PRELIMINARY

The Economics of User-Based Innovation*

by

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First Draft: 17 June, 1997
This Version: 23 September, 1998

This paper examines the economic incentives for users, as opposed to independent manufacturers, to develop innovations to satisfy their needs. While the previous literature on user-based innovation has focussed on exogenous factors that might make users more productive in innovation than manufacturers, here we model an endogenous source of distinction. We focus explicitly on how the economic rewards from innovation are divided up between manufacturer and user. This division is affected both by the willingness and ability of manufacturers to engage in research themselves. It is also influence by the overall commercialisation prospects for the innovation. In a base case, we demonstrate that an individual user will have a greater incentive to undertake innovative activity than a manufacturer. Moreover, in that case, users have an incentive to help manufacturers innovate but not the other way around. In contrast, as the number of potential users expands, manufacturer's incentives rise by more than that of any individual user. Indeed, when there is a large number of users, both the manufacturer and users have incentives to help each other generate successful innovations. This suggests an incentive-driven motivation behind manufacturers equipping 'lead' users with a greater ability to innovate.

* We thank Eric von Hippel for useful discussions. Of course, responsibility for all views expressed lies with the authors.

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When studying the sources of innovation, economists usually begin with the assumption that producers or manufacturers generate innovations that are then diffused to others. They focus on what type of firms generate innovations, that is, large versus small, incumbent versus entrant, independent researchers or integrated with manufacturing. In contrast, researchers in technological change have demonstrated that assuming that firms are the source of innovations is very limiting. For many innovations, inventors are more appropriately characterised as *users* or consumers rather than *manufacturers* (von Hippel, 1988). That is, users are agents who do not simply aim to appropriate returns from their innovative activity by commercialising innovations in the market place whereas this is the only outlet for manufacturers who have no intrinsic use of the innovation per se.

The purpose of this paper is to apply economic analysis to the question of whether manufacturers or users are likely to be innovators. In so doing, we will examine the incentives of each to engage in purposeful innovative activity in an environment where each recognises the existence of the other. Manufacturers recognise that they wish to sell innovations to users who themselves are engaged in innovative activity that, if successful, will generate substitute products. Users recognise that manufacturers' products are substitutes to their own but, moreover, their own innovation could be potentially licensed to and commercialised by manufacturers. Therefore, users can potentially appropriate market returns from their own innovations by working with manufacturers.

This economic perspective, we believe, adds to our overall understanding of the phenomenon of user-based innovation. We hope to explain why user-based innovation is important because of the differing characteristics of users as opposed to manufacturers. Initial research into user-based innovation did not to take this approach. Instead, a general approach to differing incentives was undertaken. Von Hippel (1988) identified four main criterion that would determine these incentives:

- Relative ability to establish monopoly control;
- Relative innovation-related output;

- Relative amount of displaced sales;
- Relative costs of innovating.

Each of these has a potential influence of innovation incentives. They relate to common economic variables. First, the notion that monopoly control is important in capturing innovation rents has been at the centre of economic analyses of innovation since Schumpeter. Second, the concept of innovation-related output relates to whether the product of innovation is specific to a particular user or capable of being marketed to many users. Finally, the problem of displaced sales relates to the so-called “replacement” effect identified by Arrow (1962); that an innovation may cannabilise existing assets. While each of these is critical to whether an agent would have relatively high innovation incentives, both users and manufacturers could have relatively high incentives on the basis of each of these. This criterion, while useful in establishing the importance of user-based innovation, did not identify what it was about the economic characteristics of users that would determine their innovation incentives.[1]

More recent research into user-based innovation has attempted to explain cross-sectional variation in the sources of innovation by identifying unique characteristics of users as opposed to manufacturers. Von Hippel (1994) argues that only users possess critical information that is required to solve innovation problems. This information transits between users and manufacturers with difficulty -- that is, information is “sticky.” As such, when the options for transferring user-information are particularly costly, users will have relatively lower costs in innovating and the problem for manufacturers is to encourage this. So the actual division of innovative labour is driven by a tension between the need to utilise “sticky” user-information with the technical capabilities of manufacturers.

[1] Contrast this with economic research into the differences between incumbents and entrants. This analysis centered on the unique characteristics of incumbents as opposed to entrants. For instance, incumbents could preserve monopoly power by innovating while entrants could at best hope for a duopoly or a licensing outcome. Incumbents would be concerned about their previous incumbent assets whereas entrants, without such assets by definition, would be not be concerned with cannabilisation.

