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Program Report

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Health Care

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The NBER's Program on Health Care holds two program meetings annually, as well as NBER Summer Institute sessions, an annual "Frontiers in Health Policy Research Conference," and occasional theme meetings. Program members conduct research on a diverse range of issues in the economics of health, the delivery and financing of health care, and the interactions of health and health care with other areas of economic activity. Because Health Care is a large and active program, as reflected in the Working Papers issued by program members and in their presentations and publications, this report describes only a fraction of its work.

Private Health Insurance

Most Americans pay for health care with private health insurance obtained through employers. The loss of employment-based insurance frequently leads to either enrollment in government programs like Medicaid or the loss of health insurance altogether. Michael Chernew, David M. Cutler, and Patricia S. Keenan examine why the share of Americans without health insurance rose over the 1990s, despite the relative prosperity of the decade. In one paper, they relate changes in health insurance cost growth to changes in insurance coverage rates across metropolitan areas, accounting for a broad set of additional factors that may affect changes in coverage.[1] They find that rising premiums accounted for over half of the decline in health insurance coverage during the 1990s. A $1,000 increase in premiums is associated with a 2.6 percentage point decline in insurance coverage rates. They also project that rising health insurance costs will cause

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the number of uninsured to increase by 2 to 6 million people by 2010. In another paper, they report that the availability of uncompensated care leads to greater losses of insurance coverage when premiums rise.[2]

Many of the uninsured say that they lack health insurance because it is unaffordable. M. Kate Bundorf and Mark V. Pauly develop "normative" and "behavioral" definitions of affordability, examining whether health insurance is affordable to the currently uninsured. Analyzing data from the Medical Expenditure Panel Survey, they report that when a normative definition of affordability is used for family incomes above the poverty level, health insurance was affordable to 82 percent of the uninsured. Increasing the threshold to 2 and 3 times the poverty level, the proportions of the uninsured classified as able to afford coverage were 55 percent and 34 percent, respectively. These researchers also find that, with a "behavioral" definition of affordability, which is defined by the health insurance purchase behavior of individuals with similar economic circumstances, about half of the uninsured could purchase health insurance. Thus, these economists believe that affordability is not the sole barrier to health insurance coverage.[3]

Bundorf and Jay Bhattacharya also have examined whether there are offsetting wage decreases for workers with large expected health care costs by studying the wage patterns for obese workers.[4] Annual medical expenditures are $732 higher on average for obese individuals than for normal weight individuals. In a paper on this subject, they report that obese workers with employer-sponsored health insurance pay for their higher expected medical expenditures through lower cash wages. This conclusion is strengthened by their finding that obese workers with insurance coverage through an alternative employer (for example, a spouse) do not experience similar wage offsets. Nor are there wage offsets for other types of fringe benefits whose cost to the employer is less likely to be affected by obesity.

Medicare and Medicaid

Many Health Care Program members — including Bhattacharya, Amitabh Chandra, David M. Cutler, Mark Duggan, Amy Finkelstein, Victor Fuchs, Dana Goldman, Frank Lichtenberg, Thomas MaCurdy, Mark McClellan, Jonathan Skinner, and I — have studied aspects of the

Medicare and Medicaid programs, such as the causes of growth in program expenditures and the role of disability in future expenditures.

Amy Finkelstein has looked at the introduction of Medicare to learn how the introduction of universal insurance affects health spending and technology adoption.[5] Medicare, she hypothesizes, should have had a greater effect in areas of the country in which relatively few of the elderly had health insurance than in areas in which many of the elderly were insured prior to the introduction of the program. She examines an annual hospital-level dataset from 1948–75 for six hospital outcomes: total expenditures, payroll expenditures, employment, beds, admissions, and patient-days. She finds that the effects were indeed greater in areas in which health insurance was less common; prior to 1965, hospital admissions were growing more slowly in the low-insurance areas than in the high-insurance areas, but after 1965 this pattern reversed, with admissions growing much more quickly in those areas most affected by Medicare's introduction. Similar patterns are evident in the other hospital outcome variables, including expenditures. These results suggest that the overall spread of health insurance explains at least 40 percent of the dramatic increase in health spending in the United States between 1950 and 1990.

In a series of articles, Jon Skinner and colleagues have examined variation in expenditures for the care of Medicare beneficiaries and their implications for the efficiency of Medicare. For example, the range of variation in resources used for end-of-life care for Medicare beneficiaries in the United States is striking, even among top-rated hospitals.[6] Skinner and colleagues also use geographical variations in health care spending to measure the incremental value of health care intensity among the elderly Medicare population.[7] To correct for the reverse causation problem — that residents of "sicker" areas tend to require more health care — they use a set of instruments characterizing health care intensity either among hip fracture patients or among patients in their last six months of life. Using various analytical methods, they find that a large component of Medicare expenditures — $26 billion in 1996 dollars, or nearly 20 percent of total Medicare expenditures — appears to provide no survival benefit, nor is it likely that this extra spending improves the quality of life. While secular trends in health care technology have delivered large health benefits, variation in health care intensity at a point in time suggests that more is not better.

Pharmaceutical Markets, Innovation, And Technology Diffusion

Health Care Program members have conducted a wide array of research addressing how technological innovation in medicine affects both health expenditures and health outcomes. They have also investigated the factors that promote or impede it technological innovation in medical care.

In a series of studies, Cutler and his collaborators have measured the benefits of specific medical innovations. For the most part, he has concluded, the benefits have been large and underappreciated. Much of the work is summarized in his book, *Your Money or Your Life*.[8] Extending work of Cutler and Mark McClellan on the contribution of medical innovations to changes in heart attack mortality among Medicare beneficiaries,[9] Skinner, Douglas Staiger, and Elliott Fisher examine Medicare costs and outcomes for Acute Myocardial Infarction (AMI) in the Medicare population during 1986–2002.[10] They find that the gains in mortality that Cutler and McClellan observed from 1986–98 did not continue subsequently, and that expenditures, after a brief pause, continued to increase. In cross-sectional analyses, they find that regions experiencing the greatest drop in mortality following AMI were not those with the largest gains in expenditures. Patients living in regions that had invested early in low-cost and highly effective care, such as beta blockers, experienced the largest declines in mortality with no adverse impact on expenditures. The factors yielding the greatest benefits to health were not the factors that drove up costs, and vice versa.

Laurence C. Baker has developed important evidence on the ways that financial incentives, particularly those associated with managed care organizations, can influence technology diffusion. For example, his work on the diffusion of mid-level neonatal intensive care facilities,[11] like his earlier work examining other technologies such as magnetic resonance imaging and mammography,[12] shows that tightening financial incentives limits the diffusion of new technologies. This can have important implications for the subsequent utilization of health services and spending. Work by Baker and colleagues on the effects of the diffusion of several technologies in the late 1990s demonstrated their importance in influencing utilization and spending.[13] Baker also has examined the effects of technology diffusion on well-being. Baker and C. S. Phibbs show that, counter to expectation, slowing the diffusion of neonatal intensive care facilities can improve health outcomes, apparently by helping to direct high-risk births to hospitals that are most successful at caring for such low birth weight babies.

Government health insurance programs directly affect diffusion and the incentives to innovate through their influence on demand. Mark Duggan and Fiona M. Scott Morton examine the effects on drug pricing and innovation of what was, at least before 2006, the largest government drug program.[14] In 2003, Medicaid provided prescription drug coverage to more than 50 million people nationwide. To determine the price that it will pay for each drug, Medicaid uses the average private sector price. When Medicaid is a large part of the demand for a drug, this creates an incentive for its maker to increase the prices it charges other health care consumers. Using drug utilization and expenditure data for the top 200 drugs in 1997 and in 2002, they investigate the relationship between the Medicaid market share (MMS) and the average price of a prescription. Their estimates imply that a 10 percentage-point increase in the MMS is associated with a 7 to 10 percent increase in the aver-

age price of a prescription. In addition, Medicaid rules increase a firm's incentive to introduce new versions of a drug in order to raise price. These researchers find that firms producing newer drugs with larger sales to Medicaid are more likely to introduce new versions. Taken together, their findings suggest that government procurement rules can alter equilibrium price and product proliferation in the private sector.

Frank Lichtenberg also has studied the value of technological innovation in medical care. In a recent paper,[15] he has sought to understand the role of the introduction of new drugs on life expectancy changes over time and between nations. He estimates that about 40 percent of the two years added to the average life span between 1986 and 2000 can be traced to the introduction of new drugs. He suggests that it may take several years for a new drug to be diffused to more consumers and have its full impact on survival rates, and that spending on new drugs may be a cost-effective way to increase longevity.

Several groups of Health Care Program researchers have studied the incentives for innovation. Tomas J. Philipson and Anupam B. Jena have estimated the welfare gain resulting from the introduction of anti-HIV medications and the profits that companies producing the drugs have earned from them.[16] They report that profits only represent 5 percent of the consumer surplus attributable to the drugs, and suggest that policies that seek to limit consumption based on value to individual patients may provide inadequate rewards to innovating firms. Charles I. Jones, Paul M. Romer, and I also examine the incentives to innovate, drawing a distinction between static efficiency — when quantities correspond to the competitive equilibrium, when the drug already exists — and dynamic efficiency.[17] The latter condition requires that profits equal surplus. We find that the rewards to innovation can be too small or too large in the presence of health insurance, depending on the shape of the demand curve. Neeraj Sood and Darius Lakdawalla also address the ways to ensure that the innovator receives adequate profits, while their patients also have adequate access to innovative products and technologies.[18] They show that in health care markets characterized by uncertainty and insurance, society may be able to ensure efficient rewards for inventors *and* the efficient dissemination of inventions. Health insurance resembles a two-part pricing contract in which a group of consumers pay an up-front fee ex ante in exchange for a relatively low fixed unit price ex post. This can allow innovators to extract sufficient profits — from the ex ante payment — but still sell the good at marginal cost ex post. As a result, their research shows that complete, efficient, and competitive health insurance markets lead to efficient innovation and utilization, even when moral hazard exists. Conversely, incomplete insurance markets lead to inefficiently low levels of innovation. Second, an optimally designed public health insurance system can solve the innovation problem by charging ex ante premiums equal to consumer surplus, and ex post co-payments at or below marginal cost. When these quantities are unknown, society almost always can improve static and dynamic welfare by covering the uninsured with contracts that mimic observed private insurance contracts.

In other work, these researchers develop an economic framework to discuss the social insurance aspects of several innovation policies including patents, research subsidies, and pre-commitments to buy.[19] They show that patents or rewards have an advantage over research subsidies when a new invention replaces an existing good at lower cost. Research subsidies have an advantage when inventions spawn an entirely new product.

Racial Disparities In Health Care Delivery

The federal government, and a growing research literature, has sought to understand the causes of differences in health outcomes among different racial and ethnic groups within the United States. Much of their effort is directed toward finding the mechanisms responsible for racial disparities. How much can be explained by differences in the medical care that white and non-white patients receive for the same disease?

In a series of papers, Chandra, Skinner, Staiger, and their colleagues have demonstrated the pivotal role that geography plays in racial disparities in health care. Because their work is based on analyses of Medicare claims files, they do not directly assess the role of variation in insurance coverage. They show that regions demonstrating a high level of racial disparity in the use of one procedure administered at the end of life are not especially likely to exhibit similar disparities in the use of unrelated procedures. Unusually large racial disparities in surgery are often the result of high white rates rather than low black rates. Differences in end-of-life care are driven more by residence than by race.[20]

A detailed picture of the importance of geography emerges in a study of mortality after heart attack.[21] In an analysis of fee-for-service Medicare patients hospitalized for heart attack during 1997–2001(with a sample greater than one million), the researchers classified more than 4,000 hospitals into approximate deciles depending on the extent to which the hospital served the African-American population. Decile 1 (12.5 percent of AMI patients) included hospitals without any African-American AMI admissions during 1997–2001. Decile 10 (10 percent of AMI patients) included hospitals with the highest fraction of black AMI patients (33.6 percent). The main outcome measures were 90-day and 30-day mortality following AMI.

Patients admitted to hospitals disproportionately serving African-Americans experienced no greater level of morbidities or severity of the infarction. Yet hospitals in Decile 10 experienced a risk-adjusted 90-day mortality rate of 23.7 percent (the 95 percent confidence interval is 23.2–24.2) compared to 20.1 percent (the 95 percent confidence interval is 19.7–20.4) in Decile 1 hospitals. Differences in outcomes between hospitals were not explained by income, hospital ownership status, hospital volume,

Census region, urban status, or hospital surgical treatment intensity. Thus, risk-adjusted mortality following AMI is significantly higher in U.S. hospitals that disproportionately serve African-Americans. Policies that try to equalize racial differences in outcomes within areas may have little effect on disparities overall, while a reduction in overall mortality at these hospitals could reduce dramatically black-white disparities in health. Other studies by the same group draw similar conclusions.[22]

Peter W. Groeneveld and I, in papers with Paul A. Heidenreich and Sara Laufer, have observed similar phenomena for other cardiac treatments. For example, in an analysis of Medicare claims files for the years 1990–2000, we found that black patients had higher mortality following cardiac arrest than white patients, and that the difference in outcomes was explained in part by the lower rate at which black patients received implantable cardioverter-defibrillators.[23] We then examined whether similar disparities characterized the use of the devices for ventricular arrhythmias. In the early 1990s, black patients with ventricular arrhythmias were about half as likely as whites to receive the devices, but by 1999, they received the devices at about two-thirds the rate of whites. Declining geographic variation in device implantation explained about 20 percent of the reduction in racial disparity.[24]

Hypothesizing that labor market inequality may be reflected in differences in non-wage compensation, Helen Levy examines white-nonwhite and male-female differences in health insurance coverage among full-time workers.[25] She finds that two-thirds of the gap in insurance coverage for blacks or Hispanics is explained by differences in observable characteristics (primarily education and occupation). The gap for women is not explained by controlling for observables. However, for women, coverage from other sources — primarily employer-sponsored coverage as a dependent rather than as a policyholder — more than makes up for their lower rates of own-employer coverage. Consequently female workers are less likely to be uninsured than male workers. The same is not true for blacks and Hispanics: their rates of coverage from other sources are also lower than rates for whites, so that they are significantly more likely to be uninsured even after adjusting for observables. Examining the period from 1980 to 2000, she finds that the adjusted gap in own-employer coverage for women has been relatively flat over this period and is about half as large as the male/female wage gap, so that measuring inequality in wages plus health insurance would result in a smaller estimate of male/female compensation inequality than measuring wages alone. The same is generally true for blacks, although their health insurance gap is much closer in magnitude to their wage gap. For Hispanics, the health insurance gap is nearly identical to the wage gap and both are increasing over time. Thus, Levy finds no evidence that adding health insurance to estimates of labor market compensation inequality would widen disparities for women versus men, blacks versus whites, or Hispanics versus whites.

Industrial Organization of Medical Care

NBER researchers have played an important part in the application of industrial organization approaches to medical care issues. There continues to be a great deal of interest in the behavior of for-profit and not-for-profit institutions, which often compete with one another in, for example, markets for hospital services. It is widely believed that for-profit and not-for-profit hospitals offer different service mixes, in part because for-profits more aggressively seek well-insured patients. In an analysis of American Hospital Association data for every U.S. urban, acute care hospital (1988–2000), Jill R. Horwitz asks how service profitability affects hospital specialization, comparing government, non-government nonprofit, and for-profit hospitals.[26] She categorizes more than 30 services as relatively profitable, unprofitable, or variable. For-profits are most likely to offer relatively profitable medical services; government hospitals are most likely to offer relatively unprofitable services; nonprofits fall in the middle. For-profits are also more responsive to changes in service profitability than the other two types.

