Department of Agricultural and Resource Economics EEP 101/ECON 125
University of California at Berkeley David Zilberman
Spring , 2002

Chapter 19: BIODIVERSITY, BIOTECHNOLOGY, AND INTELLECTUAL PROPERTY RIGHTS

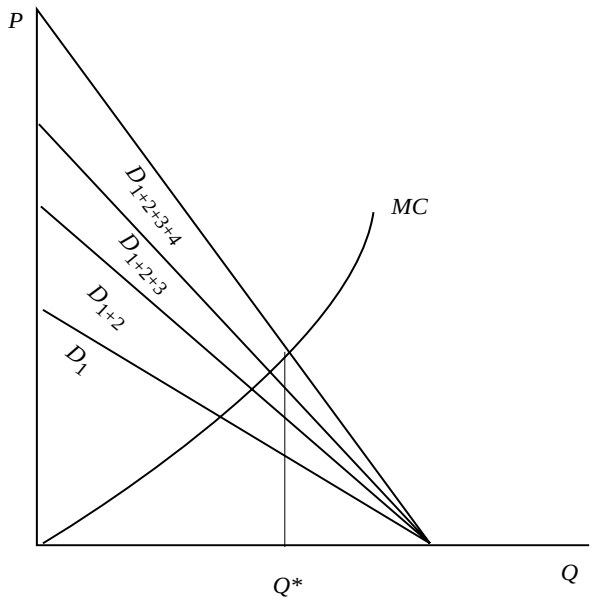
Topics

Public Goods
Global Public Goods
Knowledge as a Public Good
Innovation Process
Alternative Forms of Intellectual Property Rights
Technology Transfer from the Public to the Private Sector
Neglected Crops and Orphan Drugs
Elements of the Strategy to Provide Orphan Drugs and Address Neglected Diseases
Public Institutions of Intellectual Property Rights in the Developing World

Public Goods

Public goods are defined as goods with two properties: *nonrivalry*, i.e., it can be utilized by many people simultaneously, and *nonexcludability*, i.e., there are no barriers to utilizing these public goods. Like many other goods, production of public goods is costly. Markets left on their own tend to underinvest in public goods because each individual has a tendency to free ride and expect others to pay for the public good so he can benefit from it for free.

Let D_1 be demand of one person, D_{1+2} demand of two people, etc.



The optimal quantity is Q^*. At this level, marginal cost is equal to the sum of the marginal benefits of the consumers. As we mentioned earlier, this outcome will not be attained by the market and requires government intervention. The government uses taxation to finance public goods, but society develops other mechanisms to provide for public goods.

At the national level, the national defense is used as an example of a public good. Within a city, environmental quality (clean air) is a public good. However, even with this example, we see some of the problematic features of this notion, since some neighborhoods have cleaner air than others. Therefore, when there is differentiated access to a good that has nonrivalry of consumption, then there are differences in private benefits, and people will pay for the access. When the access to a good with nonrivalry of consumption is blocked, the private sector will have the incentive to provide this access. One example is a football stadium. When the owner of a football stadium prevents access through an entry fee, he/she has the incentive to provide these goods. Actually, in a situation where you have nonrivalry of consumption but excludability, you may have a situation where the party controlling the access may capture the entire social surplus.

When there is heterogeneity in benefits derived from goods with nonrivalry of consumption, the resource owner who charges a entry fee may underprovide the good, unless he charges a differentiated price that will reflect an individual's willingness to pay for access to the good. Without the ability to charge differentiated prices, the owner may build a smaller facility and charge a higher price to tap the richer members of the community. In

this case, there will be little access to goods with nonrivalry of consumption to the poor. In many cases (again, in the case of a sports stadium) there are differentiated prices to allow access to different members of society as well as to increase the profit of the owner of the property. The challenge, of course, is to be able to distinguish between different members' ability to pay of or to establish differentiated pricing.

When there is nonrivalry of consumption but ability to control access and heterogeneity in most cases, private sector control of a good may be suboptimal. In many cases the government either controls or interferes in management and provision of such goods. There are many examples. One is access to education. Some people pay for their education while others receive scholarships. Development of environmental amenities in many cases follows a similar pattern. A developer obtains the right to develop a property and part of it will be developed exclusively to capture benefits from rich people who are able to pay. However, the other part of the property can be provided cheaply for members of the public. In this case, part of the area that is developed (be it parks, beaches, etc.) may be allocated by queuing with a lower access fee.

