

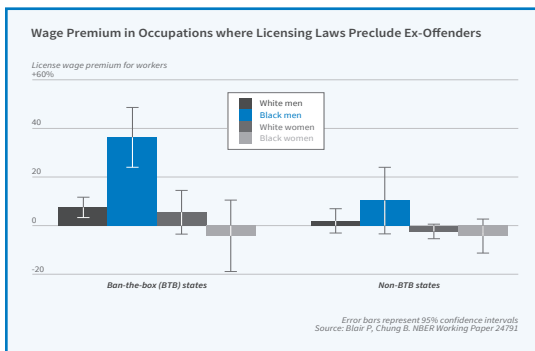
# NBER Reporter

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## Program Report

### Law and Economics

Christine Jolls\*

The Law and Economics Program emphasizes economic analysis of processes within courts, legislatures, and government agencies, as well as of the effects and causes of substantive legal rules in the foundational legal subjects of property law, criminal law, contract law, and tort law. Program members meet twice annually, once at a midyear program meeting and again at the NBER Summer Institute.

This article first describes recent research on legal processes and in the foundational legal subjects. It then examines work on the causes and effects of substantive legal rules in the additional areas of consumer financial protection, corporate law, and workplace law.

### The Operation of Legal Processes

The operation of legal processes, particularly in courts, is a core emphasis of the program. The operation of these processes in criminal cases in particular has been a focus in recent years as concerns with racially disparate effects of the criminal justice system have grown. Research by David Arnold, Will Dobbie, and Crystal Yang examines the impact of criminal defendants' race on the decisions of judges charged with setting bail requirements.<sup>1</sup> The researchers find that Black defendants are 3.6 percentage points more likely to have to post bail than their non-Black counterparts. Moreover, among defendants required to post bail, bail judges require Black defendants to post amounts that are \$9,923 greater on average than those required of non-Black defendants. As Arnold, Dobbie, and Yang note, it is sometimes suggested that racially disparate bail amounts may reflect underlying differences in the risk of misconduct across different groups. The researchers find, however, that marginally released non-Black defendants are 22.2 to 23.1 percentage points more likely to be arrested for pretrial misconduct than marginally released Black defendants. Given this finding, the greater stringency of bail judges' treatment of Black defendants is not well explained by

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# NBER Reporter

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reference to higher misconduct within this group of defendants.

Judges on state supreme courts have been a consistent focus of the program. In recent research, Elliott Ash and W. Bentley MacLeod examine the effects of nonpartisan as opposed to partisan state supreme court judge selection on judicial quality, as measured by forward citations to judges' written opinions.<sup>2</sup> In contrast to federal judges, who are appointed via presidential nomination and confirmation by the US Senate, state supreme court judges are often elected, at times in partisan elections. Ash and MacLeod identify quality effects of nonpartisan selection of state supreme court judges by means of changes in many states, over the course of the second half of the twentieth century, from partisan judicial elections to nonpartisan selection. Because state supreme court judges enter service at different times, the researchers compare judges who are working at the same time in the same court but who were selected in different manners. Nonpartisan selection occurs either through technocratic merit selection, often by senior judges, or through election via ballots that do not state a party affiliation for judicial candidates. Because state supreme court judges author opinions resolving issues appealed from lower courts but do not themselves conduct trials, the judges' opinions—their core work product—can be used to construct measures of judicial performance. Ash and MacLeod find significantly higher levels of forward citation to opinions by judges chosen via nonpartisan selection, especially those chosen through technocratic merit selection, than to opinions by judges chosen via partisan selection.

An important research focus of the program is the operation of legal processes within civil litigation. Within this system, a private party may bring a lawsuit that lacks merit but nonetheless can result in the extraction of a settlement from the party that has been sued. This is so because defending a lawsuit is costly and because the US system, in a departure from its British antecedent, does not allow costs to be recovered from the losing side.

Recent research by Albert Choi and Kathryn Spier models the role of financial market opportunities in increasing the risk that a meritless lawsuit can result in a positive settlement for the party bringing suit.<sup>3</sup> As a motivating example, the researchers offer the juxtaposition of hedge fund manager Kyle Bass's litigation challenging pharmaceutical patents with his taking short positions in the shares of companies whose patents he was challenging. Taking a short position means an actor can credibly

threaten to pursue a lawsuit even when the damages the actor bringing the lawsuit expects to recover are lower than this actor's litigation costs. The reason that taking a short position can have this effect is that the expected damages that must be paid to the actor who brought the lawsuit reduce the value of the defendant firm, which produces a further gain to the actor who pursued the lawsuit while taking a short position. In effect, the proceeds from the short sale subsidize the litigation costs of the actor filing the lawsuit, allowing this actor to profit from a suit that the actor otherwise would not bring. Choi and Spier's analysis aligns with other law and economics work exploring how third-party interactions can strengthen the hands of litigants in battling their opponents.

## Property, Criminal, Contract, and Tort Law

The racial impact of the criminal justice system spans not just the operation of processes such as bail-setting but also the substance of what is criminalized. A particularly important topic in current debates over criminalization is the effect of criminalizing minor infractions. Recent work by Amanda Agan, Jennifer Doleac, and Anna Harvey presents evidence of the impact of a presumption of nonprosecution of certain nonviolent misdemeanors on defendants' future criminal behavior; reducing criminal justice system contact for minor infractions through such a presumption may produce overall improvements in

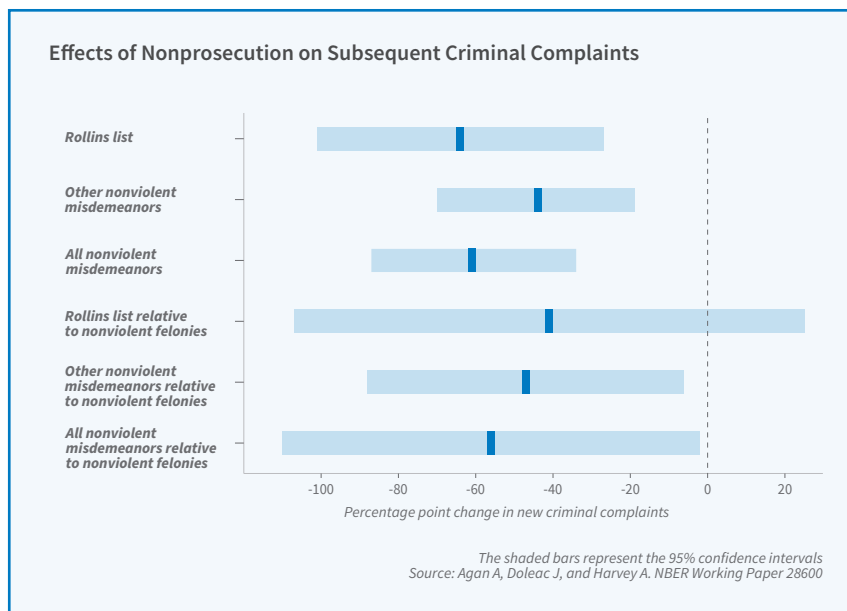


Figure 1

public safety.<sup>4</sup> Instrumenting for nonprosecution with a Massachusetts policy change under which 15 specified nonviolent misdemeanors—the “Rollins list”—are presumptively nonprosecuted, the researchers find that nonprosecution significantly decreases the rate at which defendants face new criminal complaints in the following year. As shown in Figure 1, decreases are observed in response both to the absolute level of nonprosecution of nonviolent misdemeanors and to the level of nonprosecution of non-

violent misdemeanors relative to nonviolent felonies. The researchers' analysis also examines data from the period prior to establishment of the presumption of nonprosecution for Rollins list misdemeanors; in this part of the analysis, the researchers use assignment of a defendant's case to a “lenient” prosecuting attorney as an instrument for nonprosecution and find again that nonprosecution significantly decreases the rate of new criminal complaints.

Some behavior that society seeks to deter is not criminalized but instead is

made the basis of tort liability. A prominent illustration of tort liability is that for selling products that threaten serious harm; such behavior by firms can give rise to products liability, a very large component of tort liability in the United States. Large damage awards in products liability cases have raised concerns that such liability may exert a substantial chilling effect on innovation. Alberto Galasso and Hong Luo explore the effects of products liability on innovation by examining medical patenting after large-scale lawsuits filed by silicone breast implant and temporomandibular joint (TMJ) jaw implant recipients in the late 1980s.<sup>5</sup> The researchers report that this period featured a relative decline in medical implant patenting compared to patenting in non-implant medical device technologies, as Figure 2 shows. FDA applications similarly suggest that in this period medical implant innovation experienced a decline relative to other medical device innovation. The researchers also consider the effects of the Biomaterials Access

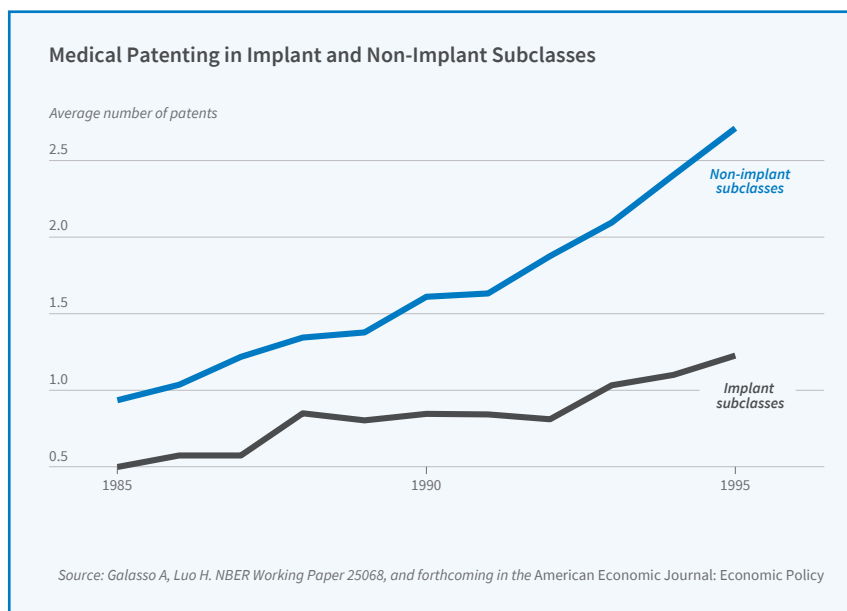


Figure 2

Assurance Act, a 1998 law designed to restore incentives for medical implant suppliers. Galasso and Luo suggest that patenting dynamics similar to those they study may occur in other technology-oriented industries associated with significant risk, such as transportation and energy.

## Consumer Financial Protection, Workplace Law, and Corporate Law

An extremely active area of contemporary research in the program is consumer financial protection. In recent work, Tal Gross, Raymond Kluender, Feng Liu, Matthew Notowidigdo, and Jialan Wang analyze the effects of the Bankruptcy Abuse Prevention and Consumer Protection Act of 2005.<sup>6</sup> This law placed a number of new limitations on filing for bankruptcy. The researchers find that bankruptcies fell by half in the two years following the law's effective date compared to the two years prior to its effective date. This result includes an adjustment for the last-minute rush to file before the law went into effect. The researchers find that 60 to 75 percent of the cost savings of the reduced likelihood of credit card debt being discharged through bankruptcy was passed along to consumers in the form of reduced interest rates.

Workplace law has long been a focus of the program. Recent work by Mason Ameri, Lisa Schur, Meera Adya, F. Scott Bentley, Patrick McKay, and Douglas Kruse investigates the efficacy of disability discrimination law via a field experiment involving responses to job openings for accounting positions with applications that either did or did not reference disability.<sup>7</sup> Examining responses from applicants with versus without a spinal cord injury, the researchers find that the probability of a positive employer reply (such as an interview, a request for further documents or credentials, or a request for a fur-

ther action by the applicant) was 4.80 percent for the former group compared with 6.58 percent for the latter group, despite the fact that a spinal cord injury would be unlikely to have a significant productivity effect in the accounting positions targeted by the applications. Further disaggregating by employers above versus below the coverage threshold for the Americans with Disabilities Act (ADA) prohibition on disability discrimination in employment, the researchers find a significantly lower probability of a positive employer reply to an applicant with a spinal cord injury among employers below the ADA's 15-employee coverage threshold relative to employers above that threshold.

Corporate law has been a longstanding centerpiece of the program. In recent work, Lucian Bebchuk and Doron Levit offer a model that addresses the effect of legal responses to the presence of short-term shareholders.<sup>8</sup> An example of such a response is the Securities and Exchange Commission's 2010 exclusion of short-term shareholders from the agency's proxy access rule. Many commentators and policymakers have suggested that short-term shareholders are unlikely to support policies and approaches that maximize firms' long-term value. Bebchuk and Levit's model endogenizes choices of such policies and approaches, and it shows that short-term shareholding does not reduce firms' long-term value. Because firms' policies and approaches are observable, choices that reduce firms' long-term value will also reduce the market prices received by short-term shareholders. The researchers note the importance of securities laws' disclosure requirements to this result.

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<sup>1</sup> "Racial Bias in Bail Decisions," Arnold D, Dobbie W, Yang C. NBER Working Paper 23421, May 2017, and *Quarterly Journal of Economics* 133(4), November

2018, pp. 1885–1932.

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<sup>2</sup> "Reducing Partisanship in Judicial Elections Can Improve Judge Quality: Evidence from U.S. State Supreme Courts," Ash E, MacLeod WB. NBER Working Paper 22071, revised June 2021, and *Journal of Public Economics* 201 (2021), 104478.

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<sup>3</sup> "Taking a Financial Position in Your Opponent in Litigation," Choi A, Spier K. *American Economic Review* 108(12), December 2018, pp. 3626–3650.

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<sup>4</sup> "Misdemeanor Prosecution," Agan A, Doleac J, Harvey A. NBER Working Paper 28600, March 2021.

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<sup>5</sup> "When Does Product Liability Risk Chill Innovation? Evidence from Medical Implants," Galasso A, Luo H. NBER Working Paper 25068, September 2018, and *American Economic Journal: Economic Policy* (forthcoming).

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<sup>6</sup> "The Economic Consequences of Bankruptcy Reform," Gross T, Kluender R, Liu F, Notowidigdo M, Wang J. NBER Working Paper 26254, revised November 2019, and *American Economic Review* 111(7), July 2021, pp. 2309–2341.

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<sup>7</sup> "The Disability Employment Puzzle: A Field Experiment on Employer Hiring Behavior," Ameri M, Schur L, Adya M, Bentley FS, McKay P, Kruse D. *ILR Review* 71(2), March 2018, pp. 329–364.

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<sup>8</sup> "Should Short-Term Shareholders Have Less Rights?" Bebchuk L, Levit D. January 2019, presented at 2019 NBER Law and Economics program meeting. [https://conference.nber.org/conf\\_papers/f117084.pdf](https://conference.nber.org/conf_papers/f117084.pdf).

