Using Traditional Knowledge for Commercial Innovations: Incentives, Bargaining and Community Profits

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Abstract

The recent interest in traditional knowledge systems within health care and biodiversity sectors is directly related to the profitable innovations that traditional knowledge can generate. This paper seeks to examine the nature of economic incentives required for protecting and sustainably using traditional knowledge. The paper asks two key questions: (a) under what conditions do communities and pharmaceutical companies enter into contracts to develop traditional knowledge-based innovations? And, (b) what factors influence the benefit-shares of the two parties from commercial use of traditional knowledge? Adapting a bargaining model, this paper shows that the actual sharing of the revenues depends on a number of issues, most importantly, the relative bargaining strengths of the two parties. Factors that affect profits and relative bargaining strengths include the contributions of the parties in developing the innovation, the availability of alternative sources and options, differences in expectations over future revenues and costs, and the involvement of a third party in the negotiations. Such factors need to be taken into account in designing incentive schemes that can help communities benefit from the use of their traditional knowledge.

Key words: traditional knowledge, pharmaceutical companies, bargaining models, incentives, and intellectual property rights

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K. Aparna Bhagirathy

1. Introduction

The international debate over the use of indigenous and traditional knowledge has frequently focused on social, cultural, and ethical concerns about the appropriateness of applying intellectual property rights for protecting traditional knowledge.[1] However, equally important are questions related to the economics of using traditional knowledge. This paper seeks to examine the nature of economic incentives required for protecting and sustainably using traditional knowledge associated with biological resources.

The recent growth of interest in traditional knowledge (TK) systems within health care and biodiversity sectors is directly linked to the profitable innovations it could generate in the future. For example, Mathur (2003) estimates that some 40 percent of the pharmaceutical drug patents are due to expire by 2006 and this has increased interest in developing new active ingredients from traditional medicine. With growth in biotechnology research, traditional knowledge no longer represents a relic from the past that needs to be preserved for its intrinsic and aesthetic values. Instead, it is seen as a rich source of raw material for new innovations. The economic value of TK accrues from serving as an information base for these future innovations.

TK also derives its value from its current use in numerous medicinal and non-medical sectors. The World Health Organization, for instance, estimates that close to 80 percent of the population in developing countries depend on traditional medicine for their health needs (WHO 2002). There has always been interest in TK systems and technologies for use in sectors such as agriculture, water management and town planning.[2] Some common examples include traditional methods of pest control, indigenous tank irrigation systems, traditional techniques of building earthquake resistant housing etc.

Bio-prospectors and pharmaceutical companies involved in plant-based drugs research are interested in TK as an information source for two reasons: (a) it provides valuable leads in the search for *active compounds* required for producing pharmaceutical drugs and can considerably reduce search costs; and (b), it can provide valuable leads for developing entirely *new* plant-based pharmaceutical drugs from medicinal properties of plants that were hitherto unknown. Pharmaceutical research and development involves several years and considerable investments. Any project involving plant-based medicines requires identifying the useful active compounds from the plants. There are costs associated with bio-prospecting, searching for the medicinal plants and identifying

[1] For the purpose of this paper, indigenous and traditional knowledge are used interchangeably because in the context of intellectual property protection, the issues are the same for both.

[2] For details, see Sengupta (1995), "Proceedings of Workshops on Traditional Knowledge" (2001, 2002).

2.1 International Agreements

Several international organizations have recognized the importance of TK and have been involved in a variety of programs to promote the preservation of TK. Some of the key agreements and initiatives are listed below.

- In what was one of the earliest initiatives, in 1982, the World Intellectual Property Organization (WIPO) adopted the Model Provisions for *National Laws on the Protection of Folklore against Illicit Exploitation and Other Prejudicial Actions* (now widely known as the Model Provisions), along with the United Nations Educational, Social and Cultural Organization (UNESCO).
- The Food and Agricultural Organization (FAO) introduced in 1989, provisions for the sharing of benefits arising out of the use of genetic resources and the protection of traditional knowledge as part of the *Farmers' Rights in the Revised International Undertaking on Plant Genetic Resources*.
- The Convention on Biological Diversity (CBD), in 1992 established a common international platform for countries by providing a framework to regulate the access to biological resources and the associated TK and to reward communities for their contribution to conservation and sustainable use of the same (Article 8j[4]).

While none of these agreements is binding, each provides a forum for discussion of TK and establishes guidelines for action by member countries.

2.2 National Legislation

Following the guidelines developed by international agreements, several countries incorporated into existing legal mechanisms, specific provisions for the protection of TK. This largely falls into two types: Intellectual Property Rights (IPR) laws and *sui generis* legislation. In this section, I focus on some of the relevant IPR initiatives in the context of TK.

