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Program Report

Economic Fluctuations and Growth

Robert E. Hall*

The U.S. economy has enjoyed uninterrupted growth since the trough of the last recession in the spring of 1991. As unemployment has declined to just over 5 percent, attention has turned increasingly to issues of longer-run macroeconomic performance. Now, the topics of economic fluctuations and growth also are combined in a single NBER program, since the economic fluctuations program has taken over the functions of the earlier growth project (officially becoming the Program in Economic Fluctuations and Growth in early 1996). This continues to be the largest of the Bureau's research programs, with roughly 60 research associates and 25 faculty research fellows.

Many of the research activities of the "EFG program" take place in small groups working on specific topics. These groups are open, and some group members do not have formal affiliations with the NBER. The small groups' work is described in some detail later in this report. Almost all of these groups also meet in Cambridge in July as part of the Bureau's Summer Institute. At that time, the entire program also meets to present and discuss six academic research papers. The small groups meet during the academic year on their own, or in conjunction with other NBER program meetings, as well. Finally, the EFG program is responsible for the NBER's Annual Conference on Macroeconomics, which takes place in Cambridge each March.

The 1995 Nobel Prize in Economics

Robert E. Lucas, Jr. of the University of Chicago, an active member of the EF program since its inception in 1978, won the 1995 Nobel Memorial Prize in Economics. The prize was announced shortly before the pro-

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gram's research meeting in October 1995, after Lucas had agreed to serve as a discussant at the meeting; this happy event was acknowledged in a suitable way at lunch. Also, program member Stanley Fischer and I were asked by the *Scandinavian Journal of Economics* to prepare papers summarizing Lucas's many contributions.¹

Program Members in Washington

Members of the EFG program have held a number of important policymaking and advisory positions in Washington. For example, John B. Taylor of Stanford University served as a member of the Council of Economic Advisers under George Bush, and Martin Neil Baily was a council member under President Clinton. Joseph E. Stiglitz currently serves as chairman of the Council of Economic Advisers; Lawrence H. Summers is deputy secretary of the U.S. Treasury, and Alan S. Blinder of Princeton University served until recently as vice-chairman of the Federal Reserve Board of Governors.

Business Cycle Dating

Traditionally, the Business Cycle Dating Committee has been the most conspicuous public element of the EFG program. The committee last met in 1992 to determine the date of the end of the recession of 1990-1. With the nonstop growth of the economy since that meeting, the committee has not met again; it will not meet until well after the economy reaches a peak of activity and begins a new recession. At this writing, there is no sign of impending recession, and the experimental recession probability index prepared by program members James H. Stock of Harvard University and Mark W. Watson of Princeton University assigns a low probability to a recession in the near future.

Macroeconomics Annual

Under the leadership of program members Ben S. Bernanke of Princeton University and Julio J. Rotemberg of MIT, the EFG program organizes a major conference on macroeconomics each year. The proceedings appear in the *NBER Macroeconomics Annual*, published by the MIT Press. The organizers choose authors from among those who have recently developed important new lines of research in macroeconomics; the format of the conference and volume permits a fuller expression and integration of the research than is possible in major economics journals, in which the line of research usually has been exposed already. The emphasis of the *Annual* is on basic quantitative research with potential policy applications.

Small Research Groups

Growth²

The first meeting of the newly formed "Growth Group" focused on the accumulation and development of human capital, finding some surprisingly paradoxical results and developing exciting avenues for future research. Lant Pritchett of the World Bank presented cross-sectional evidence that the growth of human capital, as measured by years of education, is completely uncorrelated with the growth of output. This result is surprisingly robust to the use of different datasets, as confirmed by conference participant Jong-Wha Lee, NBER and Korea University, who, together with Robert J. Barro, NBER and Harvard University, has developed a broad international database on education.

The conventional measure of human capital, the years that students devote to education, is extraordinarily crude, providing inadequate assessment of the value

and growth of human capital. Dale W. Jorgenson of Harvard University presents new estimates of the value of the output of the U.S. educational sector. Jorgenson places the valuation of human capital on an equal footing with the valuation of physical capital by using lifetime earnings profiles to estimate the net present value of the additional earnings induced by an additional year of education. Gary S. Becker and NBER Research Associate Kevin M. Murphy, both of the University of Chicago, pushed the discussion further, showing how differences in the earnings of U.S. workers by country of origin could be used to infer differences in the value of their educational attainment and, by extension, to develop deflators for the nominal output of the educational sector. The application of these methods to broader international comparisons appears to be an essential first step in unraveling the puzzle posed by Pritchett and others.