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## Research Summaries

### New Frontiers in Occupational Licensing Research

Peter Q. Blair

When an occupation is licensed by the state, a worker must have a license to legally work for pay. For some occupations, obtaining a license can be as simple as filling out a form and paying a few hundred dollars. In other cases, obtaining a license could require passing an exam, completing years of training, or having a clean criminal record. In the United States and Europe, close to a quarter of the workforce is subject to occupational licensing requirements; by contrast only 11 percent of workers in the US are unionized.<sup>1</sup>

Starting with Adam Smith,<sup>2</sup> then Simon Kuznets and Milton Friedman,<sup>3</sup> economists have long theorized that licensing an occupation requires trading off a lower labor supply and higher prices against the potential for improved worker quality and customer satisfaction. Empirically quantifying the trade-offs introduced by licensing has been challenging for researchers due to a dearth of historical data linking licensing laws to labor market outcomes. In fact, it has been only seven years since the Current Population Survey began collecting data on occupational licensing.

In my work, I augment publicly available data from the Current Population Survey and the Survey of Income and Program Participation with new administrative data on licensing laws, along with proprietary data on customer transactions from a large online marketplace, to answer three empirical questions pertaining to occupational licensing. First, how much of a barrier to entry is occupational licensing? Second, how does occupational licensing impact the effectiveness of customer search on digital platforms? And third, does occupational licensing serve as a labor market signal that reduces racial and gender wage

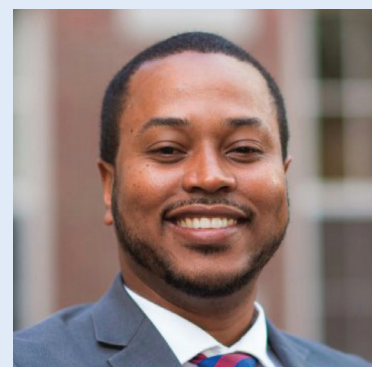
gaps? By answering these three questions, I provide empirical results that quantify the trade-offs central to economic debate on licensing policy and licensing reform.

#### How Much of a Barrier to Entry is Licensing?

Because licensing laws by nature impose entry requirements, economists have long believed that licensing would reduce labor supply. Bobby Chung and I provide one of the first estimates of the impact of licensing on the supply of workers using representative national data.<sup>4</sup>

We start with a model of occupational choice in which workers choose their occupation based on wages, a measure of the occupation's quality, and whether the occupation is licensed. Intuitively, workers are drawn to jobs that pay higher wages, that are better quality, and for which there are lower barriers to entry. To estimate the model, we implement a benchmark in which we calculate the share of workers in each occupation in a state relative to the share of workers who choose teaching as a profession in the same state. We construct our measure of relative employment shares using the teacher benchmark because teaching is the largest occupation in most states, which eliminates the problem of benchmarking against an occupation with a tiny employment share. Ultimately, we show that the log of the relative share of workers in an occupation is a linear function of whether the occupation is licensed.

We focus our empirical analysis on adjacent counties in states that share a border. We can reasonably assume that counties sharing a state border belong to the same local labor market, such that



Peter Q. Blair is a member of the faculty at Harvard University's Graduate School of Education, where he codirects the Project on Workforce. An NBER research associate affiliated with the Economics of Education Program, he is the principal investigator of the Blair Economics Lab, a multi-university collaboration that focuses on supply-side issues in higher education, the effects of occupational licensing on labor market discrimination, and the link between residential segregation and educational outcomes. Four graduates of his lab are now in tenure-track roles in economics departments.

In addition to his scholarly work, Blair served as a volunteer economist with the Council of Economic Advisers during the Biden-Harris presidential transition. He is an active member of his local church, where he mentors graduate students.

Blair received his PhD in applied economics from the Wharton School at the University of Pennsylvania, his master's in theoretical physics from Harvard, and his bachelor's degree in physics and mathematics from Duke University. He is the youngest of seven sons and got his start understanding markets by selling fruit and vegetables with his brothers in the Nassau Straw Market in the Bahamas.

variation in occupational licensing laws between the counties is not confounded with local labor market conditions. Since we have quasi-random assignment of licensing within a local labor market, we attribute any difference in the relative share of workers in each occupation across state boundaries between adjacent counties to the differences in licensing laws that pertain to the occupation. Using this boundary discontinuity research design, we find that when a profession is licensed, the relative share of workers in the profession declines by 27 percent, which is a large impact.

## Does Licensing Cause Labor Shortages?

The reduction in the number of qualified service professions caused by occupational licensing could result in labor shortages. Alternatively, licensed professionals could take on more work. Or new technologies like digital platforms could make it easier for customers and service providers to find each other blunting the negative impact of licensing on the number of service providers. Using survey data alone, it is difficult to know which of these stories is right. Mischa Fisher and I explore these questions using proprietary data from Angi, a large online marketplace for home services.<sup>5</sup>

The home services industry is a fruitful setting to study the impact of occupational licensing for two key reasons. First, we observe 21 million real-time market transactions that involve customer search, which we take as a measure of consumer demand, and the identification of qualified service professionals on the platform who purchase the customer lead generated by the customer search, which we

take as a measure of labor supply. In standard survey data, one cannot typically observe supply and demand separately or in real time. Second, there is substantial variation across states in whether completing a given home service task requires an occupational license. In California, for example, north of 500 tasks require a licensed professional, whereas in Texas fewer than 100 require a licensed professional. The rich state-by-task variation in licensing requirements allows us to exploit two natural experiments to establish the causal effect of licensing on a measure of labor shortage.

Our primary outcome of interest is the “accept rate,” which measures the probability that a customer-initiated search for a service provider yields a search result in which there is at least one service professional who is willing to

unexplored margin in the literature and one that directly maps onto labor supply, since having at least one service professional who can perform the work is a necessary condition for all downstream interactions between customers and providers—e.g., choice of a provider to hire, negotiating price, customer rating of service quality.

Using a boundary discontinuity research design like the one in the first study, we find that licensing of a task reduces the accept rate by 16 percentage points from a baseline of about 60 percent. In the presence of licensing, the accept rate can drop either because the number of accepted service requests stays the same while the volume of customer search increases, or the volume of customer search stays the same and the number of service providers accepting requests declines. We find that

licensing a task has no impact on the search volume for the task on the platform, but it has a large negative impact on the number of service providers who accept requests. We conclude that the reduction in the number of workers in the presence of licensing is not offset by workers taking on more work to alleviate the labor shortage.

This first research strategy can be thought of as an exploration of the impact of licensing on a labor market

that is in equilibrium. We have a second natural experiment in which we exploit a change in a licensing law covering swimming pool contractors in New Jersey. We trace the accept rate in New Jersey for service requests for pool tasks before and after the passage of the law and compare it to the accept rate for service requests in the pool category for all other states. As shown in Figure 1, in the four years prior to the passage of the law, there was no dif-

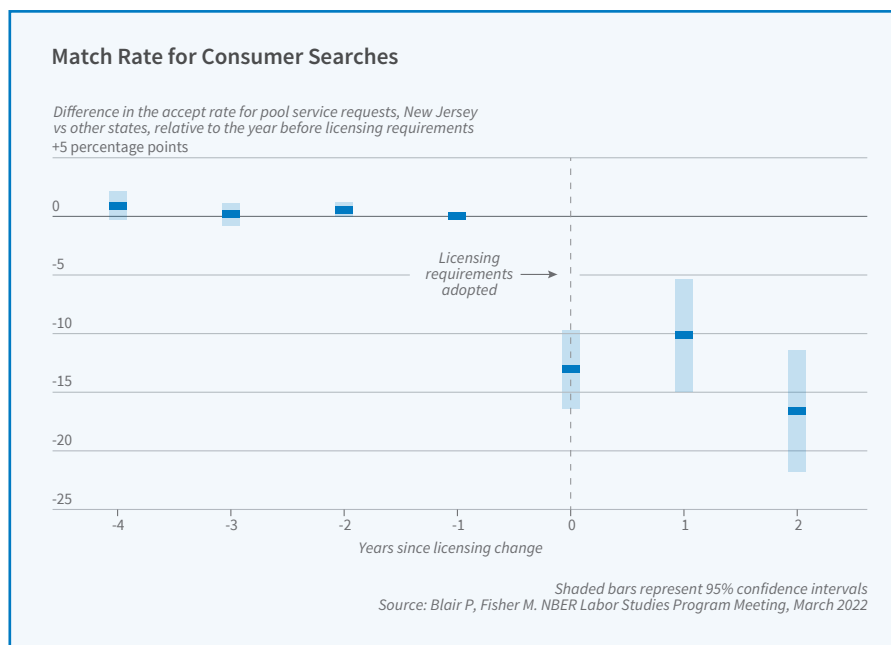


Figure 1

purchase the customer lead. We measure how much the accept rate changes in the presence of a licensing requirement. There are three excellent studies in online markets that explore the impact of licensing on outcomes that are downstream from the service provider acceptance decision; they find that licensing does not appreciably change service quality, as measured by customer ratings, or the price paid for the work.<sup>6</sup> The accept rate, however, is also an

ference in the accept rate for New Jersey relative to other states. In the year the law passed there was an instantaneous reduction of 13 percentage points in the accept rate for New Jersey. In the two years after this event, this reduction persists.

Taken together with our first study, we find clear evidence that licensing both reduces the number of service professions and makes it harder for customers to find qualified workers who can provide them with service. More broadly, we find that licensing laws reduce the effectiveness of technology to improve the success of online search.

## Is Licensing a Labor Market Signal That Reduces Wage Inequality?

While my prior two papers demonstrate the substantial economic costs of licensing, the next two papers in my research program explore whether the high cost of licensing contains information about licensed workers that is priced into wages in ways that reduce longstanding racial and gender wage gaps. We know from theoretical models of education as a job market signal that education is an effective labor market signal precisely because it is costly.<sup>7</sup> Since licensing is also costly, it could function as a labor market signal—particularly one that reduces firms’ reliance on race and gender as proxies of a worker’s ability.

My first paper in this research agenda, which is also joint work with Chung, starts with a simple model of a labor market with two sectors—one sector with a licensing requirement and the other without.<sup>8</sup> In each sector, firms set wages to maximize profits, which is the difference in expected worker output and wages. Workers choose a sector based on

the wages net of the licensing cost, which is lower for workers with higher ability. In contexts where firms have imperfect information about workers’ abilities and engage in statistical discrimination by

Our sharpest empirical test of the theory comes from showing that Black men have a larger license premium than White men only in occupations that preclude individuals with felony convictions from obtaining a license. This suggests that firms are using the license to screen Black men on felony status, given the racial disparity in felony rates. Further, we show that the license premium for Black men in occupations with felony restrictions is larger in states with ban-the-box (BTB) laws than it is in non-BTB states, as shown in Figure 2. Since these laws make it illegal for firms to inquire about a worker’s criminal past early in the hiring process, this finding is further evidence that licenses that preclude felons from gaining licenses are being used to screen Black men for a criminal past.

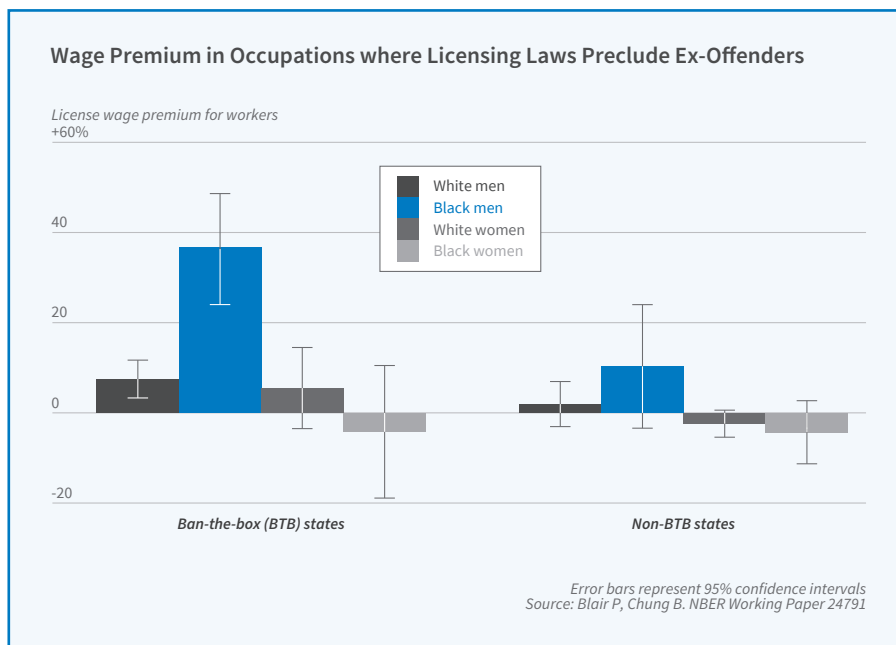


Figure 2

using demographic characteristics such as race and gender as proxies of ability, the model predicts that the wage premium for the license will be higher for workers from demographic groups that face a higher cost of licensing or face more statistical discrimination in the labor market.

In the second paper, we empirically test predictions of our theoretical model that the license premium varies by race and gender because the licensing signal is informative of worker quality and reduces the value of engaging in statistical discrimination based on race and gender.<sup>9</sup> First, we create a new administrative dataset of all licensing laws in each state that preclude workers with felony convictions from being licensed. We pair this data with survey data on licensing from the Survey of Income and Program Participation that captures wage and demographic information, in addition to information on licenses without restrictions on workers with felony records. As predicted by our model, we find that the license premium is larger for Black men and women and White women than for White men.

ing process, this finding is further evidence that licenses that preclude felons from gaining licenses are being used to screen Black men for a criminal past.

## Conclusion

The study of occupational licensing provides a fertile context for testing theories of how the labor market functions. The informational content of occupational licenses also makes them a useful probe of the extent to which labor market discrimination exists and explains income inequality. Work with my coauthors on licensing suggests that it has a profound impact in reducing labor supply in both online and offline markets and creating persistent labor shortages. Licensing can function as a labor market signal, playing an analogous role to education, precisely because it is costly to obtain. My work is part of a growing literature that measures the trade-offs inherent in the policy conversation on licensing reform.

Further progress in understand-

ing the impact of occupational licensing laws on labor markets will require building more linked datasets that map out real-time changes in licensing laws and making them publicly available to all researchers. Morris Kleiner, Jason Hicks, Edward Timmons, and I are doing some of this work by collecting historical time series on licensing laws in the US. Maria Koumenta and Mario Pagliero are spearheading this effort in Europe. As a profession, we need more licensing data and studies from other parts of the world, including South America, Africa, Asia, and Australia to measure the cost and benefits of licensing in many more markets. In addition to measuring the theorized impacts of licensing on labor supply in a global context, this effort will help us to understand how licensing couples to other features of a labor market to either impose greater costs on consumers and producers or to serve as an equalizing force in the presence of other labor market frictions.

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<sup>5</sup> “[Does Occupational Licensing Reduce the Effectiveness of Customer Search on Digital Platforms?](#)” Blair

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<sup>6</sup> “[Occupational Licensing of Uber Drivers](#),” Hall J, Hicks J, Kleiner M, Solomon R. Unpublished working paper, American Economic Association Annual Meeting, Philadelphia, PA, January 5–7, 2018; “[Consumer Protection in an Online World: An Analysis of Occupational Licensing](#),” Farronato C, Fradkin A, Larsen B, Brynjolfsson E. NBER Working Paper 26601, January 2020; “[Licensing and Service Quality: Evidence Using Yelp Consumer Reviews](#),” Deyo D. 2017.