In this paper, we wish to consider an alternative approach to explaining the relative innovation incentives of users and manufacturers. This will be based on the trading relationship between users and manufacturers. Users are the potential customers of manufacturers whereas manufacturers may purchase innovations from users. This means that both users and manufacturers potentially can substitute trade for their own innovative activity. This, in turn, will influence their overall and relative incentives to engage in innovative activity.

In the next section of the paper we outline our basic model of innovation and the value that can be derived from innovative activity. Section II then analyses the simple case of the interaction between a single user and manufacturer. There we show that because a user ultimately derives value from an innovation, it has a greater relative incentive to engage in innovative activity. Section III then considers the multiple user case and demonstrates that as the number of users grow, so does the manufacturer's innovation incentives relative to any one user. A final section examines the options for manufacturers in encouraging more user-based innovation.

I. Basic Model and Framework

Suppose that there are N agents in an industry that we call "users." For each user i, there exists a "product," "innovation," "idea," or "solution" to their needs. Specifically, there exists an innovation that, if generated, gives them a value V_i. For notational ease, we begin with the case that $V_i = V, \forall i$. If this innovation is developed, it is of this value to all users. Innovations have no intrinsic value to the manufacturer.

Both users and manufacturers can expend effort in generating either of these types of innovation. Our model is a dynamic one that is familiar in the economics of technological change.[2] Both users and manufacturers, if they expend $x\Delta$ units of research effort in a period of length Δ, have a probability, $h(x)\Delta$ of generating an innovation in that period. This hazard rate function is independent across time periods so that past research effort does not enhance current innovation chances. We assume that $h(.)$ is nondecreasing and concave with $h(0) = 0$. The cost incurred by this research is simply $x\Delta$. Both users and manufacturers have an identical discount rate, δ. We will explore solutions in continuous time as Δ goes to zero, with $\delta = e^{-r\Delta}$.

The research rate, x_i, chosen each period by agent i is unobservable to other agents. All that is observable is when an innovation is generated by some party. This means that agents cannot contract on the rate of research. We also assume that because the true nature of an innovation is uncertain it is impossible for the innovation itself to be contracted upon ex ante. This means that neither the manufacturer nor users can commit to a sale price for an innovation prior to it being generated (see Aghion and Tirole, 1994).

The timeline for the model is as follows. In stage one, both users and the manufacturer work towards generating an innovation. Initially, they choose whether to pursue a general or specific innovation and then they choose in each period how much effort to expend on innovation. When either type of agent generates an innovation a bargaining stage begins. Manufacturers negotiate with users for the sale of the product generated by the innovations. Users, if they have an innovation, negotiate with manufacturers for the sale of that innovation for manufacture into a product to sell to other users.

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[2] See Lee and Wilde (1979) and Reinganum (1983).

II. The Single User Case

We begin first with the case of a single user and manufacturer. Because there are no alternative users, the choice of which technology to develop is trivial with both user and manufacturer pursuing the specialised innovation.

We work backwards solving the bargaining game first, followed by the innovation game. The bargaining game only starts when the manufacturer has invented an innovation first. Otherwise the user simply appropriates V and the manufacturer is left with nothing.

Bargaining with a Potential User

We assume that bargaining takes the form spelt out in Gans and Stern (1997). This captures the idea that users have an option to continue searching for their own innovation during negotiations. That is, property rights over the innovation are potentially weak and the generation of an innovation does not exclude others from generating an innovation of similar economic value. In this context, a manufacturer may generate an innovation of value to the user but the user might continue their own research path and generate their own equivalent innovation. This situation is possible when innovations are not patentable but also when any particular patent can be "worked around" (Teece, 1987).

The extensive form of the bargaining game we consider is depicted in Figure One. When the manufacturer generates the innovation, Nature selects on party -- the manufacturer or user -- to be the offeror. That party, i, makes an offer of the sale price of the innovation-use, τ_i, which is either accepted or rejected. If it is accepted, the game ends with the manufacturer receiving τ_i and the user receiving $V - \tau_i$. On the other hand, if the offer is rejected then the user can continue research by selecting a research intensity, $\tilde{x}_U$. If they realise an innovation in that period the game ends with the user receiving V and the manufacturer left with nothing. If no innovation is generated, then negotiations continue with Nature once again selecting the offeror in the next round.