The scope of protection of intellectual property laws has now expanded to include genetic sequences, plant varieties and other life forms. The use and protection of traditional knowledge goes beyond the medical sphere and in the use of IPR mechanisms, beyond patents alone.[5]

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[4]Article 8j mandates that member States: "…respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity…and promote their wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of benefits arising from the utilization of such knowledge, innovations and practices."

[5] One issue that increased awareness about TK is wrongful granting of patents for innovations based on knowledge and/or practices that are already in use in traditional communities. A well-known case is the controversial patent awarded to two scientists for the use of turmeric in wound healing - US Patent No. 5,401,504 (CIPR 2002). The patent was contested and eventually revoked by an agency of the Government of India, which provided evidence to show that the use of turmeric for medicinal purposes was not novel but has been in use in India for over a thousand years for healing wounds and rashes. The Indian government provided documentary evidence including an ancient Sanskrit text and a paper published in 1953 in the Journal of the Indian Medical Association.

3. Defining the Problem: Sharing of Returns from Traditional Knowledge Innovations

Common issues in most benefit-sharing agreements between communities and pharmaceutical companies include soaring costs, risks associated with 'hits', uncertainty and mistrust in interactions between stakeholders, and the length of time involved in clinical trials and research and development. There are often high transaction costs associated with obtaining consent and collecting samples from indigenous peoples and in further clinical trials. Most benefit-sharing efforts have been frustrated by problems in identifying stakeholders interests; and consequently, in designing a system of incentives in a contract for commercial exploitation of TK.

The central concern of this paper is with designing incentive systems for stakeholders such that some of the above problems are resolved. Thus, I ask (a) under what conditions do communities and pharmaceutical companies enter into contracts to develop traditional knowledge-based innovations? And, (b) what factors influence the benefit-shares of the two parties from commercial use of traditional knowledge?

Cumulative Innovation theory provides a good starting point to think about commercialization of TK. The problems associated with investments in TK are similar to any set of cumulative innovations based on scientific and technological knowledge. In reality, there are very few pioneering innovations; most innovations build on earlier works. In the case of biotechnological research, for instance, knowledge of the genetic sequences that code for specific genetic traits is required to develop the final genetically modified product, such as Bt Corn. The social value of an innovation is compounded by the value of future innovations it facilitates. Similarly, the social value of TK depends on the value of subsequent innovations facilitated by the existing stock of knowledge. The use of the knowledge for commercial purposes does not decrease the existing stock available or exclude its current use in the traditional context. The knowledge can be held and used by several persons at a time. And, as with any good knowledge, there is no additional value for obtaining the same knowledge a second or a third time.

An important factor that influences cumulative innovations is the bargaining power held by different stakeholders. Scotchmer (1999), for example, argues that when there are positive externalities from innovations, disputes can arise over contracting between the original and subsequent generations of innovators. She emphasizes that the role of intellectual property is not to exclude competitors from the market but to establish bargaining positions from which licenses are negotiated to resolve conflicts in patent rights. By establishing these bargaining positions, intellectual property determines how the flow of profit is divided among sequential innovators.

As we will see in the subsequent section, this is the crux of the problem in the context of TK as well – the division of the flow of profits among the community and the pharmaceutical company is based on their relative bargaining strengths. However, there are some features peculiar to traditional knowledge. TK is normally held collectively by some or all members of a community rather than an individual. The rights over the

contracts can be designed to allow companies to invest in R&D to develop further marketable innovations based on traditional knowledge. There will be an incentive to undertake further innovations based on TK if both parties can share in the subsequent profits derived from the same. The issue, then, is one of determining the respective shares of the two parties in the profits. The sharing of profits between the community and the company will be a result of their relative bargaining strengths in negotiating the contract.

Consider a situation where there are two players: Player 1 and Player 2. Player 1 represents the community that holds the traditional knowledge and Player 2 represents a pharmaceutical company with the technology to develop an innovation based on TK. We assume there is only one community that can supply the TK and only one company interested in developing a TK application, a pharmaceutical product, for instance. The profit equations and conditions for the community and the company are as follows.

Let Y = present value of expected revenue from the TK-based innovation.

Let C_1 = costs incurred by the community in sharing the TK. $C_1 > 0$. These may be understood as transactions costs[8] to the community at the time of negotiating the contract.