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<sup>7</sup> “[Job Market Signaling](#),” Spence M. *Quarterly Journal of Economics* 87(3)1973, pp.355–374.

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<sup>8</sup> “[A Model of Occupational Licensing and Statistical Discrimination](#),” Blair P, Chung B. *AEA Papers and Proceedings* 1(111), May 2021, pp. 201–205.

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# Assessing Environmental Regulation in Automobile Markets

Kenneth Gillingham

Spending on transportation is the second-largest category of personal expenditure in the United States, surpassed only by housing. Spending on automobiles is in turn the largest component of transportation expenditures, an amount that is on par with health care and food.<sup>1</sup> Moreover, emissions from transportation constitute just under a third of total US greenhouse gas emissions, with light-duty vehicles accounting for almost two-thirds of this total.<sup>2</sup> These figures make studying the economic effects of automobile market regulation especially important.

The effects of environmental regulations on automobiles are governed by complex interactions between consumer behavior and firm decisions in the markets for both new and used vehicles. The design of the regulations creates incentives that can drive the overall direction of innovation and product offerings and greatly influence the nature and use of the vehicle fleet. Regulation can also have important consequences for emissions and social welfare. My work uses novel identification strategies and structural models to answer policy-relevant research questions on environmental regulation in transportation. Two of the major themes are the economics of standards and equilibrium in automobile markets.

## Fuel Economy and Greenhouse Gas Emission Standards

Fuel economy and greenhouse gas emission standards for new light-duty vehicles are perhaps the most prominent regulations intended to reduce gasoline use and the resulting emissions. Since 2012, the fuel economy standards set by

the US Department of Transportation have been aligned with the greenhouse gas emission standards set by the Environmental Protection Agency since there is an extremely close relationship between vehicles' fuel economy and carbon dioxide emissions.

Evaluating the effects of new-vehicle standards on social welfare is a complicated and fascinating endeavor. New-vehicle standards affect prices and quantities in both the new and used vehicle markets, characteristics of the new-vehicle fleet, the number of vehicles of each model year on the road, the number of miles driven, vehicle scrapage, emissions, and crash fatalities. One important issue is whether consumers fully value fuel economy when purchasing new vehicles. If consumers undervalue future savings from fuel economy improvements relative to how they make other potential investments, then mandatory standards might raise social welfare by shifting consumers into vehicles that provide valuable fuel savings that they did not fully account for in their vehicle choice decisions.<sup>3</sup> Undervaluation of fuel economy is the working assumption in all regulatory analyses and could come about due to behavioral anomalies in decision making, such as consumer myopia.

Arthur van Benthem, Sébastien Houde, and I investigated the valuation of fuel economy in the context of a major restatement of fuel economy that affected 1.6 million Hyundai and Kia vehicles in 2012.<sup>4</sup> This provided a unique natural experiment to explore how consumers value fuel economy because the restatement was abrupt and entirely unexpected by consumers, the vehicles were identical before and after the restatement, and



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Gillingham's research interests are in the economics of the environment and energy, with a particular focus on transportation, new technologies, and energy efficiency. He is especially interested in using tools of modeling consumer and firm behavior from the fields of applied microeconomics and industrial organization to investigate the effects of environmental regulations. He also has work modeling the economics of climate change.

Gillingham received an AB in economics and environmental studies from Dartmouth College and MS and PhD degrees from Stanford University. He spent a year in New Zealand studying economics on a Fulbright Fellowship in 2006 and served as the senior economist for energy and the environment at the White House Council of Economic Advisers in 2015–16. He was a wilderness ranger in Wyoming before beginning his career as an economist. He lives in Connecticut with his wife and two sons.

there were similar models that were not affected and that provided a useful control group. By examining how used-vehicle prices for the affected models changed, we explored how consumers viewed the same vehicle with a slightly higher or lower EPA-rated fuel economy. We were able to rule out other effects of the restatement, such as negative brand publicity.

Figure 1 shows that the restatement led to a 1.2 percent decline — just under \$300 — in the prices of vehicles that received a reduced EPA-rated fuel economy. There were no significant effects on the number of vehicles sold, so the primary method of equilibrium adjustment was in the prices.

The decline in prices implies that consumers valued every \$1 in future fuel savings from improved fuel economy at only \$0.11–\$0.33.

This undervaluation of fuel economy aligns with the assumptions used by the federal government, but contrasts with some other recent studies using different empirical approaches.<sup>5</sup>

Vehicle attributes besides fuel economy can also play a role in the welfare effects of standards. For example, automakers may raise fuel economy to comply with standards by reducing other valued attributes such as horsepower and acceleration.<sup>6</sup> Federal agencies hold other attributes constant and assume that all fuel economy improvements are made by adding technology. But vehicle attributes may affect how households decide whether to keep an older vehicle when they purchase a new one. The average number of vehicles owned by a household in the US is just under

two, so most households decide on the next vehicle to purchase while owning at least one other one.

Using data on the universe of vehicle registrations from California, James Archsmith, Christopher Knittel, David Rapson, and I provide evidence of attribute substitution, whereby two-car households are more likely to purchase a lower-fuel-economy vehicle for their next vehicle when the other vehicle is more fuel efficient.<sup>7</sup> In other words, if a household holds on to a fuel-efficient Toyota Prius and is replacing another car, they are more likely to purchase a larger vehicle with lower fuel economy. Perhaps the next car will have greater cargo or towing capacity. The intuition

fuel economy standards because consumers desire attributes that are not present on more-fuel-efficient vehicles. Consumers address this in their purchases of other vehicles. Second, it suggests that if fuel economy standards increase and then remain constant, as consumers purchase additional vehicles attribute substitution could lead to increased emissions from the on-road vehicle fleet over time.

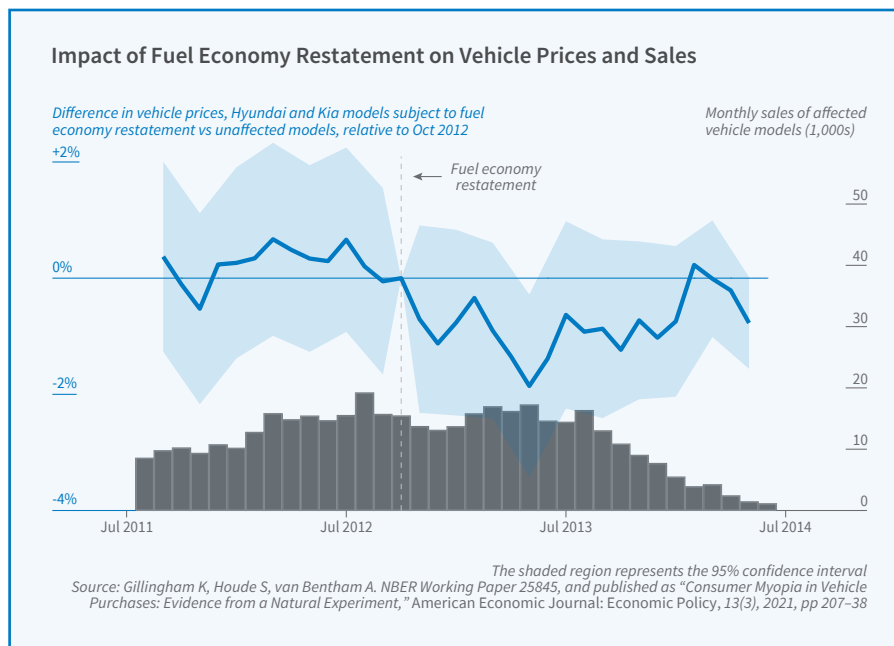
## How Standards Can Influence Driving and Accident Outcomes

If standards lead to changes in vehicle attributes, on-road safety may be impacted. A major criticism of fuel economy standards in the early 1980s was that they led to reductions in vehicle weight and that this reduced vehicle safety and increased traffic fatalities.

Antonio Bento, Kevin Roth, and I investigated how standards influenced the overall distribution of vehicle weights across the entire vehicle fleet for each of the major automakers.<sup>8</sup> Using unconditional quantile approaches and unique data on the attributes of all vehicles sold in the US since 1954, we

found evidence of down-weighting for smaller, but not larger, vehicles. We also found evidence of up-weighting by several Asian automakers that traditionally sold smaller cars. Because these automakers did not face binding standards, they had room to increase the weight of their vehicles and to improve their competitive positions.

Our analysis confirmed that accident fatalities depend on the difference in the weights of the vehicles involved in an accident.<sup>9</sup> By simulating what the full set of vehicle attributes would have



**Figure 1**

is that consumers appear to appreciate having a portfolio of vehicles that provide different attributes.

Attribute substitution implies that policies that improve fuel economy in the short run may increase demand for less-fuel-efficient vehicles in later years. This is especially important for policies like cash-for-clunkers that provide a short-run incentive for consumers to purchase more-fuel-efficient vehicles. But it is also relevant for fuel economy standards, for two reasons. First, it identifies a potential welfare cost from

been in the absence of fuel economy standards, we found that the regulations actually lowered fatalities by several hundred per year by changing the weight distribution of vehicles.

Standards may also affect accident fatalities by influencing how much households drive. With more-fuel-efficient vehicles, the cost per mile of driving is lower, leading to more driving. This is often called a rebound effect, as the additional driving increases fuel use and reduces the fuel savings from standards. It can be difficult to estimate a causal rebound effect because standards affect many vehicle attributes. To gauge the rebound effect, it is common to use the elasticity of miles driven with respect to the price per mile of driving or the price of gasoline.<sup>10</sup> These elasticities can differ substantially based on the location and characteristics of drivers.

Anders Munk-Nielsen and I explored how the responsiveness of drivers to changes in fuel prices differed across space, based on their characteristics and the availability of substitutes to driving.<sup>11</sup> Using detailed microdata covering all vehicles and households in Denmark, we identified two groups of households that were much more responsive to gasoline prices. They were in the tails of the distribution of commuting distance to work: those who had the shortest and longest commutes. Those with the shortest commutes lived in urban areas and had many viable substitutes to driving. Those with the longest commutes lived far from the cities, used vehicles to commute, and faced high fuel expenditures, though in Denmark even they had access to reasonable public transportation as a driving substitute. We estimated that if public transportation was unavailable, as is the case in many parts of the US, the fuel price elasticity of driving in Denmark would be much closer to common estimates for the US. This finding sheds new light on the determinants of changes in driving behavior in response to changing fuel prices.

The effects of standards for fuel economy and greenhouse gas emissions

will become even more important as the market share of electric vehicles increases. I recently investigated various design decisions intended to promote electric vehicles, finding that more generously crediting electric vehicles under the standard would effectively relax the standard and could even reduce sales of electric vehicles.<sup>12</sup> This suggests that other approaches to promote electric vehicles are more likely to be effective in reducing greenhouse gas emissions.

## Equilibrium in Automobile Markets

The study of new-vehicle standards brings up a set of issues relating to equilibrium in vehicle markets. Yet most analyses relating to standards do not take equilibrium in both the new and used vehicle markets seriously. Often, the used vehicle market is assumed to be unaffected or is modeled in a simple fashion.

My colleagues and I have developed a computationally tractable framework to study the effects of vehicle market regulation. It incorporates forward-looking consumers who choose to keep, trade, or discard their vehicles, imposes the condition that inflows of new vehicles must equal outflows of scrapped vehicles in each time period, and allows us to estimate how various policies will affect the fleet of vehicles, the full price schedule of vehicles of all model years in the used car market, and the set of consumer demand preference parameters. The framework models all of these key aspects of the vehicle market, while accommodating heterogeneity in household and vehicle types.

We are deploying this framework to examine the effects of a variety of automobile market regulations. In one application, we used data on vehicle registrations and inspections to quantify the effects of reducing the very high new-vehicle registration fee in Denmark and replacing the lost revenue by raising the tax on fuel.<sup>13</sup> Because the registration fee is so high, this “tax swap” could increase aggregate welfare and increase vehicle ownership while reducing vehi-

cle ages, driving, and carbon dioxide emissions. Tax shifts could raise both welfare and tax revenue.

These tools and methods hold great promise for future research on automobile markets and environmental regulation. For example, I have work underway modeling how automaker product offerings and innovation are affected by regulation, as well as the distributional impacts of environmental regulations in automobile markets.

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<sup>12</sup> “Designing Fuel-Economy Standards in Light of Electric Vehicles,” Gillingham K. NBER Working Paper 29067, July 2021.

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# Dominant Currencies

Oleg Itskhoki

There are about 180 currencies in the world, but a very small number of dominant currencies play an outsize role in international trade, finance, and central bank foreign exchange reserves. In the modern era, the US dollar has a dominant international presence, followed to a lesser extent by the euro and a handful of others. Gita Gopinath and I recently surveyed the literature on dominant currencies.<sup>1</sup>

The importance of currencies is never more evident than in global trade, where exchange rates are often at the center of fierce economic and political debates. Indeed, the use of currencies in international trade is key for the international transmission of shocks and the design of optimal monetary and exchange rate policy in an open economy.<sup>2</sup>

The use of currency in international trade is not exogenous, but is instead the consequence of active firm-level decisions at the micro level with allocative consequences at the macro level. I study this in recent work with Mary Amiti and Jozef Konings.<sup>3</sup> There is consider-

able heterogeneity across firms in the use of a handful of global currencies, especially in trade among pairs of developed countries. At the same time, currency choice is remarkably stable over time, with the status of dominant currencies remaining unchanged over decades, supported by the presence of strategic complementary forces that lock in the currency equilibrium. Nonetheless, there can be decisive shifts in the international monetary system over long time horizons, with the status of dominant currencies changing over centuries or half centuries. The previous dominant currency, the British pound, lost its dominant status in the 1930s. However, long after the UK had ceased being the leading world economy, the pound kept its role as an important currency for pricing, anchoring, and financing.

While the US dollar accounts for a disproportionate share of international trade, there is a small subset of currencies that are actively used in this trade alongside the dollar, most notably the euro, but to a lesser extent the pound, the Japanese



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Itskhoki's research interests are in macroeconomics and international economics, where he studies globalization and labor markets, and currencies, exchange rates and international relative prices, as well as other topics.

He holds a BA in economics from Moscow State University, an MA in economics from the New Economic School, and a PhD in economics from Harvard University. He was a professor of economics at Princeton University until moving to UCLA in 2019. He was a participant of the Review of Economic Studies Tour, a Sloan Research Fellow, a recipient of the Excellence Award in Global Economic Affairs from the Kiel Institute for the World Economy, and was on the IMF's list of 25 influential economists under the age of 45.

Itskhoki was born in Moscow and lives in Los Angeles with his wife, Albina, daughters Liza and Leila, and son Lev. If there is spare time, he plays tennis, rides road bicycles, skis, and surfs.