In some cases there is to some extent nonrivalry of consumption. When the size of a user of a product affects the benefits because of congestion, there is an optimal number of participants. In this case, we speak about a club where the optimal size is determined at the point where the gain accrued to an incremental individual is equal to the loss of congestion to all other individuals. The considerations associated with management of public goods, club goods, and goods with nonrivalry of consumption but ability to block access are important as one considers development of natural reserves in developing countries and principles associated with buildup of eco-tourism and preservation of biodiversity.

It is clear that we rarely have situations with pure public goods, and even then we may have heterogeneity with respect to both benefits and cost of maintaining such goods.

Global Public Goods

Global climate, biodiversity of resources, and human knowledge are all goods with public goods properties. All of mankind benefits from the o-zone layer and from moderate climate. However, some groups can benefit

more than others; furthermore, the cost of providing this public good may vary across groups. The debate on policies that deal with climate change or maintain biodiversity in developing countries addresses these issues. Some northern countries may benefit more from preservation of biodiversity than southern countries that may have to bear much of the cost to maintain global biodiversity that has public goods properties. That is the reason that establishment of compensation schemes (debt for forests, etc.) is so important.

Knowledge as a Public Good

Knowledge and the major elements of culture have nonrivalry of consumption, and excludability from knowledge may be somewhat difficult. Because of these properties, generation of knowledge and its development and cultural amenities may not be optimized under the private sector, and this is important to institutions developed by the public sector. Historically, many institutions were developed to provide public goods. They include many aspects of religion (monks that copied transcripts). Modern societies developed mechanisms to exploit human vanity and extract provision of public goods from the rich (e.g., the Rockefeller Foundation and many nonprofit organizations).

Public universities and many international research institutions have been established to conduct research that has public goods properties. However, there is a big gap between knowledge and technology and innovation. Innovations are new ways to do things. One can distinguish between innovations that are embodied in capital goods that can be sold in the markets and nonembodied innovations that may be in the form of new managerial techniques. There is a big gap between basic scientific knowledge, which are concepts for innovations, and its fruition to a workable product. This is obvious when it comes to new forms of machinery, but it is also true when it comes to management rules. There is a big difference between identifying some basic operational rules (marginal benefits should equal marginal costs) and finding the exact formula on how much pesticides to use in the case of tomatoes, and this is why intellectual property right arrangements emerged.

Innovation Process

The innovation process includes several stages:

- Inspiration
- Research
- Development
- Licensing
- Production
- Marketing

Ideas for new innovations (inspiration) may arise from developments in sciences and the needs of society (induced innovation). University research addresses basic principles that govern systems in nature and basic principles of management, but it may result in breakthrough findings that develop into new products. The internet, World Wide Web, biotechnology, etc., all resulted from university innovations. However, university innovations have to be up-scaled and commercialized, and that requires development and production. In many cases, once a new product is developed, companies need to engage in research to design a production system to produce these products effectively.

For agriculture and medicine, much effort is allotted to registration and testing to ensure that the new product does not generate undesirable side effects. The main cost in product development pertains to up-scaling and registration activities and mass production. The major companies have a relative advantage in this area.

Alternative Forms of Intellectual Property Rights

There are different forms of intellectual property rights that are the result of new discoveries or intellectual efforts. They include patents, plant breeders' protection rights, copyrights, trade secrets, etc.

In the case of patents, the owner of the patent, who has a monopoly on the use of products resulting from the patent for a given period (20 years), presents the basic idea. Owners of the patent may have the right to sell licenses to use the patents, and then the owners of the license can take advantage of the monopoly power they may obtain if the rights are exclusive. In some cases, patent owners may sell nonexclusive rights.

Patents are statements of a concept and ideas. There is a big gap between a patent and a workable innovation. The transition between a concept and the final product is costly and requires significant investment. Individuals will not assume investment in patents unless they expect ability to benefit from the research.

Under the patent system, there is underinvestment in product development, and patent owners are interested in the monopoly profit and do not take into account benefits to consumers. For agricultural commodities and medication for the poor, consumer surplus may be more substantial than producer surplus and, thus, the extent of underinvestment is dramatic. In those cases, there is a need for public intervention.

