.

ment. Those who acknowledge luck's role in their lives are more likely to feel grateful for their success—and to share their winnings to support the common good.

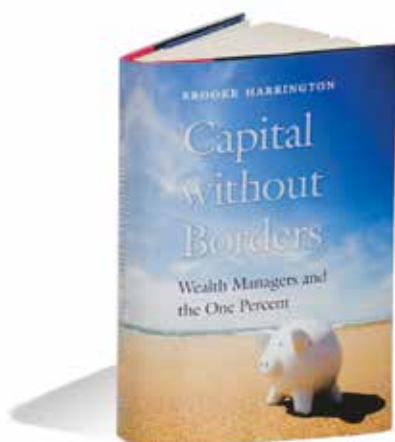
Finally, Frank argues that a change in tax policy—replacing the current progressive income tax with a much more steeply progressive consumption tax—could increase saving and investment and reduce spending. He shows evidence of both conservative and liberal interest in such a tax and provides examples of how it could be implemented.

Given the rising concern with income inequality during this U.S. election season, the tenuousness of the U.S. federal government's budget as baby boomers retire, and the urgent need for infrastructure investment, this book could not be more timely. It is not just another tax proposal; the author has deftly constructed a coherent framework for understanding some of society's most pressing issues. It is a quick and thought-provoking read—and provides far more economic insight than its title suggests.

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Control the Manager



Brooke Harrington

Capital without Borders

Wealth Managers and the One Percent

Harvard University Press, Cambridge, Massachusetts, 2016, 358 pp., \$22.95 (cloth).

Best-selling author John Grisham is famous for his detailed research before he even sits down to write a novel. Sociologist Brooke Harrington, the author of *Capital without Borders*, took the even more immersive approach of ethnography to try to understand wealth managers, who, she argues, helped create today's enormous wealth inequality. Eight years of research, including earning wealth management credentials and conducting 65 interviews with wealth managers in 18 countries, have allowed her to lift the veil of the wealth management profession.

The history of wealth management goes back to the medieval era, when a landowner away on military service would transfer the title of his assets to a trust. The process of recognizing trustees as professionals started later, in the 19th century. In the past 20 to 25 years, protection of wealth from taxes and other regulatory authorities has become a worldwide business, requiring coordination among banks, law firms, and accounting firms. Harrington argues that this change demands a new kind of professional expertise serving transnational and

hypermobile capital and clients. Established in 1991, the Society of Trust and Estate Practitioners, known as STEP, counts 20,000 such experts.

Harrington finds that wealth managers have been innovative in developing tactics and techniques that help their clients benefit from legal loopholes and conflicting rules in cross-border transactions (so-called regulatory arbitrage) to minimize tax payments, protect assets from creditors or divorced spouses, and transfer wealth to future generations. The use of offshore financial centers—which shelter trillions of dollars in private and corporate wealth—has become an essential component of wealth management plans for corporations and individuals. Wealth managers place each asset in the jurisdiction most favorable to the client's interests and disperse these assets as widely as possible. Some even draft laws on behalf of foreign governments to enable them to attract more investment from abroad and have mocked Bill Gates's failure to set up Microsoft overseas.

While the profession tends to regard tax avoidance as a form of self-defense against the excessive exercise of government authority, the vast majority of wealth management practitioners avoid criminal acts at all cost, says Harrington. But that does not stop them from adopting strategies that, albeit legal, are socially destructive. It is “a game of playing cat and mouse with tax authorities around the world,” says one wealth manager.

Harrington identifies two ways the work of wealth managers exacerbates inequality: by keeping wealth in families for generations and facilitating tax and debt avoidance. Dynastic wealth endures through the intervention of these professionals, contributing to 0.7 percent of the global population holding 41 percent of the world's wealth. Wealth managers' skillful use of trusts and other structures also reduced public awareness of this extreme concentration of economic power.

However, dark clouds are rapidly gathering in the world of the ultrarich

and wealth managers, Harrington tells us. In April 2009, Group of 20 (G20) top industrial economy leaders took action to end the era of bank secrecy. This initiative improved countries' capacity to tackle tax evasion through offshore financial centers and banking secrecy. All financial centers committed to comply with the international

“It is a game of playing cat and mouse with tax authorities around the world.”

standards on tax transparency or risk being labeled as noncooperative jurisdictions. Automatic exchange of information is to start by 2018 at the latest. Countries must also provide information on beneficial owners.

But financial secrecy and opacity are far from dead, writes Harrington. New constraints will engender new financial-legal innovation, or “creative compliance,” as wealth managers reorient their services to conform to the law. Harrington concludes by suggesting a shift in attention from the wealthy who want to hide their assets to the professionals who make it happen. “The goal should be to encourage wealth managers to apply their formidable legal, organizational, and financial skills in ways that are less harmful—or even beneficial—to states and societies,” she says.

A useful volume for tax policymakers and tax inspectors, the book is also timely: the leak of documents from Panama-based law firm and corporate service provider Mossack Fonseca—known as the Panama papers—led the G20 to improve transparency and exchange of information to stop tax evasion and avoidance by offshore financial centers.

Kiyoshi Nakayama

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