Robert Lucas, the economist who won the Nobel prize in 1995, famously commented, “Once one starts to think about economic growth, it is hard to think about anything else.” Compared to sustained growth, other sources of national wealth are insignificant. Compounded over a century, 2% annual growth (roughly the growth rate of the US economy in the last century) increases wealth by more than 7 times, and 10% annual growth (roughly the growth rate of the Chinese economy from 1980 to 2010) increases wealth by almost 14,000 times. People systematically underestimate the effects of compound growth, like thinking that a 5% increase in height is the same for a teenager and a toddler.

Sustained growth causes wealth in one country to overtake another faster than most people can imagine. Assume that country x’s national income begins *twice* as large as country y’s, but the former stagnates and the latter grows. To overtake x’s national income, y will need 36 years if it grows at 2%, 15 years if it grows at 5%, and 8 years if it grows at 10%. To illustrate concretely, most people are surprised to learn that South Korea, Mexico, and Senegal had roughly equal income per capita in 1950, yet in 2008 South Korea was more than twice as high as Mexico and ten times higher than Senegal. Similarly, in 1870 Argentina’s per capita income was 33 percent higher than...

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1 This chapter draws on Robert Cooter and Aaron Edlin, “Overtaking,” in The American Illness: Essays on the Rule of Law, ed. Frank Buckley (Yale University Press, forthcoming), and “Maximizing Growth vs. Static Efficiency or Redistribution,” working paper, Berkeley Economics Department.

2 Here’s a table of size reached by an economy that starts at 1 and grows at various rates and years.*

<table>
<thead>
<tr>
<th>Growth rate</th>
<th>1 year</th>
<th>5 years</th>
<th>10 years</th>
<th>25 years</th>
<th>50 years</th>
<th>100 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>0.5%</td>
<td>1.005</td>
<td>1.01</td>
<td>1.05</td>
<td>1.13</td>
<td>1.28</td>
<td>1.65</td>
</tr>
<tr>
<td>1%</td>
<td>1.01</td>
<td>1.05</td>
<td>1.10</td>
<td>1.25</td>
<td>1.64</td>
<td>2.70</td>
</tr>
<tr>
<td>2%</td>
<td>1.02</td>
<td>1.10</td>
<td>1.22</td>
<td>1.64</td>
<td>2.69</td>
<td>7.24</td>
</tr>
<tr>
<td>5%</td>
<td>1.05</td>
<td>1.28</td>
<td>1.63</td>
<td>3.39</td>
<td>11.47</td>
<td>131.50</td>
</tr>
<tr>
<td>10%</td>
<td>1.10</td>
<td>1.61</td>
<td>2.59</td>
<td>10.83</td>
<td>117.39</td>
<td>13,780.61</td>
</tr>
</tbody>
</table>

*size of economy = \((1+r/100)^t\), where \(r=\)percentage growth rate, and \(t=\)years of growth
than Sweden’s, yet by 2004 Argentina’s per capita income had dropped to 43 percent of Sweden’s.

Angus Maddison estimated changes in wealth over millennia for regions in the world. He concluded that Egypt was the world’s richest region two thousand years ago with per capita income 50 percent higher than elsewhere in the Roman Empire, China, or India. In the year 1000, Iran and Iraq under the Abbasids were the economically most advanced countries with a per capita income 50 percent higher than in Europe or Asia. By 1500 Italy had the lead with a per capita income 50 percent higher than in the rest of Western Europe, double that of Asia, and three times that of Africa. In 1820 Western Europe and the United States had the highest income per capita, twice as much as in eastern Europe, Latin America, or Asia, and three times as much as Africa. In the 19th century the rate of growth gradually accelerated, and accelerated more in the 20th century. Constant compound growth such as 2% implies accelerating absolute growth, just as a 2% gain in a teenager’s weight is absolutely more than a 2% gain in a toddler’s weight. From the perspective of two centuries, the compound growth rate in the industrializing countries accelerated modestly, which implies a large acceleration in the absolute growth rate. The successful countries are getting absolutely richer very fast. However, economic growth in the world is uneven, so the economic gap between fast-growing countries and slow-growing countries is much larger today than ever before in history. The wealth of the fastest growers has risen above the slowest growers like the Himalaya Mountains rising above the Ganges Plain.
Behind these facts stands a mathematical generalization: an economy that increases at an exponential rate will overtake an economy that increases at a constant absolute rate. ("Exponential rate" is a mathematician’s term for “constant proportional rate”.) Figure 1.2 depicts this fact. First consider function A, whose value increases at a constant rate with time, as indicated by A’s constant slope. An addition to the value of A shifts it up and yields B. A multiplication of B’s value rotates it up and yields C. The additive and multiplicative increases make C larger than A or B at each point in time. Now contrast C to function D that increases at an exponential rate. D starts behind C at time 0, and overtakes it at time $t^*$. This book concerns exponential growth like function D.

