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ABSTRACT

Growth theory offers two plausible explanations of growth. One stresses the supply of productive ideas and holds that the industrial revolution had to wait until we had thought up enough inventions to lift us into the era of modern growth. It says, roughly, that the growth of living standards depends on the growth of science. The other explanation stresses incentives: Growth could begin only when hard work and business enterprise were free of heavy taxation, of social stigma and of other interference by the government and the church. The first branch of theory is well developed; it is the second that now challenges the growth economist to explain not just growth, but the evolution of political and religious institutions and social attitudes as well.

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Growth theory offers two explanations for growth. One stresses the supply of productive ideas and says, roughly, that the growth of living standards depends on the growth of science. The other explanation invokes incentives: Growth could begin only when hard work and business enterprise were free of interference by authority. The first branch of theory is well developed; it is the second that now challenges the growth economist to explain not just growth, but the evolution of the policies and institutions that shape our incentives.

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Growth theory was developed in the 1950's and 1960's, and some early growth models are collected in Stiglitz and Uzawa (1969). After a lull in the 1970's, the arrival of better data in the 1980's prompted a burst of activity during which economists refined their models so that they could better answer question like: Why did growth take off two hundred years ago and why in England and then the West, and why do Africa, Latin America and most of Asia lag so far behind? And, what measures will improve things, especially in the poor countries? It is mostly the new crop of models that I shall survey here.

Growth

What determines the rate at which our standard of living grows? Economic theory has settled on three broad categories:

A. The progress of science and productive knowledge
B. The growth of individual skills
C. Incentives

Incentives impinge on every economic decision, of course, including the decision to accumulate knowledge and skill. Still, I list (A) and (B) separately because science and skills have evolved, in part, spontaneously or accidentally as people went about their business or pursued their curiosity.

A. Science

The world's wealth grows thanks mainly to the growth of knowledge. As with anything else, when adding to knowledge, there is strength in numbers. Even before the fifth century B.C. and the beginnings of science, early stone tools, farming, the domestication of animals, the wheel, and other inventions spread not by parallel and independent invention, but by imitation. If I

was alone in the world, I would have to do my own inventing. But if there are two of us and you have invented the wheel already, I don't need to reinvent it, I can just copy your design. In copying you, moreover, I do not deprive you of your wheel -- we both can make a wheel even though you alone came up with the idea. Thus, knowledge is a form of social capital that grows when anyone adds to it, and a bigger world will grow faster simply because more people will think up more new ideas. From the first stone tools to the steam-engine, electricity and the computer, the mass of the people who derived some use from new ideas have had no part in coming up with them. So, if the overriding constraint on growth is scientific progress, a more populous world is one in which living standards will rise at a faster rate.

Arrow (1962) argued that we get new ideas when we use our old ideas, and that invention is incidental to normal production activity. He called this process "learning by doing" and he assumed that the process operates in the machine-producing industry: The more machines we make, the better at it we get. The learning process operates at the level of the industry as a whole in that each producer learns from the experience of all other producers.

Because it relies exclusively on learning by doing, however, Arrow's growth mechanism contains only a small part of the engine that drives modern growth. After all, how many of our big inventions were made fortuitously at the workplace? Even when it is an accident -- penicillin and the post-it note, e.g. -- a discovery usually occurs, instead, in the research lab. Moore's law, the observation that the speed of computers doubles every two years, is driven by research on the computer chip, and not by the mere fact that the world produces a lot of chips. Of course, if we made a greater number of chips, we would probably also be *choosing* to do more research to make them faster; the rate of production and the rate of growth of chip-quality would, in this sense, be positively related, but it would still be the research scientist and not the

production worker whom we would have to thank for that quality growth.

Romer (1990) recognizes the importance of research. In his model, the more researchers we have, the faster we can invent, and the faster we grow. As in Arrow's model, then, here too a bigger economy grows faster. This positive effect that the scale of the world has on growth holds up well historically. Kremer (1993) finds that the rise in the world's population has, at least until around 1900, gone hand in hand with a rise in the rate of growth of income per head. The industrial revolution thus took place only when people came up with enough ideas – e.g. the steam engine -- that then kicked off the industrial era.

B. Skills

Science cannot be all there is to growth and development. For one thing, large parts of the world seem almost untouched by the many scientific inventions of the past century -- many people are still illiterate and still live without electricity and running water. Moreover, the world is becoming more populous, and its cadre of scientists is growing by leaps and bounds, yet since the second world war, income per head has grown more or less steadily at about 1.5 percent per year. This, too, Jones (1995) tells us, is not consistent with science-driven models which predict that a bigger world should grow faster as long as the well of ideas has not run dry. But there is not much evidence that the supply of new ideas is dwindling -- on the contrary, computer-aided simulation has made research easier.