These different approaches to service mixes should affect the financial performance of the different ownership types. Yu-Chu Shen and colleagues apply meta-analytical methods to synthesize studies that investigate the effect of ownership on hospital financial performance, focusing on two questions: 1) what is the magnitude of the ownership effect on financial performance? 2) how do differences in analytic methods and other study features affect the estimates of ownership effect?[27] In a systematic review of 41 studies, they find that the diverse results in the hospital ownership literature can be explained largely by differences in underlying theoretical frameworks, assumptions about the functional form of the dependent variables, and model specifications. Weaker methods and functional forms tend to predict larger differences in financial performance between not-for-profits and for-profits. The combined estimates across studies suggest little difference in cost among all three types of hospital ownership, and that for-profit hospitals generate more revenue and greater profits than not-for-profit hospitals, although the difference is only of modest economic significance. There is little difference in revenue or profits between government and not-for-profit hospitals.

To study the interaction between competing not-for-profit and for-profit hospitals, Duggan asks whether the behavior of private not-for-profit hospitals is systematically related to the share of nearby hospitals organized as for-profit firms.[28] His findings show that the not-for-profit hospitals in areas with predominantly for-profit hospitals are significantly more responsive to a change in financial incentives than their counterparts in areas served by few for-profit providers. Differences in financial constraints and other observable factors correlated with for-profit hospital penetration do not explain the heterogeneous response. The findings suggest that not-for-profit

hospitals mimic the behavior of private for-profit providers when they actively compete with them.

Modifying physician behavior, and understanding how physicians respond to incentives, is an increasing focus of policy as interest in pay-for-performance and other programs to improve the quality of health care has grown. Physician incentives are controversial because they may induce doctors to make treatment decisions that are not in the best interests of their patients. Martin Gaynor, James B. Rebitzer, and Lowell J. Taylor examine the effect of physician incentives in an HMO network.[29] They set out a theoretical framework for assessing the degree to which incentive contracts do in fact induce physicians to deviate from a standard guided only by patient interests and professional medical judgment. They analyze details of an HMO's incentive contracts, along with internal expenditure records, in their empirical evaluation of the model. They estimate that the HMO's incentive contract provides a typical physician an increase, at the margin, of ten cents in income for each dollar reduction in medical utilization expenditures. The average response is a 5 percent reduction in medical expenditures. These researchers also find suggestive evidence that financial incentives linked to commonly used quality measures may stimulate an improvement in measured quality.

The economics of the pharmaceutical industry remains an important topic both because the industry is an important source of major advances in care and because the industry has undergone dramatic change in the past decade. Perhaps the most visible manifestation of change has been industry consolidation; the success of mergers is a matter of interest not only to investors but also to anyone concerned with pharmaceutical innovation. Patricia M. Danzon, Andrew Epstein, and Sean Nicholson examine the determinants of merger and acquisition activity in the biotech and pharmaceutical industry between 1985 and 2000, as well as the impact of a merger on a firm's market value, employment, R and D expenditures, and sales.[30] They find evidence supporting the hypothesis that firms merge in part to avoid having excess capacity once their products lose patent protection and/or their late-stage drugs fail in clinical trials. This analysis of post-merger performance strongly confirms the importance of controlling for pre-merger firm characteristics. Once the researchers control for a firm's propensity to merge, they find that mergers have very little effect on a firm's subsequent growth in market value, employees, R and D expenditures, and sales among large biotech/pharmaceutical firms. For small firms, however, mergers appear to be an effective growth strategy, presumably because mergers provide a source of funds for financially distressed firms.

Other Health Care Program Research

Health Care Program research spans a wide range of other areas. For example, Christopher Ruhm has studied the relationship between the macroeconomy and health, showing that mortality increases during economic downturns.[31] And, David Meltzer has examined how a change in the organization of hospital care — placing hospitalized patients in the hands of "hospitalist" physicians who devote nearly all of their work time to inpatient care — can both lower costs and improve hospital outcomes.

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Consumption and Saving: Theory and Evidence

Christopher D. Carroll*

Consumption and saving decisions are at the heart of both short- and long-run macroeconomic analysis (as well as much of microeconomics). In the short run, spending dynamics are of central importance for business cycle analysis and the management of monetary policy. And in the long run, aggregate saving determines the size of the aggregate capital stock, with consequences for wages, interest rates, and the standard of living.

Since the pioneering work of Friedman and of Modigliani and Brumberg in the 1950s, the principal goal of the economic analysis of saving has been to formulate mathematically rigorous theories of behavior. But that goal was difficult until recently because the optimal response of saving to uncertainty was difficult to compute. Research was generally carried out under the assumption that uncertainty might boost saving somewhat, but that behavior in the presence of uncertainty was likely to be broadly similar to optimal behavior in a world in which households had perfect foresight about their future circumstances.

In two papers that grew out of my 1990 dissertation,[1] I showed that the presence of uncertainty could change the nature of optimal behavior in qualitatively and quantitatively important ways. Specifically, I examined the optimal behavior of consumers with standard attitudes toward risk (constant relative risk aversion) facing income uncertainty of the kind that appears to exist in household-level data sources. The first paper found that target or "buffer-stock" saving may be optimal under some circumstances; the second paper found that, depending on households' income profiles and their degree of impatience, it can be optimal for average household spending patterns to mirror average household income profiles over much of the life cycle. This was surprising because, in models without uncertainty, optimizing consumers spend based on their expected lifetime resources without regard to the expected timing of income. That is, spending patterns by age are not intrinsically determined by income patterns by age. (This work, and my subsequent related work, assumes that consumers have successfully solved any "self-control" problems of the type that David Laibson and others have so persuasively described).

This paper was related to two other, more abstract, papers. The more fundamental of these,[2] written with Miles Kimball, showed that in the presence of uncertainty, households with low levels of wealth will respond more to a windfall infusion of cash than households with ample resources. The other paper[3] demonstrated that the logic of precautionary saving undermines the standard "Euler equation" method of testing for optimizing consumption behavior.

Mathematical and computational aspects of optimal behavior have remained a theme in my research to the present. A recent paper provides the rigorous foundations for the mathematical methods employed in my earlier work.[4] Another paper with Miles Kimball[5] explores the theoretical implications of borrowing limitations; and, a very short new paper describes a conceptual trick that can be used to simplify and accelerate the solution of many kinds of optimal intertemporal choice models.[6] As an aid to other researchers, I have posted on my web page computer software that implements this trick to solve a variety of standard optimization problems. My web page also contains software that reproduces the computational and empirical results in most of my published papers, as well as a set of lecture notes (and associated software) that provide a comprehensive treatment of the methods for solving these models.[7]

In the end, however, mathematical models are useful only insofar as they can be related to empirical evidence about the real world. Toward the end of matching theory and data, Andrew Samwick and I wrote two papers[8,9] whose goal was to get a quantitative sense of the nature and magnitude of household responses to uncertainty. The first of these papers found that a standard source of microeconomic data, the Panel Study of Income Dynamics, implied that income uncertainty was very large indeed. According to the benchmark specification, a conservative estimate was that in any given year about a third of households could expect their "permanent" income to rise or fall by as much as 10 percent. ("Permanent" changes in income here mean the kind of change associated with a promotion

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or being laid off and settling for a new lower-paying job). The second paper with Samwick estimated that as much as 40 percent of the wealth held by the typical household represented a response to the fact that some households face greater uncertainty than others.

An important caveat about these results is that many of the wealthiest households are missing from the PSID dataset on which the estimates are based. Since a large proportion of aggregate wealth is held by the richest few percent of households, these estimates very likely overstate the proportion of aggregate wealth that can be attributed to precautionary motives. Indeed, another paper[10] showed that the theoretical model used in the first paper with Samwick severely underpredicts the wealth holdings of the wealthiest households in the United States even if wealthy individuals are assumed to be more patient than others. That paper argued that a bequest motive in which bequests are a "luxury" good is essential to explaining why saving rates of wealthy households are so high. A subsequent paper[11] showed that the "bequests as luxuries" model can also explain a variety of facts about the portfolio choices of wealthy households, particularly their comparatively high tolerance for financial risk.

Another potential problem with my work with Samwick is that we were forced by data limitations to make the assumption that income risk is something over which people have no control. If instead people make employment choices based partly on the riskiness of the different alternatives (for example, if risk-averse people seek civil service jobs while the risk-lovers become entrepreneurs), then the estimated effect of uncertainty on saving might be incorrect. The likeliest effect would be to underestimate the importance of precautionary behavior, since the theory tends to suggest that those who dislike risk more will both avoid risky occupations and save more. But in an attempt to get around this problem, Karen Dynan and Spencer Krane and I wrote a paper[12] that used temporary regional variations in unemployment risk (over which individual households have no control) to measure the size of uncertainty. Empirical results in that paper suggested that precautionary motives for saving were more important for people in the upper half of the income distribution, and that precautionary behavior is manifested partly in a reluctance to borrow against home equity when unemployment is high, rather than an explicit accumulation of greater liquid assets.

If uncertainty matters this much for spending decisions on average, it seems plausible that the changes in uncertainty that accompany business cycles might be an important source of fluctuations in consumer spending. Wendy Dunn and I showed[13] that while there does not seem to be any systematic relationship between spending and various measures of households' financial condition, measures of consumers' degree of uncertainty (especially their assessment of whether the unemployment rate is likely to rise) have a powerful impact on spending (particularly purchases of big-ticket items like vehicles and houses).

In fact, the model in that paper suggested that, if anything, the mystery is why uncertainty-driven fluctions in expenditures on durable goods are not even larger. According to the model, most of the people who were on the verge of buying a car should be willing to postpone their purchase in response to even a very modest increase in uncertainty. While the evidence confirms that durable goods spending is indeed more volatile than spending on nondurables like food, the size of the discrepancy is not as large as the rational optimization model tends to suggest it should be.

This finding seems to fit with the results of an earlier paper with David N. Weil[14] which found that, across countries, the relationship between aggregate saving and aggregate growth is not what would be expected from the standard framework in which spending depends on expectations about future income. The problem is that people living in fast-growing economies should expect their future incomes to be large relative to their current incomes, and should therefore be borrowing to finance their current expenditures, while people in slow-growing economies should anticipate that they may need to save a lot if they wish to maintain their current standard of living in the future. The logic therefore suggests that we should expect to see a negative association between saving and growth.

One objection to this thread of reasoning might be that countries' saving rates differ partly for cultural reasons, and it seems natural to expect that countries whose saving rates are high because of a cultural preference for saving would consequently exhibit high growth. Byung-Kun Rhee and Changyong Rhee and I used data on immigrants to Canada[15] to investigate the possibility that cultural differences explain saving differences. Under the "cultural" theory of saving, one might expect that immigrants from high-saving countries (for example, Japan) to save more than immigrants from low-saving countries (for example, Sweden). But we found no evidence of such a pattern, either in Canada or in a subsequent study using Census data from the United States.[16]

Furthermore, the evidence clearly suggests that the relationship between saving and growth is dynamic, not static: countries that go through periods of prolonged growth tend to experience rising saving rates, while countries that experience sustained economic slowdowns tend to suffer declining saving rates.

Both the sluggish response of spending to uncertainty and the pattern in which increases (or decreases) in growth produce increases (respectively, decreases) in saving might be explained by a model in which spending "habits" exert a powerful influence on behavior. A paper with Jody Overland and David N. Weil[17] explored how the incorporation of spending habits modifies the predictions of a model of optimal spending behavior. A subsequent paper[18] incorporated both habits and uncertainty, and argued that the broad patterns of saving and growth seen in the East Asian "tiger" economies could be explained in a model where both precautionary motives and habit formation were important. This work meshes with

a prominent strand of the macroeconomics and finance literatures over the past decade that has argued that habit formation can explain a wide range of empirical observations that are difficult to reconcile with standard models without habits.

A new paper with Jirka Slacalek,[19] however, casts doubt on the view that habits are the right explanation for the sluggishness of aggregate spending dynamics. This paper points out that habits imply that spending dynamics should be similar in microeconomic and macroeconomic data. Yet empirical studies using microeconomic data, using exactly the same methods as applied to macroeconomic data, find very different results. While the data hint that there may be some modest habit formation effects in a few categories of spending, models in which habits are a dominant force in microeconomic spending decisions can be decisively rejected.

The new paper relates to another strand of my research, which argues that economists should pay more attention than has been customary to the evidence provided by surveys of households. A 2001 NBER working paper proposed modeling household survey data on inflation expectations using a simple model of disease transmission. The idea is that rather than forming their own independent views of the likely future inflation rate, typical people's views are formed by exposure to the views of experts as represented in the news media. In this model, households' forecasts of inflation, while not fully "rational" in the economist's usual strict sense of the term, do not deviate very long or very far from the experts' view. The paper presented empirical evidence that information in newspaper reports about inflation seems to filter out to the population gradually rather than instantly. The proposed model can be interpreted as providing a concrete theoretical justification for the model of "sticky expectations" that has become increasingly popular in the macroeconomics literature in recent years. (The NBER working paper was subsequently split into two papers, one containing the empirical evidence and a stripped-down version of the model, and the other examining a detailed examination of the epidemiological modeling framework and its application).[20]

The paper with Slacalek proposes to reconcile the microeconomic and macroeconomic evidence about consumption dynamics by applying the same model of sticky expectations. The essential idea is that people have a very good understanding of the circumstances they face in their own lives (for example, they know whether they have been fired), but they do not pay as much attention to macroeconomic developments (for example, they may not know the latest aggregate unemployment statistic). Since household-specific uncertainty is much greater than aggregate uncertainty (a rough estimate is that household-specific risks are about 100 times larger than macroeconomic risks), it makes sense for busy consumers to pay less than perfect attention to the macroeconomy.

Whether or not this particular explanation for the conflict between microeconomic and macroeconomic data on consumption dynamics is accepted, this conflict seems likely to be a topic of growing attention over the next few years. While great progress has been made in understanding the quantitative implications of alternative models of consumption and saving behavior, much remains to be understood.

