

## Special Feature B

# Rivalry and Prosperity

by Paul Romer<sup>1</sup>

Picture your worst nightmare as a parent. Both your child and someone else's child are deathly ill. There is a bottle with enough medicine to save the life of just one child. You have worked all your adult life as a teacher. The other family made a fortune speculating in real estate. Because they are wealthier, they outbid you for the medicine and use it to treat their child. Before reading on, pause and think about the emotions you would feel as you looked at your sick child.

Now, change the story. Suppose that the other family finds on the bottle of medicine the formula for making more: add water, salt, a bit of crushed banana, and some sugar. They call you and give you the formula so you can make more medicine and save the life of your child, too. Now, think about how differently you would feel in this case.

The medicine in the bottle is what economists call a rival good. You and someone else are rivals for the use of this good – rivals in the sense that if the other family uses the medicine to save the life of its child, you cannot use it to save yours. In contrast, the formula for making more of the medicine is a non-rival good. You can use the formula to make medicine for your child without in any way depriving the other family, or any other family, of the ability to use it as well.

The non-rival good described here is real. The formula is the basis for oral rehydration therapy (ORT), the standard of care for children with diarrhoea who might die of dehydration if they are not treated. Doctors estimate that this formula saves millions of lives each year.

The formula for ORT illustrates a deep result about economic activity. When statisticians tell us that a firm or an economy has produced so many dollars

of value, what precisely does that mean? If you think about the world the way a physicist or chemist would, you realise that people do not actually produce anything. All the physical objects that we have to work with have been here on earth since the planet was formed. All we have ever done and all we can do is rearrange them in ways that give us more value. It turns out that some mixtures or arrangements are worth vastly more than others. On the shelf and in the sink, water, sugar, salt, and a few minerals like the potassium you can get from a banana are worth pennies. Mixed in just the right proportions, they can save a life.

This is what production is all about: rearranging low value physical objects to put them in a form that is more valuable or pleasing to us. In most cases, the raw materials like water, salt, and sugar are relatively abundant. It is the formulas that are scarce. Every year, people working all over the world use a vast array of formulas, instructions, blueprints, designs, recipes, and processes to rearrange physical objects. The GDP that we measure is our estimate of the total value created by all this rearranging. A smaller group of people find new formulas.

Throughout human history, some of these new formulas were so important and novel that they defined entire epochs: "Mix tin with copper to make bronze." "Combine these semiconductors and metals in just the right pattern to create a transistor." Most are small refinements on productive ideas that already exist. "Use aluminium instead of steel to make this car part just a little bit lighter." Economic output in any year depends on the visible transformations that we undertake with existing formulas. However, it is the discovery of new formulas that really

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matters. Economic growth, true improvement in the quality of life, is possible because we keep making these discoveries.

A deceptively simple exercise should persuade you that the number of possible formulas that remain to be examined is so vast that humans will never run out of new things to discover. Picture a chemist's workbench with 100 jars, each containing a different basic element from the periodic table. Ask yourself how many different mixtures you could make from those elements. Do not worry about the proportions in the mixture or the conditions we use to do mixing. Just keep track of the elements that are being used. We know about some of these. Bronze made from tin and copper is one mixture. Steel made from iron and carbon is another. Water made from hydrogen and oxygen is one that we could find naturally. So is salt, made from sodium and chloride. How many total mixtures might there be? The answer is  $100 \times 99 \times 98 \times \dots \times 3 \times 2 \times 1$ . This number turns out to be far larger than the total number of seconds since the Big Bang created the universe plus the seconds left until the sun explodes in 5 or 10 billion years and incinerates the earth.

A remarkable result follows from these facts: the formulas we use to create value are non-rival and there is a virtually unlimited scope for discovery of valuable new formulas. We benefit enormously from interacting with the billions of other people like us here on earth. Suppose that among every 10,000 persons, just one discovers a truly valuable new formula (perhaps a new pharmaceutical) each year. If there were only 10,000 of us on earth, we could share the one idea produced each year, which would mean that we would each have one new idea to use. If there were 20,000 people, we would each have two new ideas each year. Generalising, when there are more people, each of us can make use of more new ideas each year.

In a world where all nations can trade and communicate with each other, ideas discovered anywhere can raise standards of living anywhere else. People in China make use of transistors invented in the US. People in the US now will drive more energy-efficient cars because of hybrid electric drive systems developed by Japanese auto firms. Children throughout the world survive because of non-intuitive improvement to the

formula for ORT discovered by a doctor in Bangladesh – adding sugar. The medical challenge is to replenish a child's normal balance of water, salt, and minerals. The sugar turns out to be important because it speeds up absorption of the water and minerals. These benefits from sharing valuable non-rival goods are the deep force behind the wave of globalisation that is touching all of our lives.

There are, to be sure, some important rival goods that are scarce. As the worldwide population grows, more of us will compete for these. Over the course of human history, land remained fixed as the worldwide population grew immensely. For centuries, people have predicted that more people trying to live off a fixed quantity of land would soon lead to disastrous food shortages. In fact, the benefits we derived from having more people discovering more new ideas about better methods for raising food have far outstripped population growth.

At some point, a population that grew too large would overstress the world's natural resources, but the world's population will stabilise in this century, almost surely at a level that will allow a remarkably high standard of living for all. There will be a few scarce rival goods (beautiful diamonds or lovely spots on the beach) that we compete for. As the world's population gets richer, the prices of these goods will increase. Less trivially, a critical one will turn out to be the atmosphere's capacity to absorb more greenhouse gases. We will have to learn to live under social and economic systems that limit the total amount of fossil fuel that we burn each year, just as we had to live for centuries with a fixed amount of land. (Ironically, the problem for humans may turn out to be that we have too much oil and coal, not too little.) Discoveries that we will end up sharing will let us derive more satisfaction and value from less fossil fuel burned per person, just as we now enjoy far more and far better food from less land per person. Land is a far more important input into agricultural output than energy is for non-agricultural output. Especially given the fact that we have many alternative sources of carbon free energy like solar power, dealing with limited amounts of fossil fuel per person is a simpler technical challenge than the one we have already solved of getting more food from less land per person.

Therefore, our prospects for improving standards of living are remarkably bright. We will also have the chance to bring out the best in ourselves. The potential for discovering new non-rival goods means that we can all live lives that get better from year to year and generation to generation. Even more important, we can develop the best side of human nature, the emotional side that you could feel when you thought of the family that shared the formula with you, not the ugly side you could sense when you thought about the unfairness of a world in which there was not enough medicine for both children.

Economists are professional worriers. In a physical world that gives us such remarkable opportunities, what could go wrong? The problems will arise on the social side, not from limits imposed by nature. To get the full benefit from working with so many others, humans need institutions that structure our interactions. One of the most important is the collection of legal institutions that keep us safe and define the property that we own and exchange with others. Some countries remain very poor, unable to share in the world's stock of existing ideas because they have not yet developed legal systems that can provide these prerequisites. Until they do, they will lag behind as growth takes off everywhere else. In the rich countries, we can and should help these countries put this kind of system in place.

For the world as a whole, we will also have to come up with some system of property rights to burn fossil fuel, or some equivalent system that limits total annual consumption of fossil fuels. The challenge here lies in finding a way to adopt these rules simultaneously in all the major countries of the world. This will take some negotiation and compromise, but if we can remember that we are not rivals, we should be able to rise to the challenge.