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4 Joke: “Economists need a graph to reach the wrong conclusions with certainty, whereas lawyer can do so immediately.”
An economy produces different goods like houses, clothes, books, and clean water. The usual measure of economic growth is the increase in wealth (a stock) or income (a flow). To measure wealth or income, economists combine different goods into comprehensive aggregates, such as gross national product (GNP). To combine heterogeneous goods, economists first weight quantities of goods by their market prices. Economists ideally adjust market prices for unpriced externalities such as the social cost of pollution. Comprehensive measures of wealth or income include externalities, and also public goods such as national security and air quality. To get closer to human welfare, economists measure consumption instead of wealth or income, and they divide the total by the number of people. Later we consider more controversial measures, specifically utility and social welfare.

The vertical axis in Figure 1.2 is unlabeled because the measure of growth -- total or per capita wealth, income, consumption, utility, or welfare -- matters little to our conclusions. For all economic measures, exponential growth

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5 In the national accounts, income can be “consumed” or “invested.” Consumption includes almost all the activities that people will pay to do, but not activities that people must be paid to do. Thus people “consume” an opera, a golf lesson, or a holiday. Note that in the technical language of economics, people “consume” many things without using them up, like playing a recording, whereas in ordinary speech “consumption” refers to using up something, like eating food or burning wood.
overtakes static effects. The overtake principle in economics is my name for the proposition that rapid exponential economic growth quickly overtakes the direct effects of static efficiency and redistribution on wealth and welfare. Given fast growth, static efficiency and income redistribution effects are important for their contribution to growth, and unimportant in themselves.

Besides prioritizing dynamic over static effects, the overtaking principle prioritizes some dynamic paths over others. Thus in Figure 1.3, the growth-path of income or wealth represented by D is unambiguously better than the growth-path represented by E, because D starts higher and grows faster than E. The analysis is different, however, when comparing E and F. F starts lower than E, grows faster, and overtakes E at t*. If overtaking occurs rapidly, then t* is small and nothing matters except growth. If, however, overtaking occurs slowly, then t* is large and static effects of efficiency and redistribution matter. Thus F is better or worse than E depending on the rate of growth. The measure of growth seldom changes these conclusions because different measures have similar overtaking times.

In contrast, the overtaking principle loses much of its normative appeal when growth and overtaking is slow. Thus interpret E and F as two sequences of consumption in an infinite number of generations. In the first sequence E,
initial consumption is higher and growth is lower. In the second sequence \( F \), initial consumption is lower and growth is higher. If overtaking occurs quickly (\( t^* \) is small), any reasonable economic measure will yield a larger value for \( F \) than \( E \). Conversely, if overtaking occurs slowly (\( t^* \) is large), some reasonable economic measures will yield a larger value for \( F \) than \( E \), and other reasonable measures will yield a large value for \( E \) than \( F \). For example, utilitarians measure economic value by summing the utilities of different people. Theorists disagree over whether lawmakers should give similar weight to the utility of future generations as to the present generation. If growth is fast and \( t^* \) is small, the sum of utilities in \( F \) overtakes the sum of utilities in \( E \) for any reasonable discount rate. \(^6\) Conversely, if growth is slow and \( t^* \) is large, whether \( F \) or \( E \) yields the larger sum of utilities depends on the rate for discounting future utility.

**Innovation**

Economic theory ascribes long run growth to three broad factors: physical capital (buildings and machines), human capital (work adjusted for the skills people bring to their jobs), and “innovation”. An increase in these factors increases income and wealth. MIT economist Robert Solow won the Nobel Prize partly for showing that innovation was more important to growth in the 1950s in the United States than increased physical or human capital. Subsequent empirical work by Edward Denison, Robert Barro, and others confirmed this finding for other developed economies. \(^7\) In the last 100 years, innovation caused more economic growth than anything else, including using more resources.

