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Raghuram Rajan

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The Two Faces of Liquidity

Raghuram Rajan*

It has been about 10 years since the global financial crisis. What have we learnt about it? The behavior of financial-sector participants was clearly aberrant, and needed to be rectified. We have had a tremendous amount of regulation since then, especially focused on banks. Whether this will solve the underlying problems is an issue that is much debated. Yet we have at least attempted to tackle the problems of poor incentives and distorted financial firm capital structures, including mismatched asset-liability structures.

We have paid far less attention to the shadow financial sector — the financial institutions other than the banks — or to the role of macroeconomic conditions in precipitating the crisis. We do acknowledge the need to bring the shadow sector under the regulatory net, for we did learn that institutions can infect one another through common markets. We are less clear about what ought to be done. On macroeconomic conditions, even when we do acknowledge a role, when it comes to altering policy, we shrug and move on. Somehow, it seems that we have agreed that macroeconomic conditions are outside the remit of anyone tasked with addressing financial stability. I will argue in my talk today that this is a mistake.

*Raghuram Rajan *is the Katherine Dusak Miller Distinguished
Service Professor of Finance at the University of Chicago's Booth School
of Business. He served as the 23rd Governor of the Reserve Bank of
India between September 2013 and September 2016, and was chief
economist and director of research at the International Monetary Fund
2003–06. He delivered the 2018 Martin Feldstein Lecture, based
on this article, at the NBER Summer Institute on July 10, 2018. The
lecture is named in honor of the NBER's president emeritus.

The IMF Financial Conditions Index, 1991–2017

Median cross-country measure of financial conditions

Easing   *Easing*

Tightening
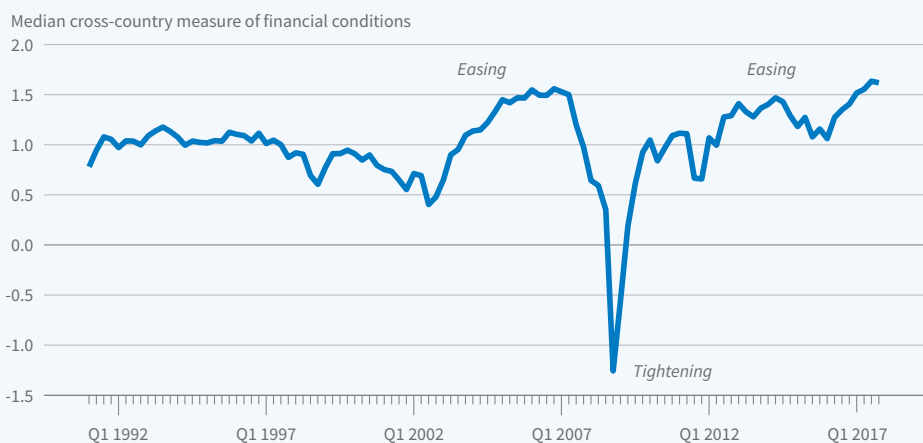
The Financial Conditions Index is an internationally representative composite of various economic indicators
Source: The International Monetary Fund

Figure 1

Financial Conditions and Monetary Policy

Figure 1, computed by the IMF, is the median at every point in time of the distribution of financial conditions across countries, with higher being easier.[1]

What we see is that leading up to the financial crisis, we have a tremendous easing of financial conditions, even though the Fed started raising the federal funds rate in June 2004. As the crisis spread in 2007, we had an extremely sharp tightening of financial conditions. By the middle of 2009, you see financial conditions easing once again, and they have continued to become much easier.

Now consider two figures from the work of Angela Maddaloni and José-Luis Peydró.[2]

Figure 2 suggests that monetary policy in the Eurozone was very accommodative before the crisis, as measured by Taylor rule residuals (the difference between policy rates and rates suggested by the Taylor rule, an empirical description of how policy is ordinarily set). It also indicates that lending standards for corporate loans and mortgage loans did not start tightening until after Taylor rule residuals became positive. In other words, there seems to be a lag between a tightening of monetary policy and a tightening of representative elements of financial conditions.

In Figure 3, we see a similar picture for the United States, with major components of financial conditions tightening with a lag, especially after Taylor rule residuals become positive. Put differently, part of the reason there is so much of a gap between when the Fed started raising interest rates and when financial conditions started tightening may well be because monetary conditions remained very accommodative until 2006.
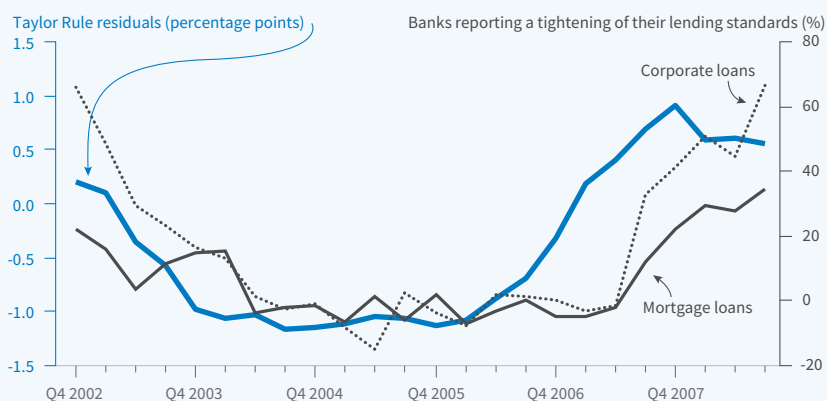
These figures are obviously not proof that credit conditions remained easy before the crisis because monetary policy was easy. All I want to establish is that it is not entirely ridiculous to argue that monetary policy's influence needs to be investigated in any post-mortem of the crisis. However, for the rest of the talk, it is sufficient for my purposes if you grant me that financial conditions were easy for a long period before the crisis.

The Consequences of Easy Financing Conditions

What are the consequences of easy financing conditions? The seminal work of Claudio Borio and Philip Lowe suggests sustained rapid credit growth combined with large increases in asset prices increases the probability of an episode of financial instability.[3] More recently, in a study of crises, Arvind Krishnamurthy and Tyler Muir show that credit growth and credit spreads are negatively correlated before a crisis begins, with spreads widening a little only just before the onset of the crisis.[4] The change in credit spreads as the crisis occurs seems to predict the extent of the subsequent output decline. It seems the credit markets do not really price in the crisis until it is almost upon them; the greater their complacency, the greater seems the gravity of the crisis. David López-Salido, Jeremy Stein, and Egon

Euro Area Taylor Rule Residuals and Lending Standards

Taylor Rule residuals (percentage points)

Banks reporting a tightening of their lending standards (%)

Corporate loans

Mortgage loans

Taylor Rule residuals are a measure of expansionary or contractionary monetary policy. Each residual is the difference between the policy rate and the rate suggested by the Taylor Rule – an empirical description of how policy is ordinarily set
Source: Maddaloni and Peydró, European Central Bank Working Paper Series, No. 1248

Figure 2

Zakrajšek[5] and Atif Mian, Amir Sufi, and Emil Verner[6] find similar effects. What theories might account for this?

Three come immediately to mind. One is herd behavior in banking markets. Perhaps the most famous statement made before the crisis was by Chuck Prince, the chairman of Citigroup, who responded thus to a ques-

since everybody was doing it, Citi could not be the only one to stop. Herd behavior models of banking such as one I have analyzed have this flavor; being the lone lender to stop lending has costs.[7] For instance, in a credit boom, loan officers may believe they have to maintain the pretense that they have really good lending prospects, and credit
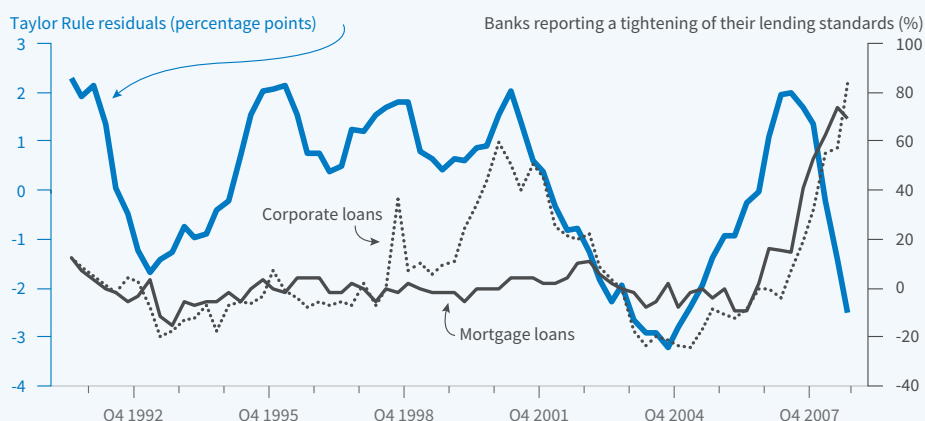
tors get lulled by a series of good signals to overweight the probability that the state of the world is good.[8] A few bad signals do not cause investors to worry that the bad state may be imminent, because they still think the good state is likely. Eventually, though, enough bad news leads to a radical change in beliefs, and investor pessimism causes the financial crisis. So there is a neglect of the "tail" bad state initially and excessive credit extension, an initial underreaction to bad news, and eventually, overreaction.

A different behavioral model, in which there is a distribution of optimists and pessimists in the economy, is advanced by John Geanakoplos.[9] Relative to pessimists, optimists think there is a higher probability of the good state, where the price of the asset being traded will be higher still. They are willing to buy the asset, and even borrow to buy yet more. The pessimists sell at the price available in the market, and lend money to the optimists. The arrival of good news therefore enhances the wealth of optimists, and their positive views have greater impact on the asset price. In contrast, bad news renders a few optimists bankrupt, and allows the consequent preponderance of pessimists to push down the asset price. Therefore there is overreaction to news in either direction because it changes the wealth of players, and therefore effectively changes the monetary weight placed on beliefs. So behavioral explanations of various kinds could be useful in explaining the abrupt shift that we saw from the complacency before the crisis to the panic once it got underway.

U.S. Taylor Rule Residuals and Lending Standards

Taylor Rule residuals are a measure of expansionary or contractionary monetary policy. Each residual is the difference between the policy rate and the rate suggested by the Taylor Rule – an empirical description of how policy is ordinarily set
Source: Maddaloni and Peydró, European Central Bank Working Paper Series, No. 1248

Figure 3

tion from the *Financial Times*: "When the music stops, in terms of liquidity, things will be complicated. But as long as the music is playing, you've got to get up and dance. We're still dancing."

I met Mr. Prince at a conference a few years later and I asked him, "So why did you say that?" He responded that he had a whole lot of investment bankers who were doing deals. And while he was aware the quality of deals was falling, he knew that if he stopped them from doing more deals, they would have left immediately for a job with the competition. Hiring and grooming people is tough. So in an attempt to preserve the franchise, so to speak, he had to let them go a little more to the edge.

Now, of course, he was making a calculation that retaining these people was more important than the cost to the balance sheet in terms of deteriorating credit quality. The statement came back to haunt him. But nevertheless, there was a rationale, which is that

quality has not deteriorated, since no one else seems to be worried or shows signs of problems. Rather than be singled out as the incompetent lender who cannot find good prospects, the loan officer ensures credit spreads do not reflect deterioration, and neither does loan volume. Indeed, if any borrower cannot repay, he lends him more money to paper over default, thus "evergreening" the loan. It is only when credit problems become overwhelming, marking the start of the crisis, that banks start declaring their true losses and stop lending, at which point it is much easier for everyone else to disclose their mistakes, since they will no longer be outliers. The longer the period of hiding, of course, the greater the losses that have built up, and the greater the deterioration in credit quality when the crisis starts.

Then there are true behavioral models such as that of Nicola Gennaioli, Andrei Shleifer, and Robert Vishny in which inves-

A Liquidity-based Model of the Consequences of Easy Financing Conditions

As if we do not already have enough models, let me add one more. Unlike these other models, it will relate leverage increases and spread declines directly to the easy liquidity that prevailed before the crisis. It will explain why spreads were flat until just before the crisis. We will see why sustained expectations of high future liquidity can make the subsequent downturn longer and deeper, other than just through the increase in leverage during the run-up to the crisis and the change in expectations

at its onset. This model is detailed in my work with Douglas Diamond and Yunzhi Hu.[10] Essentially, I will argue that high expectations of liquidity can be problematic.

I will then propose another liquidity-based model to explain why the downturn was so sharp and the recovery so abrupt. Taken together, we will see the two faces of financial liquidity, the title of this talk, and why the authorities have the serious challenge of keeping liquidity at the right level — neither too high nor too low.

Consider an industry that requires special industry knowledge to produce. Within the industry, there are firms run by expert incumbents. There are also industry insiders, who know the industry well enough to be able to run firms as efficiently as the incumbents. Industry outsiders — such as financiers who don't really know how to run industry firms but have general managerial/financial skills — are the other agents in the model.

Financiers have two sorts of control rights; first, control through the right to repossess and sell the underlying asset being financed if payments are missed, and second, control over cash flows generated by the asset. The first right only requires the frictionless enforcement of property rights in the economy, which we assume. It has especial value when there is a large number of capable potential buyers willing to pay a high price for the firm's assets. Greater wealth amongst industry insiders — which we term industry liquidity — increases the availability of this asset-sale-based financing. Because we analyze a single industry, high levels of this industry liquidity can be interpreted as an economy-wide boom. Easy monetary policy, with lower than normal policy rates, would contribute positively to industry liquidity. Clearly, this kind of control right is exogenous to the firm.

The second type of control right is more endogenous, and conferred on creditors by the firm's incumbent manager as she makes the firm's cash flows more appropriable by, or pledgeable to, creditors over the medium term. She could do this, for example, by improving accounting quality or setting up escrow accounts so that cash flows are hard to divert. We assume enhancing pledgeability takes time to set up but is also semi-durable; improving accounting quality is not instantaneous, because it requires adopting new systems and hiring reputable people, but equally, firing a reputable accountant or changing accounting practices has to be done slowly — perhaps at the time the accountant's term ends — if it is not to be noticed. So the incumbent manager sets pledgeability one period in advance, and it lasts a period.

The two sources of control rights interact. When

anticipated industry liquidity is sufficiently high, increased pledgeability has no effect on how much industry insiders will bid to pay for the firm; they have enough wealth to buy the firm at full value without needing to borrow much against the firm's future cash flows. Higher pledgeability is not needed for enhancing bids when the industry is very liquid. When anticipated liquidity is lower so that industry insiders have to borrow substantially to bid for the firm, higher pledgeability does enhance their bids.

Let us now understand an incumbent firm manager's incentives while choosing cash flow pledgeability for the next period. Let us assume she may have some reason to sell some or all of the firm

creditors to collect more if the incumbent stays in control, because the creditors have the right to seize assets and sell them when not paid in full. In such situations, the incumbent has to "buy" the firm from creditors, by outbidding industry insiders or paying debt fully, which reduces her incentive to enhance pledgeability.

The tradeoff in setting pledgeability depends both on the probability she will need to sell and on the amount that she has promised to pay creditors — as well as industry liquidity, as explained earlier. A higher promised payment increases the amount that she needs to pay to "buy" the firm from creditors but reduces the residual proceeds that she receives if she sells the firm. Therefore, higher prom-

credit spreads that lenders charge are contained, even as borrowing increases.

However, consider now a sustained boom that is anticipated to continue with high probability, where industry insiders will have plenty of wealth. Repayment of any corporate borrowing today is enforced entirely by the potential high resale value of the firm — at the future date, wealthy industry insiders will bid full value for the firm without needing high pledgeability to make their bid, as described by Shleifer and Vishny.[11]

Since pledgeability is not needed to enforce repayment in a future highly liquid state, a high probability of such a state encourages high borrowing up front, which crowds out the incumbent's incen-

How Anticipated Market Liquidity Crowds Out Future Pledgeability

1	2	3	4	5
High probability of high future liquidity	*High capacity to repay debt*	*More borrowing available up front to buy firm*	*Higher-price bid for firm, higher debt*	*Low incentive to raise pledgeability*

Source: Illustrative diagram representing author's theory

Figure 4

next period with some probability, either because she is no longer capable of running it or she needs to finance a new investment. Higher pledgeability generally increases the price at which she can sell the firm when she is no longer capable of running it, because industry insiders can borrow against future pledgeable cash flows to finance their bids for the firm. It increases the firm's debt capacity up front — we assume the incumbent has bought the firm by borrowing as much as she can to buy it, which also allows us to examine leverage choices.

However, having borrowed up front, the incumbent faces moral hazard associated with pledgeability. A higher bid from industry insiders also enables the existing

ised payments exacerbate the incumbent's moral hazard associated with pledgeability, and when they exceed a threshold, the incumbent will set pledgeability low. Anticipating this, creditors will limit how much they will lend to the incumbent up front.

In sum then, we have two outside influences on pledgeability — the anticipated liquidity of industry insiders and the level of outstanding debt. In normal times, the need to provide the incumbent incentives for pledgeability keeps upfront borrowing moderate. As prospective industry liquidity increases, though, the incumbent is able to borrow more to finance the asset, while still retaining the incentive to set pledgeability high. The

tive to enhance pledgeability, even if there is a possible low liquidity state where pledgeability is needed to enhance creditor rights. In other words, when prospective liquidity exceeds a threshold, lenders stop imposing any constraint on leverage, and take their chances if that liquidity does not materialize. Leverage increases, but becomes riskier. Figure 4 summarizes this sequence.