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Child Health and Human Capital

Janet Currie*

When economists use the phrase "human capital," it generally means "education." But one's health can also be viewed as a form of capital. Both education and health are strongly influenced by "family background," which is commonly measured using parent's education and income. Much of my research over the past decade seeks to evaluate the effect of public programs designed to improve the outcomes of children from disadvantaged backgrounds. In my forthcoming book, *The Invisible Safety Net: Protecting the Nation's Poor Children and Families*, I argue that while the cash welfare system receives more attention, elements of a largely invisible safety net of in-kind programs have proven remarkably effective in improving the lives of poor children.[1]

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Intervention Programs

For example, my work with Eliana Garces and Duncan Thomas shows that Head Start (a pre-school intervention for poor children) improves long-term outcomes for disadvantaged children, although it does not bring these children up to the level of their more advantaged peers. Using a special supplement to the Panel Study of Income Dynamics, we ask whether children who attended Head Start had better outcomes (on a range of measures) than their own siblings who did not attend. We find that among whites, children who attended Head Start were about 25 percent more likely to have completed high school than their siblings who did not. Among African-Americans, the Head Start children were half as likely to have been booked or charged with a crime. This is the first study to show a lasting effect of Head Start.[2]

Still, programs like Head Start remain "black boxes," in that we know little about exactly why they work. It is possible that much of the beneficial effect of Head Start is not through explicitly educational interventions but rather through mandates to improve nutrition, link families with community services, and increase utilization of preventive health care.[3]

Head Start's emphasis on getting children into care remedies an important limitation of programs that focus primarily on extending health insurance via such programs as Medicaid or the State Child Health Insurance Program (SCHIP). Lack of health insurance remains an important issue, but is not the major determinant of child health. One reason is that providing eligibility for health insurance does not always lead people to use care appropriately. In a broader review of the "take up" of social programs, I discuss the low take-up rate among individuals eligible for public health insurance; this is an important social problem that reduces the use of preventive care and may increase the use of expensive palliative care.[4]

SES and Child Health

Maternal education is one important determinant of take-up and of other health behaviors. However, it has been difficult to demonstrate this relationship empirically because maternal education is a choice. To tackle this problem, Enrico Moretti and I compiled data on openings of two- and four-year colleges between 1940 and 1990. We used data about the availability of colleges in the woman's county of residence in her seventeenth year as an instrument for her education at the time of her child's birth. We found that higher maternal education does improve infant health, as measured by birth weight and gestational age. It also increases the probability that a new mother is married, reduces parity (birth order), increases use of prenatal care, and reduces smoking, thus suggesting that these are important pathways for the ultimate effect on health.[5]

In subsequent work, Moretti and I created a unique longitudinal dataset of California births from the 1960s to the present in order to investigate the relationship between maternal income (measured at the time of the mother's birth and at the time of the child's birth), maternal birth weight, and the child's birth weight. We used names and birth dates to link the records of mothers and children and also identified mothers who were siblings. We showed that there is a strong inter-generational correlation in the birth weight of mothers and children, but that a measure of household income at the time of the mother's birth is also predictive of low birth weight in her child. Our most interesting finding is that there is an interaction between maternal low birth weight and maternal poverty in the production of child low birth weight. Together these findings suggest that inter-generational correlations in health could play a role in the inter-generational transmission of income. Parent's income affects child health, and health at birth affects future income.[6]

The relationship between family income and child health starts at birth but grows stronger as children age, even in countries with universal health insurance such as Canada. Using a panel of Canadian children, Mark Stabile and I show that the health of poor children relative to that of richer children worsens with age, just as it does in the United States. We argue that this deterioration may be related to a higher "arrival rate" of negative health shocks among poor children. For example, poor children are more likely than richer ones to have new chronic conditions diagnosed at virtually all ages, and they are also more likely to be hospitalized.[7] Perhaps surprisingly, in our data, both rich and poor children were equally likely to recover from any given health shock. Identifying the sources of these health shocks and policies that may prevent them is an important avenue for future research.

Threats to Child Health

One example of a negative health shock not prevented by conventional medical care is unintentional injuries. Such injuries are a leading cause of death among children over the age of one in the United States. Joseph Hotz and I show that accident rates are responsive to child care policy — they are lower among children in care when the care givers are more educated — although stiffer child care regulations may also increase accident rates among children pushed out of regulated care by higher prices.[8]

Pollution is another factor that affects disadvantaged children disproportionately. In our study of the effects of air pollution in California on infant health, Matthew Neidell and I find that the most polluted zip codes have 50 percent more mothers who are high school dropouts than the least polluted ones. This complicates our attempts to identify the causal effect of pollution. We use individual-level vital statistics data to investigate the effects of criterion air pollutants on infant mortality, fetal deaths, low birth weight, and prematurity. Our models are identified using within-the-zip-code level variation in pollution levels that remains after controlling for seasonal patterns and weather. We find that the reductions in carbon monoxide (CO) and particulates (PM10) that occurred over the 1990s saved more than 1,000 infant lives in California.[9]

Nutrition is a key determinant of health that is receiving increasing attention, given an "epidemic" of obesity and obesity-related diseases such as diabetes. I have examined the determinants of child nutrition in a series of studies with Jayanta Bhattacharya, Steven Haider, and Thomas Deliere. We find that poverty is an important predictor of nutritional outcomes among preschool children, but not among school-aged children. However, "food insecurity" (missing meals or being afraid that there will not be sufficient money to buy food) is not predictive of poorer nutritional outcomes among either group of children (although it could be viewed as a bad outcome in itself). Nevertheless, there are many children with nutritional deficiencies, even among those who consume too many calories.[10]

Using data from the National Health and Nutrition Examination Surveys, we also find that poor families reduce expenditures and calories consumed in response to cold weather shocks (a "heat or eat" effect), although we find no evidence that this affects the quality of the diet. Despite recent concerns about inadequacies in child nutrition programs, we find that the School Breakfast program improves the quality of children's diets.[11] Taken as a whole, these studies suggest that there is a link between poverty and poor child nutrition that is mitigated by the food safety net that is in place, particularly for school aged children.

While most of the economic research on child health focuses on physical health, mental health may be much more important. The majority of workdays lost among adults are attributable to mental health problems, and many such problems have their roots in childhood. The best available estimates suggest that mental health problems may be much more prevalent among poor than among non-poor children, confounding attempts to measure the effects of mental illness per se. Stabile and I use nationally representative samples of U.S. and Canadian children to

examine the medium-term outcomes of children with symptoms of Attention Deficit Hyperactivity Disorder (ADHD), the most common child mental health problem.[12]

Rather than relying on diagnoses, we use "screener" questions administered to all children, and we use sibling fixed effects to control for omitted variables such as poverty. We find large negative effects on test scores and schooling attainments, and positive effects on the probability of being placed in special education. The effects are remarkably similar in Canada and the United States. Moreover, the effects are approximately linear, suggesting that even moderate symptoms have costs in terms of educational attainment. In contrast, physical health problems such as asthma are found to have insignificant effects. These results indicate that mental health conditions might well prove to be a "missing link" between family background, child health, and educational attainments.

The Role of Health Insurance

Despite the key role of family background and non-medical threats to child health, most discussions of disparities in child health focus not on more general interventions, such as Head Start, but rather on the role of health insurance. I have continued to study Medicaid, the main system of public health insurance for poor women and children. Using individual-level vital statistics data, Jeffrey Grogger and I find that state welfare reforms prior to 1996 were associated with reductions in the use of prenatal care and with negative impacts on infant health, presumably because women who went off the welfare rolls were no longer automatically eligible for Medicaid coverage.[13]

Over the 1990s, most states switched their Medicaid caseloads from traditional fee-for-service to some form of Medicaid managed care (MMC). Like the managed care programs that cover most privately insured Americans, MMC restricts access to services in order to reduce costs. In the case of Medicaid patients, though, it has been argued that managed care might have some offsetting benefits for patients. For instance, it would guarantee access to providers who were contractually obligated to treat Medicaid patients, whereas under the fee-for-service system, many providers did not accept Medicaid.

However, incentives facing providers are complex and may result in many consequences that were not intended by legislators. John Fahr and I find that the introduction of MMC in California was accompanied by shifts in the composition of the Medicaid caseload away from black children, and that black children who lost coverage were subsequently more likely to go without doctor visits. Using a panel of all California births among mothers in the 1990s, Anna Aizer, Moretti, and I are able to follow mothers who were required to join MMC plans between births. We find that mothers forced to switch to MMC were more likely to delay prenatal care and to suffer adverse birth outcomes than other mothers.[14]

Aizer and I also examine estimates of "network effects" in the utilization of public prenatal care services provided under the Medicaid program. We find that these effects are similar for first-time mothers and for second-time mothers who have already used prenatal care services. This suggests that the measured effects do not represent transmission of information about the services between network members, because mothers who have already used the services presumably know about them. Moreover, the estimated effects are much reduced when we control for the hospital of delivery. Perhaps surprisingly, women who live in the same neighborhoods, but who are from different ethnic groups, tend to deliver in different hospitals. These results suggest that it is the enrollment services provided by hospitals, and not the woman's "network," that facilitates access to Medicaid-sponsored prenatal care services.[15]

In summary, my research points to a holistic view of child human capital development that encompasses educational attainment, physical, and mental health, and seeks to explore the feedbacks between them. Interventions to reduce the transmission of poverty from one generation to the next could perhaps be improved if we understood these linkages better.

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Estate Taxation

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Taxation of estates and inheritances is one of the most controversial issues in tax policy. While this type of taxation is viewed by some as an integral part of a system that guarantees equality of opportunities, others describe it as a "death tax" and argue that it is both inherently unfair to levy a tax at death and that it is particularly costly to do so, highlighting its adverse effect on wealth accumulation, discrimination against savers, negative consequences for the survival of small businesses, and a multitude of avoidance opportunities.

From an economist's point of view, estate taxation touches on a wide array of important topics. It is a form of a tax on capital. It is heavily progressive, with U.S. federal tax rates currently approaching 50 percent and exceeding 70 percent in the past. It is closely tied to the propagation of inequality and the impact of redistribution. It affects the intergenerational mobility of wealth. Its impact and its cost depend on the presence and nature of a bequest motive. How individuals plan for leaving an estate depends also on their acceptance and attitudes toward their own death, thus providing a natural place for looking for examples of the importance of psychological considerations. The U.S. estate tax is nominally a tax on individuals, but its incidence depends on family structure and interrelationships. The tax has been dubbed a "voluntary tax," highlighting that tax avoidance and administration issues are also very important.

Estate taxation has figured in economic research in three different ways. First, one may be interested in understanding how the actual estate tax affects economic decisions. Second, there is an important theoretical question regarding the role that this type of taxation should play in the tax system. Third, the existing data on estate taxpayers provides a source of information that can shed light on central economic, but non-tax, issues. In my research, I have pursued each of these directions.

In a few of my papers, I looked at how transfer taxation affects economic decisions. The notion that the estate tax forces people to make difficult late-in-life, even deathbed, decisions, has its place in the political discourse about the tax, but is it really true? Using linked estate and income tax data, I studied how estates of people who suffered from a lengthy illness differ from estates of those who died instantaneously.[1] I found that the size of the reported estate (of wealthy estate taxpayers) is as much as 20 percent lower for decedents whose terminal illness lasted months or more, but I also showed that

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this effect is unlikely to be explained by medical expenses or lost wages. Instead, I found strong evidence pointing to a flurry of estate planning activity following the onset of a terminal illness, that results in a reduction in the value of the reported taxable estate and therefore tax liability.

How strongly do estates respond to estate taxation? By exploiting more than 80 years of IRS data covering multiple tax regimes, and age variation of estate tax decedents, Joel Slemrod and I estimate an elasticity of reported estates with respect to the net-of-tax rate of about -0.16, suggesting that the estate tax does in fact reduce reported estates, either because it curtails wealth accumulation or induces tax avoidance, or both.[2] Note, though, that (as has been argued in the taxable income elasticity literature, including my own work) both avoidance and wealth accumulation channels entail similar short-term efficiency costs, although the longer-term implications are likely very different.[3] In another joint paper, we also show that the estate tax has important implications for charitable contributions.[4] Finally, we demonstrated that the reported timing of death is sensitive to tax considerations: in a four-week period surrounding estate tax reforms, more taxable deaths are observed during the "low-tax" regime than during the "high-tax" regime.[5] We were, unfortunately, unable to conclude how much of this response represents the strength of willpower of tax-averse individuals and how much reflects cheating by their beneficiaries, but this finding provides another example of the variety of behavioral responses that individuals pursue in response to tax incentives.

From the theoretical point of view, one way of thinking about taxation of estates is as a tax on capital. Under the standard model of perfect altruism, the question of how to tax estates reduces to the question of how to tax capital with infinitely lived agents, and there is a large and growing literature on the subject. However, the relationship between a tax on estates and a tax on wealth or capital income depends crucially on the nature of the bequest motive. Any theoretical analysis of estate taxation requires taking a stand on the nature of intergenerational links. Unfortunately, despite a lot of research on this topic, there is no consensus regarding the types of bequest motive or even the prevalence of *any* bequest motive. Joseph Lupton and I revisit the influential work of Michael Hurd,[6] who demonstrated that people with and without children have similar consumption patterns in the old age, thereby putting in question the possibility that they have different bequest considerations.[7] We relax the assumption that children are a deterministic indicator of a bequest motive, and instead show that consumption patterns of the elderly are explained by a parsimonious structural two-type model with both bequest-motive and no-bequest types. We estimate that the first group constitutes three-fourths of the population but that for most people the difference between the bequest and non-bequest consumption patterns is small, and only at the very top of the wealth distribution do these differences become economically important. Overall, we find no evidence that having children is an important indicator of the presence of a bequest motive.

One popular argument for taxation of estates is that a tax on "accidental" bequests, that is, on savings of non-annuitized individuals subject to stochastic mortality, is particularly efficient because it does not stimulate any behavioral response. I show that this reasoning is potentially misleading, because non-annuitization may be due to a market failure that can be addressed by government policy.[8] Theoretically, such an intervention could reduce or eliminate accidental bequests altogether and would be preferred to their taxation. I also show that estate taxation may provide implicit annuitization (the necessary and sufficient condition being that the present value of estate tax payments falls with age), and argue that it does so in practice. In principle, such an annuity should be welcome by individuals who do not have access to actuarially fair insurance markets.

Although the timing of death is uncertain, it does occur eventually with probability one, and a forward-looking planner should have a contingency plan in place. As mentioned earlier, my research shows that much estate planning takes place shortly before death, suggesting that procrastination in this context is plausible. One possibility is that standard models do not accurately represent how people incorporate mortality risk in their behavior. Borrowing from the psychological literature on terror management theory, Joel Slemrod and I explore the consequences of utility-reducing fear in acknowledging one's own mortality.[9] We equip agents with a fear function that increases with subjective mortality risk and the ability to repress information. We conclude that such agents are "behavioral;" in particular, we find that such individuals have an incentive to behave in a time-inconsistent fashion regardless of whether they actually repress information or not.

The U.S. federal estate tax was introduced in 1916. It has always applied to a relatively small group of the wealthiest decedents; applying at the peak of its coverage in the 1970s to over 7 percent of adult deaths, and at its minimum coverage to less than 0.5 percent. Its long history and its focus on the top of the distribution make estate tax statistics a natural source for studying long-term changes in wealth concentration. This is what Emmanuel Saez and I have done.[10] We relied on (unfortunately confidential) IRS micro databases that include all of the estate tax returns filed between 1916 and 1945, samples for a few years between 1962 and 1976, and annual samples starting in 1982, and supplemented this data with published tabulations for other years. We applied the estate-multiplier technique (that amounts to weighting individuals by the inverse of their mortality risk) and constructed estimates of wealth controlled by groups within the top 2 percent of the wealth distribution going back to 1916. Similar to findings from studies of the long-term evolution of income inequality for example, (Piketty and Saez, 2003),[11] we find that wealth concentration decreased rapidly in the 1930 and 1940s but there is no evidence of an increase in past 20 years. This latter result is particularly puzzling in light

of the sharp increase in income concentration over this period. However, these findings are consistent with the Survey of Consumer Finances (for broader wealth categories), as documented by John Karl Scholz.[12]

One potential explanation that we offer for the lack of an increase in wealth concentration is that increases in income concentration were driven by labor rather than capital incomes, so it may be that not enough time has passed for the increase in wealth accumulation concentration to materialize. Another potential factor is changing income mobility. However, Emmanuel Saez, Jae Song, and I study longitudinal Social Security earnings data that allow us to trace the same individual over long periods of time and therefore to understand how income mobility has evolved over the past 50 years (and with less detail since 1937). In our still preliminary work, we find no evidence that mobility of earnings has changed much over time.[13]

My work with Lena Edlund provides a different perspective for thinking about long-term changes in wealth concentration.[14] We observe that the gender distribution of estate taxpayers evolved over time. In particular, the number of women among the very wealthy estate taxpayers (top 0.01 percent) rose until the 1960s, but has been declining since the 1970s. We argue that the gender distribution of the wealthy group reveals the relative importance of self-made and inherited wealth. While women and men inherit from their parents about equally, entrepreneurship remains predominantly the domain of men. This notion is strongly supported by the Forbes 400 list of the richest Americans. There are of course many potentially confounding factors that can affect the number of women at the very top of the wealth distribution, such as bequests to widows, changes in gender-specific mortality and the age gap between spouses, community property rules and tax treatment of married couples that we discuss in detail. We reach the conclusion that the relative importance of self-made wealth in the twentieth century indeed followed a U-shaped pattern: it decreased in the 1930s and 1940s, and has been increasing since the 1970s. Reconciling it with the flat wealth concentration series in the past 20 years therefore requires that the relative wealth from inheritances has been declining, while self-made wealth has been increasing. These findings are consistent with the pattern observed in the Forbes list, where the fraction of people classified as deriving their wealth from inheritance halved over the past 20 years, and with Census data about self-employment and the number of employers. The results also provide an important qualification to the interpretation of the drop in income and wealth concentration in the 1930s and 1940s: our findings suggests that entrepreneurial wealth declined during that period more than inherited wealth did. This is further supported by historical lists of the wealthy, which show that the importance of inherited wealth at the top of the wealth distribution peaked after World War II.