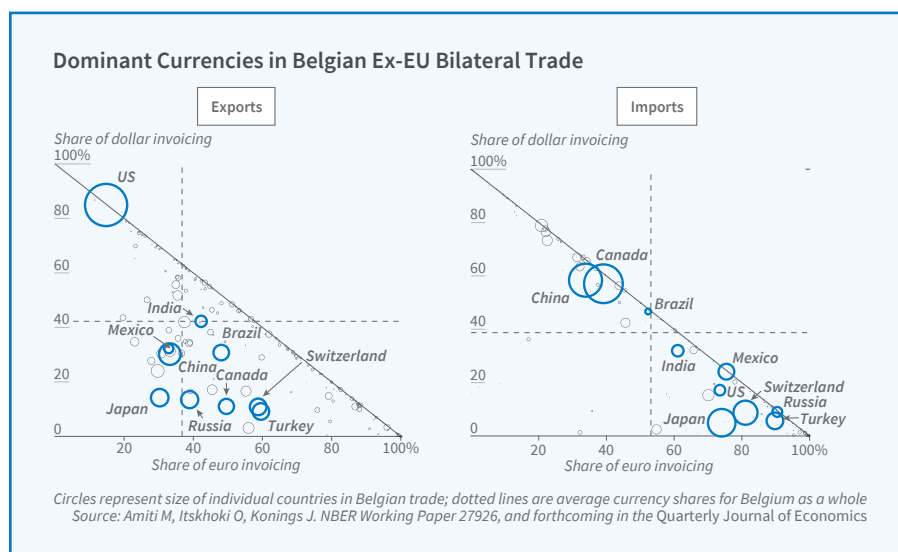


Figure 1

yen, the Swiss franc, and the Chinese yuan. In some bilateral trade flows these currencies play as important a role as the dollar [see Figure 1], with considerable variation in currency use across individual firms even within narrowly defined industries. The dollar and the euro have emerged as the two leading currencies in accounting for international trade flows, with the role of the euro elevated by the fact that a large portion of international trade happens among European countries or involves one of the European countries. A distinctive feature of dominant currencies is that the same currency is equally prevalent in both imports and exports, a feature common to both the dollar and the euro, which is also at odds with standard international macro models that assume a greater role for many currencies to be present in global trade. Nonetheless, a clear distinction between the dollar and the euro is that the dollar in many cases is also a vehicle currency, not used domestically by either the importing or the exporting country. One can thus think of the dollar as the dominant global currency and of the euro as the dominant regional currency, all in the presence of a handful of other currencies used in specific bilateral trade flows.

The presence of this heterogeneity permits a study of the determinants of currency choice at the micro level, as well as the implications of this choice for exchange rate transmission into export prices and quantities at different time horizons. The findings of these analyses can then be used for counterfactual analysis of changes in the currency equilibrium in response to large shifts in the global monetary system.

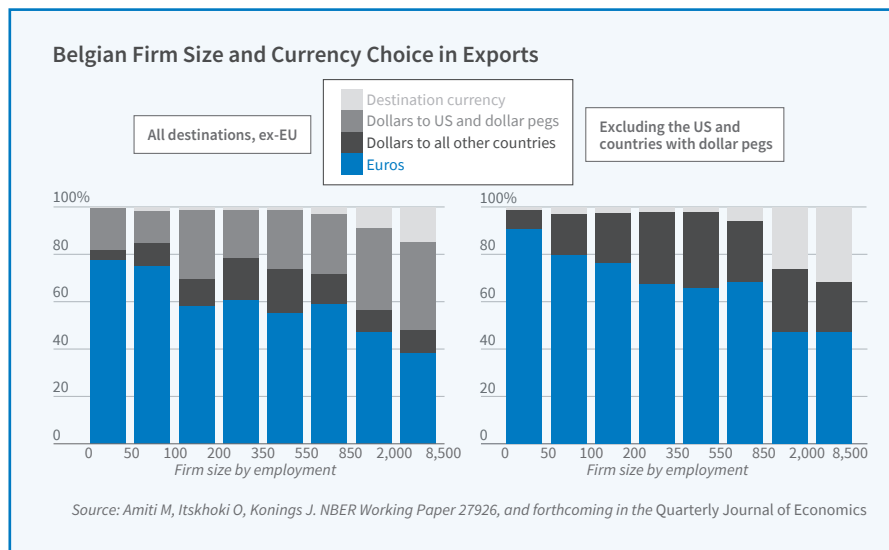
Theories of currency choice can be classified based on the three conventional uses of money. Medium-of-exchange the-

ories emphasize that a currency is adopted if it guarantees the lowest transaction costs or maximizes room for mutually beneficial exchange. These theories stress country size as a fundamental force, as well as the likelihood of multiple coordination equilibria and other macroeconomic factors that make it too costly to use currencies of developing countries, which explains the existence of only a small subset of global currencies. Note that “invoicing currency” can refer to either the transaction currency or the currency in which the price is preset; the two typically coincide, likely reinforcing each other’s roles.

Store-of-value theories link currency

a result, desired price stability, or low desired exchange rate pass-through in a given currency, favors the use of this currency for presetting prices. The desired price, in turn, is shaped by the properties of the marginal cost and the desired markup of the firm. Consequently, desired exchange rate pass-through depends on the import intensity of the firm and its strategic complementarities in price setting with other firms in the market, which are stronger for larger firms with larger market shares.<sup>6</sup> The currency choice of firms in turn shapes the dynamics of prices and quantities, resulting in a two-way feedback between currency choice and exchange rate pass-through, which are jointly determined in equilibrium.

Using detailed Belgian data, Amiti, Konings, and I observe that firm size, proxying for strategic complementarities in pricing with competitors in the destination market, and the cost share of imported inputs are the two key determinants of currency choice; larger and more import-intensive firms are more likely to deviate from pricing in euros and choose foreign-currency pricing of exports. Figure 2 illustrates this pattern by displaying a steep gradient in the use of currencies across firms of different sizes. Smaller Belgian exporters use euros almost exclusively in their ex-EU exports. In contrast, larger exporters use the dollar, and the largest firms occasionally price in the destination currency.<sup>7</sup> Furthermore, the firms that rely more on imported inputs, in particular those invoiced in dollars, are more likely to adopt the dollar in export pricing, while larger firms are more likely to adopt the destination currency. Firms with cross-border ownership, arguably proxying for their participation in global value chains, are more likely to invoice in dollars. We also provide direct evidence



**Figure 2**

choice in exports with the currency of financing of the firm as part of a combined risk-management decision. Finally, unit-of-account theories postulate that a price is set in a given currency and is not adjusted in the short run, thus forming the basis for open economy New Keynesian analysis. This is the framework for which both theory and empirical evidence is well developed.<sup>4</sup>

A seminal insight by Charles Engel was to link currency choice to optimal (or desired) exchange rate pass-through.<sup>5</sup> Intuitively, currency choice is an indexing decision to the exchange rate; thus, it attempts to approximate the desired response of prices to the exchange rate when nominal prices cannot adjust. As

of strategic complementarities in currency choice, whereby the currency used by a firm's competitors has a strong impact on the firm's own currency choice.

A firm's currency choice is a key determinant of the exchange rate pass-through into prices and quantities. A large literature has shown that exchange rate pass-through into destination prices is incomplete when exports are invoiced in a foreign currency. However, establishing whether the effects of foreign-currency price stickiness are causal is challenging, for two reasons. First, the relationship could be driven by confounding macroeconomic variables, whereby exchange rates comove with macroeconomic shocks, (e.g., a global financial crisis) that also affect prices and quantities of traded goods. Second, this relationship could be due to

selection, where certain firm characteristics determine simultaneously the firm's currency choice and the exchange rate pass-through into its prices and quantities. By comparing firms with similar characteristics that choose to price in different currencies for idiosyncratic reasons, we are able to isolate the effect of the firm's currency choice on pass-through, controlling for selection effects. Furthermore, our inference is based on the differential response of firms to the same exchange rate shocks in the same equilibrium environment, thus excluding confounding macroeconomic variation.

We find that the direct effects of foreign-currency price stickiness are large and significant even beyond a one-year horizon, and slowly dissipate in the long run. Specifically, small Belgian exporters with no exposure to foreign inputs that price their exports in euros exhibit complete pass-through of the euro-destination exchange rate into destination prices at all horizons, and are insensitive

to the dollar-destination exchange rate. By contrast, large firms with high foreign-input intensity have a significantly lower pass-through of the euro exchange rate, and a positive pass-through of the dollar exchange rate into destination prices. Firms that price their exports in a foreign currency, whether destination or dominant, exhibit a much lower pass-through

literature. This extent of price stickiness implies that about 30 percent of prices have yet to adjust a year after the shock, and the differential pass-through across firms pricing in different currencies is approximately 50 percentage points for 12-month changes in prices, consistent with our empirical estimates.

Finally, the cross-currency differential

pass-through into prices translates into consistent differences in the responses of quantities, with an estimated negative export quantity elasticity of around 1.5 for all goods and over 2 for differentiated goods, in line with other macroeconomic estimates of this elasticity.<sup>8</sup> This establishes the allocative effects of sticky prices in the endogenously chosen currency of invoicing. The quantities, how-

ever, take time to adjust, with the effects becoming significant only about a year after the shock, as we illustrate in the right panel of Figure 3, suggesting a role for quantity adjustment frictions in addition to price stickiness.

These results have broad macroeconomic implications. In particular, they emphasize the forces that currently lock in the dominant role of the dollar in world trade, but may also ultimately lead to the demise of the dollar and its replacement by either another single dominant currency or a basket of currencies. One possibility is that the US dollar strengthens its position as the dominant global currency. This could happen with greater globalization of production and more intensive reliance on global value chains; our results show that cross-border foreign direct investment—a proxy for global value chains—is associated with more US dollar currency invoicing. This would render exchange rates less relevant as determinants of relative prices and

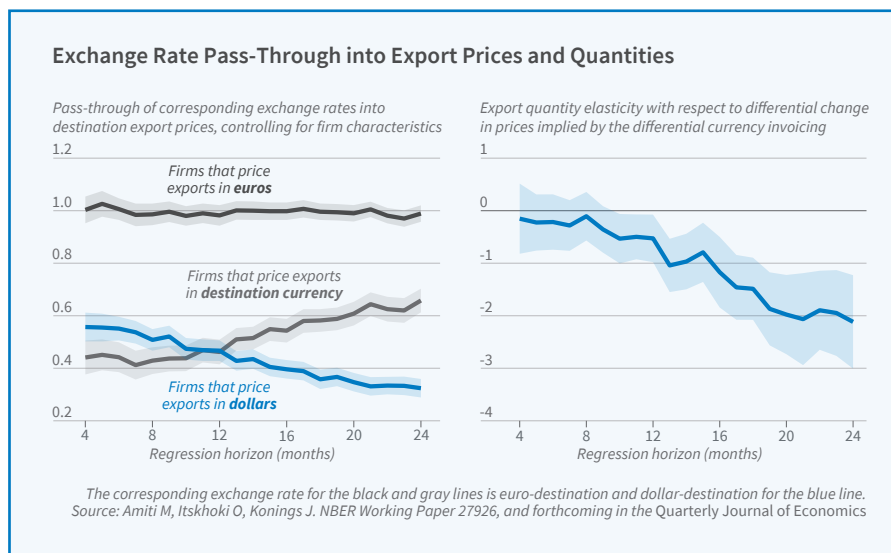


Figure 3

of the euro-destination exchange rate, especially in the short run, with the gap slowly decreasing over time. In addition, firms that price in dollars exhibit large pass-through of the dollar exchange rate into destination prices in the short run, which also gradually decays over time. We illustrate this in the left panel of Figure 3.

These dynamic pass-through patterns are in line with the predictions of a sticky-price model with endogenous currency choice. Our structural estimates offer a new test of the allocative effects of price stickiness by estimating the treatment effect of invoicing currency on the response of prices and quantities to an exchange rate shock. We show that the nonparametrically estimated dynamics of pass-through are consistent with a Calvo model of staggered price setting with roughly a 10 percent monthly probability of price adjustment, or in other words, with an average duration of prices of 10 months, broadly consistent with somewhat higher direct estimates in the



expenditure switching in the global supply chain. In contrast, fragmentation and localization of production chains, which might happen in response to a global pandemic shock, can reverse this trend and speed up the transition to a multi-currency equilibrium, with more intensive regional trade and greater barriers to cross-regional trade. This, in turn, may increase the expenditure-switching role of bilateral exchange rate movements.

Alternatively, a shift in the exchange rate anchoring policies of the major trade partners, such as China, could trigger a long-run shift in the equilibrium environment. If China were to freely float its exchange rate, encouraging Chinese exporters to price more intensively in renminbi, then the equilibrium environment would change for exporting firms around the world. In particular, this would alter both the dynamics of prices in the input markets as well as the competitive environment in the output markets across many industries. As our results show, the currency in which a firm's imports are invoiced and the currency in which its competitors price are key determinants of an exporting firm's currency choice, and hence this shift could dramatically change the optimal invoicing patterns for exporting firms. This, in turn, may lead monetary authorities across the world to further adjust their nominal anchoring and realign their exchange rate management policies, further changing the equilibrium in the international monetary system.

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<sup>7</sup> For imports, there is no robust relationship between firm size and currency use. This is consistent with the common theoretical approach whereby currency choice in exports is a more active firm-level decision than in imports: exporters make currency-choice and price-setting decisions, while importers choose quantities given prices.

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# The Social Value of Science and Innovation

## Investments and Sources of Breakthroughs

Benjamin Jones

Per capita income in the United States today is about 50 times greater than it was in 1820, and life expectancy is decades longer. Amidst these impressive gains, there is a broad appreciation that science and innovation—the discovery and implementation of new ways of doing things—is critical. Yet there is also substantial skepticism about the value of investments in research and development, including those in science. Many R&D investments fail to yield successful outcomes, whether in science or the marketplace. Most pharmaceutical development projects and new business ventures fail, most patents have little apparent market value, and most scientific research projects, even if they are published, receive very few citations.

Uncertainty about the value of R&D investments makes it difficult to answer fundamental questions about R&D policy, including the appropriate direction and scale of research spending. The US economy invests between 2 and 3 percent of GDP annually in R&D. Is that the right amount? The economy now appears to be caught in a productivity growth slowdown. If innovation is key to productivity gains, can R&D policy accelerate the rate of progress? And how might we do this?