A crisis or downturn under these circumstances occurs when liquidity does not materialize. If the low liquidity state is realized, the enforceability of the firm's debt, as well as its borrowing capacity, will fall significantly because pledgeability has been set low. Industry insiders, also hit by the downturn, no longer have

much personal wealth, nor does the low cash flow pledgeability of the firm allow them to borrow against future cash flows to pay for acquiring the firm. The firm's debt capacity falls significantly, and it gets into financial distress. Credit spreads rise substantially, and they will stay high until the firm raises pledgeability, which will take time, or industry liquidity comes back up, which could take even longer. The neglect of pledgeability because of high leverage at the end of a sustained boom makes the recovery difficult and drawn out.

Testable Implications

The testable implications of this model are that pledgeability falls as high liquidity persists.[12] There is a greater fall in industries that are undergoing booms. Conversely, it rises over time when liquidity dries up. Petro Lisowsky, Michael Minnis, and Andrew Sutherland examine the percentage of unqualified (that is, good) audits submitted to bankers by firms in the booming construction industry before the crisis.[13] As Figure 5 shows, that percentage fell steadily before the crisis, only to stabilize when the crisis hit. Of course, since other industries were booming, the percentage fell for them also.

So what we really want to see is the difference between the construction industry and others.

As is clear from Figure 5, the gap increased until about 2006, around the time monetary policy started getting tight by the Taylor rule measure or around the time financial conditions started tightening. The gap then reversed. In sum, pledgeability did fall during the construction industry boom, only to reverse course, albeit slowly, as tight liquidity set in.

Recoveries following periods of an asset price boom and high leverage are thus delayed, not just because debt has to be written down — and undoubtedly frictions in writing down debt would increase the length of the delay — but also because firms have to restore the pledgeability of their

Measuring Pledgeability: Unqualified Audits

Percentage of firms submitting unqualified audits

Other firms

Construction firms

2.0 3.5 4.5 6.3 6.1 5.3 4.3 4.4 4.1

2002 2003 2004 2005 2006 2007 2008 2009 2010 2011

An "unqualified audit" is the best possible outcome from a financial audit
Source: Lisowsky, Minnis, and Sutherland, The University of Chicago Booth School of Business Working Paper No. 14-30

Figure 5

cash flows to cope with a world where liquidity is scarcer. It is the need to raise pledgeability that may make the downturn more prolonged. Higher anticipated liquidity in some future states can therefore induce more eventual misallocation in less-liquid states, a spillover effect between states that operates through leverage and pledgeability!

The Sharp Onset of the Crisis

As the crisis hit, illiquidity spread through the economy, not just among corporate assets where issues like pledgeability might be a concern. Liquidity dried up for a large set of financial assets, with significant price drops and high bid/ask spreads. Consider, for example, instruments issued on the U.S. Leveraged Loan 100 Index. Figure 6 shows that the average bid collapsed from around 90 cents on the dollar to just above 60 cents around September 2008 (the Lehman Brothers crisis), while the bid/ask spread blew out from about 100 basis

points to over 300 basis points. A steady recovery to normal levels started around mid-2009.

Bankers alleged a "buyers" strike during this period. What they meant, presumably, was that the market was clearing at such a low price for financial assets that few wanted to sell if they could hold on. Arbitrage opportunities also appeared, such as a large negative bond-CDS basis, which meant that a riskless position paying a positive spread over Treasuries could be created, provided one could borrow.

And there was the nub. No one, including well-capitalized liquid financial institutions, seemed willing to lend. There was a sharp rise in central bank reserves held by commercial banks from around the time of the Lehman failure, suggesting they were holding cash instead of lending. Why was there this flight to liquidity?

To explain the extreme tightness in credit and the decline in trading, I will appeal to the idea of liquidity
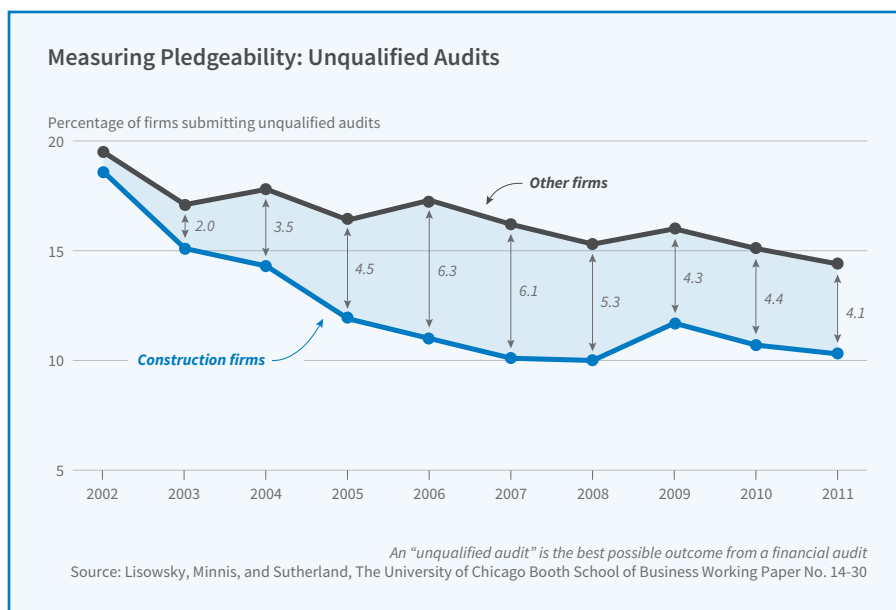
S&P/LSTA U.S. Leveraged Loan 100 Index

Average bid as a percent of par value

100 90 80 70 60 50
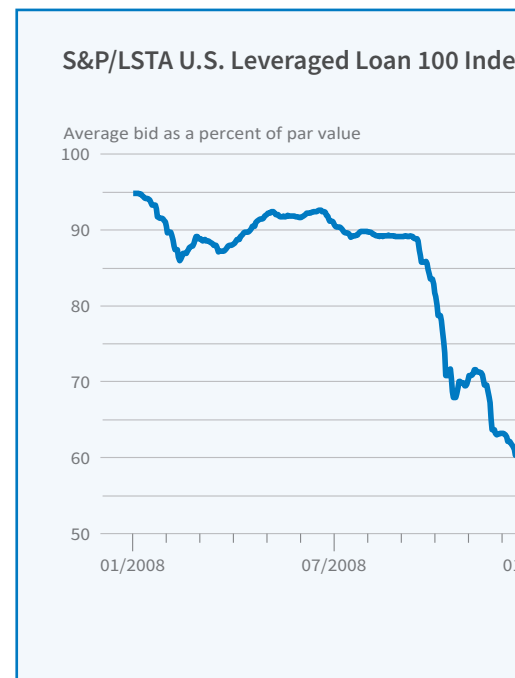
01/2008   07/2008   01

Figu

again, this time the liquidity — or illiquidity — of financial institutions identified by Diamond and myself.[14] Here is the idea: Let a set of banks which we will term "fragile," with substantial short-term liabilities, have a significant quantity of assets that have a limited set of potential buyers. One example of such an asset is a mortgage-backed security which, in an environment in which some mortgages have defaulted, can be valued accurately only by some specialized firms such as BlackRock or KKR. Furthermore, let us assume that, with some probability, the fragile banks will need to realize cash quickly in the future. Such a need for cash may stem from unusual demands of the banks' customers, who draw on committed lines of credit or on their demandable deposits. It may also stem from panic, as depositors and customers, fearing the bank could fail, pull their deposits and accounts from the bank. Regardless of where the demand for liquidity comes from, it would force banks to sell assets or, equivalently, raise money quickly at a future date. Given that the potential buyers for the bank's assets, like BlackRock and KKR, have limited resources and will drive a hard bargain, the asset would have to be sold at fire sale prices (Shleifer and Vishny, and Franklin Allen and Douglas Gale).[15]

One consequence of the prospective fire sale is that it may depress asset values so much that the bank is insolvent. This may precipitate a run on the bank, which may cause more assets to be unloaded on the market, further depressing the price. Importantly, the returns to those who have excess liquid cash at such times can be extraordinarily high.

Folding back to today, the prospect of a future fire sale of the bank's asset can depress the asset's current value — investors need to be enticed through a discount to buy the asset today, otherwise they have an incentive to hold back because of the prospect of buying the asset cheaper in the future. More generally, the high returns potentially available in the future to those who hold cash can cause them to demand a high return for parting with that cash today.

However, the elevated required rate of return now extends to the entire segment of the financial market that has the expertise to trade the security. If this segment also accounts for a significant fraction of the funding for potential new loans, the elevated required rate of return will be contagious and also will depress lending. Moreover, the overhang of fragile banks will affect lending not only by distressed banks but also by healthy potential lenders, a feature that distinguishes this explanation from those where the reluctance to lend is based on the poor health of either the bank or its potential borrowers. Note that the adverse effect of prospective future illiquidity on current lending is absent in models where future asset values are low for other reasons, such as reduced future payoffs. In such cases, low asset values do not lead to an elevated rate of return to buyers.

More surprising though, the fragile bank's management, knowing that the bank could fail in some states in the future, does not have strong incentives to sell the illiquid asset today, even though such sales could save the bank — sales of the asset subject to potential fire sales dry up. The reason is simple. By selling the asset today, the bank will raise cash that will bolster the value of its outstanding debt by making it safer. But in doing so, the bank will sacrifice the returns that it would get if the currently depressed value of the asset recovers. Since the states

in which the depressed asset value recovers are precisely the states in which the bank survives, bank management would much prefer holding on to the illiquid assets and risking a fire sale and insolvency to selling the asset and ensuring its own stability in the future. Indeed, the bank would prefer to spend its cash to load up more on securities that are exposed to the liquidity risk because its private valuation for those securities exceeds the market's valuation. Fragile banks become "illiquidity seekers."

The intuition here is clearly analogous to the risk-shifting motive of Michael Jensen and William Meckling[16] and the underinvestment motive of Stewart Myers,[17] though the bank "shifts" risk or underinvests in our model by refusing to sell an illiquid asset rather than by taking on, or not taking on, a project. Also, illiquid institutions not only act as an overhang over the market, elevating required rates of return, but they also risk future insolvency by holding on to the assets, further elevating required returns. Thus, there is an inherent source of adverse feedback in any financial crisis, which is why cleaning up the financial system *ex post* may be an important contributor to recovery. At the same time, *ex ante* regulation to prevent an excessive buildup of exposure to liquidity risk may also be warranted.

In sum then, this model can explain both the trading freeze as well as the credit freeze that occurred after the Lehman debacle. The market feared that there were many banks with hard-to-sell assets, and these assets would be dumped on the market if these fragile banks had to meet demands for liquidity. Hoping no such liquidity demand would materialize, banks held on to the hard-to-sell assets, for these would generate high returns under those conditions. Anticipating that such liquidity would be demanded with high probability, thus forcing fire sales by fragile banks, healthy financial firms held on to cash so that they could put it to work at that time when returns would be high. Credit therefore became scarce, thus opening up arbitrage opportunities wherever borrowing was needed to close them.

Finally, what explains the recovery in asset prices, the decline in spreads, and the disappearance of arbitrage opportuni-

x

1/2009   07/2009   01/2010

Source: Data from Thomson Reuters

re 6

U.S. Unemployment and Mortgage Delinquency Rates

NBER dated recession

Source: Data from the U.S. Bureau of Labor Statistics and the Board of Governors of the Federal Reserve System
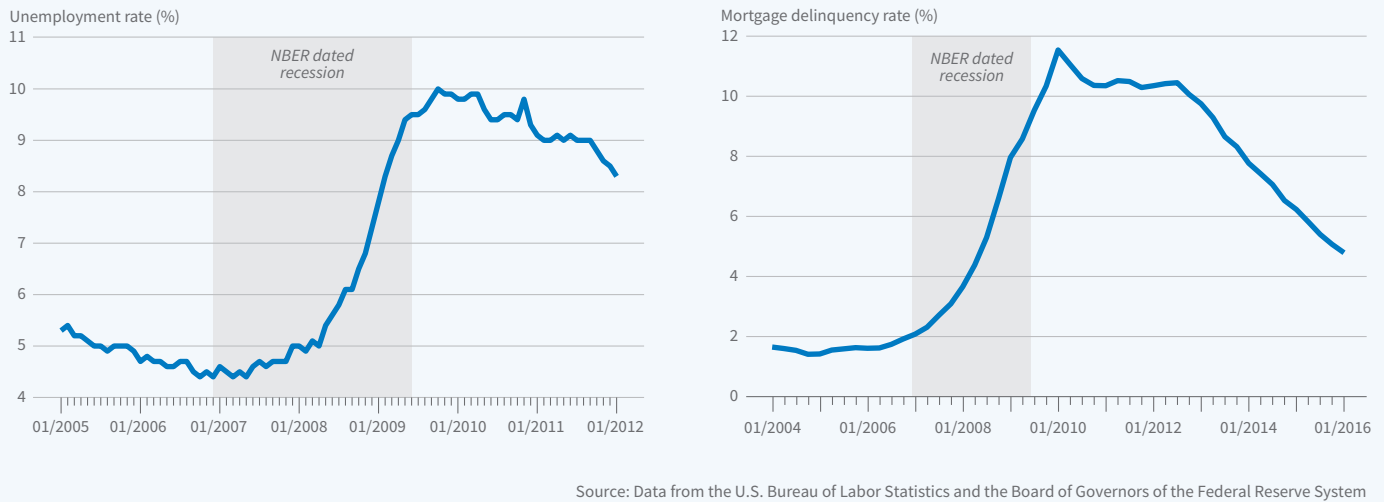
Figure 7

ties? Was it good news on fundamentals? While the NBER dated the recovery from June 2009, that dating happens only much later. As seen in Figure 7, unemployment stabilized only in 2010, and the first month without job losses was November 2009. It is hard to imagine that it was well known that the recovery was underway from mid-2009.

Was it good news on mortgages? As seen in Figure 7 on the next page, delinquencies started declining steadily only in mid-2012.

Why then did markets start returning to normal around mid-2009? Arguably, it was a sequence of Fed emergency programs but especially the stress tests conducted by the Federal Reserve in March 2009, with the results announced in May 2009, which were responsible. The regulators examined 19 banks, and 10 were asked to raise capital. The details of each bank's examination were made public.

Moreover, capital was set to be raised so that bank assets would not shrink. Finally, the Treasury backstopped banks that could not raise capital with its Capital Assistance Program.

By forcing banks to become healthy, and implicitly guaranteeing they would be, the stress tests effectively removed the overhang of potentially insolvent or highly illiquid banks, thus reducing

returns from purchasing in potential fire sales or holding on to illiquid assets, thus allowing trading and lending to resume. Bid/ask spreads narrowed, asset prices recovered, and arbitrage opportunities dwindled.

In sum then, the lesson to take away from this model is that anticipated illiquidity can lead to frozen markets and credit. The authorities may need to clean up a system even in the midst of a crisis in order to restore trading and lending. So liquidity infusion into the markets and capital infusion into specific institutions may be necessary to stabilize the financial system. Of course, if a little liquidity infusion is good, why not do more, and more permanently? This seems to be the lesson financial authorities have drawn.

If we go back to Figure 1, financial conditions across the world are now again

U.S. 'Covenant-Lite' Leveraged Loans, 2004–2017

Total covenant-lite loans outstanding (billions of dollars)

Percentage of leveraged loans that are covenant-lite

"Covenant-lite loans" do not contain typical protective covenants that benefit lenders
Source: Data from S&P Global Market Intelligence

Figure 8

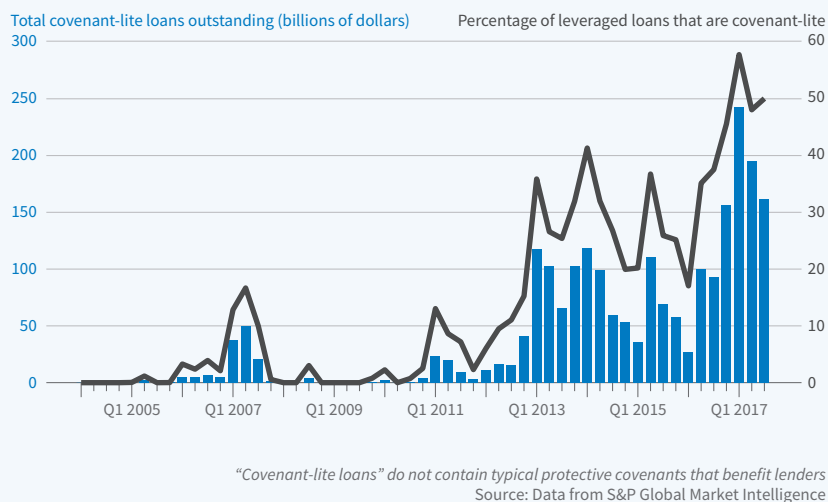as easy as they have ever been. But as we saw from the first model, too much liquidity can also be bad, for it induces leverage and causes financial sector participants to effectively neglect risks. Indeed, if we look at the volume of covenant-lite loans today in Figure 8, it dwarfs the quantity before the global financial crisis.

The bottom line is that both too little, as well as too much, anticipated liquidity can be problematic for financial stability. To the extent that accommodative financing conditions (i.e., easy liquidity) are caused by accommodative monetary policy, it suggests monetary policy and financial stability cannot be separated.