Technology Transfer from the Public to the Private Sector

Table 10. Common Patterns of the Division of Labor of the Innovation Process*

Pattern	Research	Development	Production	Marketing
1	C	C	C	C
2	U →OTT→	C	C	C
3	U →OTT→	S	S	S
4	U →OTT→	S	S+C	S+C
5	U →OTT→	S	S=C	S=C
6	U	U →OTT→	S or C	S or C
7	C →?→	S	(then any of 3-5…)	

U** = ***university, **S** = ***startup, and*** **C** = ***established company.***

Since the passage of the Bayh-Dole Act in the United States, universities own research patents financed by federal money, and universities in the United States are engaged in selling rights to technologies to private companies. They sell the rights because, otherwise, companies will not develop the technologies because they do not reap the monopoly profit. In some cases the universities sell the rights to multinationals, but in other cases they sell to startup companies supported by venture capitalists, and then the startups either grow to become major companies or are bought

out by major companies. Today many of the major companies such as Monsanto are based on knowledge acquired when they took over startups such as Calgene.

Universities have new organizations called offices of technology that transfer and negotiate agreements with companies to transfer technologies. Universities and the public sector own the patents to many innovations, but actually the rights have been transferred to private companies.

There is a difference between ownership of a patent and a license. When the rights to utilize a technology are transferred to a company, then they become the monopolists. To understand what happens to international property, we then need to determine who owns the right rather than who owns the patent. While information about patents is available to the public, information about rights is private and may not be known. We suspect that in most cases companies own rights to patents rather than the patent themselves, and the distribution of patent ownership among different types of institutions underestimates the control that the private sector may have over intellectual property.

Designing optimal right agreements is challenging. Companies may not invest in a new product unless they have exclusive rights for this product. However, patents are often quite broad, and transferring all the rights exclusively to one company may be problematic, especially if the company is interested in targeting its effort to certain markets. Thus, in the past offices of technology transfer tended to sometimes make broad agreements to the companies. In many cases these agreements may need to be reversed, so that the broad utilization of patents for different products and markets, e.g., in developing countries, will be feasible. In some cases companies may recognize that the PR gain as well as human benefits from giving away rights for patents will not be utilized. However, they may be reluctant to give up these rights because of liability considerations or pure greed.

Neglected Crops and Orphan Drugs

Most of the research in developing agricultural biotechnology was aimed to solve crop problems in the North (such as corn and soybeans). Much less attention was given by companies to develop technologies aimed at crops such as cassava and sorghum. Even in the developed world, fruits

and vegetables are neglected crops because the cost of developing new technologies for these crops may outweigh the benefits to the companies. As we said earlier, for neglected crops, it may be worthwhile from society's perspective to develop new technologies because of the gain to consumers. However, these technologies may not be profitable to the industry and, therefore, is a case for public intervention.

In the area of medicine, there is a big gap between product development in the North and the needs of the South. Most of the research efforts in the North are geared towards geriatric diseases such as cancer, heart attack, and strokes. Less emphasis is given to studying tropical diseases that are problematic in the South.

Multinational companies in many cases are more interested in investing in drugs that generate more returns than investment in vaccines. Sick people are more likely to pay for a cure, while healthy people are less likely to pay for prevention of diseases when the probability is unknown. Therefore, development and manufacturing of a vaccine is, again, left to the public sector. Development of vaccines is especially important in developing countries, which suffer from many diseases that are quite rare in the developed world.

While most of the knowledge and intellectual property in medicine are in the North, there is much expectation for the growing intellectual and productive capacity of the South. There is a significant gap in the cost of developing new medical products and devices in developed versus developing countries. Some reports suggest that the cost of developing new medicines in the United States or Western Europe may approach a billion dollars, while developing a similar product in countries like India or Indonesia may cost $150 million. Obviously, we may expect to see a more productive capacity shift to developing countries. It is a gradual process, as human capital gradually accumulates in developing countries, but the notion of gain from trade will lead to a shift of production patents between nations. One obvious challenge that countries have is to encourage this pattern by maintaining and developing a capacity to produce the human capital needed. One major issue is brain drain. It is not enough to be able to raise talented young individuals; we need to find ways to keep them productive in their country of origin.