This bargaining game has a unique subgame perfect equilibrium.

Proposition 1. *In the continuous time bargaining game, an agreement is reached immediately with offeror offering and having accepted:*

$$\tau = \frac{Vr + \tilde{x}_U}{2\left(h(\tilde{x}_U) + r\right)}$$

where $h'(\tilde{x}_U)\tau = 1$.

The proof of the proposition is in the appendix. The user chooses its research level during negotiations to minimise the price it has to pay. If it did not research at this time then τ would be the familiar Nash/Rubinstein solution of $V/2$. The ability to continue research during negotiations, therefore, serves to make the user relatively more patient than the manufacturer. This results in a lower price to the manufacturer.

Ex Ante Innovation

We now turn to consider how the expectation of the equilibrium price for the innovation, τ, influences both the manufacturer's and user's ex ante innovation incentives. The manufacturer's ex ante payoff from innovation is:

$$v_M = \frac{h(x_M)\tau - x_M}{h(x_M) + h(x_U) + r}$$

In contrast, for the user the payoff is:

$$v_U = \frac{h(x_U)V + h(x_M)(V - \tau) - x_U}{h(x_M) + h(x_U) + r}$$

Notice that the payoff to each depends upon the research intensity chosen by the other. There is, therefore, a strategic component to their interaction in anticipation of potential trade later on.

Nonetheless, despite the apparent complexity of their interaction, we are able to characterise which agent is likely to research more intensively in equilibrium.

Proposition 2. *In equilibrium, the user researches more intensively than the manufacturer, i.e.,* $\hat{x}_U > \hat{x}_M$.

The proof of this proposition is in the appendix. Its significance is that when there are no differences between user and manufacturer in terms of their intrinsic ability to generate innovations, users have a greater incentive to pursue innovations than manufacturers.

To see this note that there are two broad motivations that drive agent's to intensify their research effort. The first of these is a purely strategic motive -- *preemption*. The preemption motive is simply the difference in payoffs an agent receives from being the first to generate an innovation or not. For the manufacturer, this preemption motive is τ as they receive this by innovating first and nothing otherwise. For the user, the motive for preemption is governed by the desire to avoid this payout. That is, they receive V if they win and $V - \tau$ if they lose. So the preemption incentive for each, given the expectation of trade, is the same.

The second motive for greater research effort is simply each agent's willingness to pay for the innovation. That is, we ask what is the maximum amount an agent would pay to generate the innovation today in the absence of a strategic concern? For the manufacturer this is τ as their intrinsic motive for innovation is the expectation of selling it to the user. For the user, they receive V by generating the innovation. As $V > \tau$, the user's willingness to pay motive is always greater than the manufacturer's. Note that this comes from the fact that the user has the option to operate independently of the manufacturer and find its own innovation while the manufacturer has to deal with the user in order to realise a return. As their pre-emption motives are the same, then in the absence of greater research productivity on the part of the manufacturer, the user will have greater overall innovation incentives. Hence, they are more likely to generate the innovation first.

Our approach here also gives a prediction about each agent's preference for greater research effort on the part of the other. If one agent had a preference for innovation by the other they might expend other resources to help that agent and given them an incentive to undertake further research. Our results here are summarised in the following proposition.

Proposition 3. *The user prefers more manufacturer research (i.e., the maximised value of v_U is non-decreasing in x_M). The manufacturer prefers less user research (i.e., the maximised value of v_M is non-increasing in x_U).*

The proof is in the appendix. That proof demonstrates that a preference for research by the other agent will be positive if the agent prefers the payoff from immediate innovation by the agent to the expected return from continuing the innovation race. For the manufacturer, this is always negative as user innovation earns them nothing while continuing to research gives them v_M. For the user, however, they receive a positive benefit from manufacturer innovation, $V - \tau$. The proposition demonstrates that this is always greater than v_U and hence, the user's payoff increases when the manufacturer researches more intensively.

III. The Many User Case

What happens when there are N users? This case is more complicated than the single user case because a user-innovator will have an incentive to sell the innovation to the manufacturer. It, in turn, will sell the innovation to other users. The user-innovator will anticipate these returns to the manufacturer in their negotiations, complicating the bargaining game.

