Research Proposal

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1 Motivation

As one of the greatest US presidents in history, Lincoln has been the center of the discussion far beyond the scope of politics. The rise of Lincolnology that describes the managerial decisions made by the board has inspired two professors from Harvard Business School, publishing books on this topic. Their books Indispensable and The Outsiders delve into the possible advantages of what they call unfiltered leaders, whose capabilities have never been tested before. Professor Thorndike examined eight firms that outperformed the Standard and Poor average by more than 20 times and found that they were all outsiders, while Professor Mukunda found the results rather mixed, with successful outsiders like Lincoln yet also failed ones that make things worse.

The difference between outsiders and insiders is mainly represented by how much information we have on their overall abilities. Outsiders are new to the firms as their abilities are usually unknown or only proved in some other loosely connected industry. We either have no ideas what they are capable of, or can only infer from their previous performance, updating our beliefs as they start working. On the other hand, they tend to make a series of bold moves that may help them stand out in the time of crisis. Insiders are a group of people whose type we know exactly since they have been exposed to a succession of tests, and their strategies of managing a firm is nothing surprising. We know what cards they will play in either normal situations or crisis, and thus they bring little change or novel ideas to the firms, enjoying stableness yet detrimental especially when being caught in a crisis.

My research proposal will focus on the decision making process under different information structures, and also see the boards decision when the job candidates strategies are incorporated. The question here is on what criterion we should decide whether to hire an insider or outsider. More generally, given different information structures about the distribution of either rewards or types, what the optimal decision rule is. Furthermore, when the job candidates interact with career concerns and evolve their strategies along the time, how the decision rule will change accordingly. To address these issues, formal models are needed.

2 Related Literature

The framework of bandit problems is among the most widely-used models for the study of optimal decision problem and information acquisition at the same time. Bergemann and Valimaki (2006) serves a literature review on bandit problems and its applications in economics. The tradeoffs between utilizing the stable arm and searching for other arms with uncertainty, that is, the tradeoffs between exploitation and explorations, are raised in the basic setting. The application they mention includes market searching, multiple agents experimentation, experimentation and pricing, and experimentation in finance. Market searching problem is represented by Rothchild (1974), where sellers are initially ignorant of the demand curves they face, and can experiment on charging different prices at the cost of possible customer loss. Thus the optimal strategy is to find the value brought by the new information and compare with charging optimally under the present information. Roberts and Weitzman (1981) and Whittle (1981) throw light on the sequential and explorative nature of research projects by finding the funding rules for Sequential Development Project, and propose how to allocate effort between projects at different stages of development.

Though the bandit problem on job market has similar settings that a workers productivity is not known ex-ante and will get more clear and precise as the time passes, the central themes and applications are varied. Jovanovic (1979) studies workers' decision on turnover. Manso (2011) contrasts incentive schemes that motivate exploration or exploitation respectively. Motivating exploitation requires standard pay-for-performance schemes, excessive termination, short-term contracts, and no

feedback on performance. In contrast, motivating exploration involves tolerance or even reward for early failure and long-term success, so that both total performance and the path of performance matters for compensation.

Bandit problem with dependent multi-arms are not fully researched due to its extreme complexity. Bolton and Harris (1999) extends the bandit problem into many-agent setting where N players each face the same experimentation problem. The emerging issue of learning from other agents experimentation is analyzed. Valsecchi and Sassari (2000) is concerned with job mobility when observing performance is an imperfect signal of the output that can be expected in other jobs. Those papers are helpful in explaining the interaction and externality among the different arms.

Another strain of literature focuses on the incentives provided by career concern: performing well in the current position makes a good impression on potential future employers. Holmstrom (1999) provides a classic treatment of informal incentives based on career concerns. Workers can take unobserved actions in order to influence the learning process based on the observation of past performance. In the model, the productivity abilities are revealed over time through the