Whether the estate tax in the United States will remain an important issue depends on the fate of its ongoing phase-out that culminates in complete repeal scheduled to occur in 2010. As is well known, the repeal is part of a set of provisions that sunset in 2011, so that current law specifies that in 2011 the estate tax will revert to its 2001 version. Policymakers have provided researchers with a rich set of experiments that will help in years to come in understanding the effect of estate taxation itself and, perhaps more importantly, other economic decisions related to death and intergenerational transfers.

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6 *M. Hurd, "Savings and Bequests," NBER Working Paper No. 1826, November 1989, and "Mortality Risk and Bequests,"* Econometrica, *57 (1989), pp. 360–99.*

7 *W. Kopczuk and J. Lupton, "To Leave or not To Leave: The Distribution of Bequest Motives," NBER Working Paper No. 11767, November 2005, forthcoming in the* Review of Economic Studies*.*

8 *W. Kopczuk, "The Trick is to Live: Is the Estate Tax Social Security for the Rich?" NBER Working Paper No. 9188, September 2002, and* Journal of Political Economy, 111 (2003), pp. 1318–41.

9 *W. Kopczuk and J. Slemrod, "Denial of Death and Economic Behavior," NBER Working Paper No. 11485, July 2005, and* Advances in Theoretical Economics*, The B.E. Journals of Theoretical Economics, 5 (2005).*

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12 *J. K. Scholz, "Wealth Inequality and the*

Wealth of Cohorts," May 2003, University of Wiconsin, mimeo.

[13] *W. Kopczuk, E. Saez, and J. Song, "Earnings Mobility in the United States, 1937–2004: Evidence from Social Security Administration Data," work in progress.*

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Rules for Monetary Policy

Michael Woodford*

Much of my recent research has sought to use economic analysis to determine the consequences of alternative rules for the conduct of monetary policy, and to formulate rules that will be desirable from the standpoint of individual welfare. Interest in the study of monetary rules has increased over the past decade, for reasons having to do with progress in central banking and progress in macroeconomic theory. On the one hand, many central banks — most notably, but not only, the "inflation targeting" banks — have increasingly come to organize their policy deliberations around an attempt to conform to specific targets or objectives, sometimes explicit quantitative targets. Moreover, central banks worldwide have increased the degree to which they discuss their decisions with financial market participants and the general public, and this too has increased the importance that the banks assign to having a clear framework to guide their deliberations. At the same time, the development of a new generation of quantitative macroeconomic models — that can be estimated using macroeconomic time series and have optimizing foundations that allow an explicit evaluation of outcomes in terms of individual welfare — has allowed modern macroeconomic analysis to be brought to bear on the evaluation of stabilization policies, in the context of models with sufficient claim to quantitative realism to be of interest to policymaking institutions. My own work has sought to extend the analysis of optimal monetary policy rules in directions that bring the theoretical literature into closer contact with the practical concerns of modern central bankers.[1]

Inflation Stabilization and Welfare

One goal of my research has been to clarify which kinds of macroeconomic stabilization objectives best serve economic welfare. Grounding the objectives of policy in consumer welfare has a number of advantages: one avoids the arbitrariness otherwise attendant upon the choice of a particular definition of "price stability," "full employment" or other conventional objectives. And, it also makes possible a natural integration of the theory of optimal monetary policy with the theory of optimal taxation. Yet it is not immediately obvious what the conventional goals of monetary stabilization policy — especially the nearly universal emphasis that central banks place on maintaining a low and stable inflation rate — have to do with consumer welfare; after all, the arguments of household utility functions generally are assumed to be the quantities of various goods and services, but not their prices. Nonetheless, I have shown that in familiar classes of sticky-price dynamic stochastic general equilibrium (DSGE) models — models that incorporate key elements of the current generation of empirical models of the monetary transmission mechanism, and even some relatively small complete macro models — it is possible to show that the expected utility of the representative household varies inversely with the expected discounted value of a quadratic loss function, the arguments of which are measures of price and wage inflation on the one hand and measures of real activity relative to a (time-varying) target level of activity on the other.[2] Thus, it makes sense to rank alternative monetary policies according to how well they stabilize (an appropriate measure of) inflation on the one hand, and how well they stabilize (an appropriate measure of) the output gap on the other. The theory clarifies both the appropriate definition of these stabilization objectives, and the appropriate relative weights to assign to them when a choice must be made between them.

The answer obtained depends, of course, on the structure of the economy.[3] In particular, inflation variability reduces welfare because of the presence of nominal rigidities; the precise nature of these rigidities determines the appropriate form of the inflation-stabilization objective. For example, if wages are flexible (or there are efficient contracts in the labor market), and price adjustments are staggered in the way assumed in the popular specification proposed by Guillermo Calvo[4] (with an equal prob-

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ability of any given price being revised in any time period), then inflation variation results in distortions caused by the misalignment of prices that are adjusted at different times. The resulting welfare losses are proportional to the expected discounted sum of squared deviations of the inflation rate from zero. Other assumptions about the timing of price adjustments also imply that inflation variations reduce welfare, but with a different form of loss function, and thus a different ranking of equilibria in which prices are not completely constant. For example, if the probability of adjustment of an individual price is increasing in the time since that price was last reviewed — a specification that is both intuitively plausible and more consistent than the simple Calvo specification with empirical models of inflation dynamics[5] — then welfare losses are proportional to a discounted sum of squared deviations of the current inflation rate from a moving average of recent past inflation rates, rather than deviations from zero.[6] The goal of policy then should be to keep inflation from differing too greatly from the current "inertial" rate of inflation, which implies that inflation should not be reduced too abruptly if it has been allowed to exceed its optimal long-run level.[7] A similar conclusion is obtained if prices are assumed to be automatically indexed to a lagged price index, as in the well-known empirical model of Christiano, Eichenbaum, and Evans[8] and related studies, or if some prices are adjusted in accordance with a backward-looking "rule of thumb," as proposed in the empirical model of inflation dynamics of Jordi Gali and Mark Gertler.[9]

The theory also provides important insights into the question of *which* price index or indexes it is more important to stabilize. Again, the answer depends on the nature of the nominal rigidities. If prices are adjusted more frequently in some sectors of the economy than in others, then the welfare-theoretic loss function puts more weight on variations in prices in the sectors where prices are stickier, as first shown by Kosuke Aoki.[10] This provides a theoretical basis for seeking to stabilize an appropriately defined measure of "core" inflation rather than an equally weighted price index. Pierpaolo Benigno has used reasoning of this kind to argue that a monetary union would maximize welfare by seeking to stabilize an index that does not weight the different countries' inflation rates strictly in proportion to the size of their economies,[11] as is true of the inflation measure used in the European Central Bank's definition of its price stability objective. Similarly, if wages are sticky as are goods prices, as implied by many empirical DSGE models, then instability in the rate of growth of a broad index of nominal wages results in distortions similar to those created by variations in goods price inflation. If wages are staggered in accordance with the Calvo specification, then the welfare-theoretic loss function includes a term proportional to the squared rate of goods price inflation and another term proportional to the squared rate of wage inflation each period. In this case, optimal policy involves a tradeoff between inflation stabilization, nominal wage growth stabilization, and output-gap stabilization, as first shown by Chris Erceg, Dale Henderson, and Andy Levin.[12]

Analysis of these questions has required careful consideration of the conditions under which a linear-quadratic (LQ) stabilization policy problem (minimization of a quadratic loss function subject to constraints that represent the log-linearized structural relations of a DSGE model) yields a correct local approximation to optimal policy in the exact DSGE model. In fact, it is not generally sufficient that the loss function be a correct quadratic local approximation to household utility — if that local approximation involves non-zero linear terms, then a correct second-order approximation to utility cannot be obtained by substituting into the approximate objective a solution for the equilibrium under a given policy that is accurate only to *first* order.[13] For this reason, much of the recent literature seeking to evaluate policy rules in DSGE models has found it necessary to compute second-order perturbation expansions as an approximate characterization of equilibrium outcomes under a given rule.

But Benigno and I have shown that it is possible, in the case of quite a broad class of optimal policy problems in DSGE models, to find a quadratic loss function that correctly approximates expected utility under any policy, yet involves no non-zero linear terms. In that way, welfare can be evaluated to second order using only a first-order (log-linear) solution for the equilibrium under a candidate policy.[14] Essentially, our method incorporates into the loss function itself the second-order effects of stabilization policy on the average levels of endogenous variables in a second-order perturbation solution of the model. This allows us to consider how the existence of steady-state distortions (attributable either to market power or, more importantly, to taxes) affects the relative weights that should be placed on alternative stabilization objectives. Under the specifications that we regard as most empirically realistic, the importance of inflation stabilization relative to output-gap stabilization is *increased* the more distorted is the economy's steady-state level of output; this is because stabilization of inflation does more to increase the *average* level of output than does stabilization of output, and this consideration is more important for welfare the more sub-optimal is the steady-state level of output.[15]

Expectations and Optimal Policy

My research has emphasized that, when choosing a policy to best serve the goal of stabilization, it is crucial to take account of the effects of the policy's systematic component on people's expectations of future policy. For this reason, my work has focused largely on the study of policy *rules:* this forces one to think about the systematic patterns that one can expect to be anticipated by sufficiently sophisticated market participants.

Taking account of the effects of systematic policy on policy anticipations

has important consequences for the conclusions one reaches about optimal policy, some of which are counter-intuitive. One fairly general result is that optimal policy will not be purely forward-looking; that is, it will not depend solely upon what can be achieved with respect to the stabilization objectives now, or in the future, but also on *past* conditions that no longer affect what is currently possible to achieve. A history-dependent policy can improve stabilization outcomes, to the extent that it is correctly anticipated, by changing people's expectations about subsequent policy at the time that economic disturbances occur. And, an appropriate shift in expectations often can mitigate the degree to which the disturbances interfere with macroeconomic stability.[16]

For example, I have shown that when one takes account of forward-looking behavior, it can be desirable for a central bank to only gradually adjust its operating target for overnight interest rates when underlying fundamentals change, rather than jumping immediately to a new level that depends only on current conditions. This kind of policy inertia — often argued to characterize actual central bank behavior, but frequently assumed to indicate a failure of central bankers to fully optimize — can reduce the amplitude of the swings in short-term interest rates required to stabilize inflation and real activity in response to real disturbances. It allows market participants to anticipate that the movements in short rates that occur will be more persistent, resulting in a larger effect on long rates and other asset prices, which are what matter for the effect of policy on aggregate demand.[17] Hence calls for central bankers to respond more promptly to changes in conditions in order to avoid "getting behind the curve" may actually be counter-productive.

Prescriptions for purely forward-looking policy in the name of optimization also characterize many normative discussions of inflation-forecast targeting. Central banks that base their interest-rate decision on projections of the future evolution of inflation and other variables often are directed to choose among alternative possible scenarios on the basis of a purely forward-looking criterion. But such an approach may lead to time-inconsistent choices, and even when it does not, it will almost inevitably lead to policy that is insufficiently inertial.[18] An optimal outcome can in fact often be achieved through a procedure focused on ensuring that projections satisfy an appropriate target criterion at all times, but the criterion should be history-dependent. The acceptable transition path along which the inflation rate and output gap should be projected to return to their medium-term target levels will depend on recent past conditions.[19]

Purely forward-looking policy can be especially harmful when the zero lower bound on short-term nominal interest rates is reached, as in Japan for the past several years, and as some feared could occur in the United States in 2003. When the zero bound is reached, further monetary stimulus is possible *only* by shifting expectations about future policy. But if policy is expected to be conducted in a purely forward-looking way in the future, then there will be no reason for the public to expect looser policy in the future simply because the zero bound currently prevents interest rates from being cut as sharply as would be needed to create demand in line with the economy's productive capacity. Gauti Eggertsson and I have shown that this can result in a protracted and severe deflationary contraction, even when the same real fundamentals would be consistent with a much more benign outcome in the case of alternative policy expectations. A desirable outcome requires advance commitment to a history-dependent policy, under which rates will be kept unusually low for a period of time even after fundamentals have recovered, even though higher rates would be called for under the latter conditions if one were determined to avoid generating inflationary pressures.[20] It is arguable that the Bank of Japan's emphasis (prior to 2001) on its determination to end loose monetary policy as quickly as possible prolonged the Japanese deflation unnecessarily.[21] When the possibility of a similar situation arose in the United States, the Fed undertook a bold experiment with policy signaling, committing to maintain a low federal funds rate "for a considerable period" as a substitute for further interest-rate cuts. This seems to have dissipated the market anxiety about premature tightening that had threatened to derail the U.S. recovery.[22]

A possible objection to advice of this kind is that theoretical analyses of optimal policy that assume a rational expectations equilibrium consistent with whatever kind of systematic policy is adopted exaggerate the degree of precision with which a central bank can expect to control the expectations of market participants simply by disciplining its own procedures. In recent work, I have sought to relax this assumption by assuming instead only that the central bank should expect that private-sector expectations about the future evolution of the economy will not be *too far* from model-consistency, as measured by a relative-entropy criterion (which ensures that the public will not believe in patterns that they should be able to reject on the basis of even short time series). One can then characterize the optimal policy decision of the central bank if it wishes to choose a *robust* policy — one that is not too bad even under the worst of the outcomes that can occur under "near-rational expectations." My analysis shows that the qualitative conclusions of the rational-expectations analysis of optimal policy continue to apply. For example, policy commitment continues to be important — indeed, the losses resulting from discretionary policy are *even greater* in the case of allowance for near-rational expectations; and optimal policy continues to be history-dependent — in fact, even *more* history-dependent than if the central bank could count on the public's having precisely model-consistent expectations.[23]

Optimal Target Criteria for Policy

One way of specifying a rule for the conduct of policy that has both practical and normative relevance is in terms of a

"target criterion" that the central bank is committed to ensure is satisfied (or at least, projected to be satisfied) each time its instrument setting is reviewed.[24] The criteria used by inflation-forecast targeting central banks, such as the Bank of England (which seeks to ensure that CPI inflation is always projected to reach its target level of 2 percent per year at a horizon two to three years in the future), are an example of commitments of this kind. They represent the closest approximation to the ideal of rule-based policymaking yet observed. At the same time, target criteria often provide an especially convenient way of characterizing optimal policy. For example, it may be possible to specify optimal policy in this way independently of the parameters governing the statistical properties of the economic disturbances affecting the economy; the target criterion is then a particularly robust characterization of optimal policy.

