

Scarcity of Ideas and R&D Options: Use it, Lose it or Bank it

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- A question central to effective policy making in innovation is:
 - Which innovations deserve protection?
- Patent law: Protection is given to those innovations which satisfy the requirements of
 - novelty and nonobviousness (US), or
 - novelty and inventive step (Europe and Australia).
- This paper analyzes this question by developing a theoretical framework which differentiates between scarcity of ideas and scarcity of resources.

How the innovative environment is conceptualized

- What creates the opportunity for investment in R&D?
 - ① An idea for a market niche (creativity)?
 - ② An idea for how to fill the market niche (creativity)?
 - ③ Resources?
- Which of these is scarce? Which scarcity retards progress?
 - In most models of R&D, it is the scarcity of resources which retards progress.
 - In our model, it is also the scarcity of ideas which retards progress.
- We distinguish between ideas, which are scarce, and innovations, which occur with the investment of resources after an idea becomes known.

Model

Ideas

- A market niche of value $\frac{v}{r}$ is known.
- To innovate (i.e., fill the market niche), an inventor must first have an idea and then the incentive to invest in it.
- Ideas for how to fill the market niche arrive at random times to random individuals according to a Poisson process with parameter λ .
 - The arrival rate λ measures scarcity.
- Ideas have a random cost drawn independently from a common distribution F with support in $[0, \infty)$ and density f .

Model

Ideas

- Only the recipient of the idea knows his idea and observes its cost.
- The recipient of an idea can invest in it, discard it, or bank it for future use.
- If the recipient of an idea invests the cost, the idea becomes an innovation that fills the market niche. The game ends.

Model

Optimal policy

- The social problem is to choose a cost threshold $c : \mathbb{R}_+ \rightarrow \mathbb{R}_+$, where $c(t)$ is the maximum cost for investing at time t .
- The social planner chooses a reward structure ρ that (hopefully) implements the optimal cost threshold c .
 - The social planner knows the distribution on costs, but does not know the ideas which have arrived (and have been banked), who received them, and what their costs are.
- Purpose of the reward system is to choose among substitute ideas.
 - If all ideas were available at the same time, the goal of the social planner would be to find the minimum cost idea.
 - However, ideas arrive at random times. Even if a market niche is known, there may be considerable delay before someone fills it.
- Optimal policy will operate by getting potential innovators to screen their ideas and to discard those with costs that are too high.

- The private decision problem is different from the social decision problem because each agent receives at most one idea.
- Private problem: Is my idea profitable?
- Social problem: Is it better to wait for a better idea?
- The option that is preserved by not investing is a social option, not necessarily internalized by any potential investor.
- The policy objective is to ensure that private recipients of ideas preserve socially optimal options.

- First define the optimal cost threshold and then analyze how it can be implemented.
- Policy at time t should maximize social welfare going forward from time t .
- The stochastic process that determines the option value depends on whether rejected ideas are lost forever (“use it or lose it”) or banked for future use (“use it or bank it”).
 - An idea may be lost or forgotten if the recipient moves on to other projects.
 - However, not all ideas will be lost, especially if there is an incentive to remember them.

Use it or lose it

Arrival rate is known

- If the threshold function c is optimal, the following condition holds at each t .

$$\left(\frac{v}{r} - c(t)\right) = V(t, \lambda, c)$$

- Society faces a tradeoff between cost and delay.
 - Can weed out high-cost ideas by offering limited rewards. This would introduce delay.
 - A higher reward means that if someone invests, society gives up the option to wait for a better (lower cost) idea.
- Welfare as a function of the stationary threshold \bar{c} can be written as

$$\bar{V}(t, \lambda, \bar{c}) = \left(\frac{v}{r} - E_F(\bar{c})\right) \frac{\lambda F(\bar{c})}{\lambda F(\bar{c}) + r}$$

Use it or lose it

Arrival rate is known

- In the case when the recipient of an idea must use it or lose it, if the arrival rate of ideas, λ , is fixed and known, the optimal c is stationary.
- The optimal cost threshold is decreasing with the arrival rate λ .
 - If ideas come rapidly, the cost of waiting is reduced, and it is optimal to be more selective in choosing an idea for investment.
 - If ideas are scarce, there may be long delay in waiting for a better idea. It is desirable to encourage investment in less good ideas to avoid delay.
- This is true even though the distribution of costs is the same.