How should monetary policy take financial stability into account? This, to my mind, is the huge unaddressed issue since the crisis, though some papers — for example, one by Diamond and myself,[18] and another by Emmanuel Farhi and Jean Tirole[19] — have made beginnings. Today, liquidity is slowly in the process of being withdrawn. Will we have better or worse outcomes than the previous time liquidity was withdrawn? I don't know, though it is clear we will have some stress in pockets where leverage has built up as easy financial conditions change. We have to see whether, this time around, it is indeed different.

[1] *The Financial Conditions Index, presented in the IMF's Global Financial Stability Report, is a composite of short-term rates, long-term real rates, term spread, corporate spread, interbank spread, equity price growth, equity return volatility, credit to GDP, credit growth, and house price growth.*
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[2] *A. Maddaloni and J. Peydró, "Bank Risk-Taking, Securitization, Supervision, and Low Interest Rates: Evidence from the Euro Area and the U.S. Lending Standards," European Central Bank Working Paper No.* 1248, *2010, pp. 2121–65.*
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[3] *C. Borio and P. Lowe, "Asset Prices, Financial and Monetary Stability: Exploring the Nexus," BIS Working Paper No.* 114, *2002.*
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[11] *A. Shleifer and R. Vishny, "Liquidation Values and Debt Capacity: A Market Equilibrium Approach,"* Journal of Finance, *47(4), 1992, pp. 1343–66.*
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[12] *For the interested reader, related recent papers include: V. Acharya and S. Viswanathan, "Leverage,*

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Research Summaries

Matthew Kotchen is a professor of economics at Yale University, with a primary appointment in the Yale School of Forestry & Environmental Studies and secondary appointments in the School of Management and the Department of Economics. His research interests lie at the intersection of environmental and public economics and policy.

Kotchen is a research associate in the NBER Programs on Environmental and Energy Economics and Public Economics. He has held previous and visiting positions at Williams College, the University of California, Santa Barbara and Berkeley, Stanford University, and Resources for the Future. He has also served as an associate dean of academic affairs at Yale, as deputy assistant secretary for environment and energy at the U.S. Department of the Treasury, and as a member of the Environmental Economics Advisory Committee of the U.S. Environmental Protection Agency.

Kotchen leads a new NBER initiative comprising an annual conference in Washington, DC, and an annual publication, both titled *Environmental and Energy Policy and the Economy*. Funded by the Alfred P. Sloan Foundation, this is an effort to stimulate policy-relevant research in the field and to disseminate this research directly to policymakers. It is modeled after the NBER initiatives *Tax Policy and the Economy* and *Innovation Policy and the Economy*.

Environment, Energy, and Unintended Consequences

Matthew J. Kotchen

Economists are fascinated with unintended consequences. A policy designed to accomplish a particular objective will sometimes have the opposite effect, or create new problems apart from the one it originally sought to correct. Well-intentioned individuals will sometimes make choices that are counterproductive to the very causes they seek to support. Understanding the full impact of policy interventions and individual choices is critical for the design, implementation, and improvement of more effective and efficient policies.

Much of my research over the last 15 years has focused on unintended consequences in the field of environmental and energy economics and policy. The starting point is often a simple question: Does a specific policy or choice that is driven by concern for environmental protection or energy conservation deliver on its promise, and if not, why not? Research attempting to answer this question has led to contributions to economic theory on the private provision of public goods and to empirical studies on a range of topics such as renewable energy, corporate social responsibility, daylight saving time, building codes, and electric cars.

Private Provision of Environmental Public Goods

Many individuals are concerned with the environmental impact of their consumption choices, and these concerns have driven the emergence of markets for environmentally friendly goods and services. My first theoretical contribution was to model "green goods," based on joint production of a private good and a public environmental good.[1] The purchase of electricity from renewable sources of energy provides an example. While green electricity may cost more than electricity generated from fossil fuels, it produces the joint products of electricity (a private good) and lower emissions (a public good).

Does this mean green products are always beneficial for the environment? The answer turns out to depend on whether there are opportunities to provide the public good separately. It is possible, for example, that one's purchase of green electricity crowds out other activities that reduce emissions. In such cases, introducing a green good can counterintuitively increase pollution and reduce economic welfare.

In a subsequent theoretical paper, I consider joint production that is instead based on the private provision of a public "bad."[2] The setup more closely aligns with the way economists typically think about particular goods and services generating a negative externality. A novel feature of the model is the way that consumers can make donations that are motivated, in part, to offset the negative externality. In this context, I show how donations and economic welfare differ from the standard model for privately provided public goods.

One general result is that donations continue to increase, rather than decrease, as an economy grows. Moreover, an unintended consequence of this market arrangement is that the opportunity to make offsetting donations will typically stimulate demand for the externality-causing good. For exam-

ple, the ability to purchase a carbon offset might help an individual justify the purchase of a less fuel-efficient car. Indeed, the theory provides a framework for understanding markets for environmental offsets, with those that promote carbon neutrality in response to climate change being an increasingly salient example.

Offsetting Goods and Bads

Does giving consumers a way to pay for their "sins of emissions" help justify an increase in polluting activities? Along with collaborators Grant Jacobsen and Mike Vandenbergh, I set out to investigate whether such behavior occurs.[3] We obtained electricity billing data for residential households in Tennessee before and after a utility company introduced a voluntary green-electricity program. A key feature of the program was that households could choose to participate at different levels in support of new wind and solar generation intended to offset the emissions associated with their own electricity consumption.

We found that households participating above the minimum threshold had no change in electricity consumption, but those participating only at the minimum level — representing a "buy-in" mentality — increased their electricity consumption by 2.5 percent. We thus identified some of the first evidence on the behavioral response to undertaking a pro-environmental action.

I then became interested in knowing whether a similar phenomenon was taking place within corporations. The existing literature on corporate social responsibility (CSR) tends to focus on the relationship between CSR and financial performance. I was curious about a potential intervening mechanism, whereby companies might pursue CSR strategies to offset corporate social irresponsibility (CSI).

Jon Jungbien Moon and I disaggregated one of the widely used indices for CSR into separate measures of CSR and CSI across seven dimensions, including corporate governance, community relations, human rights, and the environment.[4] Analyzing data on more than 3,000 publicly traded companies over 14 years, we found that CSI is a significant predictor of CSR, both overall and within specific dimensions. For example, when a company is responsible for

The Effect of Daylight Saving Time on Electricity Use

Percentage change in monthly residential electricity consumption due to daylight savings time

Period of daylight saving time

Light-blue bars represent 95% confidence intervals
Observations for April and November are excluded due to partial exposure to DST during those months
Source: M. Kotchen and L. Grant, NBER Working Paper No. 14429

Figure 1

an environmental accident, it compensates by undertaking pro-environmental actions. When it comes to corporate governance, however, the findings are more nuanced: After an event that reflects poorly on corporate governance, companies tend to compensate in nearly all dimensions of CSR except for reforming governance itself.

Saving Energy and Reducing Pollution — Or Not

Many people are surprised to hear that daylight saving time (DST) is one of the more longstanding and universally applied energy policies. Implemented as a conservation measure in both world wars, DST has a long and fascinating history. Indeed, Benjamin Franklin produced an early economic analysis of DST, showing how much tallow and candles could be saved if clocks were changed to encourage early rising during long summer days, when people could take greater advantage of natural daylight. The same argument is still used today to justify DST as energy policy in the United States, yet surprisingly little analysis on the subject has occurred since Franklin's day.

Taking advantage of a natural experiment that occurred in Indiana, Laura Grant and I estimated the effect of DST on electricity consumption.[5] In 2006, the state switched to DST while simultaneously shifting some of its counties to a different time zone. The combination of these two policies provided treatment and control groups that allowed us to compare differences in residential electricity consumption before and after the policy change. We found that — contrary to the policy's intent — DST increased electricity consumption [Figure 1]. While Franklin's conjecture about the demand for lighting holds up, modern-day demand for heating and cooling differs across hours of the day, and the shift to DST increased both.

Building codes are another ubiquitous form of energy policy. The regulation of building practices first focused on energy for purposes of national security in the wake of the Arab oil embargo in the 1970s. Today, building energy codes across the United States and other countries are motivated by concerns about energy efficiency and climate change. Until recently, however, engineering simulations provided the only evidence on
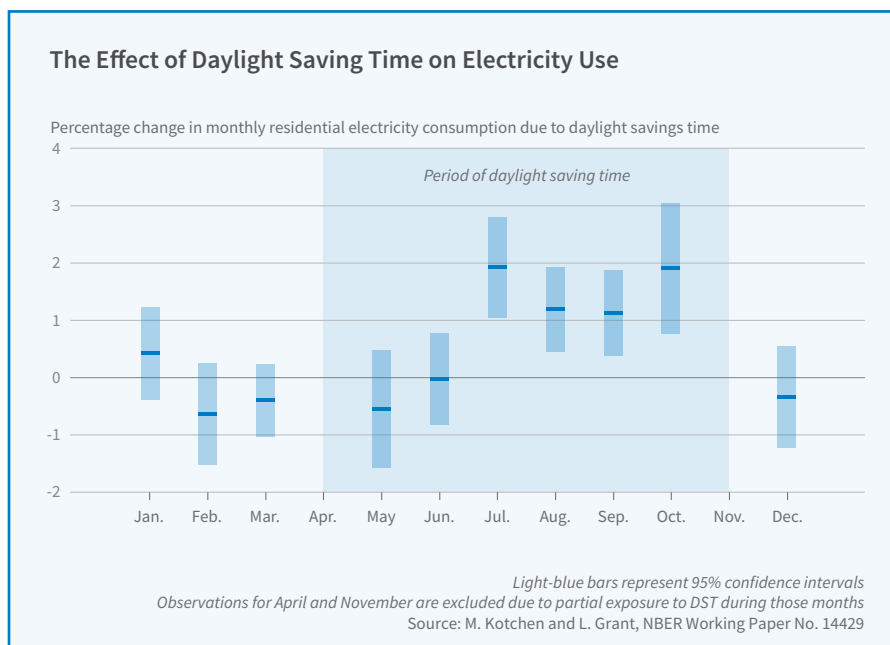
their effectiveness. This led Jacobsen and me to search for an opportunity to provide an evaluation that accounted for actual construction practices and the behavior of household residents.

We found one in Florida, where the state increased the stringency of its building energy code in 2002. We obtained a unique dataset that included detailed information on the characteristics of residential dwellings and monthly billing data for electricity and natural gas. This enabled us to compare energy consumption of observationally similar residences built just before and after the building code change. We found significant decreases in both electricity and natural gas consumption, and estimated the private payback period to be approximately six years.[6]

Yet subsequent research by Arik Levinson, studying data from California, raised questions about whether the energy saving effects would endure over the long run.[7] This spurred a reevaluation of our Florida findings over a longer time period when additional data were available. The results indicated that after five or six years, electricity savings were no longer evident, while the natural gas savings persisted.[8] Questions about the underlying mechanism and generalizability of these short-run and long-run effects remain, but the number of papers appearing on the subject suggests that we will soon learn

more about the effectiveness and efficiency of building energy codes.

We are also beginning to learn more about the potential of electric cars to lower demand for energy and reduce pollution. Generous subsidies at the state and federal level, along with the extraordinary market valuation of Tesla, signal high confidence in the future benefits and scale of the electric car market. But often missing from future visions is that charging electric cars also requires energy,

and their environmental impacts depend on a comparison of emissions at tailpipes versus power plants.

Joshua Graff-Zivin, Erin Mansur, and I developed a method for estimating marginal emissions of electricity generation at different locations and times of day across the United States.[9] While previous studies either relied on simulation estimates or average — rather than marginal — emissions, our approach is based on hourly load and emissions data across different interconnections of the electricity grid [Figures 2 and 3].

The results can be used to estimate the effect on CO2 emissions from any electricity-shifting policy; we focused on increased demand to charge electric cars. We found considerable differences in the emissions based on geographic location and hours of the day. The heterogeneity is driven by the fact that electricity is generated in different ways, mostly from coal or natural gas, at different locations and at peak versus off-peak times of day. Notably, we found that in many Upper Midwestern states, an electric car generates more CO2 emissions than the average economy car. The research showed that the future environmental promise of electric cars depends critically on how electricity is generated on the grid. Subsequent research has also shown the importance of considering the health effects of local pollution.[10]

Variation in Emissions Produced to Charge an Electric Car

Pounds of CO₂ emissions produced by an electricity-generating power plant needed to power a plug-in electric vehicle for 35 miles

Legend: 1–4, 5–8, 9–12 (am); 1–4, 5–8, 9–12 (pm)

Regions (see Figure 3 for reference)

"Regions" are various interconnected power grids overseen by the North American Electric Reliability Corporation
Source: J. Graff Zivin, M. Kotchen, and E. Mansur, NBER Working Paper No. 18462

Figure 2

Regional Powergrids
Interconnected power grids overseen by the North American Electric Reliability Corporation

MRO, RFC, NPCC, WECC, SERC, SPP, FRCC, ERCOT

Intended for illustrative purposes. Only represents the U.S. portion of North American interconnections.
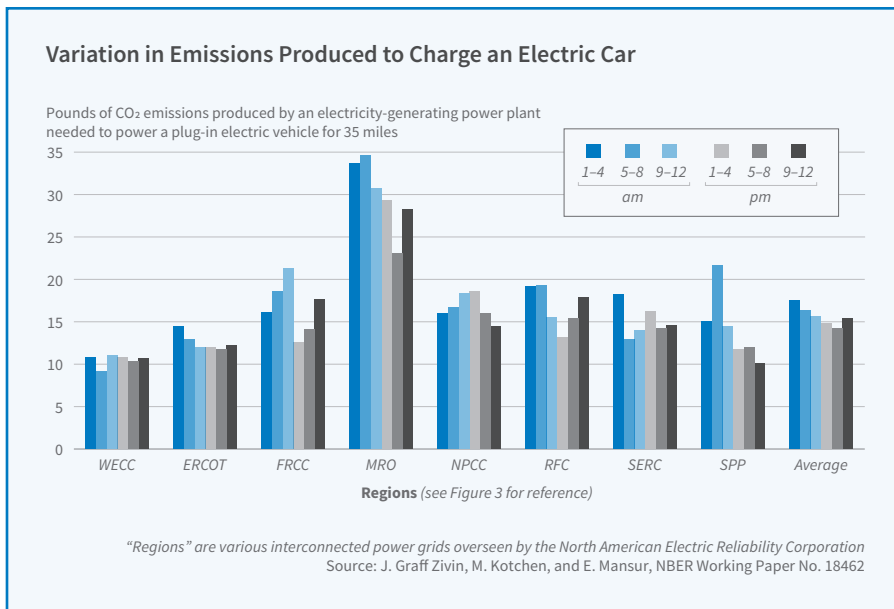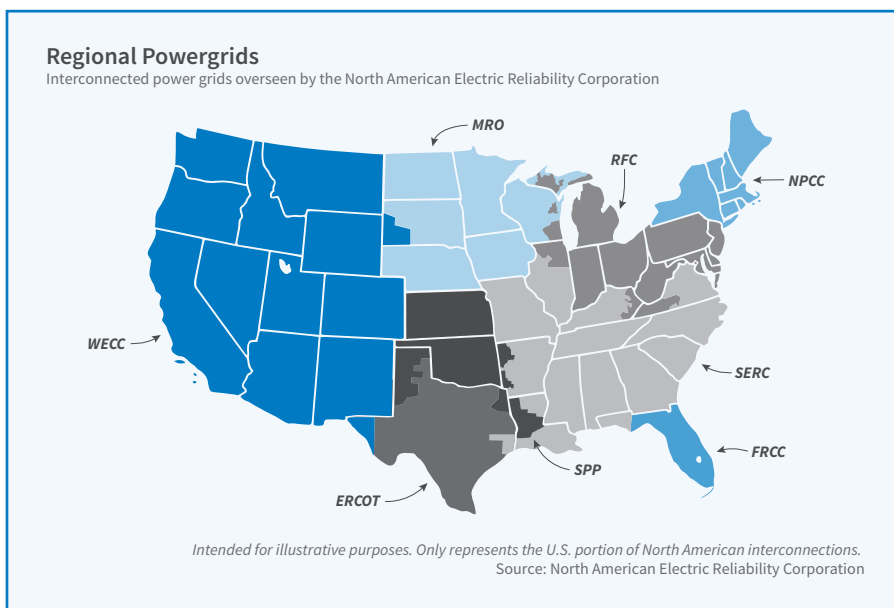Source: North American Electric Reliability Corporation

Figure 3

Looking Ahead

To conclude, I must admit that the pattern in my research of identifying and estimating unintended consequences is itself an unintended consequence, the result of opportunistically pursuing research questions without preconceived notions. While I think that uncovering unexpected and sometimes counterintuitive findings is important, the growing set of environmental and energy challenges also requires economic research with a directly constructive agenda. Fortunately, many in the field are doing precisely this. A few recent and selected examples of my own efforts with such a goal include using revealed preferences to test among models for charitable giving to environmental causes,[11] drawing insights about national and international climate policy from a public goods framework,[12] and developing new ways to think about long-term and intergenerational social discount rates.[13]

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Taxation and Innovation

Ufuk Akcigit and Stefanie Stantcheva

Ufuk Akcigit is an associate professor of economics with tenure at the University of Chicago and a research associate at the NBER, where he is affiliated with the Productivity, Innovation, and Entrepreneurship program. He also is affiliated with the Centre for Economic Policy Research.