Marc Giannoni and I have shown that in the case of a very general class of linear-quadratic policy problems, it is possible to derive a target criterion that is robustly optimal in the sense just described: a credible commitment to ensure that the criterion holds at all times will implement an optimal equilibrium, regardless of the statistical properties of the various types of exogenous disturbances, as long as they are all additive, mean-zero disturbances.[25] The precise form of the optimal target criterion depends, however, on the non-stochastic part of the structural equations of one's model of the transmission mechanism. In the case of a canonical "New Keynesian" model, with an aggregate-supply relation of the kind implied by flexible wages and Calvo-style staggered pricing, the optimal target criterion is a "flexible inflation target," under which short-run departures of the inflation rate from a constant long-run target level should vary inversely with the projected growth in the output gap. Such a criterion would allow inflation to increase temporarily in response to a positive cost-push shock, for example, given the expected decline in the output gap, although the amount that inflation should be allowed to increase will be strictly limited by the required proportionality between the inflation projection and the projected output-gap change. After the real effects of the disturbance dissipate, the rate at which the output gap should be returned to zero will be determined by the necessity of programming lower-than-average inflation during a period of output-gap growth. Anticipation of this kind of history-dependent policy should restrain price increases during the period of high costs, mitigating the temporary effect of the shock on the available inflation/output tradeoff at the cost of a slower recovery.[26] And, because the projected medium-term growth rate of the output gap will always be zero, a credible commitment to such a criterion would never allow ambiguity about the medium-term outlook for inflation, despite the existence of transitory variations in the inflation rate in response to shocks.

More complex (and realistic) economic models imply that a more complex target criterion would be needed to implement a fully optimal policy. For example, if the likelihood of a price revision increases with the time since the last revision, then the optimal target criterion allows the short-run inflation projection to be an increasing function of recent past inflation Thus temporary increases in inflation should not be immediately reversed. (Other sources of intrinsic inflation inertia, such as the kind of indexation commonly assumed in current-vintage empirical DSGE models, lead to a similar conclusion.) If wages and prices are sticky, then the optimal target criterion involves projected nominal wage growth as well as projected goods price inflation.

Moreover, if a binding lower bound on interest rates sometimes forces targets to be missed, then the target criterion in subsequent periods should be adjusted in proportion to the size of the targeting errors. This would create the kind of anticipations of history-dependent policy that mitigate the distortions created by the lower-bound constraint.[27]

Given the dependence of the optimal target criterion on model structure, research of this kind cannot hope to derive a single rule that would represent a universally optimal policy prescription. And in any event, even a minimally realistic degree of complexity in one's model implies that a fully optimal criterion will be more complex than any principle for guiding policy deliberations that one can imagine actually being adopted at a central bank.[28] Nonetheless, I believe that the study of optimal target criteria for fairly simple environments that capture important features of more realistic models can suggest qualitative features of desirable target criteria. For example, one important conclusion from my study of this topic is that an optimal target criterion almost surely will not be focused so exclusively on projected outcomes two or more years in the future, as are the criteria that currently are used at the leading inflation-targeting central banks, at least according to their official rhetoric. In a realistic model, a commitment of this form is unlikely even to suffice to determine an appropriate short-term policy stance, in the absence of auxiliary assumptions such as a constant interest rate over the projection horizon, while the forecast-targeting exercise is likely to be time-inconsistent with the addition of such an assumption.[29] An approach that is both coherent and transparent would instead require central banks to commit themselves in advance to clear criteria for judging the acceptability of the transition paths along which an economy is expected to return to its normal state following a disturbance.

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[1] *These developments are described in more detail in* Interest and Prices: Foundations of a Theory of Monetary Policy, *Princeton University Press, 2003.*

[2] *This approach was first illustrated in J. J. Rotemberg and M. Woodford, "An Optimization-Based Framework for the Evaluation of Monetary Policy,"* NBER Macroeconomics Annual *12: pp. 297–346 (1997). The general method is discussed in "Inflation Stabilization and Welfare," NBER Working Paper No. 8071, January 2001, and* Contributions to

Macroeconomics *2(1), article 1 (2002). The results of the latter paper are generalized in P. Benigno and M. Woodford, "Inflation Stabilization and Welfare: The Case of a Distorted Steady State," NBER Working Paper No. 10838, October 2004, and* Journal of the European Economics Association *3: pp.1185–236 (2005).*

[3] *The results summarized here are discussed further in* Interest and Prices *[cited footnote 1], chapter 6.*

[4] *G. A. Calvo, "Staggered Prices in a Utility-Maximizing Framework,"* Journal of Monetary Economics *12: pp. 383–98 (1983).*

[5] *A. Wolman, "Sticky Prices, Marginal Cost, and the Behavior of Inflation,"* Federal Reserve Bank of Richmond Economic Quarterly *85: pp. 29–48 (1999); R. Mash, "Optimizing Microfoundations for Inflation Persistence," Oxford University Department of Economics discussion paper no. 183, January 2004; K. D. Sheedy, "Structural Inflation Persistence," working paper, Cambridge University, November 2005.*

[6] *K. D. Sheedy, "Resistance to Persistence: Optimal Monetary Policy Commitment," working paper, Cambridge University, November 2005.*

[7] *This is not the conclusion that Sheedy draws from his loss-function derivation in the paper cited in footnote 6. For my own analysis of the consequences of intrinsic inflation inertia, see* Interest and Prices *[cited footnote 1], section 7.1; and M. P. Giannoni and M. Woodford, "Optimal Inflation Targeting Rules," NBER Working Paper No. 9939, September 2003, and in B. S. Bernanke and M. Woodford, eds.,* The Inflation Targeting Debate, *University of Chicago Press for NBER, 2005.*

[8] *L. J. Christiano, M. Eichenbaum, and C. Evans, "Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy," NBER Working Paper No. 8403, July 2001, and* Journal of Political Economy *113: pp. 1–45 (2005).*

[9] *J. Gali and M. Gertler, "Inflation Dynamics: A Structural Econometric Analysis,"* Journal of Monetary Economics *44: pp. 195–222 (1999). A welfare-theoretic loss function is derived for this model in J. Steinsson, "Optimal Monetary Policy in an Economy with Inflation Persistence,"* Journal of Monetary Economics *50: pp. 1425–56 (2003).*

[10] *K. Aoki, "Optimal Monetary Policy Responses to Relative Price Changes,"* Journal of Monetary Economics *48: pp. 55–80 (2001). Aoki's analysis is generalized in* Interest and Prices *[cited footnote 1], section 4.3.*

[11] *P. Benigno, "Optimal Monetary Policy in a Currency Area,"* International Economic Review *44: pp. 195–222 (1999).*

[12] *C. J. Erceg, D. W. Henderson, and A. T. Levin, "Optimal Monetary Policy with Staggered Wage and Price Contracts,"* Journal of Monetary Economics *46: pp. 281–313 (2000). This derivation is generalized in P. Benigno and M. Woodford, "Optimal Stabilization Policy when Wages and Prices are Sticky: The Case of a Distorted Steady State," NBER Working Paper No. 10839, October 2004, and in J. Faust, A. Orphanides, and D. Riefschneider, eds.,* Models and Monetary Policy, *Federal Reserve Board, 2005.*

[13] *For further discussion of the general problem and a demonstration of the pitfalls of "naïve" LQ approximation, see* Interest and Prices *[cited footnote 1], section 6.1, and P. Benigno and M. Woodford, "Optimal Taxation in an RBC Model: A Linear-Quadratic Approach," NBER Working Paper No. 11029, January 2005.*

[14] *Our method was first introduced in P. Benigno and M. Woodford, "Optimal Monetary and Fiscal Policy: A Linear-Quadratic Approach," NBER Working Paper No. 9905, August 2003, and* NBER Macroeconomics Annual *18: pp. 271–333 (2003). It is also illustrated in the Benigno and Woodford papers cited in footnotes 2, 12, and 13 above. A general algorithm for the application of this method to the derivation of LQ approximations to policy problems is discussed and illustrated in F. Altissimo, V. Curdia, and D. Rodriguez Palenzuela, "Linear-Quadratic Approximation to Optimal Policy: An Algorithm and Two Applications," working paper, European Central Bank, September 2005.*

[15] *Benigno and Woodford, "Inflation Stabilization" [cited footnote 2].*

[16] *"Pitfalls of Forward-Looking Monetary Policy,"* American Economic Review *90(2): pp. 100–4 (2000); and* Interest and Prices *[cited footnote 1], chapter 7.*

[17] *"Optimal Monetary Policy Inertia," NBER Working Paper No. 7261, July 1999; parts of this paper appear in revised form in "Optimal Interest-Rate Smoothing,"* Review of Economic Studies *70:pp. 861–86 (2003). The desirability of policy inertia is also analyzed in more complex models in J. J. Rotemberg and M. Woodford, "Interest-Rate Rules in an Estimated Sticky-Price Model," NBER Working Paper No. 6618, June 1998, and in J. B. Taylor, ed.,* Monetary Policy Rules, *University of Chicago Press for NBER, 1999; and in M. P. Giannoni and M. Woodford, "How Forward-Looking is Optimal Monetary Policy?"* Journal of Money, Credit and Banking *35(6–2): pp. 1425–69 (2003).*

[18] *"Commentary: How Should Monetary Policy be Conducted in an Era of Price Stability?" in Federal Reserve Bank of Kansas City,* New Challenges for Monetary Policy, *1999.*

[19] *L. E. O. Svensson and M. Woodford, "Implementing Optimal Policy through Inflation-Forecast Targeting," NBER Working Paper No. 9747, June 2003, and in B.S. Bernanke and M. Woodford, eds.,* The Inflation Targeting Debate, *University of Chicago Press for NBER, 2005.*

[20] *G. B. Eggertsson and M. Woodford, "The Zero Bound on Interest Rates and Optimal Monetary Policy,"* Brookings Papers on Economic Activity *2003–1: pp. 139–211.*

[21] *More recently, the BOJ has consciously sought to signal an intention not to tighten prematurely, at least partially along the lines argued for by Eggertsson and myself; see, for example, K. Ueda, "The Bank of Japan's Struggle with the Zero Lower Bound on Nominal Interest Rates: Exercises in Expectations Management," CIRJE discussion paper, University of Tokyo, September 2005.*

[22] *For discussions of this episode, see my "Central-Bank Communication and*

Policy Effectiveness," NBER Working Paper No. 11898, December 2005; and B. S. Bernanke, V. R. Reinhart, and B. P. Sack, "Monetary Policy Alternatives at the Zero Bound: An Empirical Assessment," Brookings Papers on Economic Activity *2004–1: pp. 1–78.*

[23] *"Robustly Optimal Monetary Policy under Near-Rational Expectations," NBER Working Paper No. 11896, December 2005.*

[24] *An important early discussion is by L. E. O. Svensson, "Inflation Forecast Targeting: Implementing and Monitoring Inflation Targets,"* European Economic Review *41:pp. 1111–46 (1997).*

[25] *M. P. Giannoni and M. Woodford, "Optimal Interest-Rate Rules: I. General Theory," NBER Working Paper No. 9419, January 2003.*

[26] *Both this paragraph and the following one are based on Giannoni and Woodford [cited footnote 7].*

[27] *Eggertsson and Woodford [cited footnote 20].*

[28] *See, for example, the optimal target criterion derived for a small empirical model in Giannoni and Woodford [cited footnote 7].*

[29] *"Inflation Targeting and Optimal Monetary Policy,"* Federal Reserve Bank of St. Louis Economic Review, *July/August 2004, pp. 15–41.*

NBER Profile: *Christopher Carroll*

Christopher Carroll is an NBER Research Associate in the Programs on Monetary Economics and Economic Fluctuations and Growth and Professor of Economics at the Johns Hopkins University in Baltimore. Originally from Knoxville, Tennessee, he received his A.B. in Economics from Harvard University in 1986 and his Ph.D. from the MIT in 1990.

After graduating from MIT, he worked at the Federal Reserve Board in Washington, where his responsibilities included preparation of the forecast for consumer expenditure. He moved to the Johns Hopkins University in 1995, but spent 1997–8 working at the President's Council of Economic Advisers in Washington; there, his responsibilities included analysis of Social Security reform proposals, tax and pension policy, and bankruptcy reform.

Carroll's research has focused primarily on consumption and saving behavior, with an emphasis on reconciling the empirical evidence from both microeconomic and macroeconomic sources with theoretical models. In addition to articles in economics journals, he has written *Encyclopedia Britannica* articles on consumption-related topics. He was also the recipient of an Alfred P. Sloan Foundation early career fellowship and of the TIAA-CREF/Samuelson Certificate of Excellence for his work on precautionary saving behavior over the life cycle.

Carroll's recent research has focused on models of the dynamics of expectations formation, particularly on how expectations reflect households' learning from each other and from experts. This focus flows from a career-long interest in consumer sentiment and its determinants. He is also an associate editor at the *Review of Economics and Statistics* and the *Journal of Business and Economic Statistics*.

Carroll lives in Columbia, Maryland with his wife, Jennifer Manning. His interest in economics dates from early in his life: his father recently retired from a career as Professor of Economics at the University of Tennessee, where he taught Industrial Organization for many years.

NBER Profile: *Wojciech Kopczuk*

Wojciech Kopczuk is a Faculty Research Fellow in the NBER's Public Economics Program. He is also an Associate Professor of Economics and International and Public Affairs at Columbia University.

Kopczuk received his M.Sc. in Computer Science from Warsaw University (Poland) in 1996 and his Ph.D. in Economics from the University of Michigan in 2001. Before moving to Columbia University in 2003, he was an assistant professor at the University of British Columbia.

Kopczuk was the recipient of an Alfred P. Sloan Research Fellowship (2005) and — somewhat less proudly, but jointly with Joel Slemrod — of the 2001 IgNobel Prize in Economics. His research interests include behavioral responses to income and estate taxation, tax avoidance and administration, optimal taxation and tax systems, evolution of wealth and income inequality, and the nature of intergenerational linkages.

Kopczuk lives in New York City with his wife, Joanna, and son, Kuba. When he used to have free time, he wasted it playing the game of "Go," tinkering with his Microsoft-free computer, and listening to music described by one of his colleagues as "head-banging".

NBER Profile: *Michael Woodford*

Michael Woodford is a Research Associate in the NBER's Programs on Economic Fluctuations and Growth and Monetary Economics and the John Bates Clark Professor of Political Economy at Columbia University. He received his A.B. from the University of Chicago, his J.D. from Yale Law School, and his Ph.D. in economics from MIT.

Woodford began his academic career at Columbia in 1984 and moved to the University of Chicago in 1986. He became a full professor at Chicago in 1992. In 1995, Woodford left for Princeton, where he served as the Harold H. Helm '20 Professor of Economics and Banking until 2004. He has been at Columbia since 2004.

Woodford has been a Visiting Professor in universities throughout the United States and in several foreign countries. He is a Consultant to the Federal Reserve Bank of New York, and also has served as a Consultant to the European Central Bank and the Banco Central do Brasil, and as Professorial Fellow in residence at the Reserve Bank of New Zealand. He is a Fellow of the American Academy of Arts and Sciences and of the Econometric Society.

Woodford's research has been published in all of the major economic journals. His 2003 *Interest and Prices: Foundations of a Theory of Monetary Policy,* published by Princeton University Press, won the Association of American Publishers Award for Best Professional/Scholarly Book in Economics. His most recent book, *The Inflation Targeting Debate,* co-edited with Federal Reserve Chairman Ben S. Bernanke, was published by the University of Chicago Press in 2005.

Woodford lives in Manhattan with his wife, Argia Sbordone, an economist at the Federal Reserve Bank of New York, and their daughter, Antonia. He enjoys running, movies, and off-Broadway theater.

Conferences

Seventh Annual Conference in India

On January 15-17, 2006 the NBER and India's National Council for Applied Economic Research (NCAER) again brought together a group of NBER economists and about thirty economists from Indian universities, research institutions, and government departments for their seventh annual conference in India. **Mihir A. Desai** and **Martin S. Feldstein,** NBER and Harvard University, organized the conference jointly with **Suman Bery** of NCAER.

