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Economic possibilities for our children

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2013 Number 4



Lawrence H. Summers

The 2013 Martin Feldstein Lecture

Economic Possibilities for Our Children

Lawrence H. Summers*

This is the 40th anniversary of the summer when I first met Marty Feldstein and went to work for him. I learned from working under Marty's auspices that empirical economics was a profoundly important thing, that it had the opportunity to illuminate the world in important ways, that it had the opportunity to change people's perspectives as they thought about economic problems, and that the successful solution or resolution of economic problems didn't happen with the immediacy with which a doctor treated a patient, but did touch and affect the lives of hundreds of thousands, if not millions, of people.

I learned about how to approach economic research from watching Marty. There is a central element that has been a part of his approach to economics, and it has always been a part of mine, both as an economist and a policymaker. It is the approach of many in our profession, but not all. This is the belief that we cannot aspire to know the world with complete precision; that no single parameter will measure with precision how our economy is going to respond to a policy or a shock. Rather, what we can aspire to establish is a combination of logic, modeling, suggestive anecdote and experience, and empirical measurements from multiple different perspectives that lead to an overall view on economic phenomena. That kind of overall view on economic phenomena moves the world forward much more than a precise estimate of a single parameter.

It is very much in that spirit that I want to reflect with you this afternoon on economic possibilities for our children. Keynes wrote a famous essay entitled "Economic Possibilities for Our Grandchildren." I am not Keynes, so I cannot look nearly as far forward as he did. But I am seeking

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to speak in the same spirit. At a moment of substantial cyclical distress, at a moment of financial preoccupation, I would like to look to the broader technological forces that are operating and that will shape the structure of our economy and how people live over the long term.

I think of my horizon as being more like a generation than the century that Keynes spoke of. At one level, by the way, Keynes did pretty well. He predicted that incomes in the industrialized world would rise eightfold between 1930 and 2030 and they've risen a little more than sixfold so far, so he's looking pretty good on that prediction. But Keynes also got some things wrong. He predicted that as incomes rose eightfold, the workweek would fall to 15 or 20 hours. The reason he got that wrong is something that I hadn't previously reflected on.

When I took introductory economics, a big feature of the textbook was the backward bending labor supply curve, where it was explained that past a certain point, the income effect took over from the substitution effect and so the labor supply curve bent backwards. This does not get much attention in textbooks today. The reason is that people with higher wages now work more hours than people with lower wages. The time series tracks the cross section. Over time, as we have all gotten richer, the number of hours worked for many people has risen.

Keynes missed many other things. He missed that there was a developing world and an industrialized world, for example. And he missed entirely issues relating to the distribution of income, either within countries or across countries. This too contributes to my desire to speak about one generation rather than more.

I believe in a much more anecdotal way than Dale Jorgenson, who has quantified it to an extraordinary degree, that the defining feature of economic growth in this era is the set of changes that are associated with information technology. The single example I find most striking is the self-driving automobile. Automobiles have now been driven from California to New York, stopping at red lights, accelerating, going through green lights, accelerating through yellow lights without being touched by a human hand. And if one thinks about almost any aspect of economic activity, it either has been, is being, or quite possibly will be revolutionized by the application of information technology. In my friend Marc Andreessen's phrase, software is eating the economy.

I am told that there exist software programs that can grade at least some kinds of student papers with more reliability relative to human beings than human beings can grade essays relative to other human beings. Larry Katz has famously remarked that computers do not do empathy, but there have existed for many years computer programs that actually do a credible job of providing psychotherapy. In response to confessionals, they prompt with responses like: “Tell me a little bit more about what’s distressing you. That must have been very hard for you. Can you explain a little more fully?” On at least some occasions these programs have been an important source of solace.

In Heathrow Airport, you now check out of the newsstands without passing a human being. Increasing amounts of surgery are done remotely. Think of an industry that a group like this has a particular attachment to — the publishing industry. It is perhaps prototypical of where things are going.

First there were bookstores, then there were superstores, then there was Amazon, and now there are the Kindle and e-books. And at every stage it was better to be a reader, better to be an author, and worse to be an ordinary person involved in the intermediation between the authors and the readers.

This set of developments is going to be the defining economic feature of our era, and we are seeing its consequences in many aspects. When I was an MIT undergraduate in the early 1970s, a young economics student was exposed to the debate about automation. There were two factions in those debates. There were the stupid Luddite people, who mostly were outside of economics departments, and there were the smart progressive people, who at that time were personified by Bob Solow. The stupid people thought that automation was going to make all the jobs go away and there wasn’t going to be any work to do. And the smart people understood that when more was produced, there would be more income and therefore there would be more demand. It wasn’t possible that all the jobs would go away, so automation was a blessing. I was

taught that the smart people were right.

Until a few years ago, I didn’t think this was a very complicated subject; the Luddites were wrong and the believers in technology and technological progress were right. I’m not so completely certain now. I have done the simplest of statistical exercises, plotting the non-employment rate for men 25 to 54 and then adjusting for trend and cycle and extrapolating. Not, I hasten to say, because they’re the most important group in our society (and they are, by the way, a group of which I am no longer a part), but only because they are a group where there is the strongest prevailing social expectation that they will be working.

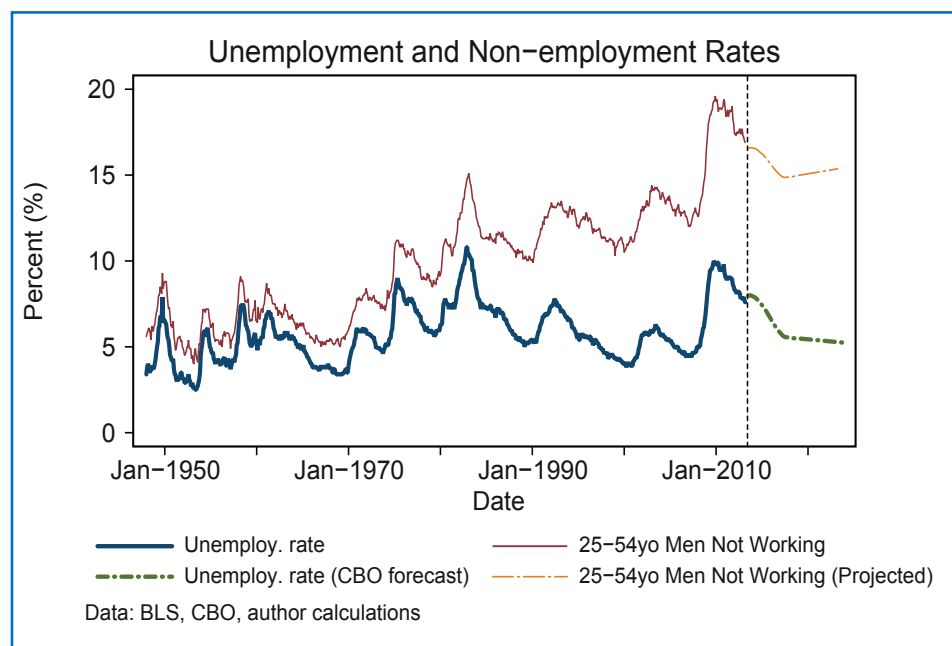
What you see is that in a secular sense, going back a long time, the fraction of them who are not working once one takes the cycle out has been increasing. I summarize this by saying that in the 1950s and 60s, one in 20 men between the age of 25 and 54 was not working. If you do a simple extrapolation based on trend and cycle to the period a decade from now, between one in six and one in seven men between the age of 25 and 54 will not be working.

And as you would expect, these patterns are substantially more pronounced if you are less educated. They are substantially more pronounced if you are

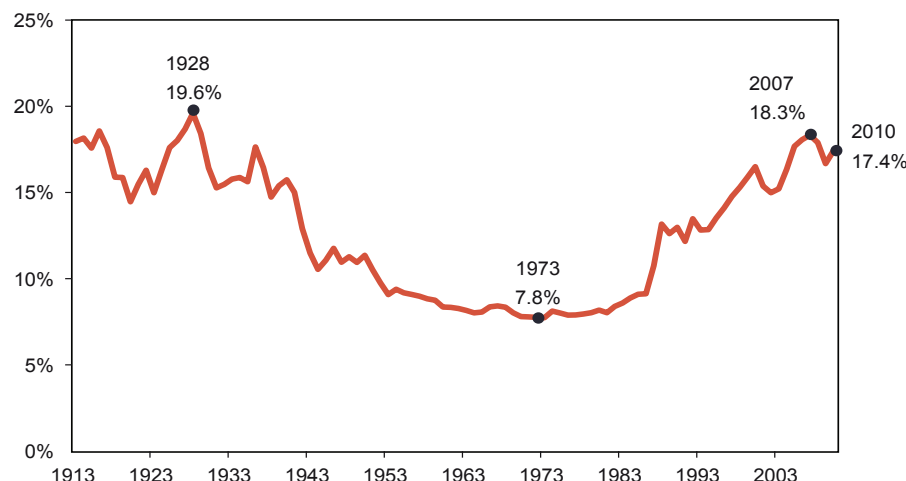
in a disadvantaged group than if you are in an advantaged group. This is associated with what is also a defining feature of our time. In the United States today a higher fraction of the workforce receives disability insurance than does *production work* in manufacturing. (Many workers in the manufacturing sector are not production workers.)

