Introduction

JOSEPH E. STIGLITZ AND BRUCE C. GREENWALD

IT WAS a real pleasure for us to deliver the First Annual Kenneth J. Arrow Lecture at Columbia University—to honor our teacher, someone who has had a lifelong influence on our thinking, as he has had on an entire generation of economists.

There is, in fact, a sense in which everyone in our generation was a student of Kenneth Arrow—even those who were not fortunate enough to take his class. His ideas influenced us, as did his style of research and his breadth of vision. He is a true model of a scientist. He could provide the definitive proof of the Pareto optimality of the competitive equilibrium (the first fundamental theorem of welfare economics), then go on to explain why the assumptions were wrong—and then go on to develop models incorporating more realistic assumptions, overturning the earlier conclusions about the efficiency of the market.

Both Arrow and Robert Solow, another of our teachers that our lecture honored, performed just those kinds of analytical feats in a series of papers that inspired this volume. The first was a paper that Solow wrote in 1956, which showed that an increase in the savings rate would *not* lead to an increase in the long-run growth rate—that was determined

by the rate of productivity growth. Then, in 1957 he decomposed the sources of economic growth and argued that most of economic growth was related not to increases in factors of production—like labor and capital—but rather to increases in productivity. Before that, economists focused on savings and capital accumulation, but not on the role of technological progress, as the source of the enormous increases in our standard of living over the past two hundred years.

In 1962 Ken Arrow published two important papers attempting to explain technological progress. One focused on research and development (1962b) and the other on learning by doing (1962a). This latter paper observed that, in the process of producing and investing, one learns. As we produce and invest, we get better at what we do. If one builds more ships, one becomes more efficient at building ships. Productivity increases. This was one of the earliest papers on what has come to be called endogenous growth theory, where the pace of innovation is determined within the model.

Each of the Arrow lectures is intended to build off one of Arrow's pathbreaking contributions. For our lecture, we took his work on innovation, in particular his remarkable 1962 paper on learning by doing. That paper itself is in part a commentary on an earlier important Arrow paper. Two hundred and forty years ago Adam Smith talked about the efficiency of the competitive market economy. He argued that competitive equilibrium was efficient, that the pursuit of self-interest would lead, as if by an invisible hand, to the well-being of society. It took a long time for economists to determine in what sense that was true (what economists now refer to as Pareto optimality) and the circumstances under which it was true. The critical works proving the conditions under which competitive equilibrium was in fact Pareto efficient were Arrow's (1951b) and, contemporaneously, Gerard Debreu's (1952; also Arrow and Debreu 1954).

Arrow had assumed in that paper that technology was fixed, that is, that there was no innovation.[1] His paper on learning by doing challenged that assumption. For a modern economy, innovation is clearly central. In that paper, as well as in his other 1962 paper on R & D (1962b), Arrow explained why the production of knowledge is very different from the production of conventional goods.

When technology is endogenous, markets are not, in general, efficient. But this immediately raises a further question: How should government intervene in the market to enhance efficiency and societal

welfare? Remarkably, in the fifty years since Arrow's 1962 paper, that question has been addressed only in a piecemeal way (e.g., in discussions about intellectual property and patent policy).

In our lecture, we investigated the implications of learning by doing for the long-standing presumption in favor of free trade. It made for a good lecture topic, which gave way to a day of useful discussions and interesting reactions, many of which are included at the end of this volume. But as we prepared our lecture for publication—since the Arrow lectures' inception, a book series was planned to accompany them—and we took to heart the comments made by Arrow and Solow, it became clear to us that to do justice to the issues we had raised required more than a short lecture. Arrow's work had opened the door to a large body of fresh analysis on how to create a learning economy and society—and how government can and should intervene to improve societal well-being.

That we chose Arrow's learning perspective as the foundation for our lecture—and the subsequent elaboration that resulted in this volume—is neither coincidence nor contrivance. Rather, Arrow's work proved the perfect starting point for the same reason that the lecture series was named after him: The contributions he made to the field are still so important that half a century later they are often the ineluctable jumping-off point for present-day work.

Like other great economists of his generation (including Solow), Arrow has ultimately been interested in improving the practice of economic policy. Clarifying economic thinking, while valuable in itself, really accrues value in the course of being applied to particular situations where policy decisions are being made, in some cases being made badly, almost always in ways that can be improved upon. In approaching the question of free trade from Arrow's learning perspective, not only do we honor his legacy and challenge the conventional views, but also hopefully we make a contribution to a key set of policy issues: how to increase the pace by which living standards increase, especially in developing countries.