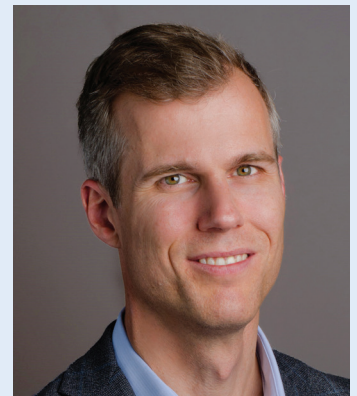
Answering these questions is both important and challenging. A central difficulty is the issue of spillovers: the value of scientific and innovative outputs accrues not just to the original creator but in substantial part to others, including those who use, imitate, or build further upon the advance. Think of calculus, the internet, and the smartphone. Tracing streams of benefits to disparate parties, including future parties, is a fundamental challenge. So is selection. Studies of R&D sometimes compute returns by picking winners, assessing the value of R&D through the lens of developments like mRNA vaccines, or Moore's Law. Such stud-

ies show extremely high returns, while the return to R&D projects more generally may look very different, and be much lower. On the other hand, skeptical observers of science funding often pick losers, emphasizing the regular failures in R&D efforts. Think of Senator William Proxmire's Golden Fleece Awards, which pilloried public investment in frivolous research, or more recent criticisms of the US Department of Energy's \$535 million in loan guarantees to Solyndra, a solar-panel maker that failed.

In a recent series of projects, my colleagues and I have been tracing the costs and benefits of R&D in a more comprehensive fashion and assessing the overall social returns to the R&D enterprise. This work builds in part on the availability of remarkable new datasets that provide increasingly detailed and wide-ranging views of scientific and innovative activity. Further, beyond "bottom-up" approaches from microdata, novel "top-down" measurement frameworks can help step past microdata limitations and elucidate macroeconomic implications. In this summary, I describe several recent studies that speak to the value and scale of scientific and innovative activities, and also consider new insights about key sources of breakthroughs.

### Measuring the Use of Science

Scientific research is a substantial component of R&D investment, and scientific discoveries are often seen as opening new doorways to progress. As Vannevar Bush wrote, science "creates the fund from which the practical applications of knowledge must be drawn."<sup>1</sup> This canonical perspective emphasizes science's spillovers. It also motivates the public goods approach to science, in which research in universities and national labs is substantially funded through



**Benjamin Jones** is codirector of the NBER's Innovation Policy Working Group and a research associate affiliated with the Productivity, Innovation, and Entrepreneurship Program and the Development Economics Program. He is the Gordon and Llura Gund Family Professor of Entrepreneurship at Northwestern University's Kellogg School of Management.

His research focuses on the sources of growth in advanced economies, with an emphasis on innovation, entrepreneurship, and scientific progress. He also studies global economic development, including the roles of education, climate, and national leadership in explaining the wealth and poverty of nations.

Jones received his bachelor's degree in aerospace engineering from Princeton University in 1995, a master's in economics from Oxford University in 1997, and a PhD in economics from MIT in 2003. He has worked in the US Treasury Department and with the Council of Economic Advisers in the White House. He is a nonresident senior fellow of the Brookings Institution and a member of the Council on Foreign Relations. Jones lives in Chicago with his spouse and three children.

tax dollars and the fruits of these investments are placed in the public domain so that others, at least in principle, will build on these insights. Understanding the value of science, and the effectiveness of its institutional architecture, thus hinges on tracing spillovers from science into broader public use.

A key measurement approach to tracing knowledge flows uses reference linkages in microdata. Economists have long applied this approach to patents: a patent codifies an invention, and the citation linkages between patents—and hence between inventors, firms, and regions—can act as proxy for knowledge flows. More recently, with the advent of large databases of scientific works, similar measurement ideas can be applied to journal articles and the reference linkages between them. Building on these databases, one can trace the spillovers of science beyond the bounds of science itself.

Mohammad Ahmadpoor and I investigate the use of science in patenting. We trace how scientific research largely conducted in university and government labs can form the foundation for marketplace invention largely developed by private sector firms.<sup>2</sup> We examine all US patents and trace their references to prior scientific articles. One key finding is that a remarkable degree of connectivity exists between patenting and prior scientific work. Conditional on a scientific article being cited at least once by other scientists, 80 percent of scientific articles are part of a stream of knowledge that leads to a specific future patent. Further, on the patenting side, patents that are closer to science prove to have much larger impact and market value.<sup>3</sup>

More recently, Yian Yin, Dashun

Wang, and I, working with a team at Microsoft, consider the uses of science across three public domains—government documents, the news media, and patents—to provide a broader picture of the use of science beyond science.<sup>4</sup> This study also integrates funding information across the corpus of scientific works. Whereas in a market setting it is natural to think that investment tracks consumer demand, the activity of science is innately more distant from its ultimate use and comparable demand signals are harder to identify. Indeed, there is substantial skepticism about the ivory tower nature of scientific research—the idea that scien-

three types of public uses together, we can predict the public funding of different science fields with considerable accuracy. These findings suggest that science is not an isolated or ivory tower activity disconnected from public interest. Rather, science generates a diverse range of spillovers, and public funding of science is closely related to public use.

## Measuring the Social Return to R&D

These analyses show how the integration of new datasets can help in assessing longstanding hypotheses and skepticism about the use of science. These micro-level studies do not, however, provide an overall assessment of the value of R&D or a comparison of its benefits and costs. Tracing knowledge using microdata only goes so far. For example, trade secrets remain a kind of “dark matter” in innovation. Surveys suggest that trade secrets are extremely important to business but, essentially by definition, they defy easy observation. Further, reference linkages provide an incomplete picture

of R&D spillovers. Negative spillovers in R&D, such as the duplication of R&D efforts or stealing among business competitors, typically will not appear through citation linkages.

In a recent study, Lawrence Summers and I introduced a top-down approach that seeks to overcome many of the measurement limits in microdata.<sup>5</sup> Our basic insight is that productivity growth in the economy captures the net result of innovative investments. Separately, total innovation investment costs capture the funding for both the successes and the dry holes, avoiding the problem of selection in studying R&D returns. One can then

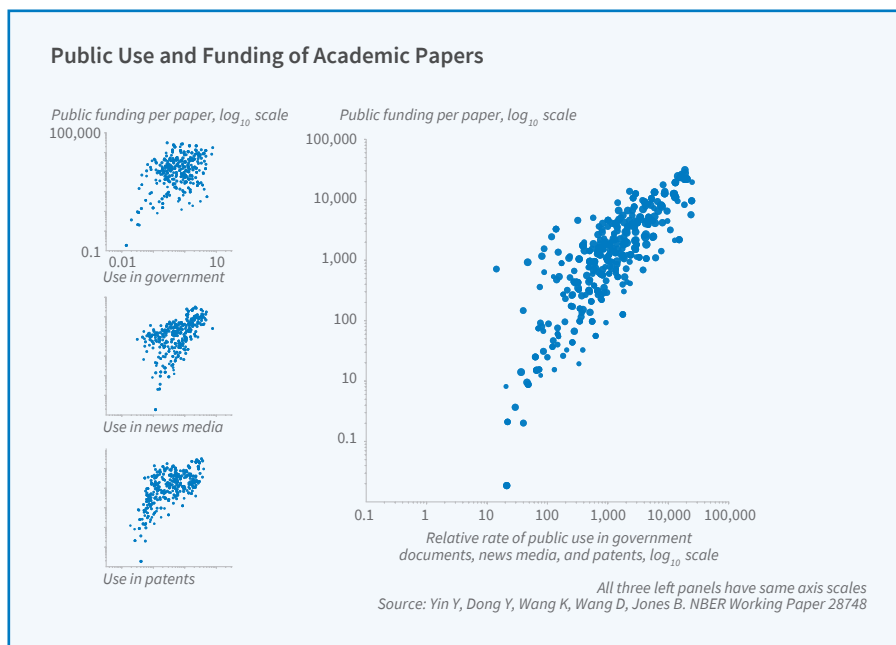


Figure 1

tists may follow abstract interests with little connection to broader society—and there is also substantial skepticism about how the public funding system, which includes legislators, funding agencies, and scientist review panels, makes investment choices.

Figure 1 examines the relationship between public funding and public use across the sciences and social sciences. We find a striking degree of alignment between a research field’s funding, measured as public expenditure per research paper produced, and the tendency for that field’s papers to be drawn upon in policy, media, and patenting. Pulling all

compare the present value of the productivity gains along the economy's growth path to the total innovation investment costs to calculate a transparent, overall measure of the social returns.

We find that average returns to investments in innovation are very large. Conservative estimates suggest that \$1 invested in R&D returns at least \$5 on average. Adding in other benefits—such as health gains—can raise these social returns higher, to \$10 of benefit per \$1 spent, or more. Our relatively comprehensive analysis echoes the high social returns to additional R&D funding found in studies that focus on narrower contexts. These results suggest that expanding R&D investment would pay for itself many times over, and would be a direct way to overcome the productivity slowdown.

## Scientific and Innovative People

A key input to R&D is people—the scientific and innovative labor force. Understanding who produces breakthroughs is key to R&D policy, since accelerating advances hinges on the capacity to scale and invest in the innovative workforce. How might we do this? And on whom might we bet?

On the scaling dimension, one key pathway may be immigration. Recent research has shown the exceptionally productive role immigrants play in both invention and entrepreneurship in the US. Pierre Azoulay, Daniel Kim, Javier Miranda, and I use administrative data from the US Census to study the founders of all new businesses in the country from 2007–15.<sup>6</sup> We measure the rate at which immigrants and native-born individuals started businesses and their degrees of success. We find that immigrants are

highly entrepreneurial: an immigrant is 80 percent more likely to start a business than a native-born individual. And immigrants don't just start businesses that remain small. Rather, as Figure 2 shows, immigrants are more likely than native-born individuals to start businesses of every size, with immigrant founders over-represented among businesses that grow to be the biggest employers or have the greatest sales. Immigrants' firms are also more likely to hold patents in every size class, indicating the technology orientation of these firms. Other recent work

work, peaks come later in life, sometimes very late.<sup>8</sup> In a recent paper, Azoulay, Kim, Miranda, and I study a census of all business founders in the US and examine the founders behind the upper tail of successes.<sup>9</sup> We find that young founders are disproportionately unlikely to produce high-growth companies, with founders in middle and even late-middle age having the highest likelihood of starting the highest-growth companies. Our findings have implications for those in whom we invest when pursuing breakthrough ideas.

Overall, new data and measurement approaches are helping to answer longstanding questions about science and innovation and generate new and often surprising insights. Much remains to be learned, and the advent of high-scale data about the science and innovation system opens many pathways to new discoveries.

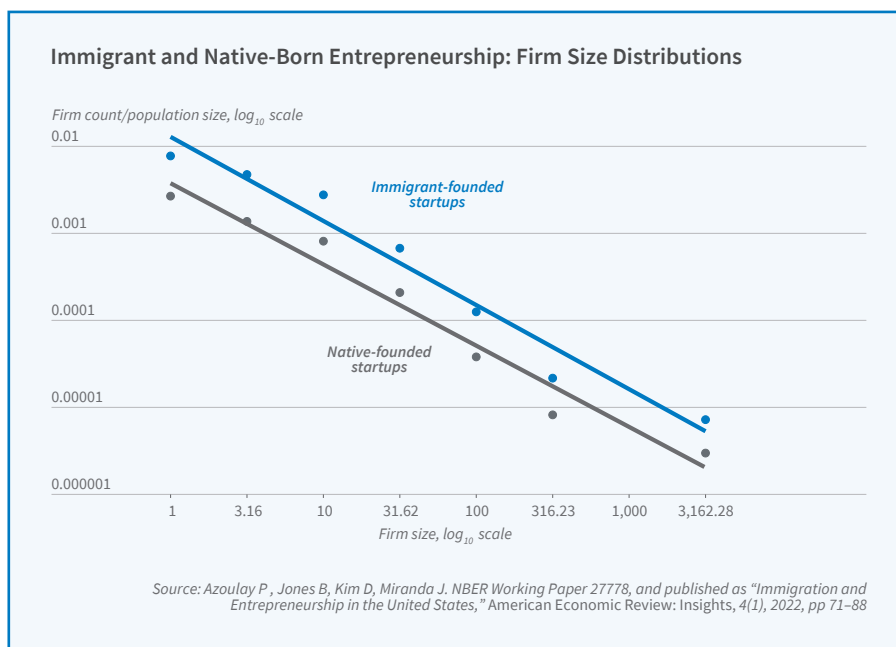


Figure 2

has shown that immigrants are overrepresented among inventors in the US and are especially successful in the quantity and value of their inventions.<sup>7</sup>

In additional work with a variety of colleagues, I have been studying the sources of scientific and innovative breakthroughs, from people inputs to idea inputs to forms of collaboration. One line of inquiry concerns the life cycle of scientists and innovators. A common view is that young people are especially capable of creating transformative advances; this view can influence the funding choices for investors. However, systematic data analysis rejects this view. In science and invention, including in Nobel Prize-winning

work, peaks come later in life, sometimes very late.<sup>8</sup> In a recent paper, Azoulay, Kim, Miranda, and I study a census of all business founders in the US and examine the founders behind the upper tail of successes.<sup>9</sup>

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<sup>1</sup> “Science: The Endless Frontier,” Bush V. US Government Printing Office, 1945.

<sup>2</sup> “The Dual Frontier: Patentable Inventions and Prior Scientific

Advance,” Ahmadpoor M, Jones B. *Science* 57(6351), August 2017, pp. 583–587.

<sup>3</sup> Ibid. See also “Standing on the

Shoulders of Science,” Watzinger M, Schnitzer M. Centre for Economic Policy Research Discussion Paper 13766, July 2021.

<sup>4</sup> “Science as a Public Good: Public Use

and Funding of Science,” Yin Y, Dong Y, Wang K, Wang D, Jones B. NBER Working Paper 28748, April 2021.

<sup>5</sup> “A Calculation of the Social Returns to Innovation,” Jones B, Summers L.

NBER Working Paper 27863, September 2020, and in *Innovation and Public Policy*, Goolsbee A, Jones B, editors. Chicago: University of Chicago Press, 2022.

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<sup>6</sup> “Immigration and Entrepreneurship in the United States,” Azoulay P, Jones B, Kim JD, Miranda J. NBER Working Paper 27778, September 2020, and *American Economic Review: Insights*

4(1), March 2022, pp. 71–88.

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<sup>7</sup> “The Contribution of High-Skilled Immigrants to Innovation in the United States,” Bernstein S, Diamond R, McQuade T, Pousada B. Stanford Graduate School of Business Working Paper 3748, November 2018.

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<sup>8</sup> “Age and Great Invention,” Jones B. NBER Working Paper 11359, May

2005, and *Review of Economics and Statistics* 92(1), February 2010, pp. 1–14.

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<sup>9</sup> “Age and High-Growth Entrepreneurship,” Azoulay P, Jones B, Kim JD, Miranda J. NBER Working Paper 24489, April 2018, and *American Economic Review: Insights* 2(1), March 2020, pp. 65–82.

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### Annual Report of Awards to NBER Affiliates

**Anjali Adukia** received an Early Career Product Award from the Education Policy Collaborative. Her study “What We Teach about Race and Gender: Representation in Images and Text of Children’s Books,” coauthored with Alex Eble, Emileigh Harrison, Hakizumwami Birali Runesha, and Teodora Szasz, was named one of the 10 most significant education studies of 2021 by the George Lucas Educational Foundation.

**Joseph Aldy** and coauthor Gianfranco Gianfrate won the 2021 FIR-PRI Finance & Sustainability Award for Best Pedagogical Innovation for “Future-Proof Your Climate Strategy: Smart Companies Are Putting Their Own Price on Carbon” in *Harvard Business Review*.