These phenomena are related. No one could give a Feldstein lecture without recognizing the possibility that a social insurance program had a distorting disincentive effect and that is certainly the case with respect to disability insurance. But I think it is also fair to say that the evolution and growth of disability insurance is substantially driven also by the technological and social changes that are leading to a smaller fraction of the workforce working.

At the same time, as has famously and repeatedly been noted, the share of income going to the top one percent of our population has steadily increased. One can debate how to treat capital gains. One can debate whether to talk about individuals or about family units. There are a hundred aspects of the numbers that one can debate, but I think it will be difficult to escape the conclusion that the very top group in our society is receiving about ten percent more of the total income than



Top 1% Share of Total Pre-Tax Income, 1913-2010



Source: Thomas Piketty and Emmanuel Saez, "Income Inequality in the United States, 1913-98", *Quarterly Journal of Economics*, 118(1), 2003. Updated to 2010 at <http://emlab.berkeley.edu/users/saez>.

they were a generation ago, that that is the equivalent of \$10,000 per household unit for everyone else, and that it represents a substantial portion of median family income.

At the same time the profit share in total income has been rising. This is a subject dear to my heart because it dates back to the first paper that I was privileged to publish, a paper with Marty in 1977. Marty and I wrote a paper entitled, "Is the Rate of Profit Falling?" And we managed to look at the data and conclude that the rate of profit was not falling. That is a reflection of the fact that we were looking at the rate of return, not the profit share, and had a variety of refinements that are not there.

It is also a reflection, no doubt, of Marty's prescience. He knew that the rate of profit would not be falling. So, I am glad to have answered the question, "Is the rate of profit falling?" in the negative in 1977. And there's a question as to whether our paper is due for a sequel, perhaps entitled, "Is the Rate of Profit Rising?" because it does seem to be rising in recent years.

What is a way of thinking about all of this? I've come to a very simple "metaphor" (I hesitate to dignify this thought with the word "model"). We are used to thinking of production functions. Output

is a function of capital and labor. Capital augments labor: it raises the productivity of labor. If there are only two factors, they have to be complements. If there's more capital, the wage has to rise. Now imagine that capital can be put to one of two uses. It can be put to the use in the production function that we are accustomed to thinking about or it can be used to substitute for labor. That is, you can take some of the stock of machines and, by designing them appropriately, you can have them do

exactly what labor did before. I am suggesting replacing the production function $Y = F(K, L)$

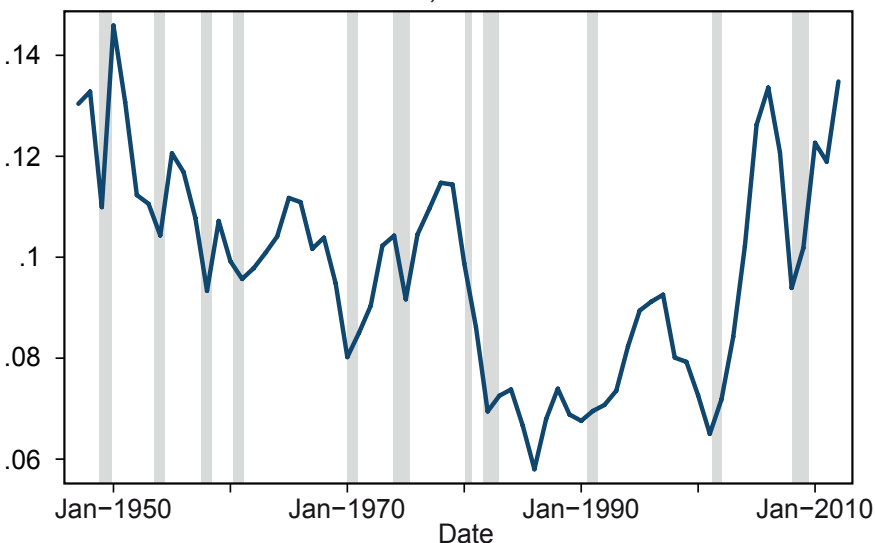
with

$$Y = F(\beta K, L + \lambda(1-\beta)K).$$

In this setting one unit of capital is the equivalent of λ units of labor. A moment's thought will reveal that capital will be deployed in these two uses to the point where their marginal productivity is the same, and that will determine what share of the capital stock is used in the customary way and what share is used to substitute for labor.

If you reflect on this a bit longer, you'll realize that three things happen. One, the availability of capital that substitutes for labor augments production opportunities. You can always choose not to use it. So, the level of output has to rise. Second, when capital is reallocated to substituting for labor, the stock of effective labor rises and the stock of conventional capital falls, and so wage rates fall. Third, the capital share, understood to include the total return to capital of both varieties, rises. That's just a corollary of output rising and wages falling. This pattern is similar to what we have seen take place. I suspect that this reflects the nature of the technical changes that we have seen: increasingly they take the form of capital that effectively substitutes for labor.

Pretax Profits, as share of GDP



Data: Federal Reserve (FRED)

Now one could augment this story in various ways. If one augmented the production function to include entrepreneurs, for example, it would not be difficult to address the rising share of income going to the top one percent of the population. My conjecture is that for the next generation we are likely to see this process continue, both because of the very substantial scope for current levels of computing power to support capital-labor substitution on a larger scale, and because of the scope for increased computational power to make possible capital-labor substitution of a kind that we have not seen to date.

The likely consequence? Increased levels of output but at the same time growing pressure on wages. Given the observation I noted earlier, this will greatly pressure the income distribution. Not only will divergent wages increase inequality but the supply response will magnify these effects. It may well be that, given the possibilities for substitution, some categories of labor will not be able to earn a subsistence income.

I think this description captures a very important aspect of what may play out over the next generation. But there is a second aspect that I think is also profoundly important—the reality that a sector’s great success in spurring productivity can make it less and less important economically. This is something that was first pointed up for me by Bill Nordhaus, who demonstrated that not quite at the pace of Moore’s Law, but at something close, the illumination sector of our economy has enjoyed great productivity growth. There’s only one problem. Most of us actually want it to be dark at night and there would be no particular advantage to this room being substantially more brightly lit. And so, vast productivity growth in illumination has been associated with the substantial shrinkage of the illumination sector, at least as measured by the share of employment in it. Candle making was an important occupation and an important industry in the 1800s. The production of light is no longer a defining aspect of economic activity today.

I believe phenomena of this type are

going to be very important for understanding the evolution of our economies going forward. The obvious example, of course, is agriculture where today less than one percent of the population produces enough food for all of us and much more. Headed in this direction also, potentially, is manufacturing. The most recent data I’ve been able to find, which are about five years old, suggest that in China a smaller fraction of the workforce is engaged in manufacturing employment today than was in 1990, despite the tremendous progress and gains in competitiveness that the Chinese manufacturing sector has enjoyed. It is the same story as above: rapid productivity growth associated with inelastic demand leads to fewer and fewer people being engaged in the activity.

The extent to which differential productivity growth characterizes our economy is, I think, sometimes underappreciated. The Bureau of Labor Statistics normalizes the consumer price indices at 100 in the period 1982 to 1984. Below are some recent values of the Consumer Price Index (CPI) for 2012.

Television sets at five stand out. That is obviously a reflection of a rather energetic hedonic effort by the Bureau of Labor Statistics. One suspects that equally energetic hedonic efforts are not applied to every consumer price. But nonetheless, the simple fact is that the relative price of toys and a college education has changed by a factor of ten in a generation. The relative price of durable goods or clothing as a category and all goods has changed by a factor of almost two in a generation.

This table provides a somewhat different perspective on the common and valid observation that real wages have stagnated

in the United States. The observation that real wages are stagnant reflects wages measured in terms of the overall consumer price index. But this obscures the truth that real wages measured in terms of different goods have behaved very differently.