The U.S. participants were: David Autor, Esther Duflo, and Glenn Ellison, NBER and MIT; Jagdish Bhagwati, Columbia University; Mihir A. Desai, Martin S. Feldstein, and Robert T. Jensen, NBER and Harvard University; Daniel Kessler, NBER and Stanford University; Anne O. Krueger and Raghuram Rajan, on leave from the NBER at the IMF; Arvind Subramanian, IMF; Richard H. Thaler, NBER and University of Chicago; John Wallis, NBER and University of Maryland; and David Weil, NBER and Brown University.

After introductory remarks about the U.S. and Indian economies by NBER President Feldstein and Bimal Jalan of NCAER, the participants discussed: globalization; growth; trade; financial policies; social infrastructure; energy and regulation; and taxation and public finance.

Partial support for this project comes from the Institute for Financial Management and Research in India.

Bureau News

NBER Researchers Head to DC

Edward P. Lazear, an NBER Research Associate in the Labor Studies, Aging, and Education Programs who has been affiliated with the NBER since 1978, is the new Chairman of the President's Council of Economic Advisers. As such, he succeeds several NBER Research Associates who have held that position: Martin Feldstein, Michael Boskin, Joseph Stiglitz, R. Glenn Hubbard, N. Gregory Mankiw, and Ben S. Bernanke.

Lazear is a Professor of Economics at Stanford University's Graduate School of Business and a Senior Fellow at the Hoover Institution. The other two current members of the President's Council of Economic Advisers are also former NBER researchers: Matthew Slaughter and Katharine Baicker.

In a related development, Randall S. Kroszner is a new member of the Federal Reserve Board of Governors. A former professor of economics at the University of Chicago's Graduate School of Business, Kroszner has been affiliated with the NBER since 1998. He was a Research Associate in the NBER's Programs on Corporate Finance and the Development of the American Economy. Kroszner will serve under Bernanke, who is a former Director of the NBER's Program on Monetary Economics and was a professor at Princeton. Bernanke was confirmed by the Senate on January 31 and sworn in the following day; his four-year term as Fed Chairman ends January 31, 2010, and his 14-year term as a Fed member ends January 31, 2020.

Velasco to Become Chile's Finance Minister

Andres Velasco, a Research Associate in the NBER's Program on International Finance and Macroeconomics and Professor of Economics at Harvard's Kennedy School of Government, has been picked as Chile's new finance minister. Velasco, who has been affiliated with the NBER since 1994, was among the first appointments of Chile's new President, Michelle Bachelet.

NBER Announces 2006 Nonprofit Fellowships

NBER Research Associate James M. Poterba has announced the recipients of NBER Fellowships for the Study of Nonprofit Institutions for the 2006–7 academic year. This NBER fellowship program is designed to encourage research on nonprofit institutions by NBER Research Associates and Faculty Research Fellows, and by graduate students in economics working closely with them through support of dissertation research on the same subject. A selection committee consisting of Charles Clotfelter, David Cutler, Steven Levitt, A. Mitchell Polinsky, and Poterba selected the award recipients from a pool of 24 applicants.

The four graduate students who will receive fellowship support are: Jillian Berk, Brown University, who will analyze non-profit organizations that manage prisons; Brianna Briggs, University of California, Santa Barbara, who will study faith-based organizations providing welfare services in Los Angeles; Yee Wai Chong, Stanford University, who will investigate the business activities of non-profit organizations in the arts and other fields; and Marit Rehavi, University of California, Berkeley, who will examine the inter-year dynamics of household charitable giving.

Faculty grants will go to: Ginger Jin, University of Maryland, for work on "College and University Reactions to the Publication of School Rankings," a project on how colleges adapt their behavior in response to published data that ranks schools on various dimensions; and Sendhil Mullainathan, Harvard University, for "Psychological Drivers of Giving," a project on how marketing strategies, framing, and other factors affect the success of charitable fund-raising.

Indian Economy

The NBER's Working Group on the Indian Economy met in Cambridge on December 16, 2005. Working Group Director Mihir A. Desai of Harvard University, organized this program:

Abhijit Banerjee, MIT; **Shawn Cole,** Harvard University; **Esther Duflo,** MIT and NBER; and **Leigh Linden,** Columbia University, "Remedying Education: Evidence from Two Randomized Experiments in India"

Esther Duflo, and **Rema Hanna,** New York University, "Monitoring Works: Getting Teachers to Come to School"

Jagadeesh Sivadasan, University of Michigan, and **Joel Slemrod,** University of Michigan and NBER, "Tax Law Changes, Income Shifting, and Measured Wage Inequality: Evidence from India"

Kalpana Kochhar, Utsav Kumar, Arvind Subramanian, and **Ioannis Tokatlidis,** International Monetary Fund, and **Raghuram Rajan,** International Monetary Fund and NBER, "India's Pattern of Development: What Happened, What Follows"

Siddhartha G. Dastidar, Columbia University; **Raymond Fisman,** Columbia University and NBER; and **Tarun Khanna,** Harvard University, " Limits to Policy Reversal: Privatization in India"

I. Serdar Dinc, University of Michigan, and **Nandini Gupta,** Indiana University, " The Decision to Privatize: The Role of Political Competition and Patronage"

Eric Edmonds and **Nina Pavcnik,** Dartmouth College and NBER, and **Petia Topalova,** Yale University, " Trade Liberalization, Child Labor, and Schooling: Evidence from India"

Kaivan Munshi, Brown University and NBER, and **Mark Rosenzweig,** Yale University, "Why is Mobility in India so Low? Social Insurance, Inequality, and Growth"

Marianne Bertrand, University of Chicago and NBER; **Simeon Djankov,** The World Bank; **Rema Hanna;** and **Sendhil Mullainathan,** MIT and NBER, " Is Corruption Efficient? Getting a Driving License in New Delhi"

Many efforts to improve school quality by adding school resources have proven to be ineffective. **Banerjee, Cole, Duflo**, and **Linden** present the results of two experiments conducted in Mumbai and Vadodara, India, designed to evaluate ways to improve the quality of education in urban slums. A remedial education program hired young women from the community to teach basic literacy and numeracy skills to children lagging behind in government schools. The authors find the program to be very effective: it increased average test scores of all children in treatment schools by 0.14 standard deviations in the first year, and 0.28 in the second year, relative to comparison schools. A computer-assisted learning program provided each child in the fourth standard with two hours of shared computer time per week, in which

students played educational games that reinforced mathematics skills. The program was also very effective, increasing math scores by 0.36 standard deviations the first year, and 0.54 the second year. These results were not limited to the period in which students received assistance, but persisted for at least one year after leaving the program. Two instrumental variable strategies suggest that while remedial education benefited the children who attended the remedial classes, their classmates, who did not attend the remedial courses but did experience smaller classes, did not post gains, confirming that resources alone may not be sufficient to improve outcomes.

In the rural areas of developing countries, teacher absence is a widespread problem. **Duflo** and **Hanna** test whether a simple incentive program based on teacher presence can reduce teacher absence, and whether it has the potential to lead to more teaching activities and better learning. In sixty informal one-teacher schools in rural India, randomly chosen out of 120 (the treatment schools), a financial incentive program was initiated to reduce absenteeism. Teachers were given a camera with a tamper-proof date and time function, along with instructions to have one of the children photograph the teacher and other students at the beginning and end of the school day. The time and date stamps on the photographs were used to track teacher attendance. A teacher's salary was a direct function of his attendance. The remaining sixty schools served as comparison schools. The introduction of the program resulted in an immediate decline in teacher absence. The absence rate (measured using unannounced visits both in treatment and comparison schools) changed from an average of 42 percent in the comparison schools to 22 percent in the treatment schools. When the schools were open, teachers were as likely to be teaching in both types of schools, and the number of students present was roughly the same. The program positively affected child achievement levels: a year after the start of the program, test scores in program schools were 0.17 standard deviations higher than in the comparison schools and children were 40 percent more likely to be admitted into regular schools.

Changes to the income tax law relating to wages and profits could provide incentives for shifting income from wages to profits (or vice versa), with important implications for measured wage inequality. **Sivadasan** and **Slemrod** use a large dataset covering all registered plants in the manufacturing sector in India (over the period 1986 to 1995) to examine the effects of an income tax law change (effective from 1992) that eliminated the double taxation of wages paid to partners in partnership firms. They find an immediate and pervasive response by partnership firms to the tax law change, reflected in a significant shifting of income from profits to managerial wages. This shift has important implications for measured wage inequality, since about half of registered manufacturing plants are incorporated in the form of partnerships (including most family-run businesses). They find a significant jump in the mean and median relative wage of skilled workers (which includes managers and partners) following the tax law change in 1992. This sudden increase in measured wage inequality follows major trade liberalization and deregulation reforms announced in July 1991. They also find that the income shifting induced by the tax law change explains almost all of the observed increase in measured wage inequality; this finding is robust to inclusion of controls for a number of other potential sources of post-liberalization increases in wage inequality. Once they control for income shifting, they find a much more moderate increase in wage inequality, in line with the pre-1991 trends. These results show that income shifting responds strongly to tax incentives, highlighting the need to control for the potential effects of tax incentives in studies of wage inequality.

India seems to have followed an idiosyncratic pattern of development, certainly compared to other fast-growing Asian economies. While the emphasis on services rather than manufacturing has been widely noted, within manufacturing India has emphasized skill-intensive rather than labor-intensive manufacturing, and industries with typically higher average scale. **Kochhar, Kumar, Rajan, Subramanian**, and **Tokatlidis** show that some of these distinctive patterns existed even prior to the beginning of economic reforms in the 1980s, and argue that they stem from the idiosyncratic policies adopted soon after India's independence. The authors then look to the future, using the growth of fast-moving Indian states as a guide. Despite recent reforms that have removed some of the policy impediments that might have sent India down its distinctive path, it appears unlikely that India will revert to the pattern followed by other countries.

Dastidar, Fisman, and **Khanna** examine the effect of regime change on privatization using the 2004 election surprise in India. In that election, the pro-reform BJP was unexpectedly defeated by a less reformist coalition. Government controlled companies that were being studied for complete privatization by the BJP dropped by 7.5 percent relative to private firms. By contrast, government controlled firms that were not being considered for privatization, or firms that had already been fully privatized, did not experience a significant drop relative to private firms. Firms that the BJP had slated for definite future privatization experienced intermediate declines of approximately 3.5 percent. The authors interpret this as evidence consistent with investor belief of policy irreversibility in privatization, where reforms may reach a "point of no return" beyond which future regimes have difficulty reversing those policies. Taking advantage of an "intermediate event" where policies were expected to be more heavily influenced by the communist party, the authors still find evidence consistent with policy irreversibility.

Dinc and **Gupta** investigate the role of political competition and patronage in the privatization of government-owned enterprises by using a unique firm-level dataset from India. They find that the government is reluctant to privatize firms located in regions where the ruling party faces more political competition from parties in opposition. They

also find that no government-owned enterprise located in the home state of the politician in charge of that enterprise is ever privatized. These results are robust to firm-level characteristics such as profitability, size, and the influence of labor groups; to industry and time effects; and to state-level differences in income, education, and urbanization.

Few issues are more controversial in the contemporary globalization debate than the effects of trade liberalization on poverty and well-being in low-income countries. The question of how changes in trade policy affect child labor and schooling is particularly contentious. **Edmonds, Pavcnik**, and **Topalova** study the relationship between changes in trade policy and schooling and child labor using detailed household level data from the Indian National Sample Survey (NSS) spanning the period of trade liberalization initiated in 1991. They explore the causal link between liberalization and changes in child labor by relating child labor to district and intertemporal variation in exposure to tariff cuts. During the time period of this study, India experienced dramatic declines in child labor and increases in schooling attendance. However, the authors find that children living in districts more exposed to tariff cuts observed smaller declines in child labor and smaller increases in school attendance. They believe the findings reflect some of the adjustment costs associated with trade liberalization and illustrate how even temporary adjustment costs may have long-term effects on the affected.

Munshi and **Rosenzweig** examine the hypothesis that the persistence of low spatial and marital mobility in rural India, despite increased growth rates and rising inequality in recent years, is attributable to the existence of sub-caste networks that provide mutual insurance to their members. Using unique panel data providing information on caste loans and sub-caste identification, the authors show that households that out-marry or migrate lose the services of these networks, which dampens mobility when alternative sources of insurance or finance of comparable quality are unavailable. At the aggregate level, the networks appear to have coped successfully with the rising inequality within sub-castes that accompanied the Green Revolution. Indeed, this increase in inequality lowered overall mobility, which was low to begin with, even further. These results suggest that caste networks will continue to smooth consumption in rural India for the foreseeable future, as they have for centuries.

To better understand corruption, **Bertrand**, **Djankov**, **Hanna**, and **Mullainathan** carefully follow about 800 individuals through the process of getting a driving license in New Delhi, India. They also generate exogenous variation by randomly assigning people into three groups: control, speed, and lesson. In the speed group, individuals were given bonuses for getting their licenses faster, while in the lesson group, they were given free driving licenses. Moreover, the authors performed a surprise driving test at the end of the study to produce a reliable measure of skill. They document several revealing facts about corruption. First, consistent with theories of endogenous red tape, the bureaucratic system shows a great deal of arbitrariness. While the average person took 30 days to get the license, others took four times as long. Similarly, bureaucrats automatically failed some on their driving exam, many of whom were skilled drivers, in a way that was unrelated to driving skills. Second, the system was very responsive to individual needs. Those who wanted the license faster (for example, the speed group), were able to get it faster. Third, the system was quite insensitive to social needs. Sixty percent of those who got the license were rated as "automatic failures" on the authors' driving test. Tellingly, the group that was given lessons was only slightly more likely to be able to get the license than the control group and less likely than the speed group. Similarly, the speed group got their license faster by simply paying, not by becoming better drivers. These findings reject the "grease-the-wheels" view of corruption, where bribes enhance efficiency. In short, corruption produces bad drivers.

Economic Fluctuations and Growth

The NBER's Program on Economic Fluctuations and Growth met at the Federal Reserve Bank of San Francisco on February 3. NBER Research Associates Steven J. Davis, University of Chicago, and Charles I. Jones, University of California, Berkeley, organized this program:

Mark Aguiar, Federal Reserve Bank of Boston, and **Erik Hurst,** University of Chicago and NBER, "Lifecycle Prices and Production"
Discussant: Richard Rogerson, Arizona State University and NBER

Jonathan Heathcote, Georgetown University; **Kjetil Storesletten,** University of Oslo; and **Giovanni L. Violante,** New York University, "Insurance and Opportunities: The Welfare Implications of Rising Wage Dispersion"
Discussant: Orazio Attanasio, University College London and NBER

Emmanuel Farhi, MIT, and **Ivan Werning,** MIT and NBER, "Inequality, Social Discounting, and Progressive Estate Taxation"
Discussant: Emmanuel Saez, University of California, Berkeley and NBER

Stijn Van Nieuwerburgh and **Laura Veldkamp,** New York University, "Information Immobility and the Home Bias Puzzle"
Discussant: Pierre-Olivier Gourinchas, University of California, Berkeley and NBER

Lars Ljungqvist, Stockholm School of Economics, and **Thomas J. Sargent,** New York University and NBER, "Jobs and Unemployment in Macroeconomic Theory: A Turbulence Laboratory"
Discussant: Robert E. Hall, Stanford University and NBER

Robert Shimer, University of Chicago and NBER, "Mismatch"
Discussant: Ricardo Lagos, New York University

Using scanner data and time diaries, **Aguiar** and **Hurst** document how households substitute time for money through shopping and home production. They find that there is substantial heterogeneity in prices paid across households for identical consumption goods in the same metro area at any given point in time. For identical goods, prices paid are highest for middle aged, rich, and large households, consistent with the hypothesis that shopping intensity is low when the cost of time is high. The data suggest that a doubling of shopping frequency lowers the price paid for a given good by approximately 10 percent. From this elasticity and observed shopping intensity, the authors impute the opportunity cost of time for the shopper that peaks in middle age at a level roughly 40 percent higher than that of retirees. Using this measure of the price of time and observed time spent in home production, they estimate the parameters of a home production function. They find an elasticity of substitution between time and market goods in home production of close to two. Finally, they use the estimated elasticities for shopping and home production to calibrate an augmented lifecycle consumption model. The augmented model predicts the observed empirical patterns quite well. Taken together, these results highlight the danger of interpreting lifecycle expenditure without acknowledging the changing demands on time and the available margins of substituting time for money.

