On the 25th Anniversary of Romer (1990)

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Abstract

If you add one computer, you make one worker more productive. If you add a new idea — think of the computer code for the first spreadsheet or word processor or even the internet itself — you can make any number of workers more productive.

The essential contribution of Romer (1990) is its clear understanding of the economics of ideas and how the discovery of new ideas lies at the heart of economic growth. The history behind that paper is fascinating. Romer had been working on growth for around a decade. The *words* in his 1983 dissertation and in Romer (1986) grapple with the topic and suggest that knowledge and ideas are important to growth. And of course at some level, everyone knew that this must be true (and there is an earlier literature containing these words). However, what Romer didn't yet have — and what no research had yet fully appreciated — was the precise nature of how this statement comes to be true. By 1990, though, Romer had it, and it is truly beautiful. One piece of evidence that he at last understood growth deeply is that the first two sections of the 1990 paper are written very clearly, almost entirely in text and with the minimum required math serving as the light switch that illuminates a previously dark room.

Here is the key insight: ideas are different from essentially every other good in that they are *nonrival*. Standard goods in classical economics are rivalrous: my use of a pencil or a seat on an airplane or an accountant means that you cannot use that pencil, airplane seat, or accountant at the same time. This rivalry underlies the scarcity that is at the heart of most of economics and gives rise to the Fundamental Welfare Theorems of Economics.

Ideas, in contrast, are nonrival: my use of the Pythagorean theorem does not in any way mean there is less of the theorem available for you to use simultaneously. Ideas are not depleted by use, and it is technologically feasible for any number of people to use an idea simultaneously once it has been invented.

As an example, consider oral rehydration therapy, one of Romer's favorite examples. Until recently, millions of children died of diarrhea in developing countries. Part of the problem is that parents, seeing a child with diarrhea, would withdraw fluids. Dehydration would set in, and the child would die. Oral rehydration therapy is an idea: dissolving a few minerals, salts, and a little sugar in water in just the right proportions produces a life-saving solution that rehydrates children and saves their lives. Once this idea was discovered, it could be used to save any number of children every year — the idea (the chemical formula) does not become increasingly scarce as more people use it.

How does the nonrivalry of ideas explain economic growth? The key is that nonrivalry gives rise to increasing returns to scale. The *standard replication argument* is a fundamental justification for constant returns to scale in production. If we wish to double the production of computers from a factory, one feasible way to do it is to build an equivalent factory across the street and populate it with equivalent workers, materials, and so on. That is, we replicate the factory exactly. This means that production with rivalrous goods is, at least as a useful benchmark, a constant returns process.

What Romer stressed is that the nonrivalry of ideas is an integral part of this replication argument: firms do not need to reinvent the idea for a computer each time a new computer factory is built. Instead, the same idea — the detailed set of instructions for how to make a computer — can be used in the new factory, or indeed in any number of factories, because it is nonrivalrous. Since there are constant returns to scale in the rivalrous inputs (the factory, workers, and materials), there are therefore *increasing returns* to the rivalrous inputs and ideas taken together: if you double the rivalrous inputs and the quality or quantity of the ideas, you will more than double total production.

Once you've got increasing returns, growth follows naturally. Output per person then depends on the total stock of knowledge; the stock doesn't need to be divided up among all the people in the economy. Contrast this with capital in a Solow model. If you add one computer, you make one worker more productive. If you add a new idea — think of the computer code for the first spreadsheet or word processor or even the internet itself — you can make any number of workers more productive. With nonrivalry, growth in income per person is tied to growth in the total stock of ideas — an aggregate — not to growth in ideas per person.

It is very easy to get growth in an aggregate in any model, even in Solow, because of population growth. More autoworkers mean that more cars are produced. In Solow, this cannot sustain per capita growth because we need growth in cars per autoworker. But in Romer, this is not the case: more researchers produce more ideas, which makes everyone better off because of nonrivalry. Over long periods of recent history — twenty-five years, one hundred years, or even one thousand years — the world is characterized by enormous growth in the total stock of ideas and by enormous growth in the number of people making them. According to Romer's insight, this is what sustains exponential growth in the long run.

References

Romer, Paul M., "Increasing Returns and Long-Run Growth," *Journal of Political Economy*, October 1986, *94*, 1002–1037.

__ , "Endogenous Technological Change," *Journal of Political Economy*, October 1990, *98* (5), S71–S102.

Additional Resources

The Romer (1990) paper

Romer's blog entries on the 25th anniversary of the 1990 paper

Chad's slides on "Growth and Ideas" (and a more in-depth paper)