In those parts of the economy that are well modeled by the introductory economics textbook treatment of widgets—firms producing a thing with workers with increasing marginal costs in a somewhat competitive industry, such as durables, clothes, and cars—we’ve seen continuing, very substantial growth in real wages as measured by the purchasing power of things that our economy produces. The reason that real wages in aggregate have stagnated is that much of what people buy are things where there are issues of fundamental scarcity: energy, the land under the houses we buy, and goods and services that are produced in complicated, heavily public-sector-inflected ways. Medical care and educational services are examples of the latter category.

Where production has taken place in the classic way we teach, productivity growth has continued. There has been progress. Real wages measured in those terms have increased substantially. It’s just that a larger and larger share of our econ-

Good or Service	September 2012 CPI Value (1982–4 = 100)
College Tuition and Fees	706
Medical Care Services	445
Medical Care	419
Services	272
Energy	258
Food	234
All Items	231
Housing	223
Transportation	224
Apparel	127
Durables	112
Toys	53
Televisions	5

Source: Bureau of Labor Statistics

omy is in sectors that are not well thought of as widgets produced by competitive firms. They are sectors where property rights, scarcities, intellectual property, and the like are of fundamental importance.

This is a way of thinking about a question that has always, and to some extent continues, to puzzle me — what I think of as the paradox of alternative dystopias. On the one hand there is the Peter Thiel-Robert Gordon dystopia that holds that we used to make rapid productivity growth progress and we no longer do. And look — real wages and median family income have been relatively stagnant for a long time. On the other hand there is the Erik Brynjolfsson-Mark Andreessen-Kurt Vonnegut dystopia that holds that machines are going to displace labor and so there are going to be very few jobs left for regular people. It seems like they can't both be true, that it can't both be that machines have the capacity to displace all the labor and that there is no capacity to enjoy rapid productivity growth.

Perhaps the resolution lies in the fact that a great deal of productivity growth can take place but it is in a sense self-limiting by demand. A larger share of the economy will inevitably migrate to those remaining residual sectors where the capacity to generate rapid productivity growth is low.

Let me close with a final observation — a projection. To the right is the BLS's projection of where job growth is going to come from over the next decade.

What stands out as by far the largest industry is healthcare and social assistance, clearly public-sector inflected. Other important growth sectors are state and local government, construction (in part something that takes place in the public sector), and educational services. I bet that when BLS next updates this, the projections on growth in retail trade, transportation and warehousing, and wholesale trade are going to have come considerably down given the trends that are underway.

As a society, we are going to need to come to grips over the next couple of decades with what has been called Moynihan's Corollary to Baumol's Law.

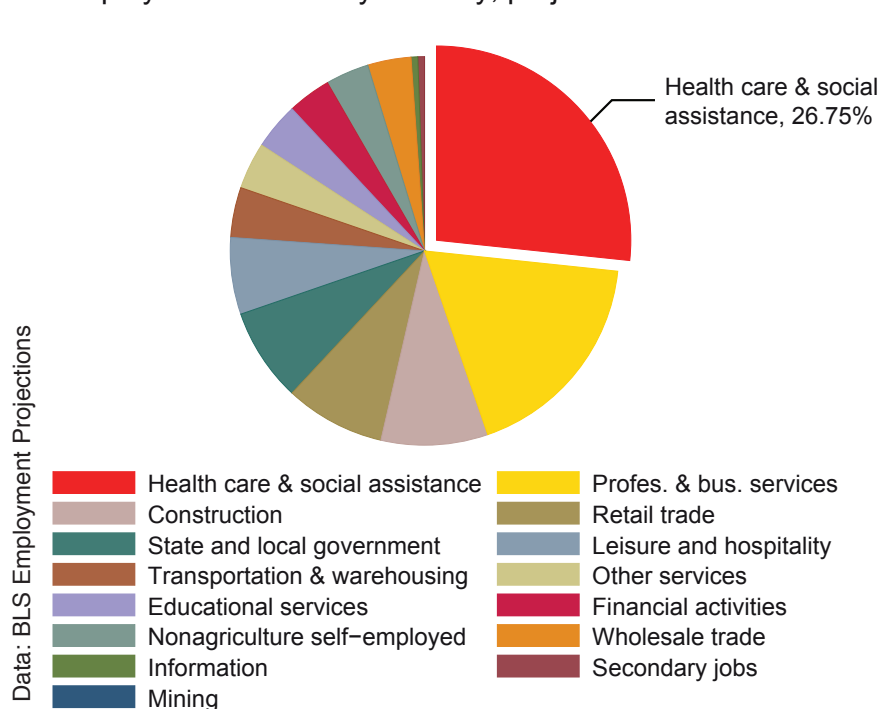
Baumol's Law is the set of observations surrounding productivity growth in some but not all sectors, which I have sought to discuss. Moynihan's Corollary is the propensity for the slow-growing sectors to end up in the public sector.

It is conventional to discuss the future of the public sector in terms of the past of the public sector, to suggest that the United States historically has some threshold of revenue generated or public spending that is in the range of 20 percent of GDP, and that those are norms that should carry us forward. One of the first things I learned from Marty, the observation that the distortion associated with taxes rises not with the tax rate but with the square of the tax rate, suggests a certain caution about the expansion of the public sector. Yet if one thinks about the 100-to-1 relative price change between television sets and goods of that kind that are dominantly produced in the private sector, and goods like healthcare and education, in which the public sector's role is substantially greater, one has to admit that it is not entirely apparent that the past should necessarily be a guide for the future with respect to the scale of the public sector.

Whether the expansion of those sectors as a share of the economy necessitates a growing share of the public sector in the economy, or whether the share of health-care and education that takes place in the public sector should decline will be a matter of great public debate. As a country, and not without controversy, we do not seem to be moving toward a smaller public role in healthcare. Nor do other countries in the world. But that will, perhaps, change over time.

In conclusion, I invite you to consider how the prodigious change associated with information technology that may be qualitatively different from past technological change may have defining implications for our economy going forward. If I have caused you to reflect on the fact that very substantial relative price changes are likely to be associated with dramatic changes in the structure of employment, the nature of economic activity, and the relative importance of the widget-producing firm in our economy, and to consider the implications this will have for the future of the subject with which I began my career in economics under Marty's tutelage, public economics, then I will have served my purpose this afternoon.

Employment Growth by Industry, projection 2010–2020



The Economics of Obesity

John Cawley*

During the past three decades in the United States, many indicators of population health such as life expectancy, the prevalence of smoking, and drug and alcohol use among youths improved significantly.¹ In stark contrast to these trends, over the same period the United States also experienced a doubling of the prevalence of obesity, which is defined as a body mass index (BMI) of greater than or equal to thirty, which corresponds to a weight of 221 pounds for someone six feet tall. As of 2009 to 2010, more than one-third of adult Americans are obese.² The United States is not alone; many countries worldwide have experienced a significant increase in obesity, and the World Health Organization estimates that 2.8 million people die each year as a result of excess weight.³

This has led to considerable debate about the causes and consequences of obesity and what can be done to prevent and treat it. Answering these questions is complicated because in many cases researchers cannot conduct randomized experiments: it would be unethical to experimentally manipulate individuals' weight. For this reason the empirical methods of economics, particularly the attention to issues of selection and omitted variables, are especially useful for identifying causal effects.

My primary research interest is the

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economics of risky health behaviors, in particular the economics of obesity. In a series of studies, my co-authors and I have investigated the economic causes and consequences of obesity and evaluated policies and programs to improve diets and increase physical activity. This research summary provides an overview of several recent projects and findings. A broader review of the economics of risky health behaviors that I co-authored with Christopher Ruhm is also available.⁴

Measurement and Trends

An important limitation of BMI, the standard measure of fatness in epidemiology, is that it does not distinguish fat from lean mass: it simply measures weight for height. A study that I conducted with Richard Burkhauser⁵ found that BMI, relative to more accurate measures of fatness such as percentage of body fat, misclassifies substantial percentages of individuals as obese and non-obese. BMI tends to be less accurate at classifying men (among whom there is more variation in muscularity) than women. The use of BMI also results in biased estimates of health disparities; the black-white gap in obesity among women is only half as large if one defines obesity using percentage of body fat rather than BMI. Moreover, the timing of the rise in obesity is sensitive to the measure of fatness used; Richard Burkhauser, Max Schmeiser and I find that if one uses skinfold thickness rather than BMI to define obesity then the rise in obesity becomes apparent 10 to 20 years earlier, which suggests that more gradual or long-run influences may be responsible.⁶ It also suggests that the rise in BMI

might have been detected earlier, and public health responses initiated sooner, if epidemiological surveillance had not relied so exclusively on BMI. Although many social science datasets continue to collect only self-reported weight and height, some innovative surveys such as the Health and Retirement Study (HRS) and the Household, Income and Labour Dynamics in Australia (HILDA) Survey are collecting additional measures of fatness such as waist circumference.