Income Distribution and Macroeconomics³

This group has concentrated on three broad topics of significant importance to the U.S. economy. First, researchers have identified four channels through which income distribution affects growth and macroeconomic activity. Inequality, in the presence of imperfections in capital markets, may affect investment in human and physical capital adversely and therefore may reduce output and economic growth. These macroeconomic effects may be magnified by the sorting of individuals into homogeneous communities. Second, inequality may generate conflict that diminishes the security of property rights, hence lowering investment and economic growth. Third, inequality may have an adverse effect on investment in human capital, and therefore may increase fertility and slow economic

growth. Fourth, inequality generates pressure for distortionary redistribution, adversely affecting investment and growth.

The first three mechanisms receive significant support from cross-country evidence, whereas the fourth is refuted. Studies carried out in the group shed new light on the potential macroeconomic implications of inequality in general, and of the recent rise in inequality in the United States in particular.

Next, several researchers in this group have examined the interaction among technological progress, intergenerational earnings mobility, and economic growth. For example, they have identified mechanisms through which technological progress determines earnings mobility and income distribution; conversely, they show how earnings mobility and income distribution affect the pace of technological progress and output growth. Major technological breakthroughs increase social mobility and income inequality and initially lower the pace of future economic growth. However, as technology becomes more accessible, mobility decreases, income inequality diminishes, and the pace of future economic growth accelerates. These studies enable us to assess the effect of the recent wave of technological progress, such as the computer revolution, on social and occupational mobility, wage and income inequality, and economic growth in the United States.

In a third area, researchers in this group have examined the implications of social institutions, such as education finance, fiscal policies, and labor market institutions, on macroeconomic performance and economic growth. Some have provided explanations for the differences in education finance and fiscal policies in the United States versus Europe and Japan. Others have examined the optimality of various forms of education finance, contrast-

ing public and private provision of education.

*Macroeconomic Complementarities*⁴

A complementarity exists when the activities of one person or firm have favorable effects on other people or firms. The topics that this group explores are standard in macroeconomics: the sources and consequences of economic fluctuations; economic growth; income distribution; the operation of labor markets; the demand for money; and the implications of government policies. In the presence of complementarities, though, there can be underemployment of resources and even the possibility of multiple equilibriums.

The idea of macro complementarities encompasses linkages across agents in an economy, so that higher activity in the economy generally induces higher activity by a single worker or firm. We may think of activity as broadly defined and including: hours worked; output produced; time spent searching; level of investment activity; and so forth. In general, these linkages can be global (that is, a single agent's choices influenced by the aggregate level of activity) or local (a single agent's choices influenced by a few neighbors).

Established research has provided examples of multiplicity through technological links across a group of agents. NBER researchers extend that formulation to the stochastic growth model with technological complementarities. Related models positing increasing returns in technology analyze the multiplicity of equilibriums and the instability in the process of financial intermediation. Models based upon these technological linkages also have been formulated to study the timing of economic decisions, stressing the possibility of

equilibrium delay. Peter A. Diamond of MIT has developed a search model with multiple equilibriums that provides another source of multiplicity and is being used to study labor markets and the demand for money.

A common theme of this group's research is that the presence of complementarities creates a source for the magnification and propagation of shocks, as well as creating the possibility of multiple equilibriums. In addition, the models are inherently nonlinear, which creates an important connection between these economies and evidence of nonlinearities in the aggregate economy.

Initially, the group's effort focused on understanding the environments that give rise to complementarities. Its more recent work has explored the quantitative aspects of these economies. In particular, evidence on the sources of complementarities and results on their time-series and cross-sectional implications are a major component of the group's activities.

*Micro and Macro Perspectives on the Aggregate Labor Market*⁵

The premise underlying this group's work is that a better understanding of the various facets of the labor market is important for many questions in macroeconomics, including for example, accounting for cyclical fluctuations, the determinants of growth, and the role of labor market regulations in explaining cross-country differences in employment.