**Marcella Alsan** was awarded a MacArthur Fellowship and received the 2021 Willard G. Manning Memorial Award for Best Research in Health Econometrics for “Does Diversity Matter for Health? Experimental Evidence from Oakland,” with Owen Garrick and Grant Graziani.

**Elizabeth Ananat** was named a Carnegie Foundation Fellow.

**Joshua Angrist, David Card,** and **Guido Imbens** shared the 2021 Nobel Prize in Economic Sciences in recognition of their contributions to labor economics and the analysis of natural experiments.

**Alan J. Auerbach** was named a Distinguished Fellow of the American Economic Association and received the Order of the Rising Sun from the Government of Japan.

**David Autor** received a Society for Progress Medal for his “path-breaking research underscoring the core contemporary issue of labor adjustment in response to developments in trade and technology.”

**Robert J. Barro** was awarded an

Honorary Doctorate by the Athens University of Economics and Business.

**Marco Battaglini** and coauthors Eleonora Patacchini and Valerio Leone Sciabolazza received the inaugural Best Publication on Effective Lawmaking Award from the Center for Effective Lawmaking at the University of Virginia and Vanderbilt University for their paper “Effectiveness of Connected Legislators.”

**Axel Börsch-Supan** received the SENECA Medal for aging research for fundamental and policy-relevant work on old-age labor supply.

**Jeffrey Brown** was named the 2021 Poets & Quants Dean of the Year.

**Markus Brunnermeier** received the 2021 German Business Book Prize, awarded by *Handelsblatt*, the Frankfurt Book Fair, and Goldman Sachs, for *The Resilient Society*, which was also on the Best Books of 2021: Economics list of the *Financial Times*.

**Dennis W. Carlton** received a best article award from *Economic Inquiry* for his paper on “Antitrust Treatment of Nonprofits: Should Hospitals Receive Special Care?” coauthored with Cory Capps and Guy David.

**Anne C. Case** was named a Distinguished Fellow of the American Economic Association and received the Matilda White Riley Award from the National Institutes of Health for research that “has contributed to behavioral and social scientific knowledge and the application of such knowledge relevant to the mission of the National Institutes of Health.”

**Dhaval Dave** and **Monica Deza** and their coauthor Brady Horn received the Georgescu-Roegen Prize for the best article in the *Southern Economic Journal* for “Prescription Drug Monitoring Programs, Opioid Abuse, and Crime.” Dave and coauthors Drew McNichols and Joseph Sabia were also runners-

up for that award for “The Contagion Externality of a Superspreading Event: The Sturgis Motorcycle Rally and COVID-19.”

**Thomas Dee’s** paper with Elizabeth Huffaker, Cheryl Philips, and Eric Sagara on “The Revealed Preferences for School Reopening: Evidence from Public-School Disenrollment” was honored by the Thomas B. Fordham Institute as the top education study of 2021.

**Stefano DellaVigna** was named a Fellow of the American Academy of Arts and Sciences and of The Econometric Society.

**Peter M. DeMarzo** and **Zhiguo He** received the 2021 Brattle Group Prize in Corporate Finance for an outstanding paper in the *Journal of Finance* for “Leverage Dynamics without Commitment.”

**William Easterly** won the Competitive Enterprise Institute’s Julian L. Simon Award for 2021.

**Hulya Eraslan** was appointed a Fellow of the Game Theory Society.

**Robert Fairlie** received the Bradford-Osborne Research Award given jointly by the UCLA and University of Washington business schools for research contributing to improving racial equality in business.

**Robert Feenstra, Annette Vissing-Jorgensen,** and **Ebonya Washington** were elected Fellows of the American Academy of Arts and Sciences.

**Xavier Gabaix** and **Ralph Koijen** won the AQR Insight Award for their paper “In Search of the Origins of Financial Fluctuations: The Inelastic Markets Hypothesis.”

**Jordi Galí** received the 2021 Pascual Madoz National Research Prize in the areas of Law, Economics, and Social Sciences from Spain’s Ministry of Science and Innovation.

**Oded Galor** received an hon-

orary doctorate from the Université Catholique de Louvain.

**Peter Ganong** and **Pascal Noel** won the 2021 TIAA Institute Paul A. Samuelson Award for Outstanding Scholarly Writing on Lifelong Financial Security for “Liquidity versus Wealth in Household Debt Obligations: Evidence from Housing Policy in the Great Recession,” and they shared the National Meeting Best Paper Award from the American Real Estate and Urban Economics Association for “Why Do Borrowers Default on Mortgages? A New Method for Causal Attribution”.

**Matthew Gentzkow** was named a Distinguished Fellow of the Center for Economic Studies at Ludwig-Maximilians-Universität München.

**Mark Gertler** and **Nobuhiro Kiyotaki** received the Banco Bilbao Vizcaya Argentaria (BBVA) Foundation Frontiers of Knowledge Award in Economics along with Ben Bernanke and John Moore.

**Sherry Glied** was named the 2021 recipient of the William B. Graham Prize for Health Services Research, awarded by the Baxter International Foundation and the Association of University Programs in Health Administration.

**Claudia Goldin** was awarded a Society for Progress Medal for her “long-standing and illuminating research on the influence of gender in the labor market.” She also delivered the Bob Gregory Lecture hosted by the Asian and Australasian Society of Labour Economics.

**Paul Gompers**, **Steven Kaplan**, and **Ilya Strebulaev**, and their coauthor Will Gornall, won the Doriot Award for the Best Private Equity Research Paper and the Jensen Prize for best paper in the *Journal of Financial Economics* on corporate finance and organizations for “How Do Venture Capitalists Make Decisions?”

**Gautam Gowrisankaran** and coauthors R. Andrew Butters and Jackson Dorsey won the Public Utility Research Center Best Paper Prize at the 2021

International Industrial Organization Conference for “Soaking Up the Sun: Battery Investment, Renewable Energy, and Market Equilibrium.”

**Bronwyn H. Hall** received the 2021 Technology and Innovation Management Distinguished Speaker Award from the Academy of Management.

**John C. Haltiwanger** won the 2021 Society of Labor Economists Prize for Contributions to Data and Measurement.

**Eric Hanushek** received the Yidan Prize for Education Research.

**Rucker Johnson** was elected a Fellow of the American Academy of Arts and Sciences, was named Sir Arthur Lewis Fellow of the American Academy of Political and Social Science, and won the University of Louisville Grawemeyer Award in Education.

**Myrto Kalouptsi** was awarded the Bodossaki Distinguished Young Scientist Award in Social-Economic Sciences, for a Greek scientist under the age of 40.

**Amir Kermani**, **Marco Di Maggio**, and their coauthor Kaveh Majlesi won *The Journal of Finance*’s Dimensional Fund Advisor distinguished paper award for “Stock Market Returns and Consumption.”

**Judd B. Kessler** was awarded the 2021 Vernon L. Smith Ascending Scholar Prize.

**Anton Korinek** received a David M. Rubenstein Fellowship from the Brookings Institution.

**Gary Libecap** won the Elinor Ostrom Lifetime Achievement Award of the Society for Institutional and Organizational Economics. He shared this award with Avner Greif.

**Annamaria Lusardi** was included in the Clarivate Highly Cited Researchers list, which acknowledges the production of multiple highly cited papers in a field and year in the Web of Science.

**Song Ma** and **Manju Puri** and their coauthor Emily Johnston-Ross received the 2021 Global Association of Risk Professionals Best Paper in Risk Management Award.

**Matteo Maggiori** received the 2021 Fischer Black Prize from the American Finance Association, awarded biennially to an outstanding financial economist under the age of 40.

**Neale Mahoney** and **Heidi Williams** were corecipients of the ASHEcon Medal, awarded by the American Society of Health Economists to outstanding health economists under the age of 40.

**Pinar Karaca-Mandic** received the 2021 Trust Award in Community Engagement from the Women’s Health Leadership TRUST for her leadership of the COVID-19 Hospitalization Tracking Project.

**Ioana Marinescu** and coauthors José Azar, Marshall Steinbaum, and Bledi Taska received the 2021 EALE Labour Economics Prize for “Concentration in US Labor Markets: Evidence from Online Vacancy Data.” She and Eric Posner received the Jerry S. Cohen Award for Antitrust Scholarship for Best Article of 2020 on Labor Antitrust for “Why Has Antitrust Law Failed Workers?”

**Pierre-Carl Michaud** was elected to membership in the College of New Scholars, Artists and Scientists of the Royal Society of Canada.

**Olivia S. Mitchell** and coauthor Daniel Gottlieb received the Robert C. Witt Award from the American Risk and Insurance Association for the best paper in the *Journal of Risk and Insurance* for “Narrow Framing and Long-Term Care Insurance.”

**Emi Nakamura** and **Jón Steinsson** received the Banque de France–Toulouse School of Economics Prize in Monetary Economics and Finance.

**Edward C. Norton** received the 2021 Willard Manning Award in Mental Health Policy and Economics Research, with coauthors Marisa Elena Domino, Jangho Yoon, Gary S. Cuddeback, and Joseph P. Morrissey, for “Putting Providers At Risk through Capitation or Shared Savings: How Strong Are Incentives for Upcoding and Treatment Changes?”

**Thomas R. Palfrey** received the

William H. Riker Prize in Political Science, which is awarded every other year to a social scientist for research that advances the scientific study of politics.

**Vincent Pons** received excellence in refereeing awards from the *Journal of the European Economic Association* and the *American Economic Journal: Applied Economics*.

**Manju Puri** and coauthors Tobias Berg, Valentin Burg, and Ana Gombović received the Michael J. Brennan Best Paper Runner Up Award (tie) from *The Review of Financial Studies* for “On the Rise of FinTechs: Credit Scoring Using Digital Footprints.”

**Assaf Razin** and coauthor Efraim Sadka won the inaugural SAGE-*Journal of Government and Economics*’ best paper award for “Migration and Redistribution: Why the Federal Governance of an Economic Union Does Matter.”

**Stephen Redding** and coauthors Yuhei Miyauchi and Kentaro Nakajima shared the 2021 National Meeting Best Paper Prize from the American Real Estate and Urban Economics Association for “Consumption Access and Agglomeration: Evidence from Smartphone Data.”

**Dani Rodrik** was elected president of the International Economic Association.

**Roberta Romano** won the Ronald H. Coase Medal of the American Law and Economics Association in recogni-

tion of major contributions to the field of law and economics.

**Alvin Roth** received the 2021 Philip McCord Morse Lectureship Award from the Institute for Operations Research and the Management Sciences.

**Raffaella Sadun** was named a Grande Ufficiale of the Ordine al Merito della Repubblica Italiana.

**Jesse M. Shapiro** was named a 2021 MacArthur Fellow.

**Robert Shiller** was awarded the Commander’s Cross of the Order of Merit for Lithuania and was inducted into the Lithuanian Academy of Sciences.

**Kosali Simon** was elected to the National Academy of Medicine.

**Jonathan Skinner** received the Victor R. Fuchs Award for Lifetime Contributions to the Field of Health Economics from the American Society of Health Economists.

**Robert F. Stambaugh** and **Lubos Pastor** and their coauthor Lucian Taylor won the 2021 AQR Insight Distinguished Paper Award for “Sustainable Investing in Equilibrium.”

**Stefanie Stantcheva** received an Andrew Carnegie Fellowship and the Calvó-Armengol International Prize, and was elected a Fellow of the American Academy of Arts and Sciences. She also was awarded the Maurice Allais Economics Prize for her paper “Optimal Taxation and Human Capital Policies over the Life Cycle.”

**Isaac Sorkin** was named a 2021

Sloan Research Fellow.

**Andrew Sweeting** was appointed a coeditor of the *RAND Journal of Economics*.

**Michael Scott Taylor** served as president of the Canadian Economics Association.

**Christopher Timmins** was named a Fellow of the Association of Environmental and Resource Economists.

**Robert M. Townsend** was named a Distinguished Fellow of the American Economic Association.

**Manuel Trajtenberg** was named a Foreign Honorary Member of the American Economic Association.

**Stijn Van Nieuwerburgh** won the TIAA Paul A. Samuelson Award in 2020 for his paper with **Ralph Koijen** “Combining Life and Health Insurance” and the Thule Foundation’s Skandia Award for research on long-term savings. He also received the Southern Finance Association’s Best Paper Prize and an honorable mention for the Marshall Blume Best Paper Award.

**Carlos A. Vegh** received the Latin American and Caribbean Economic Association’s 2021 Carlos Díaz-Alejandro Prize honoring high-quality research on economic issues relevant to the region.

**Nicolas R. Ziebarth** was awarded the Early Career Scholarly Achievement Award by the American Risk and Insurance Association.



## Aguiar, Tesar to Lead International Finance and Macroeconomics Program



*Mark Aguiar*



*Linda Tesar*

Research Associates Mark Aguiar and Linda Tesar have become codirectors of the NBER's International Finance and Macroeconomics Program.

Aguiar is the Walker Professor of Economics and International Finance at Princeton University. His research spans both open- and closed-economy macroeconomics, including sovereign debt, business cycles in emerging markets, capital taxation, growth, and the microfoundations of consumption

and labor supply.

Tesar is a professor of economics at the University of Michigan. Her research has examined cross-country business cycle linkages, capital flows, especially to emerging markets, the consequences of exchange rate exposure, and global risk-sharing.

The new codirectors succeed Pierre-Olivier Gourinchas of the University of California, Berkeley, who has gone on leave to serve at the International Monetary Fund.

## Gourinchas Becomes Chief Economist of the International Monetary Fund

Pierre-Olivier Gourinchas, professor of economics and the S.K. and Angela Chan Professor of Global Management at the University of California, Berkeley's Haas School of Business, and former director of the NBER International Finance and Macroeconomics (IFM) Program, has been named Economic Counsellor and Director of the Research Department at the International Monetary Fund (IMF). He

assumed the position full time on April 1. Other NBER affiliates who have previously served in this position include Olivier Blanchard, Jacob Frenkel, Simon Johnson, Michael Mussa, Raghu Rajan, Kenneth Rogoff, Maurice Obstfeld, and Gita Gopinath, who served with Gourinchas as codirector of the NBER IFM program before joining the IMF in 2019.



*Pierre-Olivier Gourinchas*

## Susan Collins Named President of Federal Reserve Bank of Boston



*Susan Collins*

Susan Collins, who served as a member of the NBER Board of Directors from September 2019 until March 2022, has been named the next president of the Federal Reserve Bank of Boston, effective in July. She is currently provost and executive vice president for academic affairs at the University of Michigan.

Collins is an expert on international macroeconomics who taught at Harvard University and Georgetown University before moving to Michigan, where she is the Edward M. Gramlich

Collegiate Professor of Public Policy and a professor of economics. She served for a decade as the dean of the Gerald R. Ford School of Public Policy. She received her undergraduate degree from Harvard and her PhD from MIT, both in economics.

Collins was an NBER research associate affiliated with the International Finance and Macroeconomics Program until her election to the NBER board in 2019. She stepped down from the NBER board in March.