Economic Causes and Consequences of Obesity

Many theories have been advanced to explain the rise in obesity. To measure the extent to which income affects obesity, John Moran, Kosali Simon, and I exploit the natural experiment of the Social Security Benefits Notch.⁷ The Notch is the result of a legislative accident that created variation in retirement income that was large, unanticipated, and beyond the control of the individual, making it a suitable instrument. We estimate models of instrumental variables (IV) using data from the National Health Interview Survey and find little evidence that income affects weight. The small effects are precisely estimated: for a permanent \$1,000 increase in Social Security income (in 2006 dollars) our confidence intervals rule out a change in weight of more than 1.4 pounds in either direction for men or women.

Understanding the consequences of obesity is important for evaluating calls for government intervention and for measuring the cost-effectiveness of treatment and prevention programs. One important

potential consequence of obesity is higher medical care costs. Fat releases hormones that lead to insulin resistance and damage the cardiovascular system, with the result that obesity is associated with a wide variety of health conditions such as diabetes, heart disease, and cancer. Previous studies estimated the correlation of obesity with medical care costs, which is difficult to interpret because weight may be correlated with important unobserved factors (such as socioeconomic status) and there may be reverse causality (an expensive back injury may lead to weight gain). To estimate the causal effect of obesity on medical care costs, Chad Meyerhoefer and I exploit the heritable component of weight as a natural experiment.⁸ The identifying assumption is that the similarity in weight of biological relatives is caused by genetics rather than shared environment, an assumption that is supported by a large number of studies in genetics. We estimate the IV model using data from the Medical Expenditure Panel Survey, and the results indicate that obesity raises medical costs by \$2,741 per obese individual (in 2005 dollars). This is higher than the non-IV estimate because the IV method corrects for both the endogeneity of weight and reporting error in weight. Medical costs are much greater for those whose weight places them well above the threshold for obesity than for those who are only slightly obese. Thus obesity is a heterogeneous category, with much of the medical costs occurring among a small percentage of individuals with extremely high BMI. The results imply that obesity-attributable medical costs for non-institutionalized adults in the United States totaled \$190.2 billion in 2005, or 20.6 percent of national health expenditures. These estimates suggest that the magnitude of the obesity-related externalities imposed through public and private health insurance is greater than previously appreciated, and that historically the cost-effectiveness of methods of preventing and treating obesity may have been underestimated.

Given the effect of obesity on health, one would expect obese individuals to experience worse labor market outcomes

than non-obese individuals. To estimate the effect of weight on wages, I estimate models of instrumental variables that exploit the heritable component of weight as a natural experiment using data from the National Longitudinal Survey of Youth (NLSY) 1979 Cohort.⁹ I find that weight lowers wages for white females: an increase in weight of two standard deviations (roughly 64 pounds) is associated with 9 percent lower wages. In general, the labor market consequences of obesity are greater for women than for men, and greater for white females than for other females. Based on the NLSY data, it is impossible to say whether the labor market consequences of obesity are the result of relatively worse health impairing productivity, or to employer discrimination, but other studies suggest that discrimination plays an important role.

Some occupations and industries are more affected by employee obesity than others. For the military, fitness is an important job requirement and thus rising obesity is a particular concern. Johanna Catherine Maclean and I examine data from the National Health and Nutrition Examination Surveys and find that the percentage of age-eligible civilians who exceed the U.S. Army's weight-for-height requirements more than doubled for men and tripled for women between 1959 and 2008.¹⁰ Excess weight is now the primary reason that applicants to the military are rejected, and a coalition of retired generals and admirals has called obesity a threat to military readiness.

Policies to Prevent or Reduce Obesity

There are a staggering number of policies and programs to prevent and reduce obesity, and an important contribution that economists can make is to evaluate these programs' effectiveness. For example, the Centers for Disease Control, the American Academy of Pediatrics, and the Institute of Medicine have called for increases in physical education (PE) for school children, despite a lack of evidence that it has any impact on youth weight. To assess how PE affects youth physical

activity and obesity, Meyerhoefer, David Newhouse and I exploit variation across states in PE requirements.¹¹ To minimize the risks of policy endogeneity or unobserved heterogeneity biasing the results, we control for a host of state characteristics, such as the prevalence of adult obesity, the socioeconomic status of residents, and resources provided to public schools. Using data on high school students from the Youth Risk Behavior Surveillance System (YRBSS) we find that increasing PE requirements increases physical activity among girls (not boys) but has no detectable effect on weight.

To complement that study of high school students, Meyerhoefer, David Frisvold and I estimate the impact of PE on elementary school children using data from the Early Childhood Longitudinal Study, Kindergarten Cohort (ECLS-K).¹² The results of the IV model that exploits variation over states and time in PE requirements indicate that an additional 60 minutes per week spent in PE reduces the probability of obesity in fifth graders by 4.8 percentage points. There is no significant effect in earlier grades, which could be attributable to differences in PE curriculum, variation of the treatment effect with age, or to several states instituting substantial PE requirements before the fifth grade wave, increasing the power of the instrument. Taken together, the results suggest that increasing PE requirements increases physical activity and decreases the risk of obesity for certain subgroups, but not for all students. However, the limitations of BMI are relevant here. The YRBSS and ECLS-K datasets contain only height and weight, but no information about body composition. It is possible that increased PE requirements increase muscle mass and decrease fat mass, with little net effect on weight.

An innovative approach is to offer obese individuals financial rewards for weight loss. Insurance companies may face lower claims and employers may experience lower job absenteeism and higher productivity if their enrollees or employees lose weight; as a result, these organizations are increasingly seeking a win-win solution by offering overweight

individuals financial rewards for weight loss. In addition, people with time-inconsistent preferences may be willing to put their own money at risk, hoping that loss aversion will provide them with incentives to lose weight in order to get the money back. To evaluate the effectiveness of these approaches, Joshua Price and I examine outcomes in a workplace wellness program that offers financial rewards and deposit contracts for employee weight loss.¹³ Interesting features of this program include its large sample size (2,635 workers across 24 work sites) and long duration (one year). We find that attrition in this program is high: 42.9 percent dropped out by the end of the first quarter, and 68.0 percent by the end of the year-long program. We find modest results in the program. Those offered financial rewards for weight loss have no higher year-end weight loss than those in the control group, and those who make deposit contracts have year-end weight loss that is roughly two pounds greater than that of the control group after adjusting for attrition. An important next step is to determine the optimal structure of such programs, such as the most cost-effective size of financial reward, what should be rewarded (loss of pounds, loss of fat, increase in physical activity), the optimal number and timing of measurements of progress, whether group challenges can be designed to create beneficial peer effects, and how to avoid creating incentives for the use of unhealthy methods of weight loss.

Discouraged by failed attempts at weight loss through dieting and exercise, substantial percentages of Americans have taken over-the-counter (OTC) weight loss products. There is very little, if any, evidence suggesting that these products are effective, and some have potentially fatal side effects. Rosemary Avery, Matthew Eisenberg and I study the impact of exposure to advertising on the probability of consuming such products using data from the Simmons National Consumer Survey merged with data on magazine and television advertising.¹⁴ We measure the extent to which advertisements are deceptive using detailed guidelines developed by

the Federal Trade Commission for this specific market. To address the targeting of ads, we control for each magazine read and each television show watched, and we identify the effect of exposure to advertising using changes over time in the number of ads within individual magazines and shows. We find little evidence that advertising of OTC weight loss products expands the size of the market. Instead, advertising seems to be a way to battle for market share.

Future Directions

Given the scarcity and low quality of data on calories consumed and calories expended, it may never be possible to affirm with any degree of certainty the percentage of the rise in obesity attributable to specific factors. However, it will continue to be important to exploit natural experiments in order to determine the extent to which economic variables such as food prices, income, and technological change affect the risk of obesity, and to estimate the various economic consequences of obesity. Measuring the effectiveness, and calculating the cost-effectiveness, of anti-obesity programs and policies will help ensure that the public and private sectors get the biggest “bang for the buck” from their expenditures on obesity prevention and treatment.

Diseases, 2010, *Geneva: World Health Organization*, 2011.