Bargaining Outcomes

To consider this we need to analyse bargaining outcomes in several situations. First, consider what happens when the manufacturer is the pioneer innovator. They negotiate with each user individually for the sale of the innovation. Therefore, they realise a licensing fee akin to the single user case (as defined by Proposition 1):

$$\tau = \frac{Vr + \tilde{x}_U}{2\left(h(\tilde{x}_U) + r\right)}$$

where $h'(\tilde{x}_U)\tau = 1$. By innovating first, the manufacturer, therefore, earns $N\tau$.

Second, what happens when a user sells the innovation to the manufacturer? In this case, the manufacturer negotiations with the N-1 remaining users, individually. Once again, this is akin to the single user negotiations, so the manufacturer would expect to earn τ above for each sale. Therefore, a manufacturer can expect to earn (N-1)τ if it sells a user's innovation.

Finally, when a user innovates first they are able to use the innovation but also sell it to the manufacturer who then, in turn, markets it to others. Recall that we have assumed that an individual user lacks the capability to market directly to other users. However, those users, as well as the manufacturer, can continue to research while the pioneer-user and manufacturer negotiate. If the manufacturer generates an innovation during that time, it no longer needs to negotiate with pioneer users and can claim (N-1)τ for itself. If another user generates an innovation during negotiations, the manufacturer has two users it potentially can purchase innovations from -- although only N-2 users to sell it to. We assume that in this situation, the manufacturer can play one user off against the other and hence, claim (N-2)τ for itself. This allows us to prove the following proposition.

Proposition 4. *In the continuous time bargaining game, an agreement is reached immediately with offeror offering and having accepted:*

$$\mathrm{T} = \frac{r(N-1)\tau + \sum_{i=1}^{N-1} h(\tilde{x}_i)\tau + \tilde{x}_M}{2\left(\sum_{i=1}^{N-1} h(\tilde{x}_i) + h(\tilde{x}_M) + r\right)}$$

where $h'(\tilde{x}_M)\mathrm{T} = 1$ and $h'(\tilde{x}_i)\tau = 1$.

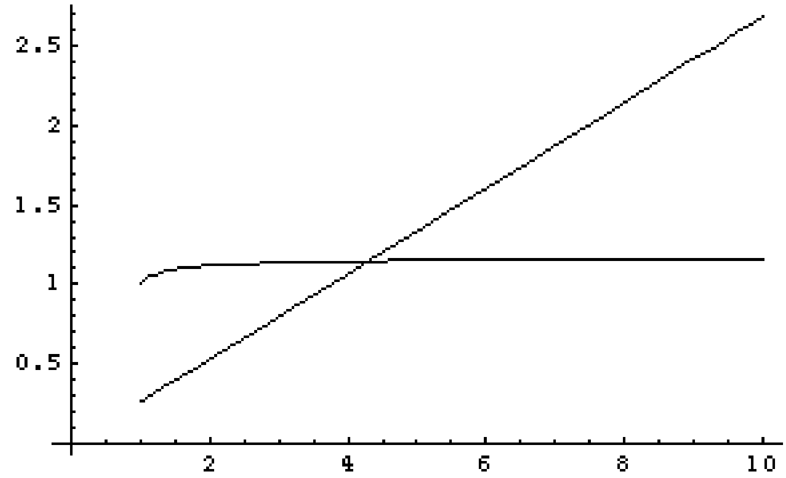
This results in the following characterisation of equilibrium research intensities.

Proposition 5. *In equilibrium, an individual user researches more intensively than the manufacturer (i.e.,* $\hat{x}_U \geq \hat{x}_M$*) if and only if* $V + \mathrm{T} \geq N\tau$.

The condition of the proposition is again a comparison of the willingness to pay incentives of an individual user as opposed to the manufacturer. Relative research incentives depend on this alone as the pre-emption incentive for the manufacturer and users are identical, being equal to $\tau + \mathrm{T}$.

As N rises it becomes more likely that the manufacturer will research more intensively than any individual user. This is demonstrated for a special case in Figure Two. However, this does not mean that the manufacturer is more likely to become the pioneer innovator. To see this, following Loury (1979), note that the expected time that the manufacturer innovates is $1/h(\hat{x}_M)$. In contrast, if $\hat{x}_U$ is the equilibrium research intensity for each user, the expected time that *any* user generates an innovation is $1/\left(Nh(\hat{x}_U)\right)$. Therefore, a user is likely to be the pioneer innovator if $Nh(\hat{x}_U) > h(\hat{x}_M)$. So even if the manufacturer researches more intensively than an individual user, there are more users pursuing innovations, raising the probability that any one user generates an innovation prior to the manufacturer.