Heathcote, **Storesletten**, and **Violante** provide an analytical characterization of the welfare effects of changes in cross-sectional wage dispersion, using a class of tractable heterogeneous-agent economies with various insurance market structures. They express welfare effects both in terms of changes in the observable joint distribution over individual wages, consumption and hours, and in terms of the underlying parameters defining preferences and the changing nature of wage risk. The analysis reveals an important tradeoff for welfare calculations. On the one hand, as wage uncertainty rises, so does the cost associated with missing insurance markets. On the other hand, greater wage inequality presents opportunities for increasing aggregate productivity by concentrating market work among more productive workers. This productivity gain means that improving the degree of insurance against wage risk offers larger welfare gains than redistributive policies that reduce individual wage variability. In a calibration exercise, the authors find that the observed rise in wage dispersion in the United States over the past three decades implies a welfare loss roughly equivalent to a 2.5 percent decline in lifetime consumption. This number is the net effect of a welfare *gain* of around 5 percent from an endogenous increase in labor productivity, coupled with a *loss* of around 7.5 percent associated with greater dispersion in consumption and leisure.

To what degree should societies allow inequality to be inherited? What role should estate taxation play in shaping the intergenerational transmission of welfare? **Farhi** and **Werning** explore these questions by modeling altruistically-linked individuals who experience privately observed taste or productivity shocks. They also study allocations where the social welfare criterion values future generations directly, placing a positive weight on their welfare so that the effective social discount rate is lower than the private one. For any such difference in social and private discounting, consumption exhibits mean-reversion and a steady-state, cross-sectional distribution for consumption and welfare exists, where no one is trapped at "misery". The optimal allocation can then be imple-

mented by a combination of income and estate taxation. The authors find that the optimal estate tax is progressive: fortunate parents face higher average marginal tax rates on their bequests.

Van Nieuwerburgh and **Veldkamp** note that many explanations for home or local bias rely on information asymmetry: investors know more about their home assets than other assets. One criticism of these theories is that asymmetry should disappear when information is tradable. But if investors have asymmetric prior beliefs, yet choose how to allocate limited learning capacity before investing, they will not necessarily obtain foreign information. Investors want to exploit increasing returns to specialization: the bigger the home-information advantage, the more desirable are home-assets; but the more home-assets investors expect to own, the higher the value of additional home information. Even with a small home information advantage, and even when foreign information is not harder to obtain, many investors will specialize in home assets, remain uninformed about foreign assets, and amplify their initial information asymmetry.

Ljungqvist and **Sargent** use three general equilibrium models with jobs and unemployed workers to study the effects of government mandated unemployment insurance (UI) and employment protections (EP). To illuminate the forces in these models, they study how UI and EP affect outcomes when there is higher "turbulence" in the sense of worse skill transition probabilities for workers who suffer involuntary layoffs. Matching and search-island models have labor market frictions and incomplete markets. The representative family model with employment lotteries has no labor market frictions and complete markets. The adverse welfare state dynamics coming from high UI indexed to past earnings are so strong that they determine outcomes in all three models. The high aggregate labor supply elasticity that emerges from employment lotteries and complete insurance markets in the representative family model implies that when generous government-supplied UI is included, the unrealistic result obtains that economic activity will collapse.

Shimer develops a dynamic model of mismatch. Workers and jobs are randomly assigned to labor markets. Each labor market clears at each instant but some labor markets have more workers than jobs, hence unemployment, and some have more jobs than workers, hence vacancies. As workers and jobs move between labor markets, some unemployed workers find vacant jobs and some employed workers lose or leave their job and become unemployed. The model is quantitatively consistent with the comovement of unemployment, job vacancies, and the rate at which unemployed workers find jobs over the business cycle. It can also address a variety of labor market phenomena, including duration dependence in the job finding probability and employer-to-employer transitions, and it helps explain the cyclical volatility of vacancies and unemployment.

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Insurance Workshop

The NBER's Working Group on Insurance, directed by Kenneth A. Froot of Harvard Business School and Howard Kunreuther, University of Pennsylvania, met in Cambridge on February 10 and 11. Their agenda was:

David M. Cutler, Harvard University and NBER; **Amy Finkelstein**, MIT and NBER; and **Kathleen M. McGarry**, University of California, Los Angeles and NBER, "Preference Heterogeneity and Insurance Markets"
Discussant: Alexander Muermann, University of Pennsylvania

Silke Brandts and **Christian Laux**, Goethe University, Frankfurt, "ART versus Reinsurance: The Disciplining Effect of Information Insensitivity"
Discussant: Morton Lane, Lane Financial

Darius Lakdawalla, RAND Corporation and NBER, and **George Zanjani**, Federal Reserve Bank of New York, "Catastrophic Bonds, Reinsurance, and the Optimal Collateralization of Risk Transfer "
Discussant: Stewart C. Myers, MIT and NBER

Rustam Ibragimov, Harvard University, and **Dwight Jaffee** and **Johan Walden**, University of California, Berkeley, "Non-Diversification Traps in Markets for Catastrophic Risk?"
Discussant: David Durbin, Swiss RE

Panel Discussion: Natural Disaster Insurance
Karen Clark, Applied Insurance Research; Gordon Stewart, Insurance Information Institute; David Moss, Harvard University; and Scott Harrington, University of Pennsylvania
Moderator: Kenneth A. Froot

Martin Grace, **Robert Klein,** and **Zhiyong Liu**, Georgia State University, "Mother Nature on the Rampage: Implications for Insurance Markets"
Discussant: Robert J. Shiller, Yale University and NBER

Francis Ghesquiere and **Olivier Mahul**, The World Bank, and **Luis Jamin**, University de Los Andes, "Earthquake Vulnerability Reduction Program in Colombia: A Probabilistic Cost-Benefit Analysis"
Discussant: Neil Doherty, University of Pennsylvania

Panel Discussion: Terrorism Risk Insurance
Christopher Lewis, The Hartford Financial Services Group; Erwann Michel-Kerjan, University of Pennsylvania; Lloyd Dixon, RAND Corporation; and Gordon Woo, Risk Management Solutions
Moderator: Howard Kunreuther

David Cummins, University of Pennsylvania, and **Yijia Lin** and **Richard Phillips**, Georgia State University, "An Empirical Investigation of the Pricing of Financially Intermediated Risks with Costly External Finance"
Discussant: Anne Gron, Northwestern University

Standard theories of insurance, dating from Rothschild and Stiglitz (1976), stress the role of adverse selection in explaining the decision to purchase insurance. In these models, higher risk people buy full or near-full insurance, while lower risk people buy less complete coverage, if they buy at all. While this prediction appears to hold in some real world insurance markets, including health insurance, in many others, such as life insurance, it is the lower risk individuals who have more insurance coverage. **Cutler**, **Finkelstein**, and **McGarry** consider a simple extension to the standard model in which individuals vary in their risk tolerance as well as risk type, with those with lower tolerance for risk becoming endogenously lower risk through investment in risk reducing activities. Depending on whether this behavioral effect dominates the standard asymmetric information effect, the authors may see higher or lower risk individuals purchasing insurance in equilibrium. They provide an empirical example from the U.S. life insurance industry in which patterns of insurance coverage are consistent with the preference heterogeneity model. Specifically, they show that individuals who engage in risky behavior are both systematically higher risk (higher mortality) and less likely to purchase insurance. They discuss the implications of preference heterogeneity for the existence, nature, and empirical detection of inefficiencies in insurance markets.

Brandts and **Laux** demonstrate a novel benefit of "Alternative Risk Transfer" (ART) products with parametric or index triggers: when a reinsurer has private information about his client's risk, outside reinsurers will price their reinsurance offer less aggressively. Outsiders are subject to adverse selection as only a high-risk insurer might find it optimal to change reinsurers. This creates a hold-up problem that allows the incumbent to extract an information rent. An information-insensitive ART product with a parametric or index trigger is not subject to adverse selection. It can therefore be used to compete against an informed reinsurer, thereby reducing the premium that a low-risk insurer has to pay for the indemnity contract. However, ART products exhibit an interesting fate in this model as they are useful, but not used in equilibrium because of basis-risk.

Catastrophe bonds feature full collateralization of a specific risk, and thus appear to be inefficient risk transfer instruments — ones that completely abandon the modern insurance principle of econo-

mizing on collateral through diversification. **Lakdawalla** and **Zanjani** confirm this paradox in an idealized world of complete insurance contracts, where catastrophe bonds indeed have no role to play. However, the real world admits a potentially important role. Insurers may find it difficult to contract completely over the division of assets in the event of insolvency, and, more generally, difficult to write contracts with a full menu of state contingent payments. Instead, the basic contract promises to indemnify with reference to a particular customer's loss experience only. In this environment, customers of the insurer will have different levels of exposure to default. When contracting constraints limit the insurer's ability to smooth out such differences, there is a potential niche for catastrophe bonds in serving those who would be heavily exposed to default. The authors show that catastrophe bonds may be useful in mitigating differences in default exposure, which arise with contractual incompleteness and heterogeneity among insureds. Heterogeneity is required, because it undermines the efficiency of a mechanical pro rata division of assets that takes place in the event of insurer insolvency.

Ibragimov, **Jaffee**, and **Walden** develop a simple model for markets for catastrophic risk. The model explains why insurance providers may choose not to offer insurance for catastrophic risks and not to participate in reinsurance markets, even though there is enough market capacity to reach full risk sharing through diversification in a reinsurance market. This is a nondiversification trap. The authors show that nondiversification traps may arise when risk distributions have heavy left tails and liability is limited. When they are present, there may be a coordination role for a centralized agency to ensure that risk sharing takes place.

The severe hurricane seasons of 2004 and 2005 and the resulting losses are prompting insurers to reassess their risk and business strategies in Southeastern states. **Grace**, **Klein**, and **Liu** examine recent trends in the affected homeowners insurance markets, analyze factors affecting insurers' adjustments in these markets, and discuss how these markets are likely to further change in response to the reassessment of hurricane risk and regulatory reactions and related policy and regulatory issues. They conduct an econometric analysis of insurers' relative shares of homeowners insurance exposures in Florida statewide and by county over the period 1996-2005. Their analysis indicates several factors that appear to be associated with changes in insurers' share of exposures. Among these factors, publicly traded stock insurers and mutual insurers have tended to increase their presence in the Florida market, although publicly traded insurers have retrenched from the highest-risk areas. Overall, this analysis and the examination of other market data suggest that significant market restructuring has occurred and is likely to continue as some insurers with large numbers of exposures will retrench and other insurers step in to fill the gap. The price of insurance also will increase significantly in high-risk areas, although the magnitude and pace of rate hikes will depend on insurers' risk assessments and regulatory approvals. The supply of insurance and market restructuring will be affected greatly by insurers' reassessments of hurricane risk, the supply and cost of reinsurance, and regulatory policies.

Cost-benefit analysis is a standard tool for determining the costs and benefits, and thus the efficiency, of planned projects. However, one of the major difficulties in risk mitigation investments is that benefits are by nature uncertain as they depend on the occurrence of a natural disaster. In this context, the standard approach relying on the average value of benefits may provide an incomplete picture of the efficiency of the risk mitigation project under consideration. **Ghesquiere**, **Jamin**, and **Mahul** present a probabilistic cost-benefit analysis relying on a catastrophe risk model. It produces risk metrics, thus providing the decision-maker with a more complete risk analysis of the net benefits of the project. This is illustrated with the earthquake vulnerability reduction project in Colombia financed by the World Bank.

Under perfect market conditions, standard capital budgeting theory predicts that the hurdle rates on financially intermediated risk products should reflect only non-diversifiable risk and be constant across firms. However, theoretical research by Froot and Stein (1998), among others, suggests that when firms invest in non-hedgeable assets under conditions where capital is costly, project pricing should reflect the covariability of the project with the firm's existing portfolio, even if this covariability represents non-systematic risk. These researchers argue that their theory is especially applicable to financial institutions pricing intermediated risks. The theoretical research also suggests that the prices of intermediated risks will reflect the capital strain that such risks place on the intermediary and hence reflect implicit allocations of capital to the intermediary's business lines (Myers and Read 2001, Zanjani 2002). **Cummins**, **Lin**, and **Phillips** test these theoretical predictions by analyzing the prices of insurance risks for U.S. property-liability insurers over the period 1997-2004. Specifically, they regress insurance price variables on capital allocations by line, measures of insurer insolvency risk, and other risk and control variables. Their results provide strong support for theoretical predictions that prices of intermediated risks vary across firms to reflect insolvency risk, marginal capital allocations, and non-systematic covariability.

Industrial Organization

The NBER's Program on Industrial Organization, directed by Nancy L. Rose of MIT, met in California on February 24 and 25. Liran Einav and Jon D. Levin, both of NBER and Stanford University, organized this program:

Silke Januszewski Forbes, University of California, San Diego, and **Mara Lederman,** University of Toronto, "Control Rights, Network Structure, and Vertical Integration: Evidence from Regional Airlines"
Discussant: Severin Borenstein, University of California, Berkeley and NBER

Pat Bajari, University of Michigan and NBER; **Stephanie Houghton,** Duke University; and **Steve Tadelis,** University of California, Berkeley, "Bidding for Incomplete Contracts: An Empirical Analysis"
Discussant: Ken Hendricks, University of Texas at Austin

Daron Acemoglu and **Amy Finkelstein,** MIT and NBER, "Input and Technology Choices in Regulated Industries: Evidence from the Health Care Sector"
Discussant: Catherine Wolfram, University of California, Berkeley and NBER

Justine Hastings, Yale University and NBER; **Thomas J. Kane,** Harvard University and NBER;and **Douglas O. Staiger,** Dartmouth College and NBER, "Public School Choice and Student Outcomes: Choices, Preferences, and Heterogeneous Treatment Effects in a School Choice Lottery"
Discussant: Eric A. Hanushek, Stanford University and NBER

Jaap H. Abbring, Free University, Amsterdam, and **Jeffrey Campbell,** Federal Reserve Bank of Chicago, "A Firm's First Year"
Discussant: C. Lanier Benkard, Stanford University and NBER

Duncan Simester, MIT; **Yu (Jeffrey) Hu,** Purdue University; **Erik Brynjolfsson,** MIT; and **Eric T. Anderson,** Northwestern University, "Does Current Advertising Cause Future Sales? Evidence from the Direct Mail Industry"
Discussant: Jean Pierre Dube, University of Chicago

Ryan M. Johnson, University of Arizona; **David H. Reiley,** University of Arizona and NBER; and **Juan Carlos Munoz,** Pontifica Universidad Catolica, Chile, "The War for the Fare: How Driver Compensation Affects Bus System Performance"
Discussant: Phillip Leslie, Stanford University and NBER

Forbes and **Lederman** investigate the relationship between vertical integration and the importance of control rights under incomplete contracts in the U.S. regional airline industry. Regional airlines operate flights for major carriers under the major's brand. The majors market the regionals' flights as their own. There is substantial variation in whether regionals are owned by the major for which they operate. Furthermore, several majors own some of their regional partners but also contract with others. Forbes and Lederman illustrate the benefits and costs of vertical integration between a major and regional. They argue that when unforeseen disruptions create the need for schedule adjustments — as frequently occurs in the airline industry — the major will internalize the impact of the disruption on its entire network, while the regional will not. Ownership of a regional mitigates this incentive problem by giving the major rights of control over how the regional's physical assets and labor force are used. However, by bringing the regional's labor force "in-house," ownership of a regional may erode some of the labor cost savings that are very reason why majors subcontract certain flights to regionals.Using data on majors' use of regionals in the second quarter of 2000, the authors test whether majors' choice of organizational form reflects this tradeoff between greater control and lower labor costs. They find that owned regionals are more likely to serve city pairs that are more integrated into the major's network, where externalities not internalized by the regional will be the greatest. Further, owned regionals are more likely to serve city pairs with adverse weather conditions, where unforeseen schedule disruptions will be more common.