One important part of the group's research draws on the empirical work of NBER Research Associates Steven J. Davis of the University of Chicago and John C. Haltiwanger of the University of Maryland (as well as others) that documents the large flows of employment across estab-

lishments at all points over the business cycle. Standard macroeconomic models abstract from these flows. There are three related lines of research that stem from this original finding: 1) more extensive measurement, aimed at identifying the important regularities; 2) building models that account for the regularities; and 3) using the models to address relevant policy questions. The group has been engaged actively in all three of these lines of research.

This work also has important implications for policy. Many labor market programs—including unemployment insurance, job protection legislation, subsidies to job creation, and subsidies to declining industries—affect job creation and destruction. Through their effects on the incentives to create and destroy jobs, these policies have implications for aggregate employment, aggregate productivity, and unemployment dynamics. To illustrate, a recent paper⁶ by Steven Millard of the Bank of England and Dale T. Mortensen of Northwestern University finds that differences in taxation, unemployment insurance, and job protection can explain differences in average unemployment, and in particular differences in unemployment duration and incidence, between the United States and United Kingdom over the last decade.

It is also of obvious interest to examine the effects of various policies on welfare. Fernando Alvarez, University of Chicago, and Marcelo Veracierto, Cornell University, assess the extent to which several policies that distort production decisions may have beneficial results for welfare because of insurance considerations that arise from incomplete markets.⁷ One of their findings is that unemployment insurance has a larger impact on allocations than do sever-

ance payments, but that in both cases the net welfare effect of these policies is still negative.

Aggregate Implications of Microeconomic Consumption Behavior⁸

One of the lines of research conducted within this group is concerned with modeling the distribution of wealth and saving across households. Karen Dynan of the Federal Reserve Board, Jonathan S. Skinner, NBER and Dartmouth College, and Stephen P. Zeldes, NBER and Columbia University, have developed evidence that households with high levels of permanent labor income have high lifetime saving rates. Mark Huggett and Gustavo Ventura of the University of Illinois have examined whether such a positive correlation between saving and income could arise in a general equilibrium model in which households experience idiosyncratic shocks and face a progressive Social Security system. Their model explains a positive correlation between permanent labor income and saving, in part because the progressivity of the Social Security system means that low lifetime-income households have comparatively high income late in life, and therefore have no need to save for retirement.

One empirical problem for this model, and for most other saving models with heterogeneous agents and idiosyncratic shocks, is that they tend to underpredict the wealthholding of the richest households. Two projects in the group examine whether the extreme concentration of wealth in the United States could be reproduced by relaxing the assumption that all consumers face the same budget opportunities. Vincenzo Quadrini of the University of Pennsylvania has developed a model in which households randomly

opportunities, and then choose to invest or not invest. Rios-Rull's model makes the rate of return a nonlinear function of the level of wealth, with wealthy consumers earning a higher rate of return. Both of these models are able to produce aggregate wealth distributions substantially similar to the empirical wealth distribution in the United States.

Another longstanding puzzle about wealthholding behavior in the United States is the small fraction of the household sector's financial wealth that is invested in risky assets. Michael C. Fratantoni of Johns Hopkins University has developed a model that shows that the combination of labor income risk and the risk associated with homeownership is large enough to induce consumers to hold any remaining assets mostly or entirely in riskless forms.

Two additional projects relate to the growing body of macroeconomic literature that has found that survey measures of consumer sentiment, and particularly measures of unemployment expectations, have substantial explanatory power for aggregate consumption growth. Nicholas Souleles of the University of Pennsylvania preliminarily finds that in household data as in the macroeconomic data, (lagged) consumer sentiment is correlated positively with current consumption growth. Carroll, Dynan, and Spencer D. Krane of the Federal Reserve Board have developed a theoretical model of the relationship between consumers' unemployment expectations and their wealthholdings. They present empirical evidence that, as the model predicts, households that face unusually high unemployment risk hold substantially more net worth than those with less risk.