Figure Two
(with $h(x) = \sqrt{x}$, $V = 1$, $r = 0.1$)



Preferences for Research Effort

In the single user case, we demonstrated that while user innovation exerted a negative externality on the manufacturer, manufacturer research benefited the user (Proposition 3). This was because the manufacturer only profited by their own innovation, whereas the user receive some benefit when the manufacturer generated an innovation.

In the many user case, these preferences become more complicated. The manufacturer now receives some positive payoff when a user innovates first. However, now there is a negative effect of manufacturer and other user innovation on an individual user -- it removes the possibility of the user receiving T. However, it is still possible that innovation could exert a positive externality on all agents.

Proposition 6. *If* T *is relatively low, then both users and manufacturers prefer greater research intensity on the part of others.*

When T is low, the manufacturer considers user innovation as an imperfect substitute to its own. Moreover, for low T, each user does not consider pioneer innovation as much of a "prize," and so, likewise, would prefer more research on the part of others. A relatively low T will arise as N gets large. In these circumstances, each agent will have an incentive to help others.

Heterogeneous Users

We now turn to consider the case where users are heterogeneous in their ability to conduct research. To this end, we consider the extreme case where there are n users who can conduct research while the remaining N - n users cannot. We demonstrate that under some conditions the removal of a user from the researching class raises individual user research effort relative to that of the manufacturer.

To see this note that T(n) now becomes:

$$\mathrm{T}(n) = \frac{r(N-1)\tau + \sum_{i=1}^{n} h(\tilde{x}_i)\tau + \tilde{x}_M}{2\left(\sum_{i=1}^{n} h(\tilde{x}_i) + h(\tilde{x}_M) + r\right)}$$

This is decreasing in n. Hence, more user-researchers reduce the price that users receive for their innovation. This is because a reduction in n, lowers the probability that another user will generate an innovation during negotiations. However, as N is fixed it does not alter the total market for the innovation.

This insight allows us to prove the following:

Proposition 7. *Suppose that* T(n) *is relatively low. Then, holding N fixed, a reduction in n raises* $\hat{x}_U$ *relative to* $\hat{x}_M$.

When T(n) is relatively low, a reduction in n raises the returns to innovation as research intensities are strategic substitutes (see Proposition 6). Thus, a reduction in T lowers the pre-emption incentives of both users and manufacturers while raising the willingness to pay incentives of users. As such, individual users will research more intensively than the manufacturer. Of course, since n has fallen we cannot tell whether this makes it more likely that a user becomes the pioneer innovator.

Appendix

Proof of Proposition 1

Following Wolinsky (1987), the subgame equilibrium is characterised by the following equations:

$$V-\tau_M = h(\tilde{x}_U)\Delta V - \tilde{x}_U\Delta + \left(1-h(\tilde{x}_U)\Delta\right)\delta\left(V-\tfrac{1}{2}\left(\tau_M+\tau_U\right)\right)$$

$$\tau_U = \left(1-h(\tilde{x}_U)\Delta\right)\delta\tfrac{1}{2}\left(\tau_U+\tau_M\right)$$

$$h'(\tilde{x}_U)\left(V-\delta\left(V-\tfrac{1}{2}\left(\tau_M+\tau_U\right)\right)\right)=1.$$

The first equation states that the offer of the manufacturer to the user must be at least as high as the user's expected payoff if they reject the offer. The second is the equivalent condition when the user is the offeror. The final equation is the first order condition for the user, maximising its disagreement payoff. This determines $\tilde{x}_U$, the user's research intensity during negotiations. Note that $\tilde{x}_U$ is unique.

