Nobel Prize for Theory of Economic Growth

Thirty years ago, Solow proved that technology, not capital, is the key factor in making economies grow—an insight now taken for granted

THERE may have been a moment in the early 1950s when Robert M. Solow, winner of this year's Nobel Prize in Economic Science, was not in the mainstream of American economic thinking. That was before Solow had published his papers on technology and economic growth, written when he was a 32-year-old assistant professor at Massachusetts Institute of Technology (MIT).

But when the papers came out and were read, the mainstream shifted course and enveloped Solow. He has stood squarely in the deep part of the stream since then, leading many younger economists to venture in, tossing jokes at those he thinks are clinging to the shallows.

Economists contacted by *Science* after the prize was announced spoke warmly of Solow's contribution to the field not just as a writer but as a person. "He's been a great moral force within the community" because of the integrity of his research and professional life, says Dale Jorgenson of Harvard. "In another society he would be a holy man." The Nobel award in this case was "long overdue," says Henry Aaron of the Brookings Institution, who also mentioned Solow's charm and wit. The Nobel committee ought to embellish the prize this time with "an oak leaf cluster for humor," according to Charles Schultze of Brookings, chairman of President Carter's Council of Economic Advisers.

These comments come from Solow's own team, in the sense that these writers share a common vision of how the macroeconomy works and how governments can intervene to ameliorate its effects, derived from the theories of John Maynard Keynes. But friendly words are heard in the opposing camp as well, among the free market, monetarist, and neoclassical writers based at the University of Chicago. Robert Lucas, Jr., an opponent of government meddling in the markets who is mentioned as a potential Nobel winner, says that in the 1950s "Solow was a real pioneer in pushing a whole field in a dynamic direction. He was a big influence on me and a lot of other people. . . . His work has had such wide influence that just about everybody believes it; ask any economist." While Lucas and the Keynesians differ on policy recommendations, Lucas sees Solow's early work as neutral: "It had nothing to do with Keynesian economics: it was just straight neoclassical economics."

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The papers the Nobel committee cited in announcing the prize were published in quick succession in 1956 and 1957. The first proposed a novel theory to explain how national economies grow. The second offered a means of testing the theory, laying out a system by which the inputs to growth could be broken down into pieces and the pieces measured. This work established some new economic truths and proved them by rigorous methods.

Solow concedes that the social sciences have "fuzzy edges" and that in economics it is possible to keep a bad idea alive for 10 years on sheer ingenuity and "enlargement of observations." But in the 30 years since Solow asserted that technology plays the key role in economic growth, his idea has been examined in literally hundreds of journal articles and a score of books, leading to a cottage industry in the profession known as "growth accounting." As Solow says, "The idea has matured. I know of no case where it has been disconfirmed in modern industrial economies."

Like other discoveries, this one seems obvious now, but was not obvious when first described. Solow recalls that like many others he was drawn to this topic after World War II by the economic drama of the newly decolonized nations. Everyone expected them to follow the path of the industrial nations, he says, but how? What would make their economies grow?

Economists had been preoccupied with the fluctuations of business cycles, the periods of growth and recession that hover about long-term trends of growth in the gross national product. But relatively little attention had been given to the question of why one country has a growth trend of 3%; a second, 4%; and a third, 2%. Most attention focused on 10-year bits of economic behavior. Solow wanted to look at longer periods.

The wisdom at the time, Solow says, was that investment of savings was the key to growth. The more a nation saved, the faster it could grow. "What distinguished poor countries from rich countries was that poor countries were able to save very little because they were poor," Solow says. The rich ones would grow faster because they started out rich. That was an idea he rejected. Another was the notion that an industrial economy—once launched on a path of high growth—would have no choice but to continue along a very narrowly prescribed growth trend line. "If it ever drifted off in one direction or the other, those movements would be magnified," leading to a crisis.

Solow formulated a new theory that did away with the "knife edge" description of growth, allowing for greater flexibility in planning. He found that the existing literature omitted forces that tend to balance one another and keep the economy in good health. His technical efforts to dissect growth made a big impression, for he came up with a startling and unexpected fact: capital investment is not the key factor in economic growth, not by a long shot. Neither is the increase in workers. Solow showed with statistics on wage and property income between 1909 and 1957 that neither of these two was the most significant element. Instead, it was a residual factor, an undefined, broad category that has come to be known as innovation or technology.

Publication of this finding made a splash in 1957, as several of Solow's colleagues point out, partly because it coincided with the Soviets' launch of Sputnik. Solow provided the intellectual basis and the Soviets provided the political impetus for an intense national drive to promote science and technology. It is now taken as an article of faith, certainly by the current Administation, that one of the best uses of federal funds is to invest them in basic research. For example, Ronald Reagan's January 1987 budget priorities statement justifies a 76% increase in research funding between 1982 and 1988 as follows: "Support for basic research, particularly at universities, is a key factor in gener-

ating sufficient new knowledge to ensure continued technological innovation. . . . " It goes on to describe the "critical importance" of research for the economy.

In the decades since Solow published his papers, many others have tried to break down the residual "technology" factor into smaller pieces to get a clearer picture of the processes that work to promote growth. Among those who have explored the topic are Edward Denison of Brookings, Edwin Mansfield of the University of Pennsylvania, and Dale Jorgenson and Zvi Griliches of Harvard, to name a few.