The constraining force on growth seems, instead, to now be the cost of adopting new ideas -- the fact that to put new ideas into practice requires resources and skill. True, some technologies are so user friendly that their use demands no skill at all; to use a light bulb, for instance, all you have to do is screw it in. But you cannot do much with a computer if you have no education and no

experience with computers. And, since the costs of technological adoption are likely to be proportional to the number of users, adoption is as costly in a big world as in a small one. Society inevitably spends much less on research and invention than it does on implementing what it has invented. Even in the U.S., research effort absorbs a mere twentieth of what is spent on educating and training the workforce. And in a developing country that imports all of its technology, the constraint on growth is purely the speed with which its citizens can enhance their skills and get the requisite machines. Lucas (1988) models such a world, a world in which countries share the same technology but not the skills of their workers. In his model, people augment their skills everywhere at the same rate, and if labor cannot move from one country to another, differences in skill-levels and, hence, in development persist indefinitely. Because education and work-experience differ so much among countries, his model explains differences of development among regions and countries. On the other hand, an Arrow-Romer type of model can explain the growth history of the world as a whole.

C. Incentives

We now come to incentives. Incentives to invent things, and to implement inventions, perhaps by acquiring the needed skills, or by investing in something else. It is impossible, e.g., to explain European stagnation during the Dark Ages without mentioning the barriers that authority placed on intellectual progress. Baumol (1990) and Mokyr (1992) argue that, historically, material progress has depended less on the state of science and the supply of potential innovations than on whether people have had the incentive to implement them:

> "The museum at Alexandria was the center of technological innovation in the Roman Empire. By the first century B.C., that city knew of virtually every form of machine gearing that is used today, including a

> working steam engine. But these seemed to be used only to make what amounted to elaborate toys. The steam engine was used to open and close the doors of a temple." (Baumol 1990, p. 910)

In other words, good ideas were plentiful two thousand years ago, but the environment for using them productively was unfriendly. The Roman Empire, Europe in the Dark Ages, China in the Middle Ages, and various nations today, have all been hostile to new ideas.

Hostility to technological change can show up in a variety of ways. Parente and Prescott (forthcoming) show, for example, that established monopoly rights over an old technology can allow it to survive the threat of entry by firms wanting to use a better new one, and that this can have a big drag on development. The real challenge, however, is to understand how the policies are chosen. Krusell and Rios-Rull (1996) show that even a democracy may well choose to erect a barrier to technological change, because the majority of the voters may stand to lose from the adoption of a new technology as it would devalue their skills.

The incentive to save has also varied a lot historically and it varies now from one place to another because of policy differences. However, growth theory predicts only modest effects of frugality -- a permanent rise in national saving has only a temporary effect on income growth. How long the stimulus lasts depends on how much physical capital matters in production. The evidence on whether frugality leads to even a temporary rise in growth is mixed (Barro and Sala-i-Martin, 1995).

Inequality

Growth theory also aims to explain inequality. The world has gotten richer, but inequality in living standards is greater than ever. The poverty that most Africans, Asians and Latin Americans now

find themselves in isn't just relative -- it isn't just that living standards in the poor world seem low because they are dwarfed by the great wealth in the U.S., Western Europe, and Japan. On the contrary, living standards in the poor world are low by any historical standard. People there often face starvation and epidemic disease, and they do not live much better than their distant ancestors did. At the end of this century, U.S. income per head is only six times what it was at the start of the century, yet it is 30 times as high incomes in Chad or Ethiopia. This means that people in Chad and Ethiopia are much worse off than Americans were a century ago. Why is the gap so wide today and why aren't the poor countries catching up?

The causes of inequality

Although one can always ask for a still prior cause, the following five are causes of inequality that seem, to me, fundamental:

Geography: Some points on the globe are natural sites for economic activity -- e.g., the estuary of a large river. Such advantages of location are compounded by economies of agglomeration such as the cost savings afforded by the sharing of cable lines, roads, railways, parks, parking lots, airports, etc.. In cities, one can more easily share knowledge as well, and, as Lucas (1999) shows, this can explain why rents are so high in city centers. These economies of agglomeration draw economic activity to some points in geographical space and not others, and output per square foot of land varies a lot from one place to another.

Specialization: Economic efficiency dictates that people who start out as equals should sometimes end up different. One reason is specialization -- we cannot all be doctors and university professors, someone must clean the streets, wait tables, etc.. Lucas (1988, section 5) explains how a natural advantage in specializing can backfire in the long run. He describes a world in which an initial comparative advantage in farming can cause a region to

become a food producer; growth potential may, however, lie not in farming but in industrial goods, goods that people living in regions that do not have good farmland will turn to. Such people will eventually become expert manufacturers, whereas farmers will in the long run lag far behind because they specialized in a good with no growth potential.