Solving these equations gives:

$$\tau_M = \left(V\left(1-\delta(1-h(\tilde{x}_U)\Delta)\right)-h(\tilde{x}_U)\Delta V+\tilde{x}_U\Delta\right)\frac{1-\delta\tfrac{1}{2}(1-h(\tilde{x}_U)\Delta)}{1-\delta(1-h(\tilde{x}_U)\Delta)}$$

$$\tau_U = \left(V\left(1-\delta(1-h(\tilde{x}_U)\Delta)\right)-h(\tilde{x}_U)\Delta V+\tilde{x}_U\Delta\right)\frac{\delta\tfrac{1}{2}(1-h(\tilde{x}_U)\Delta)}{1-\delta(1-h(\tilde{x}_U)\Delta)}$$

These are offered and accepted during the first round of negotiations. That the equilibrium is unique follows from the uniqueness of the post-innovation choice of $\tilde{x}_U$ for the user. Inthe event of a breakdown, the manufacturer's payoff would be zero while the user would earn $\max_{x_U} v_U(x_U)$ where:

$$v_U(x_U)=\frac{h(x_U)\Delta V - x_U\Delta}{1-\delta(1-h(x_U)\Delta)}.$$

Wolinsky (1987) shows that $V-\tau_U \geq \max_{x_U} v_U(x_U)$ and $V-\tau_M \geq \max_{x_U} v_U(x_U)$.

Finally, looking in continuous time, if we replace δ with $e^{-r\Delta}$ and take limits as Δ approaches zero gives:

$$\tau_M,\tau_U \to \tau = \frac{Vr+\tilde{x}_U}{2\left(h(\tilde{x}_U)+r\right)}.$$

Proof of Proposition 2

Consider the first order conditions for a Nash equilibrium in the innovation game. The first order condition for the manufacturer is:

$$\begin{aligned}&\left(h'(x_M)\tau-1\right)\left(h(x_M)+h(x_U)+r\right)=h'(x_M)h(x_M)\tau-h'(x_M)x_M\\&\Rightarrow\left(h'(x_M)\tau-1\right)\left(h(x_U)+r\right)=h(x_M)-h'(x_M)x_M\end{aligned}$$

and for the user:

$$\begin{aligned}&\left(h'(x_U)V-1\right)\left(h(x_M)+h(x_U)+r\right)=h'(x_U)\left(h(x_U)V+h(x_M)(V-\tau)-x_U\right)\\&\Rightarrow\left(h'(x_U)V-1\right)r+h(x_M)\left(h'(x_U)\tau-1\right)=h(x_U)-h'(x_U)x_U\end{aligned}$$

Notice that the right hand side of each condition is identical, as is the term interacting with r on the left hand side. What remains is the term interacting with the marginal research productivity of each agent. A comparison of these yields the condition in the proposition.

Proof of Proposition 3 and Proposition 6

This is a simple application of Proposition 5 and Corollary 3 of Gans and Stern (1997).

Proof of Proposition 4

If the user innovates first, the relevant bargaining equations are:

$$\mathrm{T}_M=\left(1-h(\tilde{x}_M)\Delta-\sum_{i=1}^{N-1}h(\tilde{x}_U)\Delta\right)\delta\tfrac{1}{2}\left(\mathrm{T}_M+\mathrm{T}_U\right)$$

$$\begin{aligned}(N-1)\tau-\mathrm{T}_U=&\,h((\tilde{x}_M)\Delta(N-1)\tau-\tilde{x}_M\Delta+\sum_{i=1}^{N-1}h(\tilde{x}_U)\Delta(N-2)\tau\\&+\left(1-h(\tilde{x}_M)\Delta-\sum_{i=1}^{N-1}h(\tilde{x}_U)\Delta\right)\delta\left((N-1)\tau-\tfrac{1}{2}\left(\mathrm{T}_U+\mathrm{T}_M\right)\right)\end{aligned}$$

$$\begin{gathered}h'(\tilde{x}_M)\left((N-1)\tau(1-\delta)+\delta\tfrac{1}{2}\left(\mathrm{T}_M+\mathrm{T}_U\right)\right)=1\\h'(\tilde{x}_i)\tau=1.\end{gathered}$$

Solving and taking the limit as Δ approaches zero, we have,

$$\mathrm{T}_M,\mathrm{T}_U\to\mathrm{T}=\frac{(N-1)\tau r+\sum_{i=1}^{N-1}h(\tilde{x}_i)\tau+\tilde{x}_M}{2\left(\sum_{i=1}^{N-1}h(\tilde{x}_i)+h(\tilde{x}_M)+r\right)}$$

where $h'(\tilde{x}_M)\mathrm{T} = 1$ and $h'(\tilde{x}_i)\tau = 1$.