Innovations use new ideas to produce goods cheaper or to make better goods. The supply curve shows the cost of making a good, \(^8\) so a cost-reducing inno-

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\(^6\) Utilitarians often hold that future utility should not be discounted, whereas future income should be discounted by its marginal utility. In this view, utility is what discounts money, but there is nothing to discount utility. For a justification of not discounting future utility or welfare, see Derek Parfit & Tyler Cowen, *Against the Social Discount Rate, in Justice Between Age Groups and Generations* (Peter Laslett & Fishkin eds., 1992).

\(^7\) Add citations.

\(^8\) The supply curve is a monotonic relationship between price and quantity. Inferring from a price to a quantity, the supply curve shows the quantity that a firm or industry will supply at a given price. Conversely, inferring from a quantity to a price, the supply curve shows the cost for a firm or industry to supply a given quantity.
novation shifts the supply curve down, as when the tractor replaced the horse for plowing. In Figure 1.4, innovation shifts the supply curve from $S$ to $S'$, and the shaded area indicates the social value of the savings in cost from producing the quantity $x$ of the good.

Figure 1.4. Social Value of a Cost-Saving Innovation

Similarly, producing a better good increases its value to consumers, as when waterproof fabrics were made to breathe (“Gor-Tex”). When quality improves, people are willing to pay more. The demand curve shows how much people are willing to pay for a good, so a quality-improving innovation shifts the demand curve up. In Figure 1.5, the innovation shifts the demand curve

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9 Like the supply curve, the demand curve is a monotonic relationship between price and quantity. Inferring from a price to a quantity, the demand curve shows the quantity that consumers will buy at a given price. Conversely, inferring from a quantity to a price, the demand curve shows the price that consumers are willing to pay for a given quantity.
from D to D’, and the shaded area indicates the social value of the improvement in quality from producing the quantity x of the good.

**Figure 1.5. Social Value of a Quality-Improving Innovation**

When one person uses a scarce resource, others cannot use it, like taking a bite from a sandwich. Scarce resources like capital and labor have rival uses. In contrast, when one person uses an idea, just as much remains for someone else to use. Thus architects have used the Pythagorean Theorem for over two millennia and just as much remains as before. Using theorems, principles, natural laws, designs, discoveries, expressions, and compositions does not use them up. Economists call this property “non-rivalry”. Furthermore, when one person uses an idea, preventing others from doing so is difficult, more difficult than preventing someone from trespassing on your land or taking a bite from your sandwich. Ideas spread like gossip in Puddletown. Economists call this property “non-exclusion.”

10 In economics, non-rivalry and non-exclusion define “public goods” like national security and air quality, which resemble ideas in these two traits.
“Nonrivalry” and “non-exclusion” are good news about ideas, and here is even better news: ideas are fertile like seeds, not dead like coal. 2,500 years after its proof, generalizations of the Pythagorean Theorem continue to expand geometry’s power. Similarly, the number of transistors that can be placed inexpensively on an integrated circuit has doubled approximately every two years for the past fifty years (Moore’s law). Ideas about transistors are so fertile that innovation grows exponentially.

With a continuing stream of fertile innovations, growth can continue indefinitely and production can rise like the falcon’s gyre. This hypothesis is a reasonable conclusion from the last century of experience. It is also a reasonable conclusion from recent technological and scientific progress, especially developments in computers, nanotechnology, robotics, genetics, and medicine. In spite of wars and recessions, the United States and other Western capitalist countries have averaged growth of 2 to 3 percent per year in per capita GDP for more than one hundred years. In 1930 after the stock market’s crash triggered the Great Depression, John Maynard Keynes wrote his essay, “Economic Possibilities for Our Children”, which argues that the economic problem of the future is how to use abundance. Similarly, in 2012 Diamondis and Kotler wrote Abundance: The Future Is Better Than You Think. Or perhaps absolute growth will accelerate so much that the future is unimaginable to us, as Kurzweil argued in The Singularity is Near: When Human Transcend Biology (2005).