Akcigit's research focuses on economic growth, productivity, firm dynamics, and the economics of innovation. His work aims to uncover the sources of technological progress and innovation that serve as engines of long-run economic growth. He is also interested in the role of public policy in growth, with a focus on environmental regulations, public research and funding for universities, and industrial policies such as R&D tax credits and corporate taxation.

Some of his current papers explore the impact of trade and foreign competition on innovation, the role of political connections in reducing innovation, and the social origins and family backgrounds of inventors.

His research has been published in leading economics journals and has been supported by the Ewing Marion Kauffman Foundation, the Alfred P. Sloan Foundation, and the National Science Foundation. He is the recipient of a CAREER Award from the National Science Foundation.

Akcigit holds a BA in economics from Koç University in Istanbul and a PhD in economics from MIT. Prior to joining the University of Chicago in 2015, he was an assistant professor of economics at the University of Pennsylvania.

Innovation is the source of technological progress and, ultimately, the main driver of long-run economic growth. In recent work with several co-authors, we have shown that the U.S. states that produced the most innovations also grew fastest over the 100-year period from 1900 to 2000.[1] We also have documented that innovation is strongly associated with social mobility. U.S. regions that experienced more innovation also witnessed much stronger intergenerational and social mobility, especially when innovations were attributable to new entrant firms. Innovation also correlates strongly with top income inequality, but not so much with measures of inequality such as the Gini or the 90/10 ratio, and is associated with greater well-being across the United States.[2,3]

Given all the important consequences of innovation, it is essential to understand how public policies impact innovation in the United States and across the world. Our joint research agenda explores the interplay between taxation and innovation.

Major changes in U.S. tax policy, such as those in the Tax Cuts and Jobs Act of 2017, raise questions about whether higher taxes stifle growth, productivity, and innovation.

If innovation, like many other economic outcomes, is the result of intentional effort and investment, then higher taxes will reduce the expected net return to these inputs and lead to less innovation. Yet for at least some path-breaking superstar inventors from history, such as Thomas Edison, Alexander Graham Bell, and Nikola Tesla, the picture that comes to mind is one of hard-working, enthusiastic scientists who are unconcerned with financial incentives and only strive for intellectual achievement.

Related questions are whether taxes impact the quality of innovation, where inventors decide to locate, and what firms they work for. In addition, there is a question of whether taxes influence where companies allocate R&D resources and how many researchers they employ.

Answers to these questions are still lacking, and there is a scarcity of empirical evidence. The gap in our understanding is especially large when it comes to the effects of tax policy on technological development over the long run.

Theory and Empirics of Taxation and Innovation

There are two complementary dimensions along which to think about the interplay between taxation and innovation. First, taxation on personal or corporate income or wealth may affect innovation. This may be an unwelcome byproduct of taxes that are set for completely unrelated goals, such as to raise revenues. Thus, reduced innovation could be one of the efficiency costs of taxation; this could affect the assessment of optimal taxes, since the elasticity of innovation with respect to taxes would influence the elasticities that enter into the optimal tax formulas.[4,5] This underscores the importance of quantifying the elasticity of innovation to taxation along all the relevant margins. Second, tax policy could be designed intentionally so as not to hurt, or even to stimulate, innovation.

Our research agenda on taxation and innovation seeks to understand and quantify the effects of

taxation — of personal income, corporate income, and wealth — on innovation by firms and individuals. How do taxes shape all these agents' choices leading up to innovations? Our empirical studies are based on modern-day data — European patent office data since 1975, for example — and on long-run historical data, such as the universe of U.S. inventors since 1836. Theoretically and quantitatively, we study the design of decentralized innovation policies: combinations of taxes, tax credits, and subsidies that can make agents internalize the spillovers from innovations and foster innovation. We illustrate our research approach by focusing on three distinct studies.

## Taxation and Innovation in the 20th Century

Although the United States experienced major changes in its tax code throughout the 20th century, we currently do not know how these tax changes influenced innovation at either the individual or corporate level. This challenging question has largely gone unanswered because of a lack of long-run systematic data on innovation in the United States and the difficulty of identifying the effects of taxes. We leverage three new datasets, which we constructed from historical data sources, to explore these issues.[6] The datasets are a panel of the universe of U.S. inventors since 1920 and their associated patents, citations, and firms; a panel of all R&D labs in the United States since 1921, matched to their patents and with data on their research employment levels and locations; and a historical state-level corporate and personal income tax database.[7] This unique combination of data allows us to systematically study the effects of both personal and corporate income taxation since 1920 on the micro level of individual inventors and individual firms that do R&D and on innovation at the macro state level.

Our innovation outcomes include the quantity of innovation, as captured by the number of patents; the quality of innovation, as measured by patent citations, and the share of patents assigned to companies rather than individuals at both the state level and individual-inventor level. We also consider the location choices of firms and inventors, including superstar inventors, as well as the creation of path-breaking, highly cited inventions.

We employ several identification strategies, and find consistent results across the different approaches. First, we control for state, year, and, at the individual level, inventor-fixed effects, and include individual or state-level time-varying controls in our specification. These go a long way toward absorbing unobserved heterogeneity. In addition, we exploit tax schedule differences across individuals within a given state-year, due to tax progressivity, and compare individuals in different tax brackets. Thus, we can also include state-times-year fixed effects to filter out other policy variations or confounding economic circumstances. Second, at both the macro and micro levels, we use an instrumental variable strategy that consists of predicting the total tax burden facing a firm or inventor — a composite of state and federal taxes — with the changes in the federal tax rate only, holding the state taxes fixed at some past level. This provides variation that is only driven by federal-level changes and, thus, exogenous to any individual state. Third, we use a border county strategy as a stand-alone and in combination with our instrumental variable. Finally, we study specific, sharp, tax-change episodes.

We find that taxation of both corporate and personal income negatively affects the quantity, quality, and location of innovation at the state level and the individual inventor and firm levels.[8] The elasticities of all these innovation outcomes with respect to taxes are relatively large, especially at the macro level, where
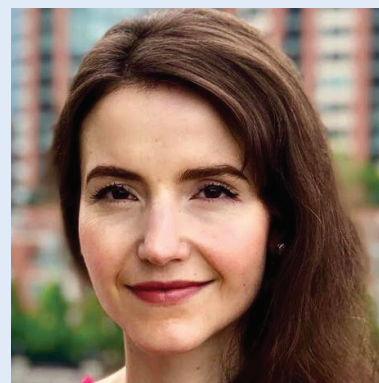
Stefanie Stantcheva is a professor of economics at Harvard University and a research associate at the NBER, where she is affiliated with the Public Economics and Political Economy programs. She is a research fellow at the Centre for Economic Policy Research.

Stantcheva's research focuses on the optimal design of tax systems and public policies, taking into account labor market features, complex social preferences, and long-term effects such as human capital acquisition and innovation by individuals and firms. Part of her work is centered around the study of empirical effects of taxation of individuals and firms, on inequality, top incomes, migration, human capital, and innovation.

In recent work, she is exploring the interplay between taxation and innovation using historical as well as modern-day data and the optimal design of R&D policies. She is also studying how people form social preferences regarding redistribution, using large-scale online survey and experiment tools.

Stantcheva is the recipient of a CAREER Award from the National Science Foundation and is a Sloan Research Fellow.

She holds a BA in economics from the University of Cambridge, a Master's degree in economics and finance from Ecole Polytechnique, a Master's in economics from the Paris School of Economics, and a PhD in economics from MIT. She was a junior fellow at the Harvard Society of Fellows from 2014–16, before joining the Harvard faculty in 2016.

cross-state spillovers and extensive margin responses add to the micro elasticities. Figure 1 illustrates the negative correlation between the personal income tax at the 90th income percentile and the log of patents in a state.

We also find that corporate inventors are more elastic with respect to personal and corporate income taxation than non-corporate inventors. Agglomeration effects appear to matter as well: Inventors are less sensitive to taxation in places where there is already more innovation done in their technological field.

The International Mobility of Superstar Inventors in Response to Taxation

There is a long-standing debate about whether higher top tax rates will cause a "brain drain" of high-income and high-skill economic agents. In fact, many of the great inventors were international immigrants: Alexander Graham Bell, inventor of the telephone and founder of the Bell Telephone Company; James Kraft, inventor of a pasteurization technique and founder of Kraft Foods; and Ralph Baer, creator of a TV gaming unit that launched the video game industry, are examples.

Inventors are frequently more mobile than other high-skill individuals, and they carry and transmit their valuable knowledge and expertise to others, which makes them important for both new knowledge creation and for its diffusion. Yet little is known about the international mobility of labor in response to taxation. Rigorous evidence is lacking because of a scarcity of international panel data.

We use a unique type of international panel data on inventors from the European and U.S. patent offices and from the Patent Cooperation Treaty to study the international migration responses of superstar inventors to top income tax rates for the period of 1977–2003.[9] We are able to tackle

U.S. State Marginal Tax Rate and Patent Production

Log patents

Both patents and tax rates are reported net of control variables
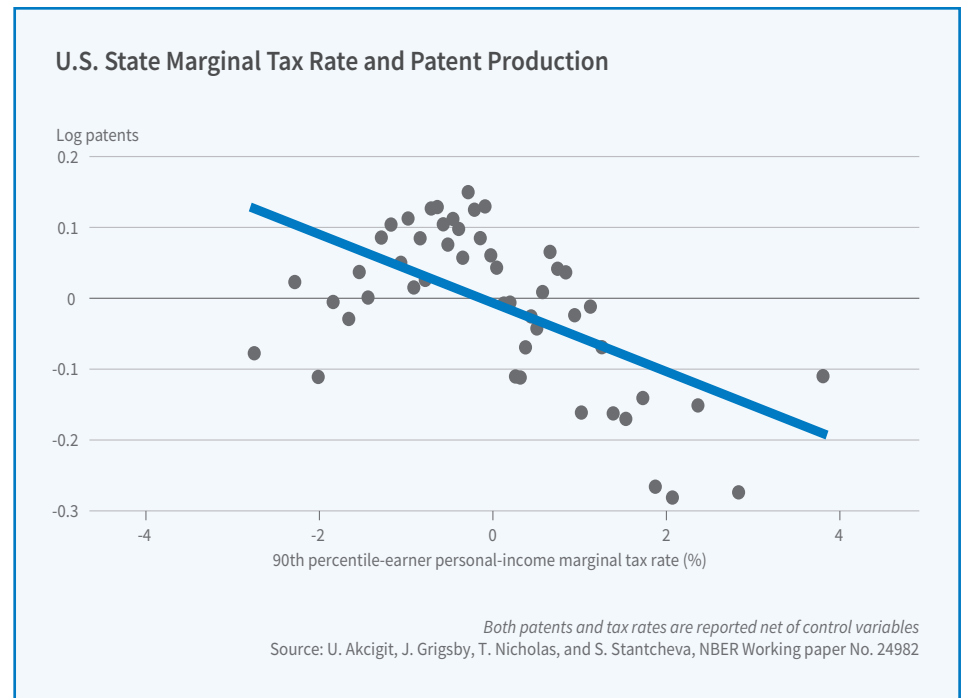Source: U. Akcigit, J. Grigsby, T. Nicholas, and S. Stantcheva, NBER Working paper No. 24982

Figure 1

one major challenge that arises when studying migration responses to taxes, namely, to model the counterfactual payoff that an inventor would get in each potential location, thanks to a set of detailed controls that come from the patent data, most notably, measures of an inventor's quality based on past citations.

Our measure of the effects of the top tax rate filters out all country-year level variation and exploits the differential impacts of the top tax rate on inventors at different points in the income distribution within a country-year cell. To implement this strategy, we define superstar inventors as those in the top 1 percent of the quality distribution, and similarly construct the top 1–5 percent, the top 5–10 percent, and subsequent quality brackets. We know from other research that inventor quality is strongly correlated with income and that top 1 percent inventors rank very high in the top tax bracket. The probability of being in the top bracket and the fraction of an inventor's income in the top bracket declines as one moves down the quality distribution. Top 1 percent inventors and those of somewhat lower

quality are comparable enough to be similarly affected by country-year level policies and economic developments; but only those inventors in the top bracket are directly affected by top taxes. Hence, the lower-quality top 5–10 percent, top 10–25 percent, and below top 25 percent groups serve as control groups for the top 1 percent group.

Figure 2 provides some preliminary visual evidence of the effects of taxes. It shows how the number of superstar top 1 percent foreign inventors in the U.S. increased after the Tax Reform Act of 1986 relative to a counterfactual path estimated from a synthetic control country.

Overall, we find that superstar inventors' location choices are significantly affected by top tax rates. The elasticity to the net-of-tax rate of the number of domestic superstar inventors is around 0.03, while that of foreign superstar inventors is around 1. These elasticities are larger for inventors who work for multinational companies. Inventors are less sensitive to taxes in a country if their company performs a higher share of its research there, suggesting that the location

decision is influenced by the company and by career concerns that may dampen the effects of taxes.

R&D Policy Design

Countries enact many different, often very costly policies designed to foster research and development by firms. These are motivated by the view that there is underinvestment in R&D because of the non-internalized spillovers that the innovations of one firm can have on other firms and, ultimately, on society. Yet, there is no consensus on how such policies should be designed.

We therefore study the joint design of R&D policies and corporate taxation.[10] The key new elements in our analysis are the assumptions that firms are heterogeneous in their ability to produce innovations, and that this ability is known to the firm, but not to the government. In addition, while some of the inputs into the R&D process are observable (R&D investment), others are unobservable (R&D effort). The returns to these inputs are also stochastic, which makes innovation risky.

These ingredients capture some of the very real constraints facing policymakers. For instance, it is very diffi-cult to predict a firm's innovation success, even based on many observables. The government would like to encourage the best firms, but policies have to work despite the asymmetric information and unobservable inputs, and need to distinguish productive firms from less productive ones.

To solve this problem, we build on new dynamic mechanism design methods developed in several recent papers and offer a new approach to allow for spillovers between agents (here, firms) with asymmetric information.[11] We then estimate the model and use it to simulate a range of policies for firms of different ages, sizes, and productivities. We use U.S. Patent and Trademark Office patent data matched to Compustat data on publicly traded firms, as well as the Longitudinal Business Database (LBD) for all firms. This allows us to see the observable inputs to innovation, that is, a firm's R&D expenses, as well as the outputs of innovation as captured by the patents and their citations.

We show that the need to screen firms can starkly influence the shape of R&D policies and firm taxation. The central policy tradeoff is between the Pigouvian correction for innova-tion spillovers and the correction for the monopoly power induced by the intellectual property rights system that emerges from the method of distinguishing good firms from bad ones. The more complementary observable R&D investment is to firm research productivity, as opposed to being complementary to the unobservable R&D effort, the more rents a firm can extract if R&D investment is subsidized. This puts a brake on how well the government can correct for spillovers and monopoly distortions. On the other hand, if R&D investments are more complementary to unobservable firm R&D effort, the optimal R&D subsidy will be greater because subsidizing the observed input will lead the firm to put in more of the unobservable input as well.

The policies that efficiently trade off these considerations are different from current policies as well as simpler policies, such as linear R&D subsidies and taxes. Nonlinear policies, such as an R&D subsidy that depends on the amount of R&D investment and a profit tax that depends on the level of profits, can come closer to the constrained-efficient outcome.

Our findings suggest that taxes significantly affect innovation and that they can thus have far-reaching consequences on technological progress and growth. If designed properly, the tax system could help foster innovation by better aligning the incentives of private agents with the social value of innovation.

The 1986 Tax Reform Act and Foreign Superstar Inventors in the U.S.

Share of foreign superstar inventors in the U.S., normalized to 1 in 1986

Tax reform takes effect

Actual

Estimate based on control (synthetic) country

Source: U. Akcigit, S. Baslandze, and S. Stantcheva, NBER Working Paper No. 21024

Figure 2

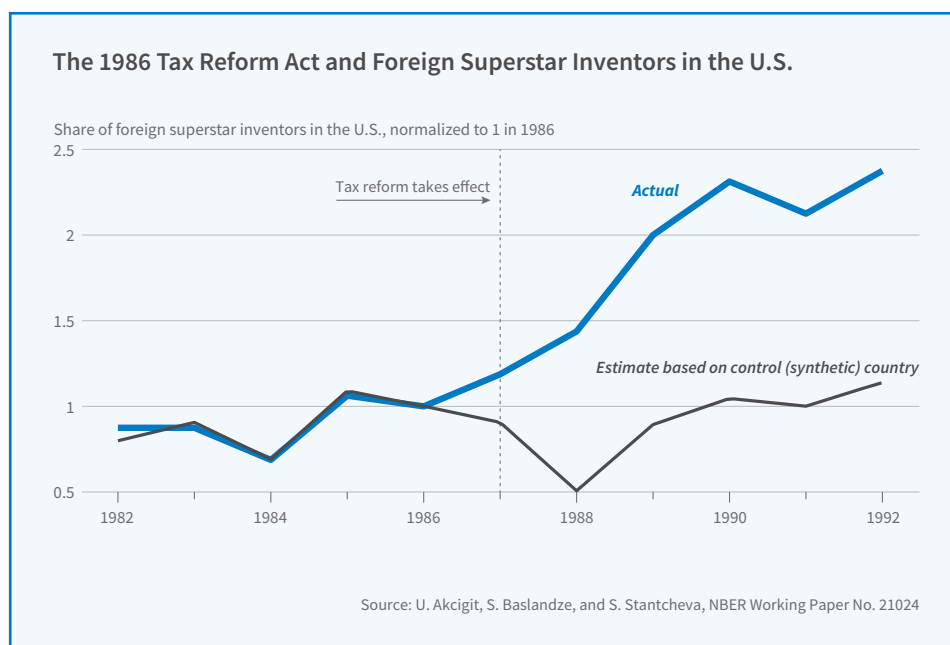[1] U. Akcigit, J. Grigsby, and T. Nicholas, "The Rise of American Ingenuity: Innovation and Inventors of the Golden Age," NBER Working Paper No. 23047, January 2017.
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The Economics of Drug Development
Pricing and Innovation in a Changing Market

Craig Garthwaite

Pricing and competition in pharmaceutical markets is an area of great debate and controversy, much of which stems from the fact that patent protection allows firms to charge high prices for potentially life-saving treatments. In the absence of patents, other firms would be attracted by the large profits earned by incumbent firms and enter the market. Such entry would likely raise current period welfare by reducing prices and increasing access to valuable medications.