Procurement contracts are often incomplete because the initial plans and specifications are changed and refined after the contract is awarded to the lowest bidder. This results in a final cost to the buyer that differs from the low bid, and may also involve significant adaptation and renegotiation costs. **Bajari**, **Houghton**, and **Tadelis** propose a stylized model of bidding for incomplete contracts and apply it to data from highway paving contracts. In the model, bidders respond strategically to contractual incompleteness; adaptation costs, broadly defined, are an important determinant of the observed bids. The authors then estimate the costs of adaptation and bidder markups using a structural auction model. Their estimates suggest that adaptation costs on average account for about 10 percent of the winning bid. The distortions from private information and local market power, which are the focus of much of the literature on optimal procurement mechanisms, are much smaller by comparison.

Acemoglu and **Finkelstein** examine the implications of regulatory change for the input mix and technology choices of regulated industries. They present a simple framework that emphasizes changes

in relative factor prices faced by regulated firms under different regimes, and investigate how this might affect their technology choices through substitution of (capital embodied) technologies for tasks previously performed by labor. Then, they empirically study the change from full-cost to partial-cost reimbursement under the Medicare Prospective Payment System (PPS) reform, which increased the relative price of labor faced by U.S. hospitals. Using the interaction of hospitals' pre-PPS Medicare share of patient days with the introduction of these regulatory changes, they can document a substantial increase in capital-labor ratios and a large decline in labor inputs associated with PPS. Most interestingly, they find that the PPS reform seems to have encouraged the adoption of a range of new medical technologies. They also show that the reform was associated with an increase in the skill composition of these hospitals, which is consistent with technology-skill or capital-skill complementarities.

Hastings, **Kane**, and **Staiger** use data surrounding implementation of a public school choice program with school assignment by lottery to estimate the effect of attending a first choice school on academic outcomes. They show that students who place a high value on academic achievement in their school-choice decision should have significant gains in their own academic outcomes as a result of winning the lottery to attend their first-choice school. Using random assignment to schools generated by the lottery, they estimate the impact of winning the school choice lottery on academic achievement, allowing the treatment effect of attending a first choice school to vary with the estimated preference for academics that generated the choice. Their results indicate that, on average, students do not have significant gains in test scores as a result of attending their first choice school. However, students who placed a high value on academics experience significant gains in test scores. These findings are consistent with the conclusion that parents may trade-off expected gains to academic achievement for gains along other dimensions, such as proximity or racial composition.

Abbring and **Campbell** determine the structural shocks that shape a firm's first year by estimating a structural model of firm growth, learning, and survival using monthly sales histories from 305 Texas bars. They find that heterogeneity in firms' pre-entry scale decisions accounts for about 40 percent of their sales variance; persistent post-entry shocks account for most of the remainder. They find no evidence of entrepreneurial learning. Variation of the firms' fixed costs consistent with an annual lease cycle explains their exit rates. The authors use the estimated model to price a new bar's option to exit, which accounts for 124 percent of its value.

Simester, **Hu**, **Brynjolfsson**, and **Anderson** present findings from a large-scale field experiment that allows them to study whether there is a causal relationship between current advertising and future sales. The experimental design overcomes limitations that have affected previous investigations of this issue. They find that current advertising does affect future sales, but the sign of the effect varies depending on the customers targeted. For the firm's best customers, the long-run effect of increases in current advertising is actually negative, while for other customers the effect is positive. They argue that these outcomes reflect two competing effects: brand-switching and inter-temporal substitution. Furthermore, the data suggest a way to distinguish between the informative and persuasive roles of advertising, providing insight into the mechanism by which advertising differentially affects various customer subsets.

Two systems of bus driver compensation exist in Santiago, Chile. Most drivers are paid per passenger transported, but a second system compensates other drivers with a fixed wage. The per-passenger drivers have incentives to engage in " La Guerra por el Boleto" ("The War for the Fare"), in which drivers change their driving patterns to compete for passengers. **Johnson, Reiley, and Muñoz** take advantage of a natural experiment provided by the coexistence of these two compensation schemes on similar routes in the same city. Using data on intervals between bus arrivals, they find that the fixed-wage contract leads to more bunching of buses, and hence longer average passenger wait times. The per-passenger drivers are assisted by a fascinating group of independent information intermediaries called *sapos* who earn their living by standing at bus stops, recording arrival times, and selling the information to subsequent drivers who drive past. This bus-bunching phenomenon has frustrated passengers in cities around the world, so it is exciting to see evidence that contract design can improve performance in this dimension. According to the results here, a typical bus passenger in Santiago waits roughly 10 percent longer for a bus on a fixed-wage route relative to an incentive-contract route. However, the improved wait times on the incentive contract routes come at a cost. The incentives lead drivers to drive noticeably more aggressively, causing at least 67 percent more accidents per kilometer driven. Most people in Santiago blame "La Guerra por el Boleto" for the poor service provided by buses.

Development of the American Economy

The NBER's Program on the Development of the American Economy, directed by Claudia Goldin of Harvard University, met in Cambridge on March 4. The following papers were discussed:

Farley Grubb, University of Delaware and NBER, "The Net Asset Position of the U.S. National Government, 1784–1802: Hamilton's Blessing or the Spoils of War?" (NBER Working Paper No. 11868)

Douglas A. Irwin, Dartmouth College and NBER, "Tariff Incidence in America's Gilded Age"

Paul W. Rhode, University of North Carolina and NBER, and **Koleman S. Strumpf**, University of North Carolina, "Manipulating Political Stock Markets: A Field Experiment and a Century of Observational Data"

Daron Acemoglu and **Simon Johnson**, MIT and NBER, and **James Robinson**, Harvard University and NBER, "Liberty, Fraternity, Equality, and Industry: The Economic Consequences of the French Revolution"

Leah Platt Boustan, Harvard University; **Price V. Fishback**, University of Arizona and NBER; and **Shawn E. Kantor**, University of California, Merced and NBER, "The Effect of Internal Migration on Local Labor Markets: American Cities During the Great Depression"

Joseph P. Ferrie, Northwestern University and NBER, "Wealth During Wartime: Mobility in Real and Personal Property Ownership in the U.S., 1860–1870"

The War for Independence left the National Government deeply in debt, but among the spoils of winning that war was an empire of land. So, was the National Government solvent after 1783? Was its net asset position — land assets minus debt liabilities — positive or negative? **Grubb** gathers evidence to answer this question by constructing a yearly time series of the U.S. net asset position, including the subcomponents of that position, from 1784 through 1802. The results indicate that the National Government was solvent, had more than enough land assets to cover its debt liabilities in this period, but only if it maintained the default on the Continental Dollar (its non-interest-bearing debt). To do this and not ruin its creditworthiness, it had to distinguish, legally and in the marketplace, between its interest-bearing and its non-interest-bearing debt. It did this, in part, by only paying interest and no principal on its debts and by curtailing direct swaps of land for debt.

In the late nineteenth century, the United States imposed high tariffs to protect domestic manufacturers from foreign competition. **Irwin** examines the magnitude of protection given to import-competing producers and the costs imposed on export-oriented producers by focusing on changes in the domestic prices of traded goods relative to non-traded goods. Because the tariff increased the prices of non-traded goods, the degree of protection was much less than indicated by nominal rates of protection; the results of Irwin's work suggest that the 30 percent average tariff on imports yielded just a 12 percent implicit subsidy to import-competing producers while effectively taxing exporters at a rate of 14 percent. He also finds that tariff policy redistributed large amounts of income (about 9 percent of GDP) across groups, although the impact on consumers was roughly neutral because they devoted a sizeable share of their expenditures to exportable goods. These findings may explain why import-competing producers pressed for even greater protection in the face of already high tariffs and why consumers (as voters) did not strongly oppose the policy.

Political stock markets have a long history in the United States. Organized prediction markets for Presidential elections have operated on Wall Street (1880-1944), the Iowa Electronic Market (1988-present), and *TradeSports* (2001-present). Proponents claim that such markets efficiently aggregate information and provide superior forecasts to polls. An important counterclaim is that such markets may be subject to manipulation by interested parties. **Rhode** and **Strumpf** analyze this argument by studying alleged and actual speculative attacks — that is, large trades, uninformed by fundamentals, intended to change prices — in these three markets. They first investigate the speculative attacks on TradeSports market in 2004 when a single trader made a series of large investments in an apparent attempt to make one candidate appear stronger. Next they examine the historical Wall Street markets where political operatives from the contending parties actively and openly bet on city, state, and national races; the record is rife with accusations that parties tried to boost their candidates through investments and wash or phantom bets. Finally, they report the results of a field experiment involving a series of planned, random investments — accounting for 2 percent of total market volume — in the Iowa Electronic Market in 2000. In every speculative attack that they study, there were measurable initial changes in prices. However, these were quickly undone and prices returned close to their previous levels. They find little evidence that political stock markets can be systematically manipulated beyond short time periods.

The French Revolution of 1789 had a momentous impact on neighboring countries. The French Revolutionary armies during the 1790s invaded and controlled Belgium, the Netherlands, Italy, Switzerland, and parts of Germany. Napoleon in the early 1800s extended the French control over these territories and also conquered Spain. Together with invasion came various radical institutional changes. Most notably, the French

Revolution removed the legal and economic barriers that had protected the privileged (nobility, clergy, and urban oligarchies), established the principle of equality before the law, and led to a reorganization of the state. **Acemoglu**, **Johnson**, and **Robinson** argue that the French Revolution can be considered an exogenously imposed institutional change on neighboring countries and they study its impact on economic outcomes. They also use this experience to evaluate several central theses about institutions: 1) that they efficiently adapt to a society's characteristics; 2) that evolved institutions are inherently superior to those rationally designed; 3) that institutions must be "appropriate" and cannot be "transplanted"; and 4) that the Civil Code has adverse economic effects. Both at the country and the city level, the evidence suggests that areas that were occupied by the French and that underwent radical institutional reform experienced somewhat more rapid economic growth, urbanization and industrialization, especially after 1850, although in some specifications the results are not statistically significant and in some others, there were slight pre-existing trends. On the whole, the evidence here is more consistent with the view that the institutional reforms brought about by the French Revolution had long-run beneficial effects; this militates against all four of the above theses. The interpretation here is that the Revolution destroyed (the institutional underpinnings of) the power of oligarchies and elites opposed to economic change, and combined with the arrival of new economic and industrial opportunities in the second half of the nineteenth century, helped to pave the way for future economic growth.

Debates over U.S. immigration policy have prompted numerous studies of the impact of immigrant arrivals on local labor markets in the United States. Yet immigration from abroad comprises a small share of total flows into local labor markets. Since 1940, new foreign entry has accounted for less than 11 percent of cross-county moves and less than 20 percent of moves across state lines. To capture this central feature of competition in local labor markets, **Boustan**, **Fishback**, and **Kantor** examine the impact of internal migration on annual earnings and employment in major U.S. cities in the late 1930s. They also explore the effect of these labor supply shocks on the outmigration of existing workers and the in-migration of firms. These worker-firm adjustments, which often go unobserved, may account for the limited relationship between immigration and wages found in previous studies. Internal migration represented the vast majority of population flows to and from local labor markets during the 1930s. Because internal migrants originate their moves from within the United States, the authors have access to a wealth of information about the economic environment in their home market. They use data on these "push" factors — including weather conditions and the generosity of New Deal policies — in "sending areas" to develop an instrument for in-migration for their sample of large U.S. cities. With this approach, they can address the endogenous location choices of migrants, who tend to be attracted to cities with high wages or strong wage growth, thus obscuring any negative relationship between in-migration and wages.

Using a new sample of 8,195 white, native-born American males located in both the 1860 and 1870 U.S. federal census manuscript schedules, **Ferrie** assesses wealth mobility over the decade that included the Civil War. He explores the impact of Emancipation on the wealth of those who owned slaves in 1860 (when slaves were a component of personal wealth) with a new sub-sample of 401 Southerners linked to the slave schedules of the census. Previous studies (Steckel, 1990) that have examined mid-19th century real estate wealth mobility have been unable to assess the extent of mobility in *total* wealth (as respondents were asked to report both real wealth and personal wealth only in 1860 and 1870, two censuses that until now had not been linked on a large scale). Ferrie also compares wealth mobility in the 1860s to wealth mobility a century later in the 1960s and 1970s (using the NLS).

Bureau Books

NBER Macroeconomics Annual 2005

NBER Macroeconomics Annual 2005, edited by Mark Gertler and Kenneth S. Rogoff, is available from the MIT Press for $35.00 in paperback and $70.00 clothbound. The *NBER Macroeconomics Annual* presents, extends, and applies pioneering work in macroeconomics and stimulates research on important policy issues. The papers here link theoretical and empirical developments with specific real-world examples and problems. This year's twentieth edition of the Annual covers such issues as: the sources of European unemployment and churn in U.S. labor markets; the causes of the 20-year trend decline in volatility in U.S. output; and the appropriate targets for monetary policy.

Gertler and Rogoff are NBER Research Associates in the Programs on Monetary Economics and International Finance and Macroeconomics, respectively. Gertler is the Henry and Lucey Moses Professor of Economics at New York University; Rogoff is the Thomas D. Cabot Professor of Public Policy and Economics at Harvard University.

E-mail orders for this volume to: mitpress-orders@mit.edu.

A New Architecture for the U.S. National Accounts

A New Architecture for the U.S. National Accounts, edited by Dale W. Jorgenson, J. Steven Landefeld, and William D. Nordhaus, is available from the University of Chicago Press this spring for $99.00. To order this volume, contact: University of Chicago Press, Order Department, 11030 South Langley Avenue, Chicago, IL 60628-2215, or 1-800-621-2736. Academic discounts are available.

This NBER volume, part of the series of Studies in Income and Wealth (No. 66), brings together a distinguished group of contributors to initiate the development of a comprehensive and fully integrated set of U.S. national accounts. The purpose of that new architecture is not only to integrate the existing systems of accounts, but also to identify gaps and inconsistencies and to expand and incorporate systems of non-market accounts with the core system.

Because the U.S. economy represents almost 30 percent of the world economy, it is not surprising that accounting for this huge and diverse set of economic activities requires a decentralized statistical system. This volume outlines the major assignments among institutions, including the Bureau of Economic Analysis, the Bureau of Labor Statistics, the Department of Labor, the Census Bureau, and the Governors of the Federal Reserve System. One important part of the motivation for the new architecture is to integrate the different components and to make them consistent. This volume is the first step toward achieving that goal.

Jorgenson is the Samuel W. Morris University Professor of Economics at Harvard University. Landefeld is the Director of the Bureau of Economic Analysis. Nordhaus is an NBER Research Associate in the Program on Productivity and the Sterling Professor of Economics at Yale University.

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