**Depletion**

Although the signs are good, the future remains in doubt until it arrives. A worrisome doubt concerns resource exhaustion and environmental degradation. Must depletion of resources eventually end growth? Some resources renew like a forest, river, or wheat. Use does not necessarily reduce their stock permanently because we replenish it. Instead of renewing, however, other resources deplete, like oil and iron. Use depletes their stock because we do not


12 For a survey of technologies where that great abundance is the future, see Peter H. Diamandis & Steven Kotler, *Abundance: The Future Is Better Than You Think* (2012).
know how to replenish it. Whereas fertile ideas increase with use, depletable resources diminish with use.

However, even with non-renewable resources, sustainable depletion is possible in principle. “Sustainable depletion” sounds oxymoronic like ”unmarried husband”, but it makes sense. In the 5th century BC, Xeno posed his paradoxes of motion that resembled the following: “By traveling half of the remaining distance to your destination each day, you never arrive (except in the mathematical limit when time goes to infinity).” Similarly, if the stock of oil falls by 50 percent in every period, the stock never reaches zero in finite time. “Sustainable depletion” refers to a path of depletion that never reaches zero, such as Figure 1.6.

Figure 1.6. Sustainable Resource Depletion

Depletion is sustainable if the rate of depletion decreases forever. Instead of decreasing, the rate of depletion is increasing in the world for many non-renewable resources. This trend could be reduced by continually reducing consumption. However, laws and policies to reduce consumption encounter fierce political resistance. If sustainability requires reducing consumption, humanity might destroy its future rather than diminish its present.

Fortunately, sustainable depletion is possible in principle through innovation, without reducing consumption. Innovation slows depletion by using
resources more efficiently, as when new automobile engines economize on fuel. Innovation also slows depletion by substituting renewable resources for non-renewable ones, as when hydro replaces coal to generate electricity. To deplete sustainably without decreasing consumption, innovation must get more output from fewer inputs of non-renewable resources, and innovation must substitute renewable resources for non-renewable resources. Consumption can increase forever if the gains from innovation outpace the losses from depletion.

**Freedom**

Every youth who watches the Olympics fantasizes standing on the central platform with a gold medal while the national anthem plays. In wealth as in sports, individuals and nations hope to surpass others and fear being surpassed by them. Like the Olympics, the value of winning the race for wealth or income is self-evident to many people. If you are one of them, facts cited above provide ample motivation to study law and growth economics.

Other readers of this book, however, will want moral or political justification for focusing on the growth of wealth. Wealth and income are means for buying goods, not ends in themselves like beauty, love, holiness, knowledge, or self-fulfillment. Accumulating wealth only to misuse it is a labor of shame. Is the nation that wins the growth race like the winner of the pie-eating contest whose prize is another pie? Does studying growth turn wealth into a fetish like falling in love with a shoe?

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13 The champion of this view in development economics is Amartya Sen, as two quotes suggest. “Economic growth cannot be sensibly treated as an end in itself. Development has to be more concerned with enhancing the lives we lead and the freedoms we enjoy.” *Development as Freedom* (New York: Knopf, 1999), 14. “The challenge of development . . . is to improve the quality of life. Especially in the world’s poor countries, a better quality of life generally calls for higher incomes—but it involves much more. It encompasses as ends in themselves better education, higher standards of health and nutrition, less poverty, a cleaner environment, more quality of opportunity, greater individual freedom, and a richer cultural life.” World Bank, *World Development Report 1991* (New York: Oxford University Press, 1991). Note that governments supply many non-market goods, and GDP measures their value by their cost (e.g. salaries paid to civil servants), not by their benefits to the citizens. Cost-benefit analysis can measure some of these non-market values more convincingly. To measure the value of non-market goods, economists try to find out how much people would pay for them if they had to pay, given that they don't have to pay. This can be a measurement maelstrom, so national accounting limits its use of cost-benefit analysis. For the relationships between happiness and money, see B. S.Frey and A. Stutter (2002), “What Can Economists Learn from Happiness Research?” *Journal of Economic Literature*. 
One justification for focusing on wealth and income concerns freedom. Like driving a car, most people think that they are good at spending money, in spite of occasional lapses such as purchasing uncomfortable shoes. People know what they want to buy, and they criticize what others buy. A liberal education should help you to think critically about what is worth buying. To critique the uses of wealth, intellectuals draw on traditions in philosophy and religion concerning what is really good, as opposed to what seems good. Thus intellectuals in the university often carp about strip malls, popular movies, fried food, ostentatious furniture, pay-day loans, and television preachers.