⁴ J. Cawley and C. Ruhm, “The Economics of Risky Health Behaviors.” NBER Working Paper No. 17081, May 2011, and published as chapter 3 in *Handbook of Health Economics*, Volume 2, T.G. McGuire, M.V. Pauly, and P.P. Barros, eds., New York: Elsevier, 2012, pp. 95–199.

⁵ J. Cawley and R.V. Burkhauser, “Beyond BMI: The Value of More Accurate Measures of Fatness and Obesity in Social Science Research,” NBER Working Paper No. 12291, June 2006, published in *Journal of Health Economics*, 27(2) (2008), pp. 519–29.

⁶ R.V. Burkhauser, J. Cawley, and M. Schmeiser, “Differences in the U.S. Trends in the Prevalence of Obesity Based on Body Mass Index and Skinfold Thickness,” NBER Working Paper No. 15005, May 2009, published in *Economics and Human Biology*, 7(3) (2009), pp. 307–18.

⁷ J. Cawley, J.R. Moran, and K.I. Simon, “The Impact of Income on the Weight of Elderly Americans,” NBER Working Paper No. 14104, June 2008, published in *Health Economics*, 19(8) (2010), pp. 979–93.

⁸ J. Cawley and C. Meyerhoefer, “The Medical Care Costs of Obesity: An Instrumental Variables Approach,” NBER Working Paper No. 16467, October 2010, published in the *Journal of Health Economics*, 31(1) (2012), pp. 219–30.

⁹ J. Cawley, “Body Weight and Women’s Labor Market Outcomes,” NBER Working Paper No. 7841, published as “The Impact of Obesity on Wages,” *Journal of Human Resources*, 39(2) (2004), pp. 451–74.

¹⁰ J. Cawley and J.C. Maclean, “Unfit for Service: The Implications of Rising Obesity for U.S. Military Recruitment,” NBER Working Paper No. 16408, September 2010, published in *Health Economics*, 21(11) (2012), pp. 1348–66.

¹¹ J. Cawley, C.D. Meyerhoefer, and D. Newhouse, “The Impact of State Physical Education Requirements on Youth Physical Activity and Overweight,” NBER Working Paper No. 11411, June 2005, published in *Health Economics*, 16(12) (2007), pp. 1287–301.

¹ See, for example, *Centers for Disease Control, “Deaths: Final Data for 2007,” National Vital Statistics Reports*, 58(19) (2010) pp. 1–17; L.D. Johnston, P.M. O’Malley, J.G. Bachman, and J.E. Schulenberg, *Monitoring the Future: National Results on Adolescent Drug Use, Overview of Key Findings*, 2010. *Ann Arbor: Institute for Social Research, The University of Michigan*, 2011.

² K.M. Flegal, M.D. Carroll, B.K. Kit, and C.L. Ogden, “Prevalence of obesity and trends in the distribution of body mass index among U.S. adults, 1999–2010.” *Journal of the American Medical Association*, 307(5) (2012), pp. E1–E7.

³ *World Health Organization*, *Global Status Report on Noncommunicable*

¹² J. Cawley, D. Frisvold, and C. Meyerhoefer, "The Impact of Physical Education on Obesity among Elementary School Children," NBER Working Paper No. 18341, August 2012, published in the *Journal of Health Economics*, 32(4) (2013), pp. 743-55.

¹³ J. Cawley and J.A. Price, "Outcomes in a Program that Offers Financial

Rewards for Weight Loss," NBER Working Paper No. 14987, May 2009, and published as chapter 4 in *Economic Aspects of Obesity*, M. Grossman and N. Mocan, eds., Chicago, IL: University of Chicago Press, 2011, pp. 91-126. See also J. Cawley and J.A. Price, "A Case Study of a Workplace Wellness Program That Offers Financial Incentives

for Weight Loss," *Journal of Health Economics*, 32(5) (2013), pp. 794-803.

¹⁴ J. Cawley, R.J. Avery, and M. Eisenberg, "The Effect of Deceptive Advertising on Consumption of the Advertised Good and its Substitutes: The Case of Over-the-Counter Weight Loss Products," NBER Working Paper No. 18863, March 2013.

Public Sector Retirement Plans

Robert Clark*

Public sector pension plans and retiree health plans have been front page news during the past decade. While the popular press has focused almost exclusively on the underfunding of these plans, economic research has examined how these plans affect state and local budgets, intergenerational equity, and the behavior of public employees. Public employees account for 14 percent of the labor force and employee benefits comprise about 35 percent of the employment cost of public employees.¹ Thus, a clear understanding of the cost and benefits of pension and health plans is central to understanding this sector of the U.S. economy. Along with colleagues, I have examined the labor market effects of public pension plans and retiree health plans. The following describes my research on primary pension plans, retiree health plans, and supplemental retirement plans offered by state and local governments to their employees.

Public Pension Plans

I began my research on public pension plans through a study of the his-

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torical origins of retirement plans in the United States. In order to consider current retirement policies, it is important to understand when public sector retirement plans were established, why they were made more generous in the last quarter of the twentieth century, and what human resource objectives they are trying to achieve. The earliest retirement plans can be found in the public sector, dating at least from the early Roman Empire. The first public pension plans in North America were those established in the English colonies which provided benefits for the members of their local militias. During the earliest stages of the Revolutionary War, the Continental Congress established a retirement plan for its naval officers and enlisted sailors. The plan was funded primarily from booty seized on the open seas. (Later a plan was created for the Continental Army.) The history of the Navy Pension Fund offers an interesting narrative of the management of early pension funds, including periodic benefit increases, which ultimately led to the fund's exhaustion and a subsequent U.S. Treasury bailout. This fund was revived and prospered during the Civil War and was eventually rolled into the federal government's pension system for Union veterans and later military plans for "regular" army and navy personnel. At the local level, larger municipali-

ties established pension plans for their police officers, firefighters, and teachers during the late nineteenth century.²

By the first decade of the twentieth century, a few states offered plans for public school teachers, but the first pensions for general (that is, non-teacher) state employees were established in the 1910s; however, only after the enactment of Social Security did most states begin to establish retirement plans for their employees, with the last state plan being implemented in the 1960s. Initially, employer-provided pension plans were the only retirement plans available to public employees, because public employees were excluded from the Social Security system until the 1950s. Through the middle of the century, except for several of the country's larger cities, local teacher plans were consolidated into state-managed plans, and in about half of the states, teacher plans merged with plans covering general state employees. By the 1970s, public sector plans had matured and covered most full-time state and local employees.

These early public sector plans were almost exclusively defined benefit plans, providing life annuities to retired public employees. The last quarter of the twentieth century saw public employers increasing the generosity of their plans³ by: increasing the multiplier for benefits

per year of service, reducing retirement ages, reducing vesting periods, and adding cost-of-living adjustments to retirement benefits.⁴ To some extent, today's funding problems are based on these decisions to increase benefits without providing adequate revenue to support them.

Private sector employers began offering pension plans on a wide scale later than the public sector, though, like the public sector, most of the early plans were defined benefit plans. After the passage of the Employee Retirement Income Security Act (ERISA) in 1974, retirement plans in the private sector began a long-term movement away from defined benefit plans toward defined contribution plans.⁵ Public sector plans were not subject to ERISA, and government employers continued to offer defined benefit plans. However, since 2000 one third of the states have altered their plan structures by adopting defined contribution plans, cash balance plans or hybrid plans, either as replacements for traditional defined benefit plans or as options that new employees can select.

There is a long history of economic research examining the effects of pension plans in general, but relatively few studies examine the effects of public sector plans. In part because of the lack of research on public retirement plans, along with several collaborators I helped to organize NBER research projects in 2010 and 2012 that explored various issues involving retirement plans and retiree health insurance offered by state and local governments.⁶ As part of the first project, Melinda Morrill and I examine the initial actuarial reports on retiree health insurance of all 50 states.⁷ Our survey shows that all states offered their retirees access to some form of retiree health insurance, although there are significant differences in the generosity of these plans across the states. Some states provide this insurance and pay the entire premium for their retirees, while some states merely offer retirees the opportunity to remain in the state plan if the individual pays the entire premium. Given this range of generosity, the unfunded liability associated with these plans varies substantially across the states.

As part of the second project, Morrill, David Vanderweide, and I examine the decisions of public employees who terminate employment but have not yet met the age and service requirements to begin their pension benefits.⁸ In general, employees at termination have the option of requesting a lump sum distribution of their pension or leaving their funds in the system. Our analysis finds that in the public sector the lump sum distribution amount is not typically equivalent to the present discounted value of the annuity payments, as it is in the private sector. Thus, although there is a considerable literature examining pension participants that finds workers have a preference for lump sums, when considering public sector workers, a very different pattern is observed. In this study, we find no such preference for lump sum distributions among public employees in North Carolina. Terminated workers tend to leave their accounts open even when the lump sum has a higher present value, suggesting an important role for framing, inertia, and defaults.