Pinelopi K. Goldberg, NBER and Princeton University, and Attanasio examine a large survey of automo-

bile purchasers to test the implications of the presence of liquidity constraints for the demand for loans. In particular, they find that the demand of groups who are more likely to be liquidity constrained, such as the young, is sensitive to the maturity of the loans and relatively insensitive to changes in the interest rate.

A final study, by Michael G. Palumbo, University of Houston, and coauthors, presents historical data from the late 19th century on saving patterns by U.S. workers. The authors find that, despite the enormous institutional changes over the past hundred years, saving behavior in that era appears to have been remarkably similar to current saving behavior.

Diversity of Agents and Specificity of Assets⁹

In macroeconomics, many advances have been made by assuming that people have similar preferences and that they own similar assets. But this group is exploring models that drop one or both of these assumptions. In these models, people and firms are quite different from one another, and place higher values on their assets than any potential buyer would.

In one example, Valerie A. Ramey, NBER and University of California, San Diego, and Matthew D. Shapiro, NBER and University of Michigan, are using the experience of a failed defense contractor to document the costs of adapting capital goods from one use to another. Olivier J. Blanchard and Michael Kremer, both of NBER and MIT, start from the premise that greater private opportunities made possible by reform in Eastern Europe may have been responsible for the costly breakdown of complex economic relationships. Mohamad L. Hammour of Columbia University and

Caballero are exploring the multiple macroeconomic consequences of unprotected asset specificity.¹⁰

A number of studies focus on search frictions and the allocation process. Daron Acemoglu of MIT is investigating the implications of search for income distribution, whereas Giuseppe Bertola, NBER and Università di Torino, and Pietro Garibaldi, Innocenzo Gasparini Institute for Economic Research, Milan, are considering the implications for the distribution of wages across different size firms. James S. Costain of the University of Chicago analyzes unemployment insurance in a general equilibrium model with precautionary savings. Harold Cole of the Federal Reserve Bank of Minneapolis and Rogerson are working on an explanation of the cyclical properties of job creation and job destruction based on a modified Diamond–Mortensen–Pissarides search model.

One natural way to model asset specificity is with irreversibility and fixed costs of adjustment. Janice C. Eberly, NBER and University of Pennsylvania, and John Shea, University of Maryland, test for differences in the degree of irreversibility among various types of investment. In order to understand durable goods cycles, Jerome Adda of the Institut Nationale de la Recherche Agronomique, and Cooper analyze the recent use of tax policy to stimulate auto demand in France. Christopher L. Foote of the University of Michigan shows that if there are costs to hiring and firing workers, the cyclical nature of job creation and destruction within the sector may depend on whether a sector is growing or declining.

Finally, a number of studies analyze the relationship between frictions and information revelation. V. V. Chari, University of Minnesota, and Patrick J. Kehoe, NBER and

University of Pennsylvania, model herding in foreign lending, and Christophe Chamley of Boston University studies the implications of information dynamics for business cycles.

*Empirical Methods*¹¹

This group's concerns are primarily methodological, but its topics are firmly grounded in applications. The group develops econometric tools needed for identifying and addressing substantive issues in empirical macroeconomics. Its activities focus on characterizing and modeling business cycle dynamics, estimation, and inference in vector autoregressive models, and estimation of macroeconomic relationships and models. A common theme, running through many of the group's activities, is the development of methods for forecasting economic activity. Much of the group's recent research will be contained in a forthcoming special symposium "Forecasting and Empirical Methods in Macroeconomics," in the *International Economic Review*.

Dynamics of the Business Cycle

The salient questions in this area are of tremendous practical importance. For example: How and why do key variables move in parallel over the cycle? What methods are best for monitoring the cycle in real time and for quickly identifying business cycle turning points? What potential exists for forecasting the cycle, and the turning points in particular? How can we learn from our track record and modify our methods accordingly? The group is working on a variety of new methods and models that will help provide answers to these and other questions.

For example, Charles H. Whiteman of the University of Iowa is developing a Bayesian approach to

the construction and estimation of a dynamic factor model of macroeconomic activity, from which he extracts an index of leading indicators. His method has been extremely successful in forecasting economic conditions and in generating state revenue forecasts in Iowa.

Bruce Hansen of Boston College is developing the statistical estimation theory for models that capture regime-switching behavior in the macroeconomy. He is exploring the applicability of such econometric techniques to macroeconomic models with multiple equilibria.