However, society enacts regulations that prohibit this entry in pharmaceuticals and other intellectual property-dependent markets, allowing high price-cost margins to exist for a period of time. Policymakers accept the reduced output from higher prices in order to provide appropriate incentives for firms to make large fixed-cost investments in new products. That is, there is an implicit tradeoff in which some degree of current welfare is sacrificed in order to ensure strong incentives for future innovation.

A body of research supports this tradeoff, showing a robust relationship between expected profitability of pharmaceutical products and investment in research and development.[1] The tradeoff is not intended to be permanent. After a period of time, patented products are meant to face additional competition that decreases prices, either through the introduction of therapeutic substitutes that engage in "brand-brand" competition that has a moderate effect on prices, or from post-patent generic competition, which drives prices even lower. The degree and nature of the eventual competition is dictated by a combination of policies and market forces.

The parameters of the complicated tradeoff between static and dynamic efficiencies, such as the length and strength of patents, are intended to provide the incentives for an optimal amount of innovation. As a result, these parameters are inherently context-specific, and as the market for developing and selling pharmaceuticals changes, policymakers should reevaluate the fundamentals of the tradeoff. For example, factors that decrease the costs of developing products — such as less stringent clinical research requirements — or those that meaningfully increase potential revenues — such as large-scale increases in prescription drug coverage or the ability to develop products targeting particularly deadly diseases — could support shorter or weaker patent protection. In contrast, factors that increase the difficulty and/or length of the development process — such as targeting diseases where demonstrating efficacy is more difficult — would support stronger or longer patent protections.

Given the dependence of the development of pharmaceutical products on the existing body of scientific knowledge, scientific advancements likely will affect the optimality of the tradeoff between access today and innovation tomorrow. In partnership with various co-authors across a series of papers, I have investigated how changes in the development process of pharmaceuticals impact the economics of drug development, pricing, and innovation.

One strand of research examines changes in the ability of firms to create products targeting small and specific patient populations — products that are often paired with diagnostic tests indicating the product's likely efficacy in an individual. Broadly speaking, these types of drugs are part of the evolving world of precision medicine. The ability of firms to develop such products is more than simply a scientific advancement or curiosity. A pharmaceutical market involving products targeting small patient populations has vastly different economic fun-

Craig Garthwaite is an associate professor of strategy and the director of the Program on Healthcare at Northwestern University's Kellogg School of Management. An applied microeconomist, he studies the effects of government policies and social phenomena, focusing on the health and biopharmaceutical sectors. Recent work has focused on private sector effects of the Affordable Care Act. In prior work, he has examined the impact of government cash assistance programs on health. He is an NBER research associate and is affiliated with the bureau's Health Care Program.

Garthwaite also studies pricing and innovation in the biopharmaceutical sector. In this area he has examined the effect of expanded patent protection on pricing in the Indian pharmaceutical market, the innovation response of United States pharmaceutical firms to increases in demand, and the relationship between health insurance expansions and high drug prices. His research has appeared in journals such as *The Quarterly Journal of Economics, American Economic Review, The Review of Economics and Statistics,* and *Health Affairs.* In 2015, he was named one of Poet and Quants 40 Best under 40 Business School Professors.

Garthwaite received a BA and a Master's in Public Policy from the University of Michigan and his PhD in economics from the University of Maryland. Prior to receiving his PhD, he served as director of research for the Employment Policies Institute and in other public policy positions.

damentals than those that prevailed when the parameters of our existing intellectual property system were developed. This mismatch between public policy and the current reality of drug development has implications for both optimal policy and firm strategies.

In a recent paper, Amitabh Chandra, Ariel Dora Stern, and I examine the degree to which the market is increasingly focusing on R&D activities related to precision medicines, and discuss the economic implications of such a shift in the product mixture.[2] We first use data from the Cortellis Competitive Intelligence Clinical Trials Database (Cortellis), which is compiled by Clarivate (and formerly by Thomson Reuters) and contains all registered clinical trials from two dozen international clinical trial registries. Importantly for our purposes, these data contain detailed descriptions of the trials including the use and specific role of any biomarkers. At a high level, a biomarker is "a defined characteristic that is measured as an indicator of normal biological processes, pathogenic processes, or responses to an exposure or intervention, including therapeutic interventions," — that is, measurable features of a patient.[3]

Biomarkers can serve a variety of purposes in a clinical trial. Some, but not all, of these purposes may relate to precision medicine. For example, a biomarker can be included to measure the toxicity of a product across an entire population; this is valuable, but isn't especially relevant to targeting. When considering the economic evolution of the pharmaceutical market, we are pri-

marily interested in trials that employ biomarkers for the purpose of identifying patient populations that are more (or less) likely to respond to particular medications. We therefore exploit additional information on the role of the biomarker in a trial to identify those related to products that we define as "likely precision medicines" (LPMs). Figure 1 depicts the growth in trials for these LPMs over time and shows an increase in their use across all phases of clinical development. In particular, there has been a marked increase in

Phase I trials for LPMs in recent years.

The increasing percentage of LPMs in pharmaceutical development has clear economic ramifications. In particular, the ability to create these products changes optimal pricing policies, decisions about which drugs to prioritize in the development process, and the structure of existing government research and development incentives.

One area in which these scientific developments affect the market involves a firm's investment decision for products targeting small patient populations. Historically, there have been limited incentives for pharmaceutical firms to develop products tar-

geting conditions afflicting relatively small numbers of patients. Since the fixed costs of research and development are broadly unrelated to the size of the potential pool of patients, firms generally find it difficult to invest profitably in products that create large amounts of value per patient but treat relatively few individuals.

Recognizing this fact, many developed countries have implemented policies that provide additional incentives for products targeting small patient populations. In the United States, these policies took the form of the Orphan Drug Act (ODA), which provides both research and development tax credits, and allows extended periods of market exclusivity for firms developing products aimed at conditions afflicting fewer than 200,000 patients. These two policies are intended to shift the optimal investment threshold for firms. Passed in 1983, the ODA originally relied on firms demonstrating a lack of economic viability for a product, rather than a strict population limit. The 200,000-patient limit was added in 1984 and, according to the Department of Health and Human Services, was arbitrarily based on the prevalence of narcolepsy and multiple sclerosis. The decision to pick those conditions, which established the patient population threshold, was influenced by the then-existing technology and associated fixed costs for drug development.

In the 35 years since the passage of the ODA, advances in technology related to biomarkers, as well as developments in the understanding of the human genome, have changed the cost structure for firms developing products

Precision Medicine Development Trials, 1995–2016

Pharmaceutical development trials using precision biomarkers (%)

Source: A. Chandra, C. Garthwaite, and A. D. Stern, NBER Working Paper No. 24026 and forthcoming in E. Berndt, D. Goldman, and J. Rowe, eds., *Economic Dimensions of Personalized and Precision Medicine,* University of Chicago Press

Figure 1

targeting small patient populations. Benjamin Berger, Nicholas Bagley, Chandra, Stern, and I examine the market for orphan drugs and the implications of changes in the ability of firms to develop these types of products.[4] Orphan designations are a formal regulatory acknowledgement that a firm is attempting to develop a drug for a rare disease and is a necessary precursor to developing an approved orphan drug. In recent years, as Figure 2 illustrates, there has been a marked increase in the number of these designations — with a rapid increase in the United States broadly following the completion of the Human Genome Project.

The rapid increase in clinical trial activity for precision products and the number of products receiving orphan designations should change the nature of pricing and competition in these markets. Precision medicines and orphan products have, on average, higher prices than other medications. As we discuss in our joint work, and as Stern, Chandra, and Brian Alexander explain in an additional paper, these high prices are the result of a selection effect of products brought to market rather than a special pricing rule for orphan diseases.[5] For example, given the small patient population, firms will only bring to market products that generate large amounts of value for individuals with those conditions. For such products, the potential value created leads to an expected price and resulting profits that justify the research and development investments. Thus, in equilibrium, prices are higher for orphan drugs that firms choose to bring to market than for other drugs.

While the high prices for orphan drugs may represent an equilibrium based on the investment decisions of firms, as for other drugs, these high prices are only intended to exist while the product is under patent protection. For traditional, small-molecule drugs, the United States has long provided the policy framework to support a robust system of generic competition. While the United States still lacks a
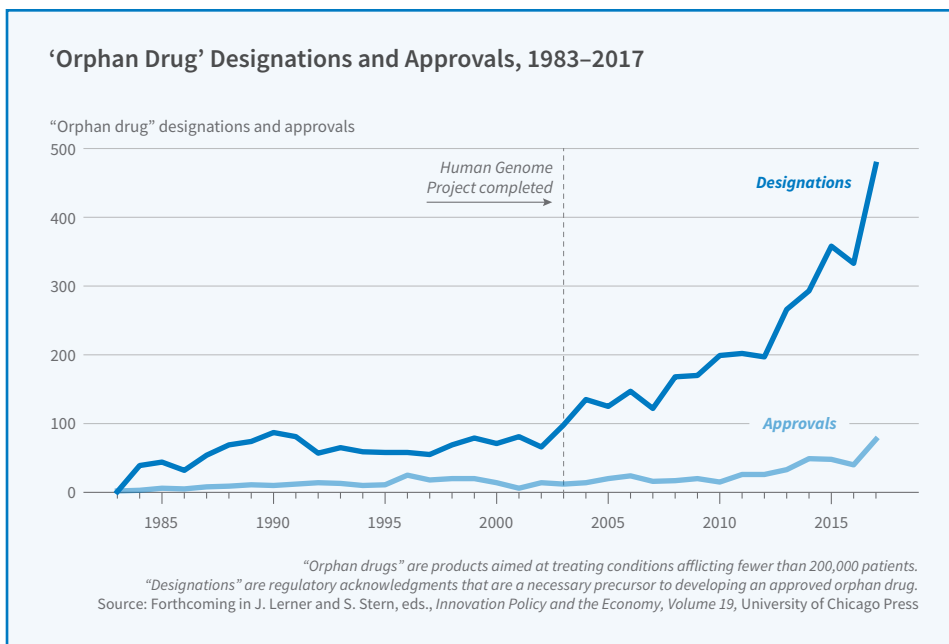
'Orphan Drug' Designations and Approvals, 1983–2017

"Orphan drugs" are products aimed at treating conditions afflicting fewer than 200,000 patients.
"Designations" are regulatory acknowledgments that are a necessary precursor to developing an approved orphan drug.
Source: Forthcoming in J. Lerner and S. Stern, eds., *Innovation Policy and the Economy, Volume 19,* University of Chicago Press

Figure 2

truly competitive post-patent market for complex biologic products (i.e. biosimilars), for small-molecule products the expiration of a patent is normally followed by generic entry and large price decreases. However, as technology allows for drug developers to target increasingly smaller patient populations, the future prospects for this competitive system are limited.
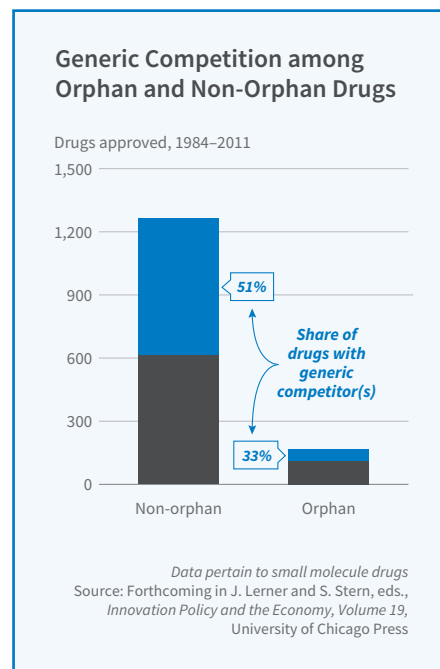
Generic Competition among Orphan and Non-Orphan Drugs

Data pertain to small molecule drugs
Source: Forthcoming in J. Lerner and S. Stern, eds., *Innovation Policy and the Economy, Volume 19,* University of Chicago Press

Figure 3

The attractiveness of any market from the perspective of a new entrant is a function of the expected profitability of entry. For products targeting exceptionally small patient populations, the fixed costs of entry and the likelihood of intense post-entry price competition mean that a new entrant is unlikely to earn profits. This means that in the markets for some drugs targeted at small populations, a generic firm will never emerge — regardless of how high a price-cost margin the incumbent firm is able to charge. Evidence of this phenomenon can be seen in the nature of generic competition across orphan and non-orphan products in Figure 3. Approximately 50 percent of small-molecule non-orphan drug products have faced generic competition in the form of a competitor firm filing an abbreviated new drug application (ANDA) — a necessary regulatory step for a firm to produce a generic product. In contrast, only 33 percent of small-molecule orphan products have ever had an ANDA filed against them.

Figure 4, on the next page, demonstrates the role of market size in determining future competition. It shows the average peak demand in pharmacy claims data for orphan and non-orphan products based on the pres-

ence of an ANDA. These data come from OptumLabs and comprise all retail and mail-order pharmacy claims and inpatient and outpatient medical claims filed by United Healthcare beneficiaries between 1992 and 2017. The table demonstrates the importance of market size in determining competition. Products that never receive an ANDA have meaningfully smaller peak demand compared with those that face some form of generic competition.

The lack of generic competition emerging to compete with branded products losing patent protection is currently limited to a relatively small number of drugs that target very small patient markets. However, as more and more firms develop precision medicines, the lack of generic entry in small drug markets could become a greater threat to future price competition across the entire market. Consider, for example, the case of Kalydeco (ivacaftor), which is a treatment for a subset of cystic fibrosis patients who also have a particular set of mutations. The likely patient population is estimated at between 2,000 and 3,000, and the drug costs several hundred thousand dollars per year. Despite the high prices, the small patient population means that it is unlikely that additional firms will attempt to target patients currently treated with Kalydeco.

Profit-maximizing firms understand the benefits of potentially long-lived profits from products targeting these smaller patient populations. As a result, it may be optimal for firms to focus increasingly on products that create meaningful value for large patient populations but where future compe-

tition may quickly allow patients to capture that value. For example, Vertex (the manufacturer of Kalydeco) is developing several additional products that target cystic fibrosis patients with mutations — each of which will likely face little competition from generics or therapeutic substitutes. Future work should examine the degree to which firms are shifting research away from the larger market products that are

more likely to receive meaningful competition in favor of these smaller markets that might offer larger and more long-lived profits.

Beyond simply extending the time period during which firms face little or no competition, an increasing ability to develop products aimed at small patient populations could change a firm's optimal pricing strategy. If firms can more accurately predict a drug's *ex ante* efficacy — as is true for many precision medicines — they could develop more complicated pricing policies that allow them to capture more of the value they create. This is particularly true if a product can be used to treat multiple conditions with varying efficacy across these conditions. In these settings, firms may be interested in charging prices based on the indication-specific value

created; this is often called indication-based pricing. Such a pricing system is promoted by many policy activists who believe that charging prices based on a product's indication-specific value will lower prices and reduce pharmaceutical profits.[6] However, a system allowing firms to charge different prices based on a consumer's value and willingness to pay for a product presents the ideal conditions for price discrimination.

To understand the way in which indication-based pricing allows firms to price-discriminate, consider how pharmaceutical firms set prices for products that can be used to treat multiple conditions. For all drugs, prices are set based on negotiations between pharmaceutical firms and payers/pharmacy benefit managers. In most cases, a firm's optimal price is limited by the value a product creates, because an insurer must pass along the cost to patients via premiums.[7] If pharmaceutical manufacturers set a high price relative to the value created for a specific indication, payers will implement utilization management programs that limit access to the product. For products treating multiple conditions, this ability for payers to restrict access requires pharmaceutical manufacturers to consider which segments of the market it will attempt to serve.