## Mentoring Program for Faculty at Minority-Serving Institutions

The NBER, in partnership with Spelman College, has launched a mentoring program to support faculty at colleges and universities which serve a high percentage of students from minority groups and who are interested in applying for research grants from the National Science Foundation (NSF). This program is supported by an NSF grant for study of the impact of mentoring. Danielle Dickens of Spelman College, Angelino Viceisza of Spelman College and the NBER, and NBER President James Poterba of MIT are the principal

investigators on this grant. [Further information on the advisory board and grant activities](https://www.nber.org/programs-projects/projects-and-centers/boosting-grant-applications-faculty-msis) may be found at [www.nber.org/programs-projects/projects-and-centers/boosting-grant-applications-faculty-msis](https://www.nber.org/programs-projects/projects-and-centers/boosting-grant-applications-faculty-msis)

The mentoring program provides course release time for five faculty members at minority-serving institutions in the 2022–23 academic year, and for ten in the 2023–24 year. Mentees, who were selected at random from the pool of eligible applicants, will be matched with mentors who have substantial expertise in both their research field and in grant

writing. They will work together for at least one semester to draft and submit an NSF research proposal. The project is designed not only to provide mentoring, but also to assess how such mentoring affects grant and research activity.

The project held [an inaugural virtual workshop](https://conference.nber.org/altsched/BGAs22) (<https://conference.nber.org/altsched/BGAs22>) on February 25 to describe the opportunities for research funding from the NSF. The workshop also included perspectives on the application process from current and past NSF program officers.

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## Conferences

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### Economic Impacts of Interjurisdictional Tax Competition

An NBER conference on the Economic Impacts of Interjurisdictional Tax Competition took place January 28 online. Research Associates James M. Poterba of the Massachusetts Institute of Technology and Owen M. Zidar of Princeton University, and David Agrawal of the University of Kentucky organized the meeting, which was supported by Arnold Ventures Grant 20-05306. These researchers' papers were presented and discussed:

- **Donghyuk Kim**, Iowa State University, “Economic Spillovers and Political Payoffs in Government Competition for Firms: Evidence from the Kansas City Border War”
- **Calvin N. Thrall** and **Nathan M. Jensen**, University of Texas at Austin, “Does Transparency Improve Public Policy? Causal Evidence from a Tax Incentive Transparency Initiative”
- **Johnny Tang**, Harvard University, “The Effects of a Global Minimum Tax on Corporate Balance Sheets and Real Activities: Evidence from the Insurance Industry”
- **Niels Johannesen**, University of Copenhagen, “The Global Minimum Tax”
- **James R. Hines**, University of Michigan and NBER, “Evaluating Tax Harmonization”
- **David Agrawal** and **William Hoyt**, University of Kentucky, and **Tidiane Ly**, Università della Svizzera italiana, “The Marginal Value of Public Funds in a Federation”
- **Michael Keen**, University of Tokyo; **Li Liu**, International Monetary Fund; and **Hayley M. Pallan**, Graduate Institute Geneva, “Tax Spillovers in Cross-Border Real Investment: Evidence from a New Dataset on Multinationals”
- **Lisa De Simone**, University of Texas at Austin; **Rebecca Lester**, Stanford University; and **Aneesh Raghunandan**, London School of Economics, “Tax Subsidy Information and Local Economic Effects”

Summaries of these papers are at [www.nber.org/conferences/economic-impacts-interjurisdictional-tax-competition-spring-2022](https://www.nber.org/conferences/economic-impacts-interjurisdictional-tax-competition-spring-2022)

### Immigrants and the US Economy

An NBER conference on Immigrants and the US Economy took place March 3–4 online. Research Associates Aimee Chin of the University of Houston and Kalena Cortes of Texas A&M University organized the meeting. These researchers' papers were presented and discussed:

- **Navid Sabet**, University of Frankfurt, and **Christoph Winter**, Ludwig-Maximilians-Universität München, “Legal Status, Local Spending and Political Empowerment: The Distributional Consequences of the 1986 IRCA”
- **Joan Llull**, Markets, Organizations and Votes in Economics, Universitat Autònoma de Barcelona, and Barcelona School of Economics, “Selective Immigration Policies and the US Labor Market”

- **Toman Barsbai**, University of Bristol; **Andreas Steinmayr**, University of Innsbruck; and **Christoph Winter**, “Immigrating into a Recession: Evidence from Family Migrants to the US”
- **Abhinav Gupta**, New York University, “Labor Mobility, Firm Monopsony, and Entrepreneurship: Evidence from Immigration Wait-Lines”
- **William J. Collins** and **Ariell Zimran**, Vanderbilt University and NBER, “Working Their Way Up? US Immigrants’ Changing Labor Market Assimilation in the Age of Mass Migration” (NBER Working Paper [26414](#))
- **Derek A. Christopher**, University of California, Irvine, “Homeownership in the Undocumented Population and the Consequences of Credit Constraints”
- **Milena Djourelova**, University of Chicago, “Media Persuasion through Slanted Language: Evidence from the Coverage of Immigration”
- **Hedvig Horvath**, University College London, and **Jamie L. McCasland**, University of California, Berkeley, “The Latinx Great Migration and Its Effects on School Segregation”

Summaries of these papers are at [www.nber.org/conferences/immigrants-and-us-economy-spring-2022](http://www.nber.org/conferences/immigrants-and-us-economy-spring-2022)

## Inequalities in Mortality in the US and Beyond

An NBER conference on Inequalities in Mortality in the US and Beyond took place March 4 online. Research Associate Janet Currie of Princeton University and Faculty Research Fellow Hannes Schwandt of Northwestern University organized the meeting, supported by National Institute on Aging Grant P30AG012810. These researchers’ papers were presented and discussed:

- **Darrell Gaskin**, Johns Hopkins University and NBER, “Rising Midlife Mortality: Economic Causes or Effects”
- **Janet Currie** and **Hannes Schwandt**, “Mortality Inequality in the United States and Europe”
- **Angus Deaton**, Princeton University and NBER, “Changing Mortality Patterns across the United States”
- **Fanny Janssen**, University of Groningen, “Country and Sex Differences in (Trends in) Life Expectancy in Europe: The Role of Lifestyle Factors”
- **Magali Barbieri**, University of California, Berkeley, “Using Cause-of-Death Data to Better Understand the US Increasing Disadvantage in Mortality”
- **Kjell G. Salvanes** and **Aline Bütikofer**, Norwegian School of Economics, “Reducing Health Inequalities — The Role of the Welfare State”

The agenda for this conference is at <https://www.nber.org/conferences/inequalities-mortality-us-and-beyond-spring-2022>

## 29th NBER-TCER-CEPR Conference

The 29th NBER-TCER-CEPR Conference took place March 11–12 online. Research Associate Joshua K. Hausman of the University of Michigan, and Shin-ichi Fukuda and Kenichi Ueda, both of the University of Tokyo, organized the meeting. These researchers' papers were presented and discussed:

- **Tommaso Bighelli**, Halle Institute for Economic Research; **Tibor Lalinsky**, National Bank of Slovakia; and **Juuso P. Vanhala**, Bank of Finland, "COVID-19 Pandemic, State Aid and Firm Productivity"
- **Tomohito Honda**, University of Tokyo; **Kaoru Hosono**, Gakushuin University; **Daisuke Miyakawa** and **Iichiro Uesugi**, Hitotsubashi University; and **Arito Ono**, Chuo University, "Determinants and Effects of COVID-19 Business Support Programs: Evidence from a Survey to SMEs in Japan"
- **Michael D. Bordo**, Rutgers University and NBER, and **John V. Duca**, Oberlin College, "How the New Fed Municipal Bond Facility Capped Municipal-Treasury Yield Spreads in the COVID-19 Recession"
- **Daisuke Fujii**, **Hiroyuki Kubota**, **Taisuke Nakata**, **Kohei Machi**, **Yuta Maeda**, and **Haruki Shibuya**, University of Tokyo, and **Masataka Mori**, Middlebury College, "Value of a COVID-19 Death"
- **Joseph Gagnon**, Peterson Institute for International Economics, and **Steven B. Kamin** and **John Kearns**, American Enterprise Institute, "The Impact of the COVID-19 Pandemic on Global GDP Growth"
- **Enrique Alberola**, Bank for International Settlements; **Gong Cheng**, European Stability Mechanism; **Andrea Consiglio**, University of Palermo; and **Stavros Zenios**, University of Cyprus, "Debt Sustainability and Monetary Policy: The Case of ECB Asset Purchases"
- **Kayoko Ishii**, **Isamu Yamamoto**, and **Mao Nakayama**, Keio University, "Potential Benefits and Determinants of Remote Work during the COVID-19 Pandemic: Evidence from Japanese Household Panel Data"

The list of presentations is at [nber.org/conferences/29th-nber-tcer-cepr-trio-conference-2022](https://nber.org/conferences/29th-nber-tcer-cepr-trio-conference-2022)

## CRIW Conference on Technology, Productivity, and Economic Growth

An NBER-CRIW conference on Technology, Productivity, and Economic Growth took place March 17–18 in Washington, DC and online. Research Associates Susanto Basu of Boston College and John C. Haltiwanger of the University of Maryland, along with Lucy P. Eldridge of the Bureau of Labor Statistics and Erich H. Strassner of the Bureau of Economic Analysis, organized the meeting, which was supported by the Bureau of Labor Statistics and the Bureau of Economic Analysis. These researchers' papers were presented and discussed:

- **José B. Santiago Calderón** and **Dylan G. Rassier**, Bureau of Economic Analysis, "Valuing the US Data Economy Using Machine Learning and Online Job Postings"
- **Carol Corrado**, The Conference Board; **Jonathan Haskel**, Imperial College London; **Massi Iommi**, Italian Statistical Institute; and **Cecilia Jona-Lasinio**, University LUISS Guido Carli, "Data, Digitization, and Productivity"
- **Daron Acemoglu**, Massachusetts Institute of Technology and NBER; **Gary W. Anderson**, National Science Foundation; **David N. Beede**, **Cathy Buffington**, **Emin Dinlersoz**, **Lucia S. Foster**, **Nathan Goldschlag**, **Nikolas Zolas**, and **Zachary Kroff**, US Census Bureau; **John C. Haltiwanger**; **Eric E. Childress**, George Mason University; and **Pascual Restrepo**, Boston University and NBER, "Automation and the Workforce: A Firm-Level View from the 2019 Annual Business Survey"



- **Kyle Jones**, UK Office for National Statistics, and **Josh Martin**, Bank of England, “An Occupation and Asset Driven Approach to Capital Utilization Adjustment in Productivity Statistics”
- **Tania Babina**, Columbia University; **Anastassia Fedyk**, University of California, Berkeley; **Alex X. He**, University of Maryland; and **James Hodson**, Jozef Stefan International Postgraduate School, “Firm Investments in Artificial Intelligence Technologies and Changes in Workforce Composition”
- **Ajay K. Agrawal**, **Joshua S. Gans**, and **Avi Goldfarb**, University of Toronto and NBER, “Similarities and Differences in the Adoption of General Purpose Technologies”
- **G. Jacob Blackwood**, Amherst College; **Cindy Cunningham**, **Matthew Dey**, **Sabrina Pabilonia**, and **Jay Stewart**, Bureau of Labor Statistics; **Lucia Foster**, **Cheryl Grim**, **Rachel L. Nesbit**, and **Zoltan Wolf**, US Census Bureau; **John C. Haltiwanger**; and **Cody Tuttle**, University of Texas at Austin, “Opening the Black Box: Task and Skill Mix and Productivity Dispersion”
- **Austan Goolsbee** and **Chad Syverson**, University of Chicago and NBER, “The Strange and Awful Path of Productivity in the US Construction Sector”
- **Diane Coyle** and **Rehema Msulwa**, University of Cambridge, “Digital Concrete: Productivity in Infrastructure Construction”
- **David Byrne**, **Adrian Hamins-Puertolas**, and **Molly Harnish**, Federal Reserve Board, “Historical Geography of the Semiconductor Industry”
- **Jon Samuels**, Bureau of Economic Analysis, “TFP Accounting with Secondary Production”

Summaries of some of these papers are at

[www.nber.org/conferences/criw-conference-technology-productivity-and-economic-growth-spring-2022](http://www.nber.org/conferences/criw-conference-technology-productivity-and-economic-growth-spring-2022)

## Economics of Innovation in the Energy Sector

An NBER conference on the Economics of Innovation in the Energy Sector took place March 17–18 in Cambridge and online. Research Associates Meredith Fowlie of the University of California, Berkeley, Ashley Langer of the University of Arizona, and David Popp of Syracuse University, and David Hemous of the University of Zurich organized the meeting, which was supported by Alfred P. Sloan Foundation Grant G-2019-12323. These researchers’ papers were presented and discussed:

- **Sugandha Srivastav**, University of Oxford, “Bringing Breakthrough Technologies to Market: Evidence from Renewable Energy Projects”
- **Sarah C. Armitage**, Harvard University, “Technology Adoption and the Timing of Environmental Policy: Evidence from Efficient Lighting”
- **Eugenie M. Dugoua**, London School of Economics; **Todd Gerarden**, Cornell University; **Kyle R. Myers**, Harvard University; and **Jacquelyn Pless**, Massachusetts Institute of Technology, “Steering the Direction of Inventors and Innovation with Supply versus Demand Policies”
- **Michaël Rubens**, University of California, Los Angeles, “Monopsony Power and Factor-Biased Technology Adoption”

- **Ashley Langer** and **Derek Lemoine**, University of Arizona and NBER; **Ralf Martin**, London School of Economics; and **Dennis Verhoeven**, KU Leuven, “The Private Value of Clean Energy Innovation”
- **Sarah Johnston**, University of Wisconsin-Madison, and **Chenyu Yang**, University of Maryland, “An Empirical Analysis of the US Generator Interconnection Policy”
- **Myriam Grégoire-Zawilski**, Syracuse University, and **David Popp**, “Do Technology Standards Induce Innovation in Grid Modernization Technologies?”