Let C_2 = present value of the costs incurred by the company in R&D and production of the TK-based innovation. $C_2 > 0$

Let a = a percentage of the revenue from the innovation paid as royalty by the company to the community $0 \le a \le 1$

Let p_1 = present value of the profits of the community

$$p_1 = aY - C_1$$

Let p_2 = present value of the profits of the company

$$p_2 = (1 - a)Y - C_2$$

The two parties will enter into a contract to develop further innovations from TK if both of the following conditions are satisfied.

$$p_1 \ge 0$$
$$p_2 \ge 0$$

[8] These refer to costs incurred by the community in organizing and meeting with the company to share the knowledge, collect and transfer the plant resource, if required etc.

4.1 Scenario One: Individual Profit Maximization and No Asymmetry

I start with the simple case, where there is no asymmetry of expectations between the two players about Y . I also assume at this point that the community only shares the TK with the company and is not involved in any other activity involving research and development of the TK-based innovation thereafter. The community does not cultivate and supply the plant resource required for making the product either. The company internalizes the cost of raw material supply.

For the community:
The value of a that maximizes π_1 is $a = 1$. This means that the entire surplus revenue from the innovation is transferred to the community in royalties. However, this is unrealistic as it provides no incentive at all to the company to develop the TK-based innovation in the first place. Thus,

$p_1 = aY - C_1$ if $0 < a < 1$, otherwise 0.

For the company:
The company, on the other hand, will find that π_2 is maximized at $a = 0$. In this case, the community will not even disclose the TK to the company, as there is no incentive for the community to share the knowledge. Thus,

$p_2 = (1-a)Y - C_2$ if $0 < a < 1$, otherwise 0

Result 1: No contracts exist at $a = 0$ and at $a = 1$. However, anything in the range of $0 < a < 1$ is possible.

Even if there is a positive social value to developing TK-based innovations, i.e. $Y > 0$ is possible unless it is profitable to both parties, they would not enter into a contract to develop the application. The final value of a will depend upon the result of negotiations between the two players, given their relative bargaining strengths.

Following the revenue sharing contract structure, the least value of a the community will be willing to accept is one that is exactly equal to its costs.

$$p_1 = aY - C_1 = 0$$

$$a = \frac{C_1}{Y} \quad \text{.....(3)}$$

In this case, the company will thus maximize its profits given the above condition.

$$\max_a (1-a)Y - C_2$$
$$s.t. aY = C_1 \qquad 0 < a < 1$$

Differentiating w.r.t. a

$$\Rightarrow a = \frac{1}{2}\left(1 + \frac{C_1 - C_2}{Y}\right)$$

This equilibrium solution represents the case where both parties have the same bargaining power. Similarly, other cooperative and non-cooperative strategies can be explored in relation to the bargaining strengths of the two players.

(b) Ex-ante Contract

The company and the community may also decide upon another type of contract structure, where they decide to share both the revenues and the costs of developing the TK-based innovation. This would represent an *ex-ante* sharing of profits from the TK application.

$$p_1 = a\left(Y - C_2\right) - C_1$$

$$p_2 = (1 - a)\left(Y - C_2\right) - C_2$$

$$\max_a \left[a\left(Y - C_2\right) - C_1\right]\left[(1 - a)\left(Y - C_2\right) - C_2\right]$$

$$a = \frac{1}{2}\left(1 + \frac{C_1 - C_2}{Y - C_2}\right)$$

Again, the final value of a that is determined is a result of the bargaining strengths of the two parties.

Result 3: Under the above assumptions, the equilibrium value of a under the *ex ante* contract is greater than the equilibrium value of a under the *ex post* contract structure.

4.3 Scenario Three : Joint Profit Maximization and Community Supplies the Plant Resources

The factors that determine the community's bargaining position depend on the extent of contribution of TK in developing the innovation and its involvement in the whole process. So far, we have assumed that the community merely provides the knowledge and is not involved in contributing its expertise in adapting the TK to develop the innovation or in clinical research trials of the product. In the following sub-sections, some specific factors that have an impact on the bargaining positions of the parties involved are introduced to analyze the impact on a .

development and marketability of future innovation. The community possesses complete knowledge about the attributes of the resource when it comes to its medicinal properties and their effects. However, the company is better informed about the costs involved in developing a marketable product from the basic knowledge and the market potential for the TK-based innovation. This causes both players to have different expectations about the costs of innovation and about the future stream of revenue from the innovation. The asymmetry about costs does not directly affect the bargaining when the sharing of **profits is** *ex-post*, i.e., costs have already been sunk by the company. It becomes important when the contract structure includes sharing of the costs as well, as in the case of an *ex-ante* contract. The impact of the asymmetry of expectations on the contract structure is analyzed below.

x = quantity of the resource supplied and C_1^p is an increasing function of x.

$C_1^p = f(x)$

q = quantity of the TK-based innovation (pharmaceutical product) produced.
q is a function of x and the future revenue is in turn a function of q.