The pricing decisions of firms for different markets is summarized in Figure 5.[8] Panel A contains a depiction of optimal pricing decisions for firms under the existing uniform pricing system for a product that treats three indications with differing efficacy. Under Scenario 1, patients with Indication C receive the least relative value of all patients. However, given the large size
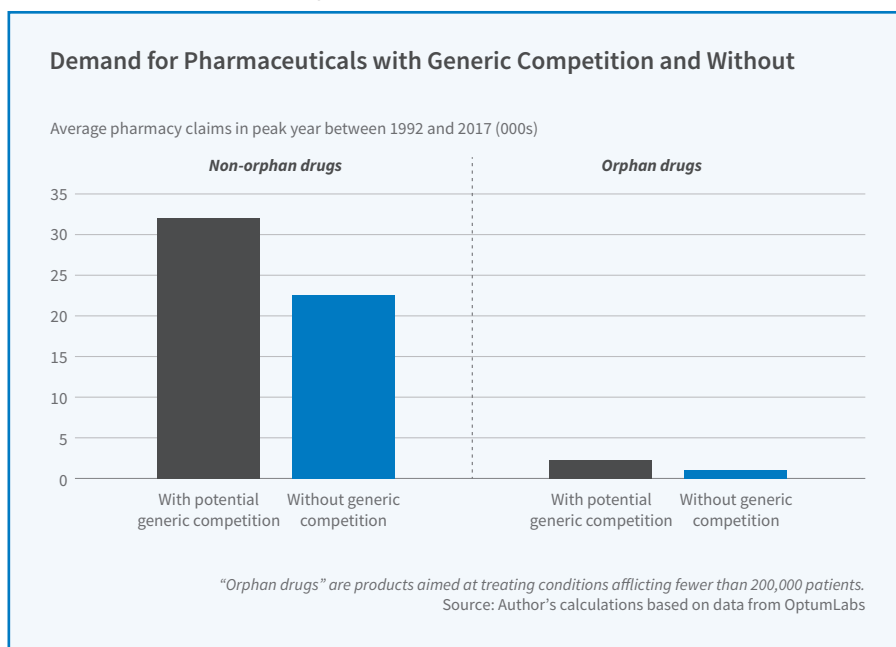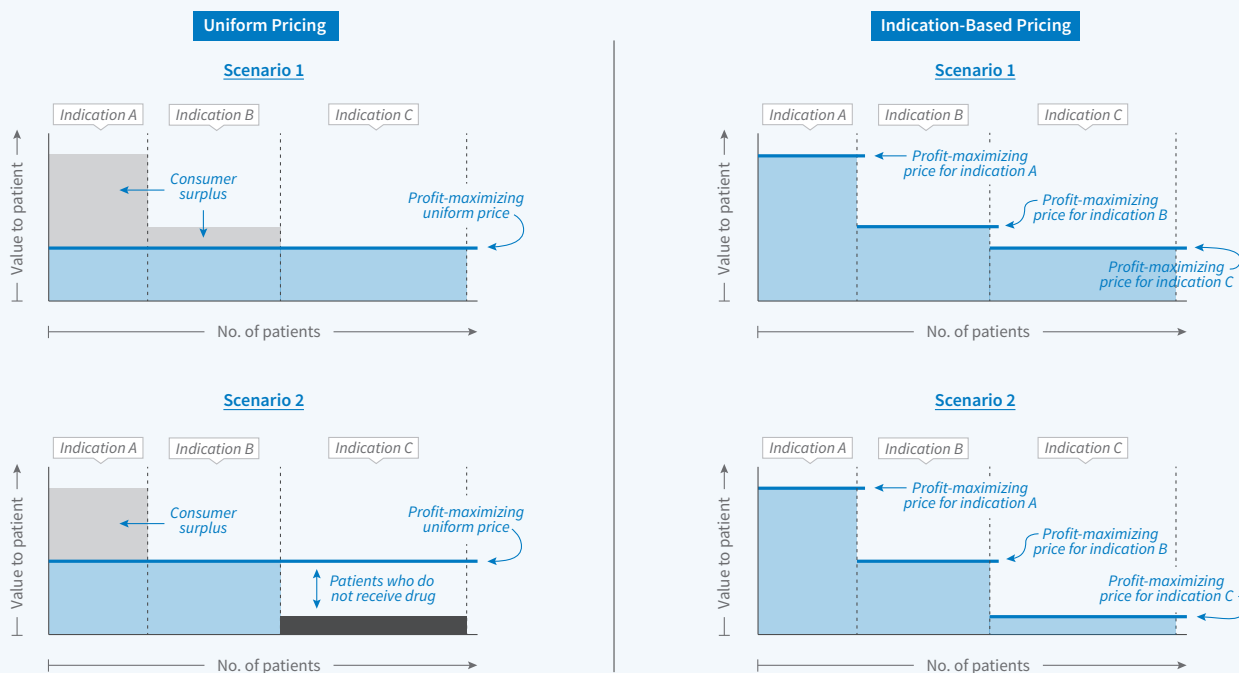
Demand for Pharmaceuticals with Generic Competition and Without

Average pharmacy claims in peak year between 1992 and 2017 (000s)

Non-orphan drugs   *Orphan drugs*

With potential generic competition   Without generic competition   With potential generic competition   Without generic competition

"Orphan drugs" are products aimed at treating conditions afflicting fewer than 200,000 patients.
Source: Author's calculations based on data from OptumLabs

Figure 4

Market Scenarios for Precision Medicine Under Uniform Pricing and Indication-Based Pricing

Source: Illustrative diagram based on author's theoretical scenarios

Figure 5

of this population, and the broadly high value they receive, a pharmaceutical manufacturer finds it optimal to set a price that causes insurers to allow these patients to access the medication. This relatively low price allows patients with Indications A and B to enjoy a relatively large amount of consumer surplus. In contrast, in Scenario 2 of Panel A, patients who have Indication C receive such a small amount of value from the product that the pharmaceutical firm finds it optimal to set a price that causes the insurer to limit these patients from accessing the drug. This decreases output and results in some of the consumer surplus from Indication B patients now being captured by the firm.

Now consider the situation where a pharmaceutical manufacturer could charge multiple prices. For ease of discussion, Panel B presents a simplified version of this for the two scenarios discussed above, where firms are able to price at the maximum willingness to pay for each indication and consumers don't respond to a higher price through reduced utilization. In this case, the ability to charge multiple prices means that firms are able to capture far more surplus than they could under a uniform pricing system.

After considering this simple example, it becomes hard to imagine how implementing indication-based pricing would result in reduced pharmaceutical profits or lower average prices. However, the welfare implications of indication-based pricing remain decidedly unclear. If the number of markets similar to Scenario 2 is large, then instituting indication-based pricing could be output-expanding. However, if most markets resemble Scenario 1, the primary effect of an indication-based pricing scheme would be to transfer value to firms. Again, the welfare implications of this transfer are unclear. Greater expected profits from such a system could increase the amount of innovation, as products that previously would not have generated sufficient profits to justify development are now worth more in expectation. However, the higher prices for each indication could reduce output — particularly if patients are exposed to meaningful cost-sharing based on the price of the product. The potential scope for these welfare losses increases if each indication is quite small and therefore unlikely to attract competition after patent expiration.

In summary, the economics of the pharmaceutical market are shaped in part by the scientific research and development process. As a result, changes in the nature and type of medications that can be developed can ripple through the entire system, impacting firms' innovation incentives, competition in pharmaceutical markets, and public and private drug spending. These changes can affect the optimal nature of decisions regarding the protection of intellectual

property, as well as pricing strategies implemented by firms that themselves will dictate the welfare generated in these markets.

Far more work is needed to understand the economic factors affecting firms in this area. For example, we know that changes in profitability can affect investments in innovation, but we know little about the quality of that innovation. In a recent paper, David Dranove, Manuel I. Hermosilla, and I find little evidence that truly novel products are affected by marginal changes to profitability, but this relationship warrants further study.[9] In addition, little is known about the current incentives for firms to develop new biomarkers — particularly those that could decrease market size by providing more information about the optimal use of existing products.[10]

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Mortgage Lending and Housing Markets

Fernando Ferreira

At the onset of the last housing crisis, it was widely believed that the lenders who extended subprime mortgages and the homeowners who had taken out those loans were responsible for the housing boom, bust, and ensuing economic crisis. With the benefit of hindsight — and aided by much better data and research designs — academic researchers now have a clearer view. The credit expansion during the housing boom was not concentrated in the subprime sector, and the majority of foreclosures during the crisis were not associated with subprime mortgages. African-American and Hispanic homebuyers paid higher mortgage costs relative to comparable homebuyers during the last cycle, independent of whether they used subprime or prime loans. Finally, those minorities were hurt most by the foreclosure crisis, especially when they bought homes at or near the peak of the housing boom.

Much of my recent research focuses on understanding three key issues related to subprime mortgages and minority borrowers during the last housing cycle: the role of subprime loans during the housing boom, the foreclosure crisis, and the vulnerability of minority homeowners during the boom and bust.

Subprime Mortgages and the Housing Boom

Joseph Gyourko and I uncover basic stylized facts about the foreclosure crisis by constructing a panel of housing ownership sequences that contains more than 33 million ownership spells from 1997 to 2012.[1] These data, acquired from CoreLogic, are based on the universe of housing transactions for almost 100 Metropolitan Statistical Areas. We merge them with the Home Mortgage Disclosure Act files in order to add more loan features and demographics. Importantly, this panel includes details on every type of

option available for financing a home purchase — prime and subprime mortgages, cash, and governmental loans — as well as for refinancing during an ownership spell. This fixes the missing data problem of research conducted early in the cycle that relied solely on subprime mortgage data.

Figure 1 documents the market shares of the different sources of funding used by homeowners. The subprime sector, which included many alternative loans issued to higher-risk borrowers, indeed expanded its share of the mar-

ket over the course of the housing boom, roughly doubling to just over 20 percent. However, this came at the expense of the government-insured subsector — Federal Housing Administration and Veterans Affairs loans — not the prime mortgage sector. Prime mortgages were always the dominant loan type across the cycle, with their share hovering around 60 percent, and in fact increasing almost 10 percentage points from 2000 to 2006. Finally, those using only cash to purchase a house constituted a relatively stable 10 to 11 percent of the sample until 2010, after which this share increased to 16 percent, due to the unavailability of credit during that period and the increase in the relative number of cash investors.

The aggregate data indicate that subprime did not take over the mortgage market during the housing boom; the pattern was rather one of broad-based expansion of credit. This has been corroborated by other recent studies. For example, Manuel Adelino, Antoinette Schoar, and Felipe Severino find that the mortgage expansion was shared across the entire income distribution, as opposed to being concentrated in low-income groups.[2] Christopher Foote, Lara Loewenstein, and Paul Willen demonstrate that, since high-income borrowers tend to use mortgages with higher loan amounts, wealthy borrowers accounted for most of the increase in outstanding mortgage debt in dollar terms.[3] Neil Bhutta looks at the dollar value of mortgage
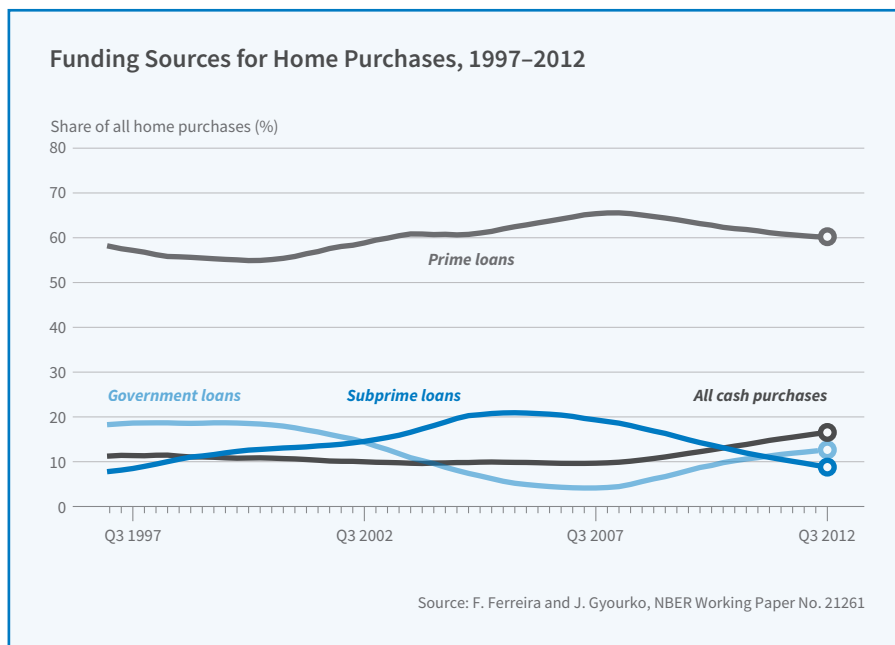

Funding Sources for Home Purchases, 1997–2012

Share of all home purchases (%)

Prime loans

Government loans   Subprime loans   All cash purchases

Source: F. Ferreira and J. Gyourko, NBER Working Paper No. 21261

Figure 1

Fernando Ferreira is an associate professor of real estate and business economics and public policy at The Wharton School of the University of Pennsylvania, where he is also the coordinator of the Wharton Applied Economics PhD Program. He is a research associate in the NBER Public Economics Program, and has co-organized the NBER Summer Institute Real Estate meeting since 2014.

Ferreira is also a faculty fellow of the Penn Institute for Urban Research, and was a co-editor of the *Journal of Public Economics* from 2013 to 2018.

His research interests lie in the intersection of real estate, urban economics, and public economics. He has written about household location decisions and valuation of public goods, with a special focus on public elementary schools; how the size and composition of local governments are influenced by housing markets, political parties, income inequality, and female leadership; and the causes and consequences of the last housing cycle, including the impact of negative equity on household mobility and the vulnerability of minority homeowners during the boom and bust.

Ferreira obtained his PhD in economics from the University of California, Berkeley. He also has an MA in economics from the Federal University of Rio Grande do Sul and a BA in economics from the State University of Maringa, both in Brazil.

inflows to reveal that first-time homebuyers, even the ones with low credit scores, experienced only modest growth in credit inflows.[4] He finds that the largest inflows were in fact due to investors, not households. And to put the proverbial last nail in the coffin of the "subprime caused the boom" narrative, Stefania Albanesi, Giacomo De Giorgi, and Jaromir Nosal show that credit growth was concentrated in the prime segment, and that so-called high-risk borrowers had similar growth in virtually all debt categories during the early 2000s.[5]

Foreclosure Crisis

Gyourko and I also document how housing distress evolved over the cycle. Distress is defined as a home being lost to foreclosure or short sale. Foreclosed

Subprime subsector borrowers' distress spiked first, beginning in 2006, and quickly reached double-digit percentage rates by the time the global financial crisis hit in 2008. But we find that this initial shock in subprime distress was spatially concentrated in a relatively small number of metropolitan areas in central California.

Much less well known is the fact that there was a surge in prime subsector distress within a few months of the initial surge in subprime borrower home losses. The rate of home loss for prime borrowers never approached that of subprime borrowers, but it remained high through 2012. Because prime borrowers far outnumber subprime borrowers, even with a lower foreclosure rate they still account for twice as many home losses as subprime borrowers. Figure 2 shows the total num-
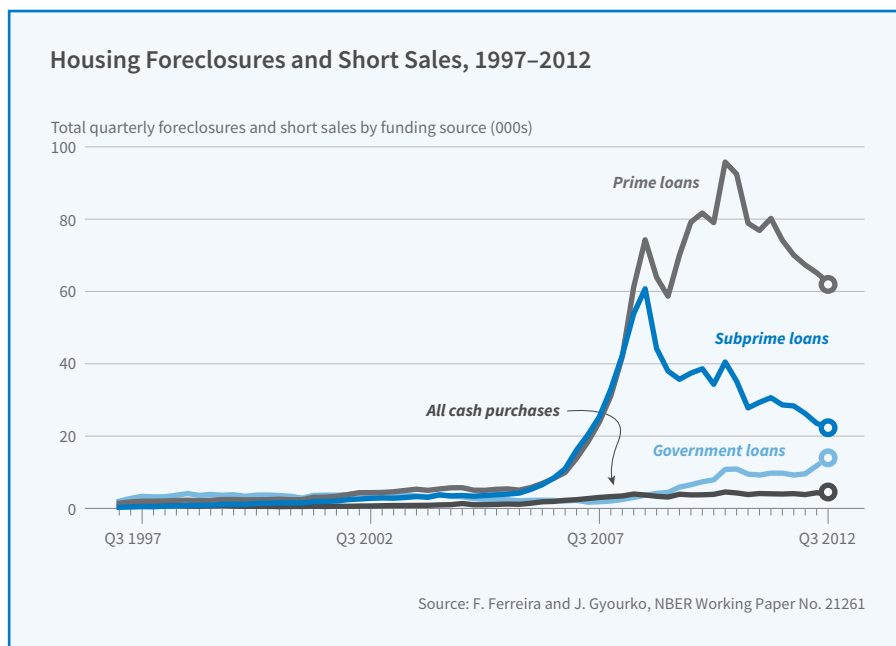

Housing Foreclosures and Short Sales, 1997–2012

Total quarterly foreclosures and short sales by funding source (000s)

Source: F. Ferreira and J. Gyourko, NBER Working Paper No. 21261

Figure 2

homes are explicitly identified in the DataQuick files by a distress code that indicates the date the home was lost by the previous owner. A short sale is defined as a transaction in which the sales price is no more than 90 percent of the outstanding balance on all existing debt.

The initial finding of distress is consistent with much previous research:

ber of home losses by quarter in this sample, by type of home financing source.

Hence, the foreclosure crisis that started in 2006 was still not over in 2012. Though it started in the subprime subsector, it did not remain there for very long, and it ultimately became a broad housing market phenomenon. This pattern of distress is also found by

Albanesi, De Giorgi, and Nosal, who report that the rise in mortgage default during the foreclosure crisis was concentrated in the middle of the credit score distribution, not among low-credit score borrowers.