Use it or lose it

Arrival rate is not known

- More realistic to assume that the social planner knows whether the market niche has been filled, but does not know λ .
- The length of time without arrival of a viable idea is a signal of λ .
- In this case, \tilde{V} is decreasing in t and hence, the optimal c is increasing.
 - Intuitively, as time passes with no innovation, the planner becomes more pessimistic about the arrival rate and expects more delay. It is optimal to tolerate higher cost in order to reduce delay.

Use it or bank it

- There are two kinds of banking.
- With unknown λ , an idea that seemed too costly a year ago may seem more attractive at present because more delay is predicted.
 - Banking raises the instantaneous probability of a viable idea because banked ideas, as well as new ideas, can be called into use.
 - Optimal cost threshold should take this into account.
- At the same time, the social planner does not want to delay investments that should be viable under the optimal cost threshold.
 - The reward function should ensure that this does not happen.

Use it or bank it

- If c is decreasing at t , banked ideas are irrelevant.
 - Any banked idea that would be chosen at t would also have been chosen at $t - dt$. Hence, if there is investment at t , it is because a viable idea materializes at that moment.
- If c is increasing at t , banked ideas may become viable.
 - Both the banked ideas and the increasing cost threshold affect the probability of investment at time t .

Use it or bank it

Results - optimal threshold with banking

- With known λ , the optimal c with banking is still stationary and is equal to the optimal c in the use-it-or-lose-it case.
 - If use it or lose it, nothing changes over time. Every point in time is a new beginning.
 - Now, the thing that changes over time is the accumulation of banked ideas. Hence, it is not *a priori* obvious whether the planner will be tempted to use banked ideas as time passes.
- With unknown λ , the optimal c with banking is still increasing.
 - It is learning about λ that causes the optimal threshold to be increasing, not the banking of ideas *per se*.

Use it or bank it

Results - social welfare with and without banking

- The optimized social welfare is higher with banking than without.
 - When ideas are banked, the social planner is more pessimistic about λ at each t for a given c .
 - At the same time, the arrival rate of viable ideas is higher when some ideas may come from the banked ones.
- It follows that the optimal c is lower with banking: $c^V > c^B$.
 - The social planner prefers to be more selective when he can rely on banked ideas, even if he is more pessimistic about λ at each t .

Implementation

- The social planner cannot implement the optimal cost threshold directly because the social planner is not the recipient of ideas.
- At best, the social planner can try to implement the optimal threshold by setting a reward function ρ which can represent patent policy or a prize system.
- The reward function ρ implements the threshold function c if the possessor of an idea with cost c_0 at time t invests in the idea if and only if his idea satisfies $c_0 \leq c(t)$.

Implementation

- Implementation is easy in the “use it or lose it” model and in the “use it or bank it” model if λ is known.
 - The optimal c can be implemented by setting $\rho(t) = c(t)$ for all t .
- Implementation is not as easy in the “use it or bank it” model if λ is not known.
 - When the optimal cost threshold is increasing, if $\rho(t) = c(t)$ for all t , the recipient of a marginal idea would not invest as intended (even if the possessor of the idea might be pre-empted during the delay).
 - Hence, the reward must be greater than the implemented cost threshold at each t .
- There exists a reward function ρ that implements c and satisfies $\rho > c$ if c is increasing. Furthermore, $\rho(t) - c(t) \rightarrow 0$ as $t \rightarrow \infty$.

Conclusion

- In addition to the scarcity of resources, the scarcity of ideas is another constraint on progress.
- We considered a model where:
 - Ideas create opportunities for investment.
 - Innovative environments are distinguished by the arrival rate (scarcity) of substitute ideas.
- How should rewards reflect the scarcity of ideas?
 - Optimal reward policy changes dynamically.
 - The reward to innovation should increase with the scarcity of ideas when λ is known and with delay when λ is unknown.
 - Under banking, the reward should be higher than the optimal cost threshold at each t .
 - The profit on R&D investments will be positive in equilibrium due to the scarcity of ideas.
- These results extend the literature by focusing on dynamic reward policies and considering impact of scarcity of ideas on optimal policy.

Existing patent doctrine

- When the statutory patent life is the same for all patentable innovations, breadth is the main lever to differentiate rewards.
 - Our prescription is that the patent office and courts should grant more generous claims (broader patents) when the innovation arrives after long delay.
- The nonobviousness requirement is a threshold standard for granting a patent.
 - When an innovation arrives after long delay, this can be seen as a measure of nonobviousness.
- Our framework lends support to the use of "long-felt need."
 - Long-felt need is one of the secondary considerations for patentability.
- We have not considered how deadweight loss incurred in collecting the reward may affect the optimal cost threshold.