The fact that markets on their own are not efficient when innovation is endogenous raised the question which is at the heart of our lecture and the book to which it gave rise: What should be the role of policy in promoting economic efficiency? Advocates of unfettered markets often respond to this question by championing the market's ability to innovate. But there is remarkably little systematic inquiry into whether

markets generate the optimal level and form of innovation. Our lecture was intended to fill this gap, with specific applications to trade policy.

There was at the time we delivered our lecture already a long-standing exception to the presumption in favor of free trade in the idea that it might be appropriate to protect infant industries.[2] Thus, if a particular industry grew with protection, and got stronger as it grew because it benefited from economies of scale, one might think there was an argument to protect that industry. There is a second exception to the principle of free trade associated with price manipulation. If a country has a large industry in the world economy, then it can manipulate the terms of trade (that is, international prices) to its benefit. These two exceptions are related, and under careful scrutiny the second argument enhances our understanding of the limits of the first: if one does not alter the terms of trade, it does not matter where the protected industry develops. Nigeria might, say, protect its auto industry until it was strong enough to compete in global markets. But if that industry can efficiently develop in England—and as long as the import prices reflect the productivity gains—Nigerians will benefit by buying and importing those cars just as much as people in England do.[3]

In fact, the terms-of-trade argument has always been a fairly weak argument. The argument that countries, even the United States, can move the terms of trade is difficult to make in practice. Thus, the standard theories do not provide very persuasive reasons for trade interventions. Nevertheless, there seems to be a persistent pattern of *successful* economies practicing trade restrictions.

In thinking about this problem, we applied Arrow's lessons in a way that brought us to a different conclusion, which forms the heart of this lecture and book. Our analysis shows that these successes are not based on the infant-industry argument for protection, where there are benefits *within* an industry to learning by doing. Instead, there is an infant *economy* argument for trade interventions. The intuition is remarkably simple: We explain why innovation is likely to be more centered in the industrial sector rather than the agricultural or craft sector. The industrial sector is not only better at learning, but also generates more externalities—more learning benefits—to the rest of the economy. An economy that starts out without a strong urban industrial sector—one that is importing those goods—is unlikely to develop improvements in productivity, even within that sector. There is little learning, little innovation. Trade barriers are necessary to enable that economy to develop

those industrial enterprises even though it might seem inefficient to do so in the beginning, because it runs counter to the country's current comparative advantage.

So far, the argument runs parallel to that of the standard infant-industry argument. But here is where the difference arises: enterprises in protected industries will generate productivity growth not only in their sector, but also across different individual products within that sector—and also across to agriculture and other sectors of the economy. It is the externalities generated by the sector that provide the real rationale for intervention.

The classic example of this is, of course, the Agricultural Extension Service in the United States, where principles of industrial research got applied to farms in an extraordinarily efficient manner. As much as anything, it accounts for the remarkable growth in agricultural productivity in the United States.

That was the basic idea that we proposed in our lecture. It calls for a kind of protection that is not industry specific. The classic complaint about infant-industry arguments—that trying to pick successful industries is a doomed effort—does not apply. This is an argument for a broad set of tariff barriers (or exchange rate interventions), within which one hopes that the best industries will survive and prosper.

A Guide to This Volume

In the years following the first lecture, our ideas took on new life. As we worked the ideas of our lecture into different papers and continued our research on related topics, it became clear to us that we had more than a slim conference volume's worth of material. Our lecture on "creating a learning society" was growing into a full-fledged body of theory that required historical context, examples of general and specific applications, and discussions of political economy.With that realization, this book began to take shape. The result is something far more expansive than the original lecture, though the core intellectual inspirations for the book are the same as those that guided us in 2008.