Most economists, however, refrain from debate about what people ought to want. By doing so, economists cultivate neutrality in controversies about the values of consumers. Instead of embracing a particular conception of goodness, economists often accept “consumer sovereignty” — the right of consumers to buy what they want. Consumer sovereignty implies the right to buy things that are good or bad, just as free speech implies the right to say things that are true or false. I may disagree with what you buy and defend your right to buy it, just as I may disagree with what you say and defend your right to say it.¹⁴

Philosophers distinguish two kinds of freedom that apply to consumer sovereignty.¹⁵ First, the absence of prohibitions or “negative freedom” increases when people have fewer restrictions on what they can do, including spending their money. Economists promote negative freedom of consumers by defending free markets. Second, the presence of opportunities or “positive freedom” increases when people have more money to spend. Economists promote positive freedom of consumers by finding policies and laws that increase wealth.

Besides consumers, the two kinds of freedom apply to entrepreneurs. Economic innovation mostly occurs in business ventures that develop new ideas. Negative freedom gives entrepreneurs the legal right to experiment with new economic ideas. Positive economic freedom gives entrepreneurs the resources to launch innovative ventures. Negative and positive economic freedom is the legal condition for business creativity, as discussed in the next chapter.

¹⁴ That’s how I felt when I drove through Las Vegas.
Welfare

Increasing negative and positive freedom is an appropriate goal for economists in a democratic state. Increasing freedom, however, is not the usual justification given by economists for increasing wealth. Economists usually justify increasing wealth as the means to increase the welfare of people. The normative branch of economics connects wealth to welfare, rather than connecting wealth to freedom. In the history of economics, the philosophy of utilitarianism was central to connecting wealth to welfare, especially in 19th and early 20th century England. Utilitarians equate individual welfare with a person’s utility, and they equate social welfare with the sum of individual utilities. In notation, \( SW = u_1 + u_2 + \ldots + u_n \). Instead of thinking of social welfare as a sum of individual utilities, however, modern economists think of it as an increasing function of individual utilities: \( SW = f(u_1, u_2, \ldots, u_n) \). The function may be additive as with utilitarianism, or it may be non-additive, such as multiplicative (\( SW = u_1 \times u_2 \times \ldots \times u_n \)) or logarithmic (\( SW = \log u_1 + \log u_2 + \ldots + \log u_n \)). From a mathematical viewpoint, the social welfare function generalizes utilitarianism, and different forms of the function have different ethical consequences for equality.

16 Economic theory assumed its recognizably modern mathematical form when theorists understood that equating marginal benefits and marginal costs maximizes utility. This recognition joined Newton’s calculus and the philosophy of utilitarianism and. See the “marginalist revolution” in economics as discussed in the classic by Joseph A. Schumpeter, HISTORY OF ECONOMIC ANALYSIS (1986).
17 “Utility” is a notoriously elusive concept that pervades economic theory. For a discussion of its various meanings, see…
18 The concept of social welfare as a function of individual utility was introduced by Abram Bergson, A REFORMULATION OF CERTAIN ASPECTS OF WELFARE ECONOMICS, QUARTERLY JOURNAL OF ECONOMICS 310–34 (1938). All forms of the social welfare function, additive or non-additive, assume that social welfare increase with individual utility. For a recent discussion of social welfare that is deep but challenging to read, see Matthew Adler, WELL BEING AND FAIR DISTRIBUTION (2012).
19 Summing utilities gives the same weight to utility regardless of its distribution among persons. Thus, in a society of 5 people, social welfare is the same as measured by the sum of utilities if 5 people each enjoy 10 utils, or if one person enjoys 50 utils and the other 4 get 0 utils. In contrast, social welfare is higher for the multiplicative or logarithmic social welfare functions if 5 people enjoy 10 utils than if one person enjoys 50 utils and the other 4 get 0 utils. In general, the additive form of SWF is indifferent about the distribution of a fixed amount of utility across people, whereas the multiplicative and logarithmic forms favor its equal distribution across people. Note, however, that all three forms of SWF favor a more equal distribution of a fixed amount of income across people, so long as the marginal utility of money is decreasing for all individuals. The most sophisticated treatment of this problem, which is also challenging to read, is found in Matthew Adler, WELL BEING AND FAIR DISTRIBUTION (2012).
People agree about some connections between wealth and welfare. Thus life expectancy at birth is 83 years in Japan and 66 years in Bangladesh, and enrollment in secondary school is 98 percent among Japanese children of the appropriate age and 42 percent in Bangladesh. Facts like these make almost everyone agree that welfare is higher in Japan than Bangladesh. The poor in Bangladesh need extra money to buy basic health care and primary education more than the rich in Japan need extra money to buy cosmetic surgery and theater tickets. In general, the poor need extra money for necessities more than the rich need extra money for luxuries.