Gyourko and I also find that loan-to-value ratios at the time of house purchase did not vary much by type of mortgage. But over the course of a homeowner's time in her house, the loan-to-value ratio varies, partly as a function of loan repayment but also as a function of house price movements. Rising house prices result in lower loan-to-value ratios. These ratios on the overall housing stock reached their lowest levels between 2005 and 2006; this may have influenced the perception that housing markets were healthy. As home prices fell after 2006, current loan-to-value ratios shot up, turning into negative equity, and foreclosure rates rose. Adelino, Schoar, and Severino find that default rates went up predominantly in areas with large house price reductions. Within those areas, the largest default effects were concentrated among high-income and high credit-score borrowers.

Defaults and foreclosures can happen because of strategic reasons — keeping up with monthly mortgage payments may not be worthwhile once a house has negative equity — and also simply because of changes in homeowners' ability to make payments due to the unemployment shock of the Great Recession. An important data limitation still faced by researchers is the difficulty of linking microdata on employment and incomes with individual-level data on credit and housing choices. Kristopher Gerardi, Kyle Herkenhoff, Lee Ohanian, and Willen use data from the Panel Study of Income Dynamics to circumvent this problem and find that change in ability to pay is the main factor explaining mortgage default.[6]

Vulnerability of Minority Homeowners

Improved datasets also helped Patrick Bayer, Stephen Ross, and me to understand and to compare mortgage costs by race and ethnicity during the last housing boom. This was not an easy task, because valid comparison required us to identify whites, African Americans, and Hispanics with similar creditworthiness, demographics, loan characteristics, etc. We dealt with this empirical challenge by assembling a unique panel data set that links individual housing transactions, individual mortgage decisions and demographics, and individual credit data. We leverage this panel to examine pricing of mortgages that vary by race of the homeowner separately from the racial composition of the neighborhood. The panel also includes a representative sample of all mortgages, not just subprime loans. Finally, it contains all standard risk factors that are typically considered in mortgage underwriting.

We find that African-American and Hispanic borrowers are 103 percent and 78 percent more likely to receive high-cost mortgages for home purchases, after controlling for individual credit scores, other risk factors, and whether the borrower used a prime or subprime loan. A large fraction of this effect is due to sorting of borrowers across lenders with a particular characteristic. This most important lender characteristic is not something observed at the time of origination; instead, it is related to the behavior of these companies during the foreclosure crisis. These lenders disproportionally foreclosed properties during the Great Recession. The role of lenders in the foreclosure crisis remains an understudied topic.

Bayer, Ross, and I in a separate paper also analyze differential rates of mortgage foreclosures and delinquencies faced by minority homeowners.[7] We first show that, while all homeowners had negligible 90-day delinquency and foreclosure rates in 2004 and 2005, very large racial and ethnic differences emerged by 2008 and 2009 [see Figure 3]. The numbers are stark: More than 1 in 10 minority homeowners in the sample had a delinquent mortgage in 2009, compared with 1 in 25 for white households.

Using the same panel data, we estimate that minorities were 3 percent more likely to experience foreclosure than white homeowners with similar credit scores, loan characteristics, demographics, house type, neighborhood, and lender.[8] This difference is especially pronounced for loans originated near the peak of prices during the housing boom. And the differential foreclosure effect by
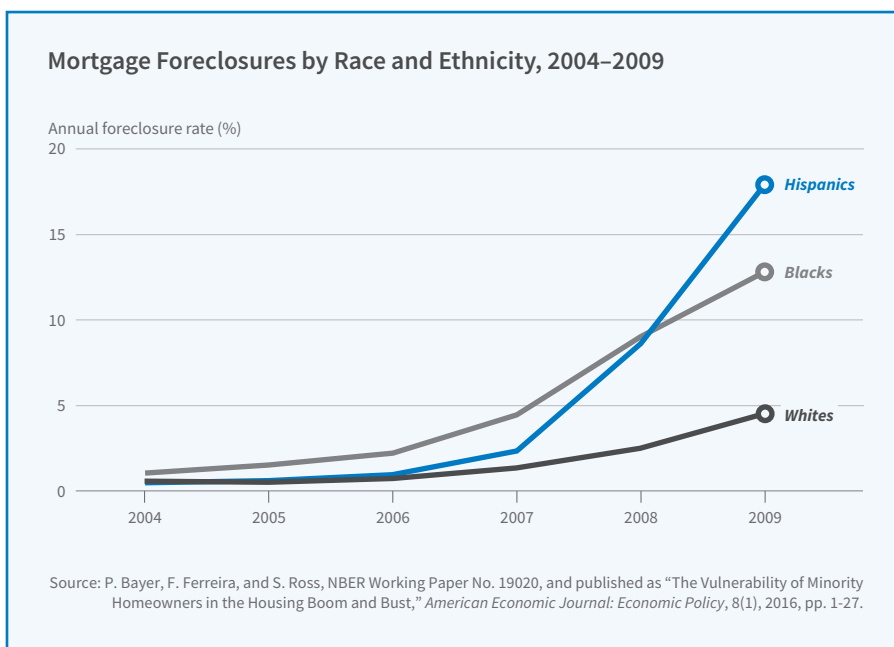

Mortgage Foreclosures by Race and Ethnicity, 2004–2009

Annual foreclosure rate (%)

Source: P. Bayer, F. Ferreira, and S. Ross, NBER Working Paper No. 19020, and published as "The Vulnerability of Minority Homeowners in the Housing Boom and Bust," *American Economic Journal: Economic Policy*, 8(1), 2016, pp. 1-27.

Figure 3

minority status seems to be explained largely by the lower rates of employment among African Americans.

Taken together, these estimates provide evidence that minority households drawn into homeownership late in the housing boom were especially vulnerable, both because they acquired assets at peak prices and because they suffered unemployment consequences of the downturn more acutely.

[1] F. Ferreira and J. Gyourko, "A New Look at the U.S. Foreclosure Crisis: Panel Data Evidence of Prime and Subprime Borrowers from 1997 to 2012," NBER Working Paper No. 21261, June 2015.
Return to Text

[2] M. Adelino, A. Schoar, and F. Severino, "Loan Originations and Defaults in the Mortgage Crisis: The Role of the Middle Class," NBER Working Paper No. 20848, January 2015, and The Review of Financial Studies, 29(7), 2016, pp. 1635–70.
Return to Text

[3] C. Foote, L. Loewenstein, and P. Willen, "Cross-Sectional Patterns of Mortgage Debt during the Housing Boom: Evidence and Implications," NBER Working Paper No. 22985, December 2016.
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[4] N. Bhutta, "The Ins and Outs of Mortgage Debt During the Housing Boom and Bust," Journal of Monetary Economics, 76, 2015, pp. 284–98.
Return to Text

[5] S. Albanesi, G. De Giorgi, and J. Nosal, "Credit Growth and the Financial Crisis: A New Narrative," NBER Working Paper No. 23740, August 2017.
Return to Text

[6] K. Gerardi, K. Herkenhoff, L. Ohanian, and P. Willen, "Can't Pay or Won't Pay? Unemployment, Negative Equity, and Strategic Default," NBER Working Paper No. 21630, October 2015.
Return to Text

[7] P. Bayer, F. Ferreira, and S. Ross, "What Drives Racial and Ethnic Differences in High-Cost Mortgages? The Role of High-Risk Lenders," NBER Working Paper No. 22004, February 2016, and The Review of Financial Studies, 31(1), 2018, pp. 175–205.
Return to Text

[8] P. Bayer, F. Ferreira, and S. Ross, "The Vulnerability of Minority Homeowners in the Housing Boom and Bust," NBER Working Paper No. 19020, May 2013, and American Economic Journal: Economic Policy, 8(1), 2016, pp. 1–27.
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Two New Directors Elected to NBER Board

Diana Farrell has been elected an at-large member of the NBER Board of Directors. She is president and CEO of the JPMorgan Chase Institute, which carries out economic and policy research using the rich administrative data resources that arise from the firm's client interactions. Previously, she was a senior partner at McKinsey & Company, where she was the global head of the McKinsey Center for Government and the McKinsey Global Institute.

Farrell served in the White House as deputy director of the National Economic Council and Deputy Assistant to the President on Economic Policy, 2009–10, and was a member of the President's Auto Recovery Task Force. She currently serves on the board of directors of eBay, the Urban Institute, and the Washington International School. She is a trustee emerita of Wesleyan University, and was a co-chair of the World Economic Forum's Council on Economic Progress. She is a member of the Council on Foreign Relations and the Aspen Strategy Group.

She holds a BA from Wesleyan University, which has awarded her a distinguished alumna award, and an MBA from Harvard Business School.

Samuel Kortum, the James Burrows Moffatt Professor of Economics at Yale University, is Yale's new representative on the board. Kortum's principal areas of research are international economics, industrial organization, and macroeconomics. In 2004, he and Jonathan Eaton shared the Econometric Society's Frisch Medal for their paper "Technology, Geography, and Trade," which provided a framework that has been applied in many subsequent studies of trade patterns. The researchers were honored with the 2018 Onassis Prize in International Trade.

Kortum taught at Boston University, the University of Minnesota, and the University of Chicago before joining the Yale faculty. He is a member of the American Academy of Arts and Sciences, a Fellow of the Econometric Society, and a past editor of the *Journal of Political Economy*. He has been an NBER affiliate since 1993 and spent the 1999–2000 academic year at the NBER as a National Fellow.

Kortum received his BA from Wesleyan University and his PhD from Yale.

Ray Fair, Yale's former representative on the NBER board, was elected to emeritus status.

Diana Farrell

Samuel Kortum

41st Annual NBER Summer Institute

Researchers from 17 countries and 427 institutions participated in the NBER's 41st annual Summer Institute, which was held in Cambridge during a three-week period in July. More than 2,800 participants took part in 51 distinct meetings arranged by 120 organizers.

There were 185 graduate student participants, and 545 participants who were attending their first Summer Institute. More than 65 percent of the participants were not NBER affiliates. Researchers submitted 5,819 papers, of which 563 were selected for presentation.

Raghuram Rajan, the Katherine Dusak Miller Distinguished Service Professor at the University of Chicago's Booth School of Business, a former governor of the Reserve Bank of India, delivered the 2018 Martin Feldstein Lecture on "The Two Faces of Liquidity." His presentation described the role of credit access for households and firms in both the run-up to the 2008 global financial crisis and in the years following the crisis. Excessive liquidity prior to the crisis permitted mortgage lending with relatively weak standards and boosted asset prices. The sharp decline in credit after the crisis constricted both investment and consumer spending, placing an important drag on the pace of recovery. An edited text of the lecture appears earlier in this

issue of the *NBER Reporter*.

The 2018 Methods Lectures, on "Weak Instruments and What to Do About Them," were presented by NBER Research Associates and Harvard faculty members Isaiah Andrews and James Stock. The so-called "weak instruments" problem arises when researchers apply instrumental variable methods in settings in which the variation in the exogenous variables accounts for only a small part of the variation in the explanatory variables. Andrews and Stock described how to diagnose this problem, and how to conduct inference when it arises.

Recognizing that the global financial crisis began a decade ago, the 2018 Summer Institute also included a day-long meeting on "The Global Financial Crisis @ 10." The conference included presentations on the role of extrapolative expectations in inflating pre-crisis asset bubbles, the weaknesses of the pre-crisis financial system, post-crisis lessons on the stabilization role of fiscal policy, and lessons learned about macroprudential financial policy.

The 2018 Feldstein Lecture, Methods Lectures, and the presentations at the Global Financial Crisis @ 10 conference and several other Summer Institute meetings were videotaped and can be accessed through the NBER Videos tab on the left side of the NBER homepage.

Conferences

Machine Learning in Health Care

An NBER conference on Machine Learning in Health Care took place June 4 in Cambridge. Research Associates David M. Cutler and Sendhil Mullainathan, both of Harvard University, and Ziad Obermeyer of Harvard Medical School organized the meeting. The conference was partially funded by a grant from the National Institute on Aging. These researchers' papers were presented and discussed:

- **Sendhil Mullainathan** and **Ziad Obermeyer**, "Are We Over-Testing? Using Machine Learning to Understand Doctors' Decisions"

- **Susan Athey**, Stanford University and NBER, "The Impact of Machine Learning on Economics" (Chapter in the forthcoming NBER book *The Economics of Artificial Intelligence: An Agenda*, Ajay K. Agrawal, Joshua Gans, and Avi Goldfarb, editors, from the University of Chicago Press)

- **David C. Chan Jr**, Stanford University and NBER, and **Jonathan Gruber**, MIT and NBER, "Triage Judgments in the Emergency Department"

- **Justine S. Hastings**, Brown University and NBER, and **Mark Howison**, **Sarah E. Inman**, and **Miraj G. Shah**, Brown University, "Using Big Data and Data Science to Generate Solutions to the Opioid Crisis"

- **Jonathan Gruber**; **Benjamin R. Handel** and **Jonathan T. Kolstad**, University of California, Berkeley and NBER; and **Samuel Kina**, Picwell Inc., "Managing Intelligence: Skilled Experts and AI in Markets for Complex Products"

- **Rahul Ladhania** and **Amelia Haviland**, Carnegie Mellon University; **Neeraj Sood**, University of Southern California and NBER; and **Ateev Mehrotra**, Harvard Medical School, "Medication Adherence and Cost Exposure: A Story in Heterogeneity"

Summaries of these papers are at www.nber.org/conferences/2018/MLs18/summary.html

Workshop on Aging and Health

A workshop on Aging and Health cosponsored by the Max Planck Institute for Social Law and Social Policy and the NBER took place June 7–8 in Munich, Germany. Research Associate Axel H. Börsch-Supan of the Max Planck Institute, Fabrizio Mazzonna of Università della Svizzera Italiana, and Research Associate Jonathan S. Skinner of Dartmouth College organized the meeting. These researchers' papers were presented and discussed:

- **Amitabh Chandra**, Harvard University and NBER, and **Douglas O. Staiger**, Dartmouth College and NBER, "Identifying Prejudice in Healthcare by Race, Gender, and Age"

- **Axel H. Börsch-Supan**; **Tabea Bucher-Koenen**, Max Planck Institute; and **Felizia Hanemann**, Technical University of Munich, "Does Disability Insurance Improve Health and Well-being?"

- **Coen W.A. van de Kraats**, Vrije Universiteit Amsterdam and Tinbergen Institute; **Titus J. Galama**, University of Southern California; and **Maarten Lindeboom**, Vrije Universiteit Amsterdam, "Light at the End of the Tunnel — Unemployment and Mental Health after Age 50"

- **Liran Einav,** Stanford University and NBER; **Amy Finkelstein,** MIT and NBER; **Sendhil Mullainathan,** Harvard University and NBER; and **Ziad Obermeyer,** Harvard Medical School, "Does High Healthcare Spending at End of Life Imply Waste? Predictive Modeling Suggests Not Necessarily"

- **Mary K. Hamman** and **John M. Nunley**, University of Wisconsin-LaCrosse; **Daniela E. Hochfellner**, New York University; and **Christopher J. Ruhm**, University of Virginia and NBER, "Peer Effects and Retirement Decisions: Evidence from Pension Reform in Germany"

- **Naoki Aizawa**, University of Wisconsin-Madison; **Soojin Kim**, Purdue University; and **Serena Rhee**, University of Hawaii, Manoa, "Labor Market Screening and Social Insurance Program Design for the Disabled"

- **Andreas Haller** and **Josef Zweimueller**, University of Zurich, and **Stefan Staubli**, University of Calgary and NBER, "Tightening Disability Screening or Reducing Disability Benefits? Evidence and Welfare Implications"

- **Peter Hudomiet** and **Susann Rohwedder**, RAND Corporation, and **Michael D. Hurd**, RAND Corporation and NBER, "Using Subjective Conditional Probabilities to Find the Causal Effects of Health, Income, Wealth, and Longevity on Retirement"

- **Gopi Shah Goda**, Stanford University and NBER; **Matthew Levy**, London School of Economics; **Colleen Flaherty Manchester** and **Aaron Sojourner**, University of Minnesota; and **Joshua Tasoff**, Claremont Graduate University, "Mechanisms behind Retirement Saving Behavior: Evidence from Administrative and Survey Data"

- **Nicholas W. Papageorge**, Johns Hopkins University and NBER; **Kevin Thom**, New York University; and **Daniel Barth**, University of Southern California, "Genetic Endowments and Wealth Inequality" (NBER Working Paper No. 24642)

- **Maarten Lindeboom**, "Pension Reform: Disentangling Retirement and Savings Responses"

- **Ethan Lieber**, University of Notre Dame, and **Lee Lockwood**, University of Virginia and NBER, "Targeting with In-Kind Transfers: Evidence from Medicaid Home Care" (NBER Working Paper No. 24267)

Summaries of these papers are at www.nber.org/conferences/2018/AHs18/summary.html

East Asian Seminar on Economics

The NBER, the Tokyo Center for Economic Research, the Korea Development Institute, the Hong Kong University of Science and Technology, the Peking University China Center for Economic Research, the National University of Singapore, the Australian National University, and the Chung-Hua Institution for Economic Research (Taipei) jointly sponsored the NBER's 29th Annual East Asian Seminar on Economics. The conference, which focused on political economy, was organized by Research Associates Takatoshi Ito of Columbia University and Andrew K. Rose of the University of California, Berkeley. It took place in Seoul, South Korea, June 21–22. These researchers' papers were presented and discussed:

- **Abhijit Banerjee**, MIT and NBER; **Nils Enevoldsen**, MIT; **Rohini Pande**, Harvard University and NBER; and **Michael Walton**, Harvard University, "Information as an Incentive: Experimental Evidence from Delhi"

- **Dongsoo Kang** and **Changwoo Nam**, Korea Development Institute, "Conflict of Interests between Government and Creditors in Corporate Restructuring: Case of Korea"

- **Ippei Fujiwara**, Keio University, and **Shunsuke Hori**, University of Tokyo, "Aging and Deflation"

- **Kenichi Ueda**, University of Tokyo, "Tail Risk Dumping"

- **Zhenyu Cui**, Stevens Institute of Technology, and **Nobuo Akai**, Osaka University, "Corruption, Political Stability and Efficiency of Government Expenditure on Health Care — Evidence from Asian Countries"

- **Weijia Li**, University of California, Berkeley; **Gerard Roland**, University of California, Berkeley, CEPR and NBER; and **Yang Xie**, University of California, Riverside, "Crony Capitalism, the Party-State, and Political Boundaries of Corruption"

- **Henry S. Farber** and **Ilyana Kuziemko**, Princeton University and NBER; **Daniel Herbst**, Princeton University; and **Suresh Naidu**, Columbia University and NBER, "Unions and Inequality Over the Twentieth Century: New Evidence from Survey Data" (NBER Working Paper No. 24587)

- **Sunjoo Hwang**, **Hwa Ryung Lee**, and **Keeyoung Rhee**, Korea Development Institute, "Regulatory Revolving Door in the Financial Industry: Evidence from South Korea"

- **Ying Bai**, Chinese University of Hong Kong, and **Ruixue Jia**, University of California, San Diego, "The Oriental City: Political Hierarchy and Regional Development in China, AD 1000–2000"

- **Meng-Chun Liu** and **Chia-Hsuan Wu**, Chung-Hua Institution for Economic Research, "Taiwan's Import Protection after Acceding to the WTO"

- **Chen Lin**, Chinese University of Hong Kong; **Randall Morck**, University of Alberta, Edmonton; **Bernard Yeung**, National University of Singapore; and **Xiaofeng Zhao**, Lingnan University, "Anti-Corruption Reforms and Shareholder Valuations: Event Study Evidence from China"

- **Xiangyu Shi**, Yale University; **Tianyang Xi**, Peking University; **Xiaobo Zhang**, Peking University and IFPRI; and **Yifan Zhang**, Chinese University of Hong Kong, "'Moving Umbrella': Bureaucratic Transfers, Collusion, and Rent-Seeking in China"

Summaries of these papers are at www.nber.org/conferences/2018/EASE18/summary.html

International Seminar on Macroeconomics

The NBER's 41st International Seminar on Macroeconomics, hosted by the Central Bank of Ireland, took place in Dublin, Ireland, June 29–30. Research Associates Jordi Galí of CREI and Kenneth D. West of the University of Wisconsin, Madison organized the conference. These researchers' papers were presented and discussed:

- **Jing Cynthia Wu**, University of Notre Dame and NBER, and **Ji Zhang**, Tsinghua University, "Global Effective Lower Bound and Unconventional Monetary Policy" (NBER Working Paper No. 24714)

- **Anna Cieslak**, Duke University, and **Andreas Schrimpf**, Bank for International Settlements, "Non-Monetary News in Central Bank Communication"

- **Alexander Bick**, Arizona State University; **Bettina Brueggemann**, McMaster University; and **Nicola Fuchs-Schündeln** and **Hannah Paule-Paludkiewicz**, Goethe University Frankfurt, "Long-Term Changes in Married Couples' Labor Supply and Taxes: Evidence from the U.S. and Europe Since the 1980s"

- **Björn Richter** and **Moritz Schularick**, University of Bonn, and **Ilhyock Shim**, Bank for International Settlements, "The Costs of Macroprudential Policy"

- **Ester Faia**, Universitat Pompeu Fabra; **Sebastien Laffitte**, ENS Paris-Saclay; and **Gianmarco Ottaviano**, Bocconi University and London School of Economics, "Foreign Expansion, Competition, and Bank Risk"

- **Marco Del Negro**, **Domenico Giannone**, and **Andrea Tambalotti**, Federal Reserve Bank of New York, and **Marc Giannoni**, Federal Reserve Bank of Dallas, "Global Trends in Interest Rates"

- **Luigi Bocola**, Northwestern University and NBER; **Alessandro Dovis**, University of Pennsylvania and NBER; and **Gideon Bornstein**, Northwestern University, "Quantitative Sovereign Default Models and the European Debt Crisis"

- **Atsushi Inoue**, Vanderbilt University, and **Barbara Rossi**, Universitat Pompeu Fabra, "The Effects of Conventional and Unconventional Monetary Policy on Exchange Rates"

Summaries of these papers are at www.nber.org/conferences/2018/ISOM18/summary.html

Advancing the Science of Science Funding Workshop

A workshop on Advancing the Science of Science Funding took place July 19–20 in Cambridge, supported by the Alfred P. Sloan Foundation. Research Associate Paula Stephan of Georgia State University and Reinhilde Veugelers of the Katholieke Universiteit Leuven organized the meeting. These researchers' papers were presented and discussed:

- **Henry Sauermann**, European School of Management and Technology and NBER; **Chiara Franzoni**, Politecnico di Milano; and **Kourosh Shafi**, University of Florida, "Crowdfunding Scientific Research" (NBER Working Paper No. 24402)

- **Charles Ayoubi** and **Fabiana Visentin**, EPFL, and **Michele Pezzoni**, Université Nice, "The Important Thing Is Not to Win, It Is to Take Part: What if Scientists Benefit from Participating in Research Grant Competitions?"

- **Misha Teplitskiy**, Harvard University; **Eva C. Guinan**, Dana-Farber Cancer Institute; and **Karim Lakhani**, Harvard University and NBER, "Social Influence in Science Funding Evaluation Panels: Field Experimental Evidence from Biomedicine"

- **Alfredo Di Tillio** and **Marco Ottaviani**, Bocconi University, and **Peter Norman Sørensen**, University of Copenhagen, "Strategic Sample Selection"

- **Marc J. Lerchenmueller**, Yale University, "Does More Money Lead to More Innovation? Evidence from the Life Sciences"

- **Jacques Mairesse**, CREST-ENSAE and NBER; **Michele Pezzoni**; **Paula Stephan**; and **Julia Lane**, New York University, "Examining the Returns to Investment in Science: A case Study"

Summaries of these papers are at www.nber.org/conferences/2018/SFIs18/summary.html

The 27th NBER-TCER-CEPR Conference

The 27th NBER-TCER-CEPR Conference, "Globalization and Welfare Impacts of International Trade," took place in Tokyo July 27. This meeting was sponsored jointly by the Centre for Economic Policy Research in London, the NBER, the Tokyo Center for Economic Research, the Center for Advanced Research in Finance, and the Center for International Research on the Japanese Economy. Shin-ichi Fukuda of Tokyo University, Takeo Hoshi of Stanford University and NBER, and Fukunari Kimura of Keio University organized the meeting. These researchers' papers were presented and discussed:

- **Richard Baldwin**, Graduate Institute, Geneva and NBER, and **Toshihiro Okubo**, Keio University, "GVC Journeys When National and Territorial Comparative Advantage Differ"

- **Ayako Obashi**, Aoyama Gakuin University, "Trade Agreement with Cross-Border Unbundling"

- **Takeo Hoshi**, and **Kozo Kiyota**, Keio University, "Potentials for Inward Foreign Direct Investment in Japan"

- **Keith Head**, University of British Columbia, and **Thierry Mayer**, Sciences-Po, "Misfits in the Car Industry: Offshore Assembly Decisions at the Variety Level"

- **Gabriel Felbermayr** and **Marina Steininger**, Ifo Center for International Economics; **Fukunari Kimura** and **Toshihiro Okubo**, "Quantifying the EU-Japan Economic Partnership Agreement"

- **Katheryn Russ** and **Deborah Swenson**, University of California, Davis and NBER, and **Kelly Stangl**, University of California, Davis, "Trade Diversion and Trade Deficits under the Korea-U.S. Free Trade Agreement"

- **Akira Sasahara**, University of Idaho, "Explaining the Employment Effect of Exports: Value-Added Content Matters"

- **Olena Ivus**, Queen's University, and **Walter Park**, American University, "Patent Reforms and Exporter Behavior: Firm-Level Evidence from Developing Countries"

- **Meredith Crowley**, University of Cambridge, and **Ning Meng** and **Huasheng Song**, Zhejiang University, "Policy Shocks and Stock Market Returns: Evidence from Chinese Solar Panels"

- **Heiwai Tang**, Johns Hopkins University, and **Hiroyuki Kasahara**, University of British Columbia, "Excessive Entry and Exit in Export Markets"

Summaries of these papers are at www.nber.org/conferences/2018/TRIO18/summary.html

Japan Project

The NBER held a meeting on the Japanese economy in Tokyo July 30. The seminar was organized by Shiro Armstrong of the Australian National University; Research Associates Charles Horioka of the Asian Growth Research Institute (Kitakyushu), Takeo Hoshi of Stanford University, and David Weinstein of Columbia University; and Tsutomu Watanabe of the University of Tokyo. These researchers' papers were presented and discussed:

- **Shuhei Kitamura**, Osaka University, "Land Ownership and Development: Evidence from Postwar Japan"

- **Sergi Basco**, Universitat Autònoma Barcelona, and **John P. Tang**, Australian National University, "The Samurai Bond: Credit Supply and Economic Growth in Pre-War Japan"

- **Cynthia Balloch**, Columbia University, "Inflows and Spillovers: Tracing the Impact of Bond Market Liberalization"

- **Martín Uribe**, Columbia University and NBER, "The Neo-Fisher Effect in the United States and Japan" (NBER Working Paper No. 23977)

- **Yuhei Miyauchi**, MIT, "Matching and Agglomeration: Theory and Evidence from Japanese Firm-to-Firm Trade"

- **Toshiaki Iizuka**, University of Tokyo, and **Hitoshi Shigeoka**, Simon Fraser University and NBER, "Patient Cost-sharing and Health Care Utilization among Children"

Summaries of these papers are at www.nber.org/conferences/2018/JPMs18/summary.html

Incentives and Limitations of Employment Policies on Retirement Transitions

An NBER conference on Incentives and Limitations of Employment Policies on Retirement Transitions, supported by the Alfred P. Sloan Foundation, took place August 10–11 in Jackson Hole, Wyoming. Research Associates Robert L. Clark of North Carolina State University and Joseph P. Newhouse of Harvard University organized the meeting. These researchers' papers were presented and discussed:

- **Maria D. Fitzpatrick**, Cornell University and NBER, "Pension Reform and Return to Work Policies"

- **Leslie E. Papke**, Michigan State University, "Retirement Options and Outcomes for Public Employees"

- **John Hsu**, Partners Healthcare; **Samuel H. Zuvekas**, Agency for Healthcare Research and Quality; and **Joseph P. Newhouse** and **Lindsay Overhage**, Harvard University, "Impact of Fiscal Shocks on Retiree Health Plans and Effect on Work and Retirement Decisions"

- **Norma Coe**, University of Pennsylvania and NBER, "Impact of Health Plan Reforms in Washington on Retirement Decisions"

- **Vanya Horneff** and **Raimond Maurer**, Goethe University Frankfurt, and **Olivia S. Mitchell**, University of Pennsylvania and NBER, "How Will Persistent Low Expected Returns Shape Household Behavior?"

- **Joseph F. Quinn** and **Kevin Cahill**, Boston College, and **Michael Giandrea**, Bureau of Labor Statistics, "Transitions from Career Employment among Public- and Private-Sector Workers"

- **Melinda S. Morrill**, North Carolina State University and NBER, and **John Westall**, North Carolina State University, "The Role of Social Security in Retirement Timing: Evidence from a National Sample of Teachers"

- **Robert L. Clark**; **Robert G. Hammond**, North Carolina State University; and **David Vanderweide**, North Carolina General Assembly, "Navigating Complex Financial Decisions at Retirement: Evidence from Annuity Choices in Public Sector Pensions"

- **Gila Bronshtein**, Stanford University; **Jason Scott**, Financial Engines; **John B. Shoven**, Stanford University and NBER; and **Sita Slavov**, George Mason University and NBER, "The Power of Working Longer" (NBER Working Paper No. 24226)

Summaries of these papers are at www.nber.org/conferences/2018/EPRTs18/summary.html

Program and Working Group Meetings

Economic Fluctuations and Growth

Members of the NBER's Economic Fluctuations and Growth Program met July 14 in Cambridge. Research Associates Virgiliu Midrigan of New York University and Hélène Rey of London Business School organized the meeting. These researchers' papers were presented and discussed:

- **Alessandra Fogli**, Federal Reserve Bank of Minneapolis, and **Veronica Guerrieri**, University of Chicago and NBER, "The End of the American Dream? Inequality and Segregation in U.S. Cities"

- **Gauti B. Eggertsson**, Brown University and NBER, and **Jacob Robbins** and **Ella Wold**, Brown University, "Kaldor and Piketty's Facts: The Rise of Monopoly Power in the United States" (NBER Working Paper No. 24287)

- **Gita Gopinath** and **Jeremy C. Stein**, Harvard University and NBER, "Banking, Trade, and the Making of a Dominant Currency" (NBER Working Paper No. 24485)

- **Anmol P. Bhandari** and **Ellen McGrattan**, University of Minnesota and NBER, "Sweat Equity in U.S. Private Business" (NBER Working Paper No. 24520)

- **Davide Debortoli**, Universitat Pompeu Fabra, and **Jordi Galí**, CREI and NBER, "Monetary Policy with Heterogeneous Agents: Insights from TANK Models"

- **Fatih Karahan** and **Ayşegül Şahin**, Federal Reserve Bank of New York, and **Benjamin Pugsley**, University of Notre Dame, "Demographic Origins of the Startup Deficit"

Summaries of these papers are at www.nber.org/conferences/2018/EFGs18/summary.html

Chinese Economy

Members of the NBER's Chinese Economy Working Group met in Beijing on September 10–11. Research Associates Hanming Fang of the University of Pennsylvania, Zhiguo He of the University of Chicago, Shang-Jin Wei of Columbia University, and Wei Xiong of Princeton University organized the meeting. These researchers' papers were presented and discussed:

- **Thomas J. Chemmanur**, Boston College; **Bibo Liu**, Tsinghua University; and **Xuan Tian**, Indiana University, "Rent Seeking, Brokerage Commissions, and the Pricing and Allocation of Shares in Initial Public Offerings"

- **Wei Xiong**, "The Mandarin Model of Growth"

- **Lily Fang**, INSEAD; **Josh Lerner**, Harvard University and NBER, and **Chaopeng Wu** and **Qi Zhang**, Xiamen University, "Corruption, Government Subsidies, and Innovation: Evidence from China"

- **Quanlin Gu**, Peking University; **Jia He**, Nankai University; and **Wenlan Qian**, National University of Singapore, "Housing Booms and Shirking"

- **Ying Bai**, Chinese University of Hong Kong, and **Ruixue Jia**, University of California, San Diego, "The Oriental City: Political Hierarchy and Regional Development in China, AD1000–2000"

- **Haoyuan Ding**, Shanghai University of Finance and Economics; **Yichuan Hu**, Chinese University of Hong Kong; and **Ninghua Zhong**, Tongji University, "Informal Financing via University Alumni: The Substitution of Political Connections"

- **Ning Zhu**, **Yinglu Deng**, and **An Hu**, Tsinghua University, "Real Life Experience and Financial Risk-Taking: Natural Experiment Evidence from Automobile Traffic Accidents"

- **Huasheng Gao**, Fudan University; **Donghui Shi**, Shanghai Stock Exchange; and **Bin Zhao**, Shanghai Advanced Institute of Finance, "Does Good Luck Make People Overconfident? Evidence from a Natural Experiment in China"

- **Jiangze Bian**, University of International Business and Economics; **Zhiguo He**; **Kelly Shue**, Yale University and NBER; and **Hao Zhou**, Tsinghua University, "Leverage-Induced Fire Sales and Stock Market Crashes"

- **Valerie J. Karplus**, MIT; **Shuang Zhang**, University of Colorado at Boulder; and **Douglas Almond**, Columbia University and NBER, "Did Scrubbing the Government Clean Up the Air? Polluter Responses to China's Anticorruption Campaign"

- **Kun Jiang**, University of Nottingham; **Wolfgang Keller**, University of Colorado at Boulder and NBER; **Larry Qiu**, University of Hong Kong; and **William C. Ridley**, University of Colorado at Boulder, "International Joint Ventures and Internal vs. External Technology Transfer: Evidence from China" (NBER Working Paper No. 24455)

- **Christopher Hansman**, Imperial College London; **Harrison Hong**, Columbia University and NBER; **Wenxi Jiang**, Chinese University of Hong Kong; and **Yu-Jane Liu** and **Juanjuan Meng**, Peking University, "Riding the Credit Boom" (NBER Working Paper No. 24586)

Summaries of these papers are at www.nber.org/conferences/2018/CEf18/summary.html

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NATIONAL BUREAU OF ECONOMIC RESEARCH

1050 Massachusetts Avenue
Cambridge, Massachusetts 02138-5398
(617) 868-3900

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