Summaries of some of these papers are at [www.nber.org/conferences/economics-innovation-energy-sector-spring-2022](http://www.nber.org/conferences/economics-innovation-energy-sector-spring-2022)

## Economic Analysis of Regulation

An NBER conference on the Economic Analysis of Regulation took place March 17 online. Research Associates Steve Cicala of Tufts University and James M. Poterba of the Massachusetts Institute of Technology organized the meeting, which was supported by Smith Richardson Foundation Grant 2021-2606. These researchers’ papers were presented and discussed:

- **Bentley Coffey**, University of South Carolina, and **Patrick McLaughlin**, Mercatus Center at George Mason University, “Regulation and Economic Growth: Evidence from British Columbia’s Experiment in Regulatory Budgeting”
- **Filip Babalievsky**, University of Minnesota; **Kyle F. Herkenhoff**, University of Minnesota and NBER; **Lee E. Ohanian**, University of California, Los Angeles and NBER; and **Edward C. Prescott**, Arizona State University and NBER, “The Sky Is Not the Limit: How Commercial Real Estate Regulations Affect US Output and Welfare”
- **Shoshana Vasserman**, Stanford University and NBER, and **Zi Yang Kang**, Stanford University, “Robust Bounds for Welfare Analysis” (NBER Working Paper [29656](#))
- **Matthias Breuer**, Columbia University; **Christian Leuz**, University of Chicago and NBER; and **Steven Vanhaverbeke**, Rotterdam School of Management, “Reporting Regulation and Corporate Innovation” (NBER Working Paper [26291](#))
- **Elena Prager**, Northwestern University and NBER, and **Nicholas Tilipman**, University of Illinois at Chicago, “Regulating Out-of-Network Hospital Payments: Disagreement Payoffs, Negotiated Prices, and Access”
- **Abe Dunn**, Bureau of Economic Analysis; **Joshua D. Gottlieb**, University of Chicago and NBER; **Adam Shapiro**, Federal Reserve Bank of San Francisco; **Daniel J. Sonnenstuhl**, University of Chicago; and **Pietro Tebaldi**, Columbia University and NBER, “A Denial a Day Keeps the Doctor Away” (NBER Working Paper [29010](#))

Summaries of these papers are at <https://www.nber.org/conferences/economic-analysis-regulation-spring-2022>

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## Program and Working Group Meetings

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### Industrial Organization

Members of the NBER's Industrial Organization Program met February 4–5 in Stanford, CA and on Zoom. Faculty Research Fellows Giulia Brancaccio and Christopher Conlon, both of New York University, and Research Associate Alan T. Sorensen of the University of Wisconsin-Madison organized the meeting. These researchers' papers were presented and discussed:

- **Benjamin Friedrich**, Northwestern University; **Martin B. Hackmann**, University of California, Los Angeles and NBER; **Adam Kapor**, Princeton University and NBER; **Sofia J. Moroni**, University of Pittsburgh; and **Anne B. Nandrup**, VIVE, “Interdependent Values in Matching Markets: Evidence from Medical School Programs in Denmark”
- **Kaiwen Leong**, Nanyang Technological University; **Huailu Li**, Fudan University; and **Nicola Pavanini** and **Christoph Walsh**, Tilburg University, “The Welfare Effects of Law Enforcement in the Illegal Money Lending Market”
- **Christoph Graf**, Stanford University; **Federico Quaglia**, Terna S.p.A.; and **Frank A. Wolak**, Stanford University and NBER, “Simplified Market Mechanisms for Non-convex Markets: Evidence from the Italian Electricity Market”
- **Luis Gonzales**, Pontificia Universidad Católica de Chile; **Koichiro Ito**, University of Chicago and NBER; and **Mar Reguant**, Northwestern University and NBER, “The Value of Infrastructure and Market Integration: Evidence from Renewable Expansion in Chile”
- **James M. Brand**, Microsoft, “Differences in Differentiation: Rising Variety and Markups in Retail Food Stores”
- **Sophie Calder-Wang**, University of Pennsylvania, “The Distributional Impact of the Sharing Economy on the Housing Market”
- **Paul Grieco**, Pennsylvania State University; **Charles Murry**, Boston College; and **Ali Yurukoglu**, Stanford University and NBER, “The Evolution of Market Power in the US Auto Industry” (NBER Working Paper [29013](#))
- **Rodrigo Carril**, Universitat Pompeu Fabra; **Andres Gonzalez-Lira**, Yale University; and **Michael Walker**, United States Military Academy, “Competition under Incomplete Contracts and the Design of Procurement Policies”
- **Juan Pablo Atal**, University of Pennsylvania; **José Ignacio Cuesta**, Stanford University; and **Morten Sæthre**, Norwegian School of Economics, “Quality Regulation and Competition: Evidence from Pharmaceutical Markets”
- **Bruno Pellegrino**, University of Maryland, “Product Differentiation and Oligopoly: A Network Approach”
- **Michael J. Dickstein**, New York University and NBER; **Kate Ho**, Princeton University and NBER; and **Nathaniel D. Mark**, US Department of Justice, “Market Segmentation and Competition in Health Insurance” (NBER Working Paper [29406](#))

Summaries of these papers are at [nber.org/conferences/industrial-organization-program-meeting-spring-2022](https://nber.org/conferences/industrial-organization-program-meeting-spring-2022)

## Economic Fluctuations and Growth

Members of the NBER's Economic Fluctuations and Growth Program met February 25 in Cambridge and online. Research Associate Şebnem Kalemli-Özcan of the University of Maryland and Faculty Research Fellow Ezra Oberfield of Princeton University organized the meeting. These researchers' papers were presented and discussed:

- **Ian Dew-Becker** and **Alireza Tahbaz-Salehi**, Northwestern University, and **Andrea Vedolin**, Boston University and NBER, "Skewness and Time-Varying Second Moments in a Nonlinear Production Network: Theory and Evidence" (NBER Working Paper [29499](#))
- **Joonkyu Choi**, Federal Reserve Board; **Veronika Penciakova**, Federal Reserve Bank of Atlanta; and **Felipe Saffie**, University of Virginia, "Political Connections, Allocation of Stimulus Spending, and the Jobs Multiplier"
- **George-Marios Angeletos**, Massachusetts Institute of Technology and NBER, and **Chen Lian**, University of California, Berkeley and NBER, "Determinacy without the Taylor Principle" (NBER Working Paper [28881](#))
- **Pablo Ottonello**, University of Michigan and NBER; **Diego J. Perez**, New York University and NBER; and **Paolo Varraso**, New York University, "Are Collateral-Constraint Models Ready for Macroprudential Policy Design?" (NBER Working Paper [29204](#))
- **Andrew Atkeson**, University of California, Los Angeles and NBER, and **Jonathan Heathcote** and **Fabrizio Perri**, Federal Reserve Bank of Minneapolis, "The End of Privilege: A Reexamination of the Net Foreign Asset Position of the United States" (NBER Working Paper [29771](#))
- **Leonid Kogan**, Massachusetts Institute of Technology and NBER; **Dimitris Papanikolaou**, Northwestern University and NBER; and **Lawrence Schmidt** and **Bryan Seegmiller**, Massachusetts Institute of Technology, "Technology-Skill Complementarity and Labor Displacement: Evidence from Linking Two Centuries of Patents with Occupations" (NBER Working Paper [29552](#))

Summaries of these papers are at [www.nber.org/conferences/efg-research-meeting-winter-2022](http://www.nber.org/conferences/efg-research-meeting-winter-2022)

## Monetary Economics

Members of the NBER's Monetary Economics Program met March 11 in Cambridge and online. Faculty Research Fellow Ludwig Straub of Harvard University and Research Associate Jing Cynthia Wu of the University of Notre Dame organized the meeting. These researchers' papers were presented and discussed:

- **Frédéric Boissay**, Bank for International Settlements; **Fabrice Collard**, Toulouse School of Economics; **Jordi Galí**, CREI and NBER; and **Cristina Manea**, Deutsche Bundesbank, "Monetary Policy and Endogenous Financial Crises" (NBER Working Paper [29602](#))
- **Xavier Gabaix**, Harvard University and NBER, and **Ralph S. J. Koijen**, University of Chicago and NBER, "In Search of the Origins of Financial Fluctuations: The Inelastic Markets Hypothesis" (NBER Working Paper [28967](#))
- **Yuriy Gorodnichenko**, University of California, Berkeley and NBER, and **Dmitriy Sergeyev**, Bocconi University, "Zero Lower Bound on Inflation Expectations" (NBER Working Paper [29496](#))



- **Francesco Bianchi**, Duke University and NBER; **Cosmin L. Ilut**, Duke University and NBER; and **Hikaru Saijo**, University of California, Santa Cruz, “Diagnostic Business Cycles” (NBER Working Paper [28604](#))
- **Leland Farmer**, University of Virginia, and **Emi Nakamura** and **Jón Steinsson**, University of California, Berkeley and NBER, “Learning about the Long Run” (NBER Working Paper [29495](#))
- **Yoon J. Jo** and **Sarah Zubairy**, Texas A&M University, “State Dependent Government Spending Multipliers: Downward Nominal Wage Rigidity and Sources of Business Cycle Fluctuations”

Summaries of these papers are at [www.nber.org/conferences/monetary-economics-program-meeting-spring-2022](http://www.nber.org/conferences/monetary-economics-program-meeting-spring-2022)

## International Finance and Macroeconomics

Members of the NBER’s International Finance and Macroeconomics Program met March 11 in Cambridge and online. Research Associates Yan Bai of the University of Rochester and Oleg Itskhoki of the University of California, Los Angeles organized the meeting. These researchers’ papers were presented and discussed:

- **Ester Faia**, Goethe University Frankfurt; **Juliana Salomao**, University of Minnesota and NBER; and **Alexia Ventula Veghazy**, European Central Bank, “Granular Investors and International Bond Prices: Scarcity Induced Safety”
- **Mitali Das** and **Gita Gopinath**, International Monetary Fund, and **Şebnem Kalemli-Özcan**, University of Maryland and NBER, “Preemptive Policies and Risk-Off Shocks in Emerging Markets” (NBER Working Paper [29615](#))
- **Juan M. Morelli**, Federal Reserve Board, and **Matias Moretti**, Princeton University, “Information Frictions, Reputation, and Sovereign Spreads”
- **Zhengyang Jiang**, Northwestern University; **Arvind Krishnamurthy** and **Hanno Lustig**, Stanford University and NBER; and **Jialu Sun**, Stanford University, “Beyond Incomplete Spanning: Convenience Yields and Exchange Rate Disconnect”
- **Michael B. Devereux**, University of British Columbia and NBER, and **Steve Pak Yeung Wu**, University of California, San Diego, “Foreign Reserves Management and Original Sin”
- **Vito Cormun**, Santa Clara University; **Pierre De Leo**, University of Maryland; and **Ryan Chahrour**, **Pablo A. Guerrón-Quintana**, and **Rosen Valchev**, Boston College, “Exchange Rate Disconnect Redux”
- **Laura Alfaro**, Harvard University and NBER; **Mauricio Calani**, Central Bank of Chile; and **Liliana Varela**, London School of Economics, “Currency Hedging: Managing Cash Flow Exposure” (NBER Working Paper [28910](#))

## Labor Studies

Members of the NBER's Labor Studies Program met March 11 in Chicago and online. Program Directors David Autor of the Massachusetts Institute of Technology and Alexandre Mas of Princeton University organized the meeting. These researchers' papers were presented and discussed:

- **Juan Carlos Suárez Serrato**, Duke University and NBER; **Kevin A. Roberts**, Duke University; **E. Mark Curtis**, Wake Forest University; **Daniel G. Garrett**, University of Pennsylvania; and **Eric C. Ohn**, Grinnell College, "Capital Investment and Labor Demand" (NBER Working Paper [29485](#))
- **Lancelot Henry de Frahan** and **Tom G. Meling**, University of Chicago, and **Thibaut Lamadon** and **Magne Mogstad**, University of Chicago and NBER, "Why Do Larger Firms Have Lower Labor Shares?"
- **Aislinn Bohren**, University of Pennsylvania; **Peter Hull**, Brown University and NBER; and **Alex Imas**, University of Chicago and NBER, "Systemic Discrimination: Theory and Measurement" (NBER Working Paper [29820](#))
- **Peter Q. Blair**, Harvard University and NBER, and **Mischa Fisher**, Northwestern University, "Does Occupational Licensing Reduce the Effectiveness of Customer Search on Digital Platforms?"
- **Rebecca Diamond**, Stanford University and NBER, and **Enrico Moretti**, University of California, Berkeley and NBER, "Where Is the Standard of Living the Highest? Local Prices and the Geography of Consumption" (NBER Working Paper [29533](#))
- **Christina L. Brown**, University of Chicago, and **Tahir Andrabi**, Pomona College, "Subjective versus Objective Incentives and Employee Productivity"

Summaries of some of these papers are at [www.nber.org/conferences/labor-studies-program-meeting-spring-2022](http://www.nber.org/conferences/labor-studies-program-meeting-spring-2022)

# The Role of Innovation and Entrepreneurship in Economic Growth

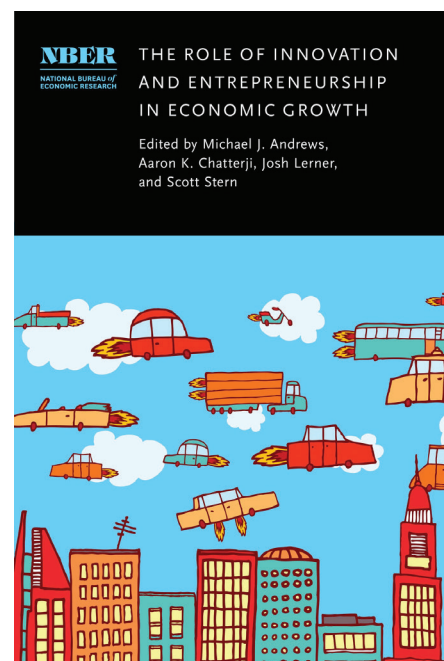
Michael Andrews, Aaron Chatterji, Josh Lerner, and Scott Stern, editors

<https://press.uchicago.edu/ucp/books/book/chicago/R/bo151022289.html>

We live in an era in which innovation and entrepreneurship seem ubiquitous, particularly in regions like Silicon Valley, Boston, and Research Triangle Park. But many metrics of economic growth, such as productivity growth and business dynamism, have been at best modest in recent years. The resolution of this apparent paradox can be found in dramatic heterogeneity across sectors, with some industries experiencing robust innovation and entrepreneurship and others stagnation.

By construction, the impact of innovation and entrepreneurship on overall economic performance is the cumulative impact of their effects on individual

sectors. Understanding the potential for growth in the aggregate economy depends, therefore, on understanding the sector-by-sector potential for growth. This insight motivates the 12 studies of different sectors that are presented in this volume. Each study identifies specific productivity improvements enabled by innovation and entrepreneurship, for example as a result of new production technologies, increased competition, or new organizational forms. The studies, along with three synthetic chapters, provide new insights on the sectoral patterns and concentration of contributions of innovation and entrepreneurship to economic growth.



# Environmental and Energy Policy and the Economy, volume 3

Matthew J. Kotchen, Tatyana Deryugina, and James H. Stock, editors

<https://www.journals.uchicago.edu/toc/eepe/2022/3>

This volume presents six new papers on environmental and energy economics and policy in the United States.

Rebecca Davis, Scott Holladay, and Charles Sims analyze recent trends in and forecasts of coal-fired power plant retirements with and without new climate policy. Severin Borenstein and James Bushnell examine the efficiency of pricing for electricity, natural gas, and gasoline. James Archsmith, Erich Muehlegger, and David Rapson provide a prospective analysis of future

pathways for electric vehicle adoption. Kenneth Gillingham considers the consequences of such pathways for the design of fuel vehicle economy standards. Frank Wolak investigates the long-term resource adequacy in wholesale electricity markets with significant intermittent renewables.

Finally, Barbara Annicchiarico, Stefano Carattini, Carolyn Fischer, and Garth Heutel review the state of research on interactions between business cycles and environmental policy.



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