Economists often describe this fact as the “decreasing marginal utility of money with respect to income”. Progressive taxes and government expenditures can shift consumption from less to more basic needs, which presumably increases a nation’s welfare. Many economists believe that the poor need extra money more than the rich, but they disagree about how much more. After a century of trying, there is no generally accepted method for measuring the marginal utility of income like the thermometer measures heat. Thus economists have no uniquely correct measure of the difference in welfare between Japan and Bangladesh.

Perhaps comparing the marginal utility of income of rich and poor is like distinguishing between your face and the back of your head: the difference is real but the boundary is imprecise. In this respect, “social welfare” may be like other values that social scientists measure in controversial ways, such as “happiness”. If so, economists can talk meaningful about the declining marginal utility of income, but they will never find a uniquely correct measure of it. According to this view, economics must encompass controversial

22 The utility of a poor person increases more from an increase in wealth than the utility of a rich person (decreasing marginal utility of money. Social welfare increases in the utility of individuals. Therefore, redistribution of wealth from rich to poor (with no loss in the amount of wealth) increases social welfare. In Adler’s theory (see preceding footnote), social welfare increases with individual wealth, and social welfare increases with a more equal distribution of wealth or utility across individuals.
measures of imprecise facts. Thus the “material welfare” school of the early 20th century held that additional money benefits the poor more than the rich, which can be shown by measures of the causes of welfare like health and education that are reasonable, pragmatic, and incomplete.24

In contrast, another tradition in economics called “positivism” holds that the marginal utility of money has no scientific meaning. Given enough data, all scientific propositions can allegedly be proved true or false. In contrast, propositions about “social welfare” or the “marginal utility of money” are value judgments or expressions of political commitments, not testable assertions of fact. The question “How much higher is the marginal utility of income of the poor than the rich?” has no more scientific meaning according to the economic positivists than the question, “Is it morning or afternoon on the sun?” Since value judgments do not make testable claims, according to the economic positivists, “social welfare” cannot be part of scientific economics.

In any case, measuring social welfare and the declining marginal utility of money is less important to growth economics than to static economics. When progressive taxation and state spending shift consumption from luxuries to necessities, the static effects – whether measured in wealth, income, utility, or welfare for the poor or everyone in society – correspond to the shift in Figure 1.2 from A to B, or from B to C. The static effects are small relative to the dynamic effects represented by D, regardless of how they are measured. When growth is exponential, the mathematics of overtaking applies, regardless of the function’s interpretation in Figure 1.2. Measuring utility or welfare is unimportant to policy conclusions when fast growth causes rapid overtaking, whereas the measure is important when sluggish growth causes slow overtaking.

To illustrate, assume that redistributive policies improve the health and education of the poor, which directly increase their welfare. In addition, healthier workers with better education are more creative, so they may increase economic growth. Economists who believe that better education and health of poor Americans would increase U.S. growth point to Denmark and Korea as examples where good education and health have contributed to robust

economic growth, whereas poor education and health of workers may partly explains the economic struggles of the Philippines.