Edward B. Montgomery, NBER and University of Maryland, Victor Zarnowitz, NBER and University of Chicago, and two coauthors assess the comparative forecasting performance of a variety of linear and nonlinear models of the U.S. unemployment rate. They find that combining standard linear forecasts with forecasts from models that allow for asymmetric behavior in the rise and decline of unemployment improves the accuracy of the forecasts.

Gabriel Perez-Quiros and Allan Timmermann of the University of California, San Diego, study the links between real macroeconomic activity and the stock market. In particular, they characterize the pattern and magnitude of business cycle variations in U.S. stock returns. Using a new approach that precisely identifies the stage of the business cycle, they document patterns that cast doubt on standard asset-pricing models, but that nevertheless suggest promising directions for future research.

Estimation, Inference, and Forecasting in Vector Autoregressive (VAR) Models

VARs are now the dominant framework for empirical macroeconomic analysis and forecasting, but

existing methods provide only very crude guidance as to the uncertainty associated with VAR parameter estimates, impulse response estimates, and forecasts. Hence the group is focusing on key questions such as: Does imposing long-run restrictions on VAR forecasting models improve the accuracy of long-run forecasts? How can we accurately assess the uncertainty associated with parameter estimates and impulse-response estimates from VARs? How can we accurately assess the uncertainty associated with our forecasts, especially long-horizon forecasts?

Peter Christoffersen of the IMF and Diebold explore the effects of imposing cointegration on VARs. Imposing cointegration guarantees that long-horizon forecasts hang together in reasonable ways. Christoffersen and Diebold nevertheless show that, contrary to popular belief, imposing cointegration does not improve long-horizon forecasts when forecast accuracy is evaluated using standard measures. They conclude that the standard accuracy measures are deficient in an important respect, and they suggest alternatives.

Stock examines long-horizon point forecasts and prediction intervals when variables are nearly cointegrated. To do so, he uses asymptotic methods in which the forecast horizon is a fixed fraction of the sample size. Based on this notion he compares the standard approaches to long-horizon forecasting with several alternatives. He finds that standard point forecasts in VARs and vector error correction models tend to be biased, and the associated standard interval forecasts tend to have distorted coverage. The performance of the alternative methods is mixed.

Stock and Watson propose procedures for computing confidence intervals for parameters in VARs with

highly persistent data, without making rigid assumptions about the nature of the persistence. They are applying their methods to obtaining improved estimates of the relationships among money, aggregate output, and interest rates.

Lutz Kilian of the University of Michigan analyzes the related problem of bias in VAR impulse response estimates, which play an important role in empirical macroeconomics. He proposes a bootstrap confidence interval designed to account for both the bias and the skewness in the impulse response distribution. He shows that this bootstrap interval is more accurate than alternative methods.

Christopher A. Sims, NBER and Yale University, and Tao Zha, Federal Reserve Bank of Atlanta, develop Bayesian methods for forecasting with VARs. They attempt to bridge the middle ground between traditional Bayesian reduced-form models and explicitly structural econometric models. Sims and Zha's main focus is on improving existing equation-by-equation estimation methods and on quantifying forecast uncertainty.

Estimation

Traditional instrumental-variable estimation remains an important tool in applied research. However, little is known about measuring instrument relevance. To aid in the selection of instruments, Shea proposes a new test for instrument relevance in multivariate linear models.

Generalized method of moments (GMM) estimation, another instrumental-variable technique, suffers from a lack of constructive diagnostic tests for assessing the adequacy of a fitted model. Fallaw Sowell of Carnegie-Mellon University proposes new tests for violations of moment conditions in the GMM framework. Unlike existing tests,

Sowell's test has power against both parameter instability and violations of overidentifying restrictions.

Can we develop estimation methods for dynamic macroeconomic models that are better grounded in statistical theory than "calibration" techniques, yet structured enough to enable the incorporation of stochastic restrictions from economic theory? David DeJong, University of Pittsburgh, Beth Ingram, and Whiteman estimate the parameters of a neoclassical business cycle model using a fully Bayesian procedure. They also quantify the sources of business cycle fluctuations. Their procedure provides an alternative to the informal calibration exercises that are now prevalent in the macroeconomic literature.