Retiree Health Insurance

Compared to the literature on pension plans, much less is known about the development of retiree health plans, how they are financed, and their effects on employee behavior. Employers began to extend health coverage to retirees on a large scale after the implementation of Medicare.⁹ While coverage in the private sector has been declining rapidly, incidence of retiree health insurance remains very high in the public sector. In 2004, the Governmental Accounting Standards Board issued a ruling requiring public employers to report their unfunded liabilities associated with the promise of health insurance in retirement. Prior to this time, very little was known about the magnitude of these liabilities.

Even though retiree health plans are an expensive component of employee compensation in the public sector, there is relatively little research on the impact of these programs on employee behavior. To address this need for research, Joseph

Newhouse and I organized an NBER research project in 2013 examining the economic effects of retiree health plans in the public sector.¹⁰

I contributed two papers to this project. One, co-authored with Olivia Mitchell, estimates the effect of coverage by retiree health insurance on individual saving.¹¹ There is a long literature by economists estimating the impact of employer pensions, Social Security, and Medicare coverage on personal saving but our paper is the first examination of the impact of retiree health insurance on saving and wealth accumulation. We find that public sector workers aged 50 and over covered by retiree health insurance had accumulated \$70,000 to \$100,000 less in net wealth than comparable private sector employees without retiree health insurance. Thus, workers expecting that their employer will subsidize their health insurance in retirement tend to save less.

In a second paper, Morrill, Vanderweide, and I examine the impact of policy changes on the choice of health plans by retirees in North Carolina.¹² All retirees receiving a pension were eligible to remain in the state health plan at no premium. Retirees had a choice between two plans with one plan (Standard Plan) being more generous than the other (Basic Plan). Retirees could select either plan, but if they wanted to add dependents to their plan both the retiree and the dependent had to be in the same plan with the retiree paying the full cost of his dependents' coverage. In 2009, 93 percent of retirees were in the more generous Standard Plan. Over a four-year period, non-Medicare-eligible retirees were subjected to changes in the default plan, introduction of a Comprehensive Wellness Initiative (CWI), the elimination of the CWI, and the introduction of a premium for enrollment in the Standard Plan.

Statistical analysis shows that these policy changes significantly altered enrollments in the two plans. The results indicate that the policy initiatives caused retirees to change to the less generous health plan, thus shifting costs from the state to these retirees. The evidence suggests a

strong role for defaults in retiree health plan choices. The findings suggest that plan sponsors can effectively move retirees from one plan to another through the use of plan characteristics and requirements. We are now engaged in a similar project examining how active workers responded to similar changes and the introduction of a new consumer-driven health plan.

Supplemental Retirement Plans and Financial Education

Many public sector employees are offered the opportunity to enroll in supplemental retirement saving plans. State and local employers can sponsor 401(k) and 457 plans while schools, universities, and health care organizations can also establish 403(b) plans for their employees. Very little is known about the participation and contribution rates of public employees in these plans. However, it does appear that public employers are much less likely to offer employer matches to these plans or to have adopted automatic enrollment or auto-escalation policies relative to private sector employers.¹³ The current state of supplemental plans raises important questions about the factors that prompt public employers to offer one of these plan types over another, and why some employers offer two or three different retirement saving plans.

In the educational sector, management of 403(b) plans appears to be inefficient and likely inhibits wealth accumulation by teachers. David Richardson and I find that states that allow all interested vendors to offer investment options to 403(b) plan participants had higher administrative fees and were more likely to include other fees, such as front-end fees and surrender charges for similar investment products.¹⁴ Emma Hanson and I review 403(b) plans in all 50 states and find that in over two-thirds of the states, 403(b) plans were managed at the school district level. In most cases, there was little or no oversight of the vendors or restrictions on their fees.¹⁵

As states reform their primary pension plans and reduce the generosity of retiree health plans, supplemental retire-

ment saving plans will become increasingly important for public sector employees. Future public employees will assume more responsibility for their retirement income. The importance of financial literacy and the need to understand sometimes complicated retirement plans will increase over time. In papers with Steven Allen, Morrill, and Jennifer Maki, I examine the role of employer-provided retirement planning programs,¹⁶ financial literacy programs,¹⁷ and the success of informational “nudges”¹⁸ in retirement planning. Our analysis shows that these types of programs have been successful in enhancing financial literacy, increasing the knowledge of retirement benefits, altering saving behavior, and modifying retirement plans.

¹ Information on employment from the Bureau of Labor Statistics, August 2013, <http://www.bls.gov/news.release/empsit.t17.htm>

² This discussion is based on R.L. Clark, L.A. Craig, and J.W. Wilson, *A History of Public Sector Pensions in the United States*, Philadelphia: University of Pennsylvania Press, 2003.

³ R.L. Clark and L.A. Craig, “Determinants of the Generosity of Pension Plans for Public School Teachers, 1982–2006,” *Journal of Pension Economics and Finance*, 10(1) (January 2011), pp. 99–118. This paper reports that the typical career teacher retiring in 1982 had a replacement rate of 50 percent of their final average salary while for a similar teacher retiring in 2006 benefit increases had raised the replacement rate to 56 percent.

⁴ R.L. Clark, L.A. Craig, and J. Sabelhaus, *State and Local Retirement Plans in the United States*, Northampton, MA: Edward Elgar Publishing, 2011.

⁵ R. L. Clark and A.A. McDermed, *The Choice of Pension Plans in a Changing Regulatory Environment*, Washington: American Enterprise Institute, 1990.

⁶ Jeffrey Brown and Joshua Rauh were co-directors of these projects. A summary of the first project can be found in J.R. Brown, R.L. Clark, and J.D. Rauh, “The

Economics of State and Local Public Pensions,” NBER Working Paper No. 16792, February 2011, and *Journal of Pension Economics and Finance*, 10(2) (April 2011), pp. 161–72. The list of research studies that were conducted as part of the second project can be found at <http://conference.nber.org/confer/2012/SLP/summary.html>

⁷ R.L. Clark and M.S. Morrill, *Retiree Health Plans in the Public Sector: Is There a Funding Crisis?* Northampton, MA: Edward Elgar Publishing, 2010. Also see R.L. Clark and M.S. Morrill, “The Funding Status of Retiree Health Plans in the Public Sector,” NBER Working Paper No. 16450, October 2010, and *Journal of Pension Economics and Finance*, 10(2) (April 2011), pp. 291–314.

⁸ R.L. Clark, M.S. Morrill, and D. Vanderweide, “Defined Benefit Pension Plan Distribution Decisions by Public Sector Employees,” NBER Working Paper No. 18488, October 2012, and forthcoming in the *Journal of Public Economics*.

⁹ In the private sector, coverage was generally limited to large companies, unionized firms, and of course, only employers who offered health insurance to active workers. In 1989, the Financial Accounting Standards Board required firms to determine the unfunded liability associated with the promise of health insurance to retirees. Subsequent to this new accounting policy, coverage in the private sector began to decline. Other factors influencing this decline were the rise in the ratio of retirees to active workers, the increase in medical cost that outpaced the general rate of inflation, and Medicare policy changes.

¹⁰ Joseph Newhouse and I were co-directors of this project. The list of research studies can be found at <http://conference.nber.org/confer/2013/SLHP13/summary.html>

¹¹ R.L. Clark and O.S. Mitchell, “How Does Retiree Health Insurance Influence Public Sector Employee Saving?” NBER Working Paper No. 19511, October 2013.

¹² R.L. Clark, M.S. Morrill, and D. Vanderweide, “The Effects of Retiree Health Insurance Plan Characteristics on

Retirees' Choice and Employers' Costs," NBER Working Paper No. 19566, October 2013.

¹³ R.L. Clark and J.M. Franzel, "Adopting Automatic Enrollment in the Public Sector: A Case Study," *Government Finance Review*, 27(1) (February 2011), pp. 42–8.

¹⁴ R.L. Clark and D.P. Richardson, "Who Is Watching the Door? How Controlling Provider Access Can Improve Teacher K-12 Retirement Outcomes," *Research Dialogue*, November 2010,

https://www.tiaa-crefinstitute.org/public/institute/research/dialogue/rd_98.html.