In the first few chapters of this book, we lay out our basic theses: that most of the increases in standards of living are, as Solow suggested, a result of increases in productivity—learning how to do things better. And if it is true that productivity is the result of learning

and that productivity increases (learning) are endogenous, then a focal point of policy ought to be increasing learning within the economy; that is, increasing the ability and the incentives to learn, and learning how to learn, and then closing the knowledge gaps that separate the most productive firms in the economy from the rest. Therefore, *creating a learning society should be one of the major objectives of economic policy*. If a learning society is created, a more productive economy will emerge and standards of living will increase. By contrast, we show that many of the policies focusing on static (allocative) efficiency may in fact impede learning and that alternative policies may lead to higher long-term living standards. Thus, the theory that we develop provides one of the most compelling and fully articulated critiques of the Washington consensus policies that dominated development thinking in the quarter century before the Great Recession. The theory also provides the basis of a new theory of the firm—a new answer to the question posed more than 75 years ago by Ronald Coase: What determines the boundaries of firms, what goes on inside the firm? It also provides a new approach to thinking about both static and dynamic comparative advantage.

Part One also gives the reader a view of the historical, empirical, and theoretical background and justification for our learning-society perspective. We describe key aspects of creating a learning society: the processes and determinants of learning and some of their broad implications for economic architecture—the design of the economic system and its subcomponents (most importantly, firms)—and policy. We explain the implications of "localization of knowledge" (both technologically and spatially), extend the concept of learning by doing to learning to learn by learning, explain why geographically concentrated large enterprises, traditionally in the industrial sector but more recently in the modern services sector, have been at the center of growth—with high rates of productivity increases and large spillovers to other sectors of the economy. We explain, too, the link between macro-stability and long-run productivity growth—a new rationale for why *real* macrostability is so important.

Having analyzed the basic determinants of learning, we address two critical questions: Is there likely to be more or less learning in economies that are more competitive (with more firms)? And is the market likely to be efficient in the level and pattern of innovation and learning? In asking the latter question, we note that the level of competition

(concentration) is itself *endogenous*—though it can be affected by government policies. As we have already noted, Arrow's earlier work provided more than a little hint that the outcomes of market processes would not be efficient, though he did not directly challenge Schumpeterian views which championed the innovative virtues of the market. The picture that emerges from our analysis is complex: Joseph Schumpeter was overly optimistic about monopolies—he thought that they would be only temporary and that competition to be the dominant firm drove innovation. We show that monopolies may be far more persistent than he (and latter-day Schumpeterians) thought and that the fight to be the dominant firm may be far less effective in stimulating innovation than he thought. Still, Schumpeter was right that more competitive markets, with many small firms, are likely to be *less* innovative.

The central message that emerges is that there is an important role for government to play in shaping an innovative economy and in promoting learning. Parts Two and Three of the book explore in more detail how the government can best do this.

Part Two provides the key analytical results, moving from simple models to more complex. The two key chapters are 7 and 11. Chapter 7 looks at a two-good (agriculture and manufacturing) closed economy (no trade) model and explains how policies promoting the industrial (manufacturing) sector (such as subsidies) lead to higher rates of growth and welfare. The short-run (allocative) distortions are more than offset by the long-term learning benefits. Simple formulae describing the optimal subsidy are derived. In this simple setting, we can compare the rate of innovation if there is competition with that when the industrial sector is dominated by a single firm. Innovation will be higher with monopoly, but whether welfare will be higher is ambiguous and depends on learning elasticities and discount rates.

Chapter 11 extends the analysis to an open economy, establishing the infant-economy argument for protection. Because the industrial sector not only has a greater capacity for learning but also more learning spillovers, encouraging that sector through protection or industrial policies can lead to higher growth and societal welfare. The force of the argument for protection is much weaker in developed economies. In economies like the United States, Europe, and Japan, there is already a dense infrastructure that has the scale to develop ideas and innovations, though there may still be cross-sector or cross-industry learning externalities that might warrant government intervention.

The theory has a wide range of implications. To illustrate: Our analysis suggests that it is desirable for large groups of countries to work together to facilitate trade amongst each other, while erecting certain barriers to trade from the outside. Competition and incentives matter. Having broad collections of countries, like the European Union, competing behind broad barriers, has considerable attraction. The protection enables the development of the "learning" (industrial) sector; the size provides scope for competition. (Our earlier remark explains why the degree of protection should be reduced over time.)

The structure of trade policy in the successful developing economies, like Japan, Europe after the Second World War, or other economies in Asia, has been very much of this sort. They have not focused on particular industries and protected them; they have tended to have broad protection across a range of industries, and they have actually encouraged competition behind those barriers.