Y_1 = community's expectation of present value of revenue from the innovation

$Y_1 = f(q(x))$

Y_2 = company's expectation of present value of revenue from the innovation

$Y_2 = f(q(x))$

$Y_1 \neq Y_2$

The conditions are the same; both players still try to maximize profits (under an *ex-post* contract). The objective here is to arrive at an optimal quantity of supply of the plant resource.

$$p_1 = aY_1(q(x)) - C_1^p(x) - C_1 \quad \text{.....(7)}$$

$$p_2 = (1-a)Y_2(q(x)) - C_2(q(x)) \quad \text{.....(8)}$$

The community maximizes p_1 w.r.t x

Max $p_1 = aY_1(q(x)) - C_1^p(x) - C_1$

By the first order condition,

$aY_1'(x) = C_1^{p\prime}(x)$

innovation.

Y_2 = company's expectation of present value of revenue from the TK-based innovation.

Here it is assumed that the involvement of the government, for example, can help the community revise its expectation if the government either already has or can obtain more information through its efforts. This can work towards raising the lower bound of α and change the relative bargaining strengths. Alternatively, the government could, through legislation, regulate the contract structures.

Let $a_{\min}$ = the minimum value of α that the community is willing to accept

And $a_{\max}$ = the maximum value of α the company is willing to pay

The final sharing of the revenue is based on a specific $a*$, determined as a result of the bargaining between the two players.

Let $b \to 1$ represent the bargaining strength of the community to the company.

$$a* = a_{\min} + b\left(a_{\max} - a_{\min}\right) \quad \text{.....(9)}$$

The bargaining strength depends on the information available to each party about the expected future return from the innovation.

With the third party acting on behalf of the community, the expectation about Y will be different so that the new expected income from the application for the community is $\hat{Y}$, where $\hat{Y} > Y_1$. It pushes up the minimum bound to $\hat{a}_{\min} > a_{\min}$. With a change in the asymmetry of distribution of information, there is correspondingly a change in the bargaining strengths.

$$\bar{a} = \hat{a}_{\min} + \hat{b}\left(a_{\max} - \hat{a}_{\min}\right) \quad \text{.....(10)}$$

The above equation shows that not only is the range of α reduced, the bargaining strength of the community also improves.

$\bar{a} > a*$ and $\hat{b} > b$.

Result 6: With the involvement of a third-party on the part of the community, the bargaining strength of the community can improve relative to that of the company and this results in a higher value of a.

It is useful to undertake such an analysis when the government or an NGO is involved in programs for the promotion of TK and practices. Formulation of different bargaining scenarios and a comparison of different contract structure can therefore help to develop

(3) Under conditions of cooperation, the equilibrium value of α is determined through joint profit maximization. There are two possible situations: *ex ante* contract and *ex* **post** contract. Under the *ex ante* contract, $a = \frac{1}{2}\left(1 + \frac{C_1 - C_2}{Y - C_2}\right)$ is greater than the equilibrium value of α under the *ex post* contract structure, $a = \frac{1}{2}\left(1 + \frac{C_1 - C_2}{Y}\right)$. In the *ex-ante* contract, since the community is involved in the process of developing the TK-based innovation and shares in the costs of innovation, it is likely that it has a better bargaining position in the contract.

(4) For instance, under conditions of joint profit maximization, when the community also supplies the plant resource associated with the TK, the equilibrium value of α is higher, $a = \frac{1}{2}\left(1 + \frac{C_1 + C_1^p - C_2}{Y - C_2}\right)$ compared to a situation, where it merely shares the knowledge with the company, $a = \frac{1}{2}\left(1 + \frac{C_1 - C_2}{Y - C_2}\right)$. However, if the company is able to synthesize the compound in the laboratory or finds an alternative source or is able to internalize the cost of the plant resource, then the community loses some of its bargaining strength relatively.

(5) Under conditions of asymmetry of expectations (and assuming the community supplies the plant resource), the community and the company have different expectations about future stream of revenues and costs. Both parties maximize individual profits based on their expectations about the future revenue and costs of the TK-based application. The value of α is determined based on negotiations between the two players on the optimal quantity of plant resource required for the innovation. The community is willing to accept a value of $a = \frac{C_1^{p\prime}(x)}{Y_1'(x)}$ (the ratio of marginal cost of cultivating and supplying the plant resource over marginal revenue). The company is willing to share $a = 1 - \frac{C_2'(x)}{Y_2'(x)}$, i.e. 1 minus the ratio of its marginal cost of the innovation relative to marginal revenue.

(6) With the involvement of a third-party (such as the government or an NGO) that supports the community, the bargaining strength of the community can improve relative to that of the company and this results in a higher value of α. With the third party, we

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