Maintaining universities of excellence and providing the incentive for the best and brightest individuals to stay in developing countries, for the purpose of producing medical products for the local poor and improving the competitiveness of countries, is a major challenge.

Elements of the Strategy to Provide Orphan Drugs and Address Neglected Diseases

There are several strategies that can be used to address these problems. They include the following:

- Global funding for research on these topics should be established. Donor countries donate significant funds for research on tuberculosis, malaria, etc. Organizations such as the Global Alliance, which provide vaccines and address the tuberculosis problem, raise funds and conduct and support the network of researchers in developed and developing countries to develop new drugs.

  These organizations provide funding and initiate public and private partnerships to conduct development efforts in technology production of drugs and vaccines whenever they are introduced. Manufacturing facilities both in the developed and developing countries are contracted to provide and establish production facilities for new medical treatments.

- Efforts to obtain intellectual property for the drugs and vaccines used to combat neglected diseases should be conducted. Private companies and universities in the West are approached to donate knowledge or private rights to address problems of developing countries. This will provide developers of new technologies "freedom to operate" in both research and development efforts.

- Efforts should be made to establish pricing schemes that make the technology available to as many people as possible. Pricing should be discriminate, with pricing in developed countries much higher than in developing countries. Also, in some cases donors may purchase the medicine to give to patients in developing countries.

Public Institutions of Intellectual Property Rights in the Developing World

There are several efforts to establish the infrastructure that will enable producers and consumers in developing countries to benefit from some of the modern technologies that were developed in the West. These include both agricultural biotechnology as well as medical biotechnology. The efforts include several elements.

(1) *Provide education to various countries on the value and utilization of intellectual property.* In countries such as India, Indonesia, and others, there is a growing realization that they need to have their own effective intellectual property rights system, and they need to verify agreements that respect intellectual property rights to develop their own industry which will benefit from it. For example, the United States began to respect intellectual property (in particular, copyrights) when it became producers and the source of a great deal of written material. The same has occurred in many developing countries.

(2) *Establish a new organization, namely, clearinghouses for intellectual property.* This organization provides both information and education about the use of property rights and, more importantly, about the availability of property rights. Namely, they aim to create databases that will indicate who owns what. Also, the organization can make a collective effort, on behalf of the disadvantaged population, to obtain rights for intellectual property for applications that may not compete with the interest of the owner of these rights.

(3) *Use this clearinghouse to help researchers and institutions in developing countries patent, and more importantly, negotiate and utilize their own intellectual property.* Before individual universities in the United States had their own offices of technology transfer, there were research cooperations present in many universities. To some extent, some of these clearinghouses may have the same role as representatives from offices of technology transfer or scientists of many universities in developing countries.

(4) *Create a set of enabling technologies that are owned by the public sector so researchers can develop technologies both in the agricultural and medical fields without the need to obtain rights.* Public sector universities in

the United States and the rest of the world have a large set of enabling technologies. However, some of them have not been patented, and in other cases universities still owned much of the patent rights, which could be donated to scientists to use in developing countries or to address neglected diseases or crops. One interesting coalition is between producers of specialty crops in the United States and agricultural producers in developing countries. Both sectors feel that a lack of access to international properties may hamper the ability to utilize the biotechnology for their own use. Therefore, they may develop coalitions that will identify shared intellectual properties so that research can be conducted without the need to obtain rights from private companies. Furthermore, they will also be able to identify intellectual property gaps and then negotiate with private sectors to obtain the technology in favorable terms.

References

de Janvry, Alain, Gregory Graff, Elizabeth Sadoulet, and David Zilberman. "Agricultural Biotechnology and Poverty: Can the Potential Be Made a Reality?" Department of Agricultural and Resource Economics, U.C. Berkeley. Paper prepared for the conference, "The Shape of the Coming Agricultural Biotechnology Transformation: Strategic Investment and Policy Approaches from an Economic Perspective," at the University of Rome "Tor Vergata," Rome, June 17-19, 1999.

Graff, Gregory, and David Zilberman. "An Intellectual Property Clearinghouse for Agricultural Biotechnology," *Nature Biotechnology* December 2001 (forthcoming).

Lesser, W. "Assessing the Implications of Intellectual Property Rights on Plant and Animal Agriculture," *American Journal of Agricultural Economics,* 9(5), 1997, pp. 1584-1591.