The question of how this affects financial markets also arises—a question that Arrow's and Solow's work is particularly well positioned to help answer. When a country exports capital, the owners of that capital are, in effect, importing capital services from overseas. Just as imports of manufactured and industrial goods fail to carry with them the learning that is associated with those sectors, imports of financial services fail to carry with them the important learning that is associated with that sector. If there are powerful arguments for broad barriers to imported industrial goods, those apply equally to restrictions on capital exports overseas and the import of financial services. In short this theory provides a new rationale for why capital and financial market liberalization may lead to lower rates of growth. Similar arguments also apply, we show, to labor exports overseas.

Chapters 8, 9, and 10 extend the basic analysis of a two-period, two-good model into a multiperiod, multigood model. For example, these chapters derive more general formulae for optimal interventions; show that there may be multiple equilibriums, in one of which societal welfare is higher than another; explain that the composition of output can affect the long-run pace of innovation (an insight which obviously cannot be derived in the highly aggregative models used in macro-growth theory); and demonstrate that it may be desirable for a country to intervene in the exchange rate, setting it at such a low rate that it runs a *perpetual* surplus, with the benefits of learning outweighing the foregone consumption and investment.

From these analytics, the book moves (in part Three) to a broader policy discussion, beginning with trade and industrial policy, moving on to macro, financial, and investment policies, and to intellectual property. We explain why the political economy objection to specific infant-industry protection—that, for instance, the special interests that benefit from such protection work to keep it in place long after the economic justification for such protection has gone—have much less force in the context of the *infant-economy argument for protection*. We show that political economy concerns affect not whether there should be industrial and trade policies, but which policies and how they are best designed. We show too that intellectual property laws, if not well-designed, may actually impede learning and that "stronger" intellectual property regimes may be associated with a slower pace of innovation.

This part ends by moving beyond creating a learning *economy* to creating a learning *society*, and beyond the standard economic model, with its assumptions of rational individuals with predetermined preferences, incorporating insights from recent advances in behavioral economics, including the notion that preferences and beliefs are, at least in part, socially determined. We ask, for instance, whether there are policies that can help create a learning "mindset."

We hope this selection of insights has provided enough tempting morsels to persuade the reader to delve deeper into what follows. As we attempted to exposit our ideas, we faced a major dilemma: Mathematics is the language of modern economics. It can help ensure that putative conclusions follow from the assumptions. It can help test the robustness of the results: Do changes in assumptions lead to markedly different conclusions? But it can also obscure: the complexity of the analysis can also hide the role of particular assumptions. Arrow and Solow taught us the value of simple models—that we should strive to find the simplest and most general model to explore and explain the particular issue at hand. We hope the exposition here lives up to the high standards that they set.

But even the simplest analysis in this area can be relatively complex. And testing the robustness of the results requires exploring multiple variants of the basic model. The most complex calculations are concentrated in the appendices and in chapters 8, 9, and 10. Still, to make persuasively particular points (for instance, concerning the persistence of monopolies or that innovation in more competitive markets may be lower than in monopolies), we felt compelled to present some of the

analytics within the body of the main text. We have written the book, however, so that the interested reader can skip over those analytic sections with little loss of continuity.

As our growing manuscript for this book grew beyond the bounds of the lecture, we still wished to preserve some of the valuable contributions from that day in 2008 when it was first presented. Both Solow and Arrow themselves were present and gave their own commentaries. Michael Woodford and Philippe Aghion also participated in discussions on the lecture topic, and Aghion delivered an entire lecture, "Rethinking Industrial Policy," that was complementary to our own. These commentaries and Aghion's lecture enriched our lecture at the time we delivered it and influenced our subsequent development of this book in important ways. We thus thought it desirable to retain these invaluable contributions in this volume. The main chapters of this book are followed by adapted transcripts of the commentaries from the lecture day. Aghion's lecture is included in its totality as an afterword.

In deciding to include these additional materials, we hope the reader enjoys getting a flavor of the day's proceedings. We feel the commentaries give a window into how our teachers and colleagues shaped our own thinking. Aghion's lecture adds depth and additional perspectives to our analyses.

This lecture also provides us with an opportunity to honor another of our teachers, Robert Solow, the father of modern growth theory. Solow and Arrow taught us how simple ideas can have profound effects. Bringing in insights from the economics of knowledge and learning fundamentally changes one's view about how to think about policies designed to promote growth. The infant-economy argument, inspired by Ken Arrow's paper on learning by doing, is, we believe, in the broad tradition of Ken Arrow and Bob Solow, in extending economic insights to new areas. We hope that the insights it provides will help poorer countries employ novel and effective policies to promote their economic growth and development.