¹⁵ R.L. Clark and E. Hanson, "403(b) Plans for Public School Teachers: How They Are Monitored and Regulated in Each State," *Research Dialogue*, No. 107 (March 2013), TIAA-CREF Institute, <https://www.tiaa-crefinstitute.org/public/pdf/institute/research/dialogue/107b.pdf>

¹⁶ S.G. Allen, R.L. Clark, J.A. Maki, and M.S. Morrill, "Golden Years or Financial Fears? Decision Making After Retirement Seminars," NBER Working Paper No.

19231, July 2013.

¹⁷ R.L. Clark, M.S. Morrill, and S.G. Allen, "The Role of Financial Literacy in Determining Retirement Plans," NBER Working Paper No. 16612, December 2012, and *Economic Inquiry*, 50(4) (October 2012), pp. 851–66.

¹⁸ R.L. Clark, J.A. Maki, and M.S. Morrill, "Can Simple Informational Nudges Increase Employee Participation in a 401(k) Plan?" NBER Working Paper No. 19591, October 2013, and *forthcoming in the Southern Economic Journal*.

High-Skilled Immigration, Domestic Innovation, and Global Exchanges

William Kerr*

High-skilled immigrants account for about 25 percent of the workers in the most innovative and entrepreneurial U.S. industries, and they are responsible for a roughly similar share of output measures like patents or firm starts. Immigrants have also accounted for the majority of the growth in the U.S. scientific workforce since the 1990s. The magnitudes of these contributions make understanding the economic consequences of immigration an important research priority.

In this piece, I summarize the major themes that have emerged from my work on high-skilled immigration. I start by describing the construction of the ethnic patenting records that I use in most of my studies. I then outline projects that have considered the economic consequences of high-skilled immigrants for the United States. The last part of this research summary focuses on the outbound economic

consequences of high-skilled emigration for the home countries of those who move to the United States.

Developing Data

While the substantial role of immigrants in U.S. technological development has long been recognized, data constraints have posed a significant challenge for research. Some datasets, like the decennial Censuses, provide rich cross-sectional accounts but limited longitudinal variation. Others, such as the Current Population Survey, provide better longitudinal detail but less cross-sectional heterogeneity. Moreover, it has been especially difficult to collect data on the role of high-skilled immigrants in research-oriented firms and universities.

Most of my work on high-skilled immigrants builds off the assignment of probable ethnicities to individuals who appear in U.S. patent records. The United States Patent and Trademark Office (USPTO) publishes all the patents it grants, which have exceeded 200,000 grants in recent years. Every patent must list at least one inventor, and patents are allowed multiple inventors.

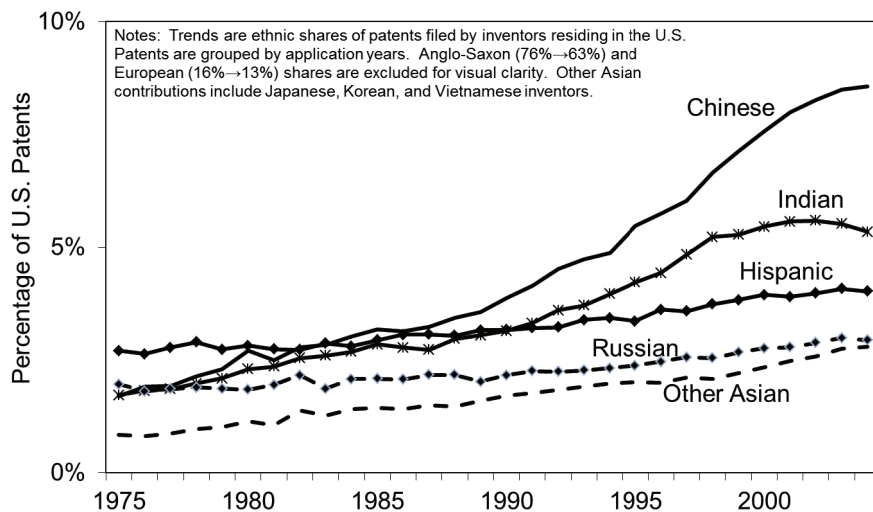
Several features of patent litigation make it advisable to correctly list the identities of those truly doing the innovative work when filing for a patent, and through the assignment of patents, this inventor role can be separated from ownership of the property rights to the patent.

I use the names of inventors to assign their probable ethnicities. This procedure exploits the fact that individuals with surnames of Gupta or Desai are likely to be Indian, Wang or Ming are likely to be Chinese, and Martinez or Rodriguez are likely to be Hispanic. Name matching procedures have been developed to provide probabilistic ethnicities for virtually all inventors in the USPTO system. The name approach is comparatively stronger at separating among Asian ethnic groups than among European or Hispanic names. This approach does not isolate immigration status directly for multiple reasons, but it does provide an indirect measure that proves useful in research.

The appeal of this approach is that it permits assignment of ethnicities to individual patent records. With this granularity, the USPTO records can be aggregated in many ways, for example by

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Fig. 1: Growth in U.S. Ethnic Patenting



year, by city, by very detailed technology codes, and by institution. Moreover, the patent data include a wealth of information, so one can, for example, study citations that patents make to other patents for evidence of ethnic networks in knowledge flow. One can also use measures developed in the technological change literature (such as patent originality scores) to compare inventor contributions across ethnicities.

Figure 1 shows the tremendous increase in the ethnic contribution of U.S. inventors over the last 30 years, focusing only on inventors residing in the United States at the time of their work. The contribution of Chinese and Indian ethnic inventors displays exceptional growth, increasing from under 2 percent each to 9 percent and 6 percent respectively. Ethnic contributions are disproportionately concentrated in high-tech fields, and Figure 2 shows the Chinese and Indian inventor shares for several noteworthy companies. The data underlying Figures 1 and 2 are the basis for most of my research on high-skilled immigration in the U.S. economy.

Domestic Inbound Consequences

One portion of my work uses the USPTO data to examine how high-

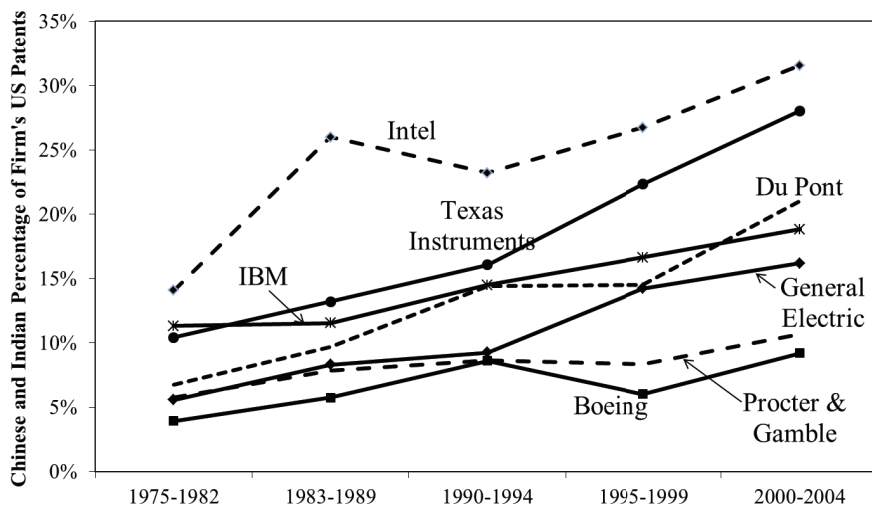
skilled immigration affects the rate of U.S. technology development and its spatial allocation. One project with William Lincoln examines how immigration policy influences the rate of U.S. innovation through changes in the supply of potential inventors to the economy.¹ We focus on the H-1B visa program that is the primary visa category for temporary workers entering the United States for employment in high-skilled occupations related to science and engineering. The U.S. national cap on new H-1B admissions has fluctuated substantially over the last

two decades, and the program is a point of significant controversy in the public debate over immigration. Proponents and detractors disagree about how important H-1B admissions are for U.S. technology advancement and whether native workers are displaced by immigrants.

We study how changes in H-1B admissions impact the growth and character of U.S. invention. Our central analysis exploits differences across cities in their dependence on immigrants for their science and engineering workforce. Dependent cities experience substantially stronger growth in Indian and Chinese ethnic inventions when H-1B admission rates are higher. We do not find evidence of adverse effects for inventors with Anglo-Saxon names, which are our proxy for native U.S. workers. If anything, the project suggests that native invention may grow slightly when the number of immigrant scientists and engineers is increasing in a city. Aggregating across ethnic groups, total U.S. invention increases by a small amount in the short run with higher H-1B admissions. This increase is primarily through the direct contributions of immigrant inventors.