¹My paper begins, "Over the last thirty years, the theory and practice of economic dynamics has undergone an extraordinary transformation. Robert Lucas has been and continues to be the leader of this transformation. He has provided economists with new tools and new ways of thinking about dynamic problems. Moreover, in the process, he has provided new answers to many of the problems of greatest concern to macroeconomists. From investment to unemployment, economic growth to monetary policy, monetary theories of the business cycle to the income distribution, one can find a seminal and path-breaking analysis from Lucas."

²Led by Charles I. Jones, Stanford University, and Alwyn Young, NBER and Boston University.

³Led by Roland Benabou, NBER and New York University, Steven Durlauf, NBER and University of Wisconsin, and Oded Galor, Brown University.

⁴Led by Russell Cooper, NBER and Boston University.

⁵Led by Richard Rogerson, University of Minnesota, and Randall Wright, University of Pennsylvania.

⁶S. Millard and D. T. Mortenson, "The Unemployment and Welfare Effects of Labor Market Policy"

⁷F. Alvarez and M. Veracierto, "Welfare Effects of Job Security Provisions Under Imperfect Insurance Markets"

⁸Led by Orazio Attanasio, NBER and University College, London, Christopher D. Carroll, NBER and Johns Hopkins University, and José-Victor Rios-Rull, Federal Reserve Bank of Minneapolis.

⁹Led by Ricardo J. Caballero, NBER and MIT, Andrew Caplin, NBER and New

York University, and John V. Leahy, NBER and Harvard University.

¹⁰R. J. Caballero and M. L. Hammour, "The Macroeconomics of Specificity," NBER Working Paper No. 5757, September 1996.

¹¹Led by Francis X. Diebold, NBER and University of Pennsylvania, and Kenneth D. West, NBER and University of Wisconsin.

Research Summaries

Heterogeneity in Schooling, Uncertainty, and the Return to Education

Joseph G. Altonji*

There is an enormous empirical literature on human capital and earnings that has grown out of work by Jacob Mincer, Gary Becker, and other pioneers. Much of the research focuses on measuring the value of a year spent in school.¹ But in recent years, the research has begun to explore more fully the implications of the fact that schooling is heterogeneous, both in quality and in subject matter, and that people make decisions about schooling without complete knowledge of their tastes and talents for different types of work. This article briefly summarizes three avenues that I have been pursuing: First, what are the implications of the fact that education is a sequential choice made under uncertainty? Second, can we get inside the black box of years-spent-in-school by examining the effects of actual courses taken on the payoff to school? And third, I use a new methodology to revisit an old and controversial question—do school inputs affect outcomes?

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The Demand for and Return to Education When Education Outcomes Are Uncertain

The standard human capital model of schooling assumes that individuals are able to choose a future level of education with no uncertainty about actually completing that level. It also focuses on the number of years of school chosen, rather than on the specific major. In contrast, I model the demand for education as a sequence of choices made under uncertainty. I then examine how variables that influence tastes for school, ability to do college work, and the payoffs to particular college programs affect the expected return to a year of school.²

Three facts suggest that uncertainty is important, and they motivate this research. First, many individuals who plan to complete college instead drop out. Second, for some demographic groups the ex post returns to education are associated largely with completing high school or completing college. Such nonlinearities in the ex post returns, or a gap between the effect of education on wages and the borrowing rate,

may produce substantial differences between ex ante and ex post returns to the first year or two of college. The return to the first year of college is not the earnings differential between individuals with 12 and 13 years of schooling. Rather, the return is the difference between the earnings of the person who stops at 12 years of education and the expected earnings net-of-education-costs of a person who attends the first year of college. Expected earnings depend on the earnings associated with 14, 15, 16, or more years of education. Expected earnings also depend on the probabilities of the various education outcomes for an individual who has completed year 13. Family background, aptitude, and other factors that affect the odds that an individual actually will complete the program may influence the expected return to starting college.

Third, there are large differences across fields of specialization in the earnings differential between graduates of college and high school. Individuals who do not know if they will be able to, but want to, complete a program in a particular field must consider the alternative options that result from starting that particular program.