External effects and market failure: Backwardness offers a society the option to "free ride" on the efforts of the leaders. Eeckhout and Jovanovic (1998) argue that the option to imitate the ideas of others can lead to a stable situation in which some will prefer the role of a perpetual follower because this allows him to copy their inventions at a fraction of their original cost. Similarly, not everyone can always use cutting edge equipment. Jovanovic (1998) argues that firms in poor regions will use a technology and the equipment that embodies it after the world's leaders are done with it and after it has become cheaper -- an external benefit that the leader bestows on the follower indirectly, through prices. A country can be poor because its internal markets provide incorrect signals and intervention can then improve things. Murphy, Shleifer and Vishny (1989) model a situation where technological development is unprofitable for any single firm unless enough firms decide to go ahead and invest simultaneously -- the "big push" idea. Similar market failures occur in the models of Azariadis and Drazen (1990), and Galor and Zeira (1993).

Policies: The overriding cause of poverty in the world -- and surely the one that dwarfs every other -- is bad or corrupt government. The world's governments vary from democracies at the one end of the spectrum to totalitarian governments -- right-wing, left-wing and theocratic -- on the other. As a result, people in different countries face vastly different policies, institutions, and laws and, hence, incentives. A policy that is bad for the average citizen may persist if it benefits or protects a minority that has somehow managed to gain power and influence. Corruption and bad policies repel foreign capital and cause domestic capital to flee.

The burden falls on the average citizen who has to pay high taxes, tariffs, license fees, bribes, etc.. It is hard to imagine, for example, how Burma can develop while its citizens are shut off from contact with the outside world.

How to reduce world inequality

The conflict between equality and efficiency, familiar in discussions of personal income differentials, is present at the world level as well. Some of the world's inequality is unavoidable and, indeed, simply signals that markets work. Nothing much can or should be done about inequality over geographical regions per se, or inequality that represents a reward for past sacrifices such as a high rate of national saving, investments in education, and so on.

An enlightened government can set taxes and subsidies so as to correct for market failures. Capitalism may seem to be at a loss in such circumstances, but perhaps not: In the late 19th century, a handful of bankers coordinated the actions of a big chunk of American business and the railroads in particular -- with anticompetitive side effects to be sure -- and seem to have engineered the big push that propelled the U.S. into industrial leadership. Later on, the U.S. government started to regulate the banks and American business in general.

Whatever good governments may have done domestically, it is quite evident that on the international front government policies have done great harm. Governments have set policies that limit the flow of people, capital and ideas. If so, the ultimate culprit for a country's poverty is the national boundary that keeps the citizens hostage to the bad policies of their rulers. Once this much is clear, several solutions to the problem of world inequality spring to mind at once.

Aid: One can help the poor world by taxing the rich countries and, since the poor hold a majority at the moment, a world

democracy would, presumably, do just this. But under today's political system, we rely, instead, on voluntary contributions -- aid -- which, even when they occur, do not lead to improved government policies, and provide only a temporary fix. Another solution is to bribe the offending politicians into give up power, or at least changing their policies. Such bribery has, in fact, been going on for decades, under the name of "conditional lending" -- a country gets a loan if its government agrees to adopt a pro-trade policy, etc.. This is better than unconditional aid, but it, too, has not worked either because the "conditions" of loans cannot be enforced as funds are diverted from their intended uses and into Swiss bank accounts.

Freer migration of labor: A better solution is to let people vote with their feet more freely than they can at present. As in Tiebout (1956) a country that adopts bad policies would find its constituents leaving for greener pastures. The lesson of the European Union is that when the boundaries come down, policies must harmonize and economic welfare converges. In spite of its size, the unified U.S. labor market has far less income inequality than the world does, and immigrants manage to catch up to the U.S. average after just a couple of generations. Right now, the rich countries limit immigration to a trickle so as to avoid a stampede that could prove disruptive, but immigration rates can probably be higher than what they today and still not endanger the fabric of life in the rich world. The rich countries are now unifying their markets (e.g., NAFTA, and the EU), but markets in the poor world -- the former Eastern Block, Africa and Asia -- are, for the time being, left out.

Where we are headed

If we can manage to avoid another global conflict, the political organization of our world will probably ease into a federal

structure in which each nation will retain much of its sovereignty, but in which a government will set its policies in the face of free labor mobility. This Tiebout type of a world organization will produce far less inequality than we see today, as each government will have to adopt policies that make its jurisdiction an attractive place to work and live.

Without centralized intervention, however, the world's rate of growth would be less than optimal. Each local government would not, on its own accord, take enough trouble to save the ozone layer, the rainforests, and the endangered species, and, in particular, it would not do enough to promote activities that push the frontiers of knowledge out -- research and development, education, etc., or enough to protect intellectual property. A global market failure involving these activities will need correcting by policies set at the world-government level. A research subsidy will raise the world's growth rate, but it will also raise inequality because research will be done in the skill-abundant parts of the world, which also is where the highest-paid workers will live. The world federation that we are headed for will thus still face the perennial tension between efficiency and equity -- it will still not be possible to have the largest pie and to distribute it equally. But the sort of inequality that we are now so used to will be a thing of the past.

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