In the preceding hypothetical, redistribution increases the growth rate by improving the welfare of workers. Redistributive policies can also decrease the growth rate by undermining economic incentives. China’s Cultural Revolution, which commenced in the 1960s and expired by 1975, enforced strict economic equality and destroyed what was left of the private sector. Economic decline immiserized many people. Reversing policies after 1980, China dissolved agricultural communes, farmers were allowed to keep the surplus from selling their crops, and agricultural productivity soared. Spectacular success in agriculture prompted the Chinese leadership to allow the development of private business in the new export sectors, where entrepreneurs could keep much of what they earned. Improved incentives unleashed economic growth without historical precedent. Instead of trickling down to the Chinese workers, the benefits of growth cascaded down like the Yangtze River at the Three Gorges dam. Equality decreased, economic growth exploded, and poverty plummeted. The lowest wage earners in China benefited greatly from a faster growth rate in national income after 1980. Even unemployed poor people who depend on welfare payments and government subsidies benefitted from faster growth, which increased state revenues available for transfer payments.

**Conclusion**

The first question of law and growth economics is, “Which laws increase the pace of economic innovation?” Increasing the pace of innovation can lead to sustained growth in wealth, income, utility, and welfare. When growth is rapid, overtaking is the only normative standard required to choose among many laws and policies. Balancing growth against static efficiency or equality is unnecessary when growth is fast, which simplifies the analysis of many laws and policies such as patents. Isaac Newton invented calculus and discovered the laws of motion associated with gravity in 1666, which historians of science call the “miracle year” (“annus mirabilis”). Civil engineers still use Newtonian physics for ordinary objects, although it fails for very large objects (the cosmos) and very small objects (sub-atomic particles). Similarly, rapid growth is the domain of the overtaking principle, which is good for making
law and policy in most of growth economics. In contrast, sluggish growth is the domain of efficiency and equality.

The overtaking principle supplies the normative justification for prioritizing growth economics over static economics. It challenges conventional law and economics that treats static efficiency as a fundamental goal of law and policy. Which was more important to agricultural production, inventing a tractor or using horses more efficiently? A better allocation of horses for plowing the fields increases agricultural production marginally, whereas inventing the tractor caused a jump in production. Once you appreciate exponential growth, it’s hard to care about static efficiency for its own sake.

The overtaking principle also challenges ethical theories concerning the redistribution of wealth. Controversies about fair distribution, social welfare, the marginal utility of income, and time-discounting do not matter when growth is rapid. In much of political philosophy, fairness concerns distributing shares of fixed income, and economic equality is an end in itself. With rapid growth, however, putative ends turn out to be only valuable as means. Economic equality mostly affects welfare through growth, not in its own right. When rapid growth is possible, progressive taxes and state expenditures increase the welfare of the poor if they cause faster growth in wages and subsidies.

Perhaps you think that static efficiency and growth align, with more efficiency causing faster growth. This view is roughly two-thirds right and one-third wrong. Efficiency and growth have a common cause: competition. To maximize innovation, the law must create a framework of open competition so innovators can develop their ideas. The core of economic growth comes from entrepreneurs. Only the possibility of extraordinary profits can induce entrepreneurs to bet big on risky ideas. However, extraordinary profits require market power, not competition. Thus patent law creates open competition to innovate and rewards the winners by giving them temporary market power. As told in this book, the story of law and growth economics is open competition to innovate and extra-ordinary profits for the winners.

Astronomers from the time of Aristotle saw the earth as the center of the universe and the sun revolving around it, until the Copernican Revolution put the sun at the center. In general, a revolution rearranges the central
elements of a scientific theory.\textsuperscript{25} Such a revolution occurred in economics in the 1930s. Before the revolution, economics was defined as the science of material welfare, and then a famous essay proposed this alternative in 1932: “Economics is the science which studies human behavior as a relationship between given ends and scarce means which have alternative uses.”\textsuperscript{26} The scarcity definition formulated a new scientific paradigm for economics that displaced its predecessor.\textsuperscript{27} The scarcity definition characterizes contemporary law and economics, which can be called “law and scarcity economics.” This book replaces scarcity with growth as the paradigm, yielding “law and growth economics.” Once one starts to think about law and growth economics, it is hard to care about law and scarcity economics.

\textsuperscript{25} This is the thesis of the classic by Thomas S. Kuhn, \textit{The Structure of Scientific Revolutions} (1st ed. 1962).


\textsuperscript{27} For a discussion of the paradigm shift, see Robert Cooter and Peter Rappoport, “Were the Ordinalists Wrong About Welfare Economics?,” \textit{J.Economic Literature} 22 (1984): 507.