Denison, who recently surveyed 500 articles on technology and growth, warns that many people may not appreciate how hard it is to pin down the elements of this vague factor known as innovation. He has concluded from his own work that government-funded research and development probably are not the most important parts for the economy. "It doesn't look like you can account for very much of the growth rate through the increase in R&D expenditures over the last 25 years, even if you assume a very high rate of return on expenditures," he says. "There just isn't enough money there." Denison thinks an unstructured kind of innovation may be more important: "You know, when people are working, they notice things" and make numerous small improvements. Others, including Griliches, stress the importance of education as a promoter of knowledge and invention. Ideas like these have led to further debates on the value of "human capital" and the need to make American industry "competitive." These subjects trace back to the Solow papers.

In the 1960s, Solow turned to other things. He took a 2-year stint as a staffer in the Kennedy White House from 1961 to 1962. Solow and Arthur Okun were staff economists on a Council of Economic Advisers that included Kermit Gordon, James Tobin, and Walter Heller, the chairman. Kenneth Arrow also joined the staff later, making this a triple-Nobel group. "That was one of the greatest periods of my life," says Solow, but by the end of 1962, "it was enough." He says he could have had a role in the Johnson and Carter administrations, but, "I'm an academic. I'm happiest sitting with a pencil and pad of paper and trying to figure something out at my leisure. And I like teaching." And that is what he has done at MIT for 38 years.

Solow earned his bachelor's and Ph.D. degrees from Harvard, but went to MIT because it offered him a job. He joined a new economics department founded by Paul Samuelson. One of the other assistant professors was George Shultz, the current secretary of state, who called to congratulate Solow the same morning *Science* phoned. Shultz and Solow are old friends, but they do not confer on policy.

Robert Merton Solow

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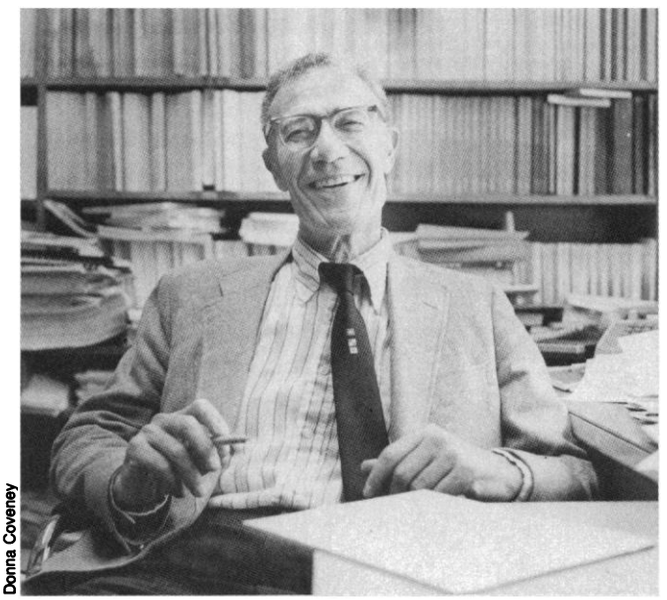

Donna Coveney

MIT hired Solow fresh out of graduate school in 1949. "You take a 25-year-old economist, a theorist at that, and you give him an office next to Paul Samuelson . . . that's a great experience," says Solow. According to Jorgenson, many other schools have tried to hire Solow: "Harvard, Yale, Chicago—everybody tried to recruit him. But he was dedicated to Samuelson, and together they were the backbone of that department for 25 years. MIT's Department of Economics has had the highest ratings in the country for the last 10 years. It's the best." Solow says, "A man would have to be a fool to go somewhere just for money when instead he could sit and talk with Paul Samuelson every day."

Solow and Samuelson are leaders in the Keynesian school, which despite earlier glories, is somewhat on the defensive these days. It was beset by criticism from the monetarists in the 1970s, led by Milton Friedman of the University of Chicago. He pointed to the Keynesian policies of the 1960s as a cause for the prolonged inflation of the 1970s. Under the rubric "money matters," the monetarists argued that through inattention to financial effects, the government had created a dangerous condition in which productivity was sinking, unemployment was high, and inflation was rising. In debating these charges, Solow deployed his wit effectively, too effectively, some have said. Many remember an impromptu remark Solow made about Friedman at a professional gathering in Washington, that went like this: "There is a difference between Milton and me, but not as big as you might think. For Milton, everything reminds him of money. Everything reminds me of sex. The difference is that I keep it out of my writing." Solow agrees that money matters, but not as much as Friedman says.

A younger generation of Chicago economists, known as the neoclassicists, has taken up the cudgels against government interference in the marketplace. They use elegant theory and impressive technical artillery to convey their message, but Solow has dismissed it as "far from reality." In his book *Conversations with Economists*, Arjo Klamer challenged Solow to explain why he uses jokes to answer serious arguments made by these young economists. Solow's response was telling. "Sometimes I think it's a flaw in my character . . . but there's another side, too," Solow said. "Suppose someone sits down where you are sitting right now and announces that he is Napoleon Bonaparte. The last thing I want to do with him is to get involved in a discussion of cavalry tactics at the battle of Austerlitz. . . . Now [the neoclassicists] like nothing better than to get drawn into technical discussions because you have tacitly gone along with their fundamental assumptions. . . . Since I find that fundamental framework ludicrous, I respond by treating it as ludicrous—that is, by laughing at it."

Nobel winners receive a monetary award now valued at about $330,000. Solow was asked what he would do with his money. He pointed out that this is the first year that Nobel winners will have to pay taxes. "I'm perfectly happy with that," he says. He wants to buy a Genoa jib and an outboard motor for his sailboat, but aside from that, his budget plan is unclear. ■

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