These results are important for understanding the consequences of more flexible immigration policies for high-skilled workers. In contrast to the demand side of innovation—where entrepreneurial innovation responds

Fig. 2: Chinese & Indian Shares by Company



to market needs and growth in market sizes — this supply side of innovation is less understood. It can be very challenging for workers to move across occupations and industries, especially in knowledge-intensive sectors. The heavy U.S. dependence on immigrants for its scientific workforce makes immigration policy an important supply-side determinant of U.S. innovation, as it governs the entry of workers who can perform key tasks in innovation-intensive industries.

A subsequent project, also using cross-city variation, considers the degree to which immigrants aid the efficient reallocation of inventors toward areas where breakthrough inventions occur.² Urban economists have long discussed cases in which innovation shifts to be near the source of the next great mousetrap, for example, the quick shift of semiconductors from Boston to Silicon Valley and the rapid rise of Micron Technology, Inc. in Boise, Idaho. As part of a broader effort to quantify this effect, this project showed the substantial degree to which immigrant inventors lead the shifts across space to new industrial clusters. This greater mobility results partly from immigrant inventors being more mobile than native workers, but it is particularly connected to the fact that initial location decisions upon moving to the United States can be easily shaped.

More recent work has turned to uniting the ethnic patenting data with administrative data on the employment structures of U.S. firms. From a conceptual perspective, this integration is very important since most forms of high-skilled immigration are 1) done through firms that sponsor visas, and 2) have many non-market aspects to their allocation. Examples of the latter are the regulated supply of new high-skilled immigrants by the government, their allocation to firms without a pricing mechanism, and the tied employer-employee relationships that follow. Given that firms effectively conduct much of the selection of U.S. high-skilled immigrants, it is imperative to understand better how they utilize the visas.³

In projects with Lincoln and Sari

Pekkala Kerr, we link the ethnic patenting dataset to the U.S. Census Bureau's Longitudinal Employer Household Database.⁴ This is a very exciting research platform because the employer-employee data allow us to follow individuals and firms over time. Moreover, the data directly identify the immigrant status of employees, which is particularly powerful in combination with the ethnic patenting data.

Our key paper analyzes how fluctuations in the H-1B program impact the hiring of different groups of workers. We explore the idea that high-skilled immigration allows dependent firms to keep their workforces younger. Advocates against the H-1B program voice this concern, arguing anecdotally that the program is used in high-tech firms for labor cost minimization by displacing older and more expensive workers. While the vast majority of H-1B workers are under the age of 40, this proposed relationship has not been rigorously examined.

We find evidence that increased employment of high-skilled immigrants in the firm links to younger workforces. Whereas younger native groups expand their employment in step with immigrants, there are very limited adjustments regarding the employment of older natives. As a consequence, the share of older workers in the firm declines, both in total and among native workers only. On the other hand, it is important to note that absolute declines in older worker employment are not observed. We consider some differences in effects by occupation, and we discuss how our results reflect a blend of cost minimization and access to scarce skills. These findings describe a pattern of substitution and complementarity between immigrants and natives that could not have been discerned with prior techniques and data.

Overall, the development of new employer-employee data offers great promise for expanding our understanding of the immigration process from both empirical and theoretical perspectives. The literature on international trade, for example, has benefited signifi-

cantly in recent years from greater consideration of the role of the firm, and I believe a similar outgrowth will occur for high-skilled immigration research in coming years.

Home-Country Consequences of High-Skilled Emigration

The studies described above analyze how immigrants influence U.S. innovation. My research also considers the relationships that high-skilled immigrants in the United States maintain with their home countries. Case studies of Silicon Valley depict powerful ethnic business networks that transfer knowledge and technology across countries, but the broader strength and generality of these networks have been rarely tested.

My initial research on this question establishes some key macroeconomic relationships using country-industry data in combination with the ethnic patenting series.⁵ This work quantifies how a larger ethnic scientific community in the United States aids the transfer of new technologies to the home country. This transfer is strong enough to show up in manufacturing output and productivity data for the home country, and it is also evident in trade patterns.⁶ At several points, my work has used the Immigration Reform Act of 1990, which differentially affected high-skilled immigration from countries based upon how general quota changes interacted with country size, to tease out causal relationships.

Understanding the channels behind this technology transfer has been the subject of subsequent work. One channel is clearly inventor-to-inventor communication. Ethnic networks are evident in global patent citations, where overseas inventors display a 50 percent higher citation rate for members of their own ethnicity working in the United States, conditional on technology area and similar controls. This ethnic transfer is particularly powerful in the first five years after a new discovery is made, and it is no longer present after technologies have been around for ten years as a result of wide-

spread diffusion.

My work with C. Fritz Foley also establishes that foreign direct investment (FDI) is an important mechanism and introduces again the theme of understanding the role of firms in these global linkages.⁷ We match the ethnic patenting data to confidential data on the foreign activities of U.S. multinationals collected by the Bureau of Economic Analysis. This platform allows us to see how growth in a firm's ethnic scientific workforce in the United States relates to FDI placement, both in total and also in activities specifically related to R&D and patenting. We find that within-firm growth in the number of U.S.-based inventors of a particular ethnicity translates into higher FDI placement by that firm in countries associated with that ethnic group. This effect is particularly strong for location decisions related to innovation. Our results suggest that employing innovators of a certain ethnicity increases some aspects of the competitiveness of U.S. multinational firms in countries associated with that ethnicity.

Another project with Ejaz Ghani and Christopher Stanton examines the outsourcing channel using contract-level data from oDesk, the world's largest online platform for outsourcing.⁸ oDesk links firms and workers from many countries; India is the largest destination country on oDesk in terms of outsourcing. We study the role of the ethnic Indian diaspora worldwide in sending contracts to India and in influencing the traits of these contracts. An important finding from this work is that while tools like oDesk minimize many of the frictions that dias-

pورا connections have historically overcome (such as information asymmetries and reputation-based contracts), the diaspora makes effective use of these tools and their role even strengthens with familiarity with the platform. This suggests that the importance of ethnic networks for international exchanges is unlikely to decline, and may even increase, with the advent of online platforms and related reductions in transportation and communication costs.

Overall, these studies find that larger high-skilled immigrant populations in the United States from a given country provide partial access to U.S. resources and opportunities for those who live in that country. This resource assembly through ethnic and professional networks complements resource assembly through spatial proximity in industrial clusters. It contrasts with traditional economic models where, for example, technology diffusion occurs instantaneously or declines uniformly with geographic distance.

¹ W.R. Kerr and W.F. Lincoln, "The Supply Side of Innovation: H-1B Visa Reforms and U.S. Ethnic Invention," NBER Working Paper No. 15768, February 2010, and *Journal of Labor Economics*, 28(3) (July 2010), pp. 473–508.

² W.R. Kerr, "Breakthrough Inventions and Migrating Clusters of Innovation," NBER Working Paper No. 15443, October 2009, and *Journal of Urban Economics*, 67(1) (January 2010), pp. 46–60.

³ These issues are further elaborated upon in W.R. Kerr, "U.S. High-

Skilled Immigration, Innovation, and Entrepreneurship: Empirical Approaches and Evidence," NBER Working Paper No. 19377, August 2013. *Under these conditions, it is not surprising that firms lobby extensively about immigration. We use the high-skilled immigration lens to study lobbying in* W.R. Kerr, W.F. Lincoln, and P. Mishra, "The Dynamics of Firm Lobbying," NBER Working Paper No. 17577, November 2011, and forthcoming in the *American Economic Journal: Economic Policy*.

⁴ S.P. Kerr, W.R. Kerr, and W.F. Lincoln, "Skilled Immigration and the Employment Structures of U.S. Firms," NBER Working Paper No. 19658, November 2013; S.P. Kerr and W.R. Kerr, "Immigration and Employer Transitions for STEM Workers," *American Economic Review*, 103(3) (May 2013), pp. 193–7.

⁵ W.R. Kerr, "Ethnic Scientific Communities and International Technology Diffusion," *Review of Economics and Statistics*, 90(3) (August 2008), pp. 518–37.

⁶ W.R. Kerr, "Heterogeneous Technology Diffusion and Ricardian Trade Patterns," NBER Working Paper No. 19657, November 2013.

⁷ C.F. Foley and W.R. Kerr, "Ethnic Innovation and U.S. Multinational Firm Activity," NBER Working Paper No. 17336, August 2011, and *Management Science* (2013).

⁸ E. Ghani, W.R. Kerr, and C.T. Stanton, "Diasporas and Outsourcing: Evidence from oDesk and India," NBER Working Paper No. 18474, October 2012, and forthcoming in *Management Science*.