Proof of Proposition 5

The first order condition for the manufacturer is:

$$\left(h'(x_M)N\tau - 1\right)\left(h(x_M) + \sum\nolimits_{i=1}^{N} h(x_i) + r\right) = h'(x_M)\left(h(x_M)N\tau + \sum\nolimits_{i=1}^{N} h(x_i)((N-1)\tau - \mathrm{T}) - x_M\right)$$

$$\Rightarrow \left(h'(x_M)N\tau - 1\right)r + \left(h'(x_M)(\tau + \mathrm{T})) - 1\right)\sum\nolimits_{i=1}^{N} h(x_i) = h(x_M) - h'(x_M)x_M$$

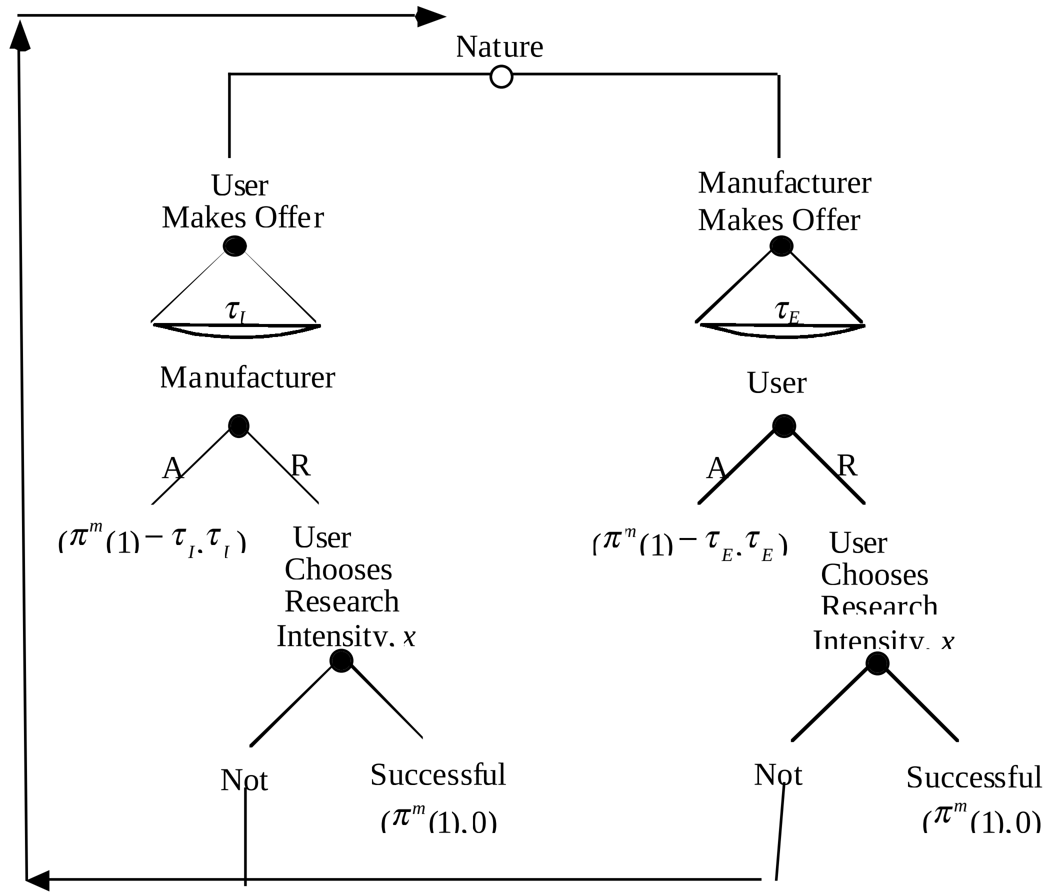
and for an individual user:

$$\left(h'(x_i)(V + \mathrm{T}) - 1\right)\left(h(x_M) + h(x_i) + \sum\nolimits_{j \neq i} h(x_i) + r\right) = h'(x_i)\Big(h(x_i)(V + \mathrm{T}) + \left(\sum\nolimits_{j \neq i} h(x_i) + h(x_M)\right)(V - \tau$$

$$\Rightarrow \left(h'(x_i)(V + \mathrm{T}) - 1\right)r + \left(h'(x_i)(\mathrm{T} + \tau) - 1\right)\left(\sum\nolimits_{j \neq i} h(x_i) + h(x_M)\right) = h(x_i) - h'(x_i)x_i$$

The proof then proceeds along the lines of Proposition 2.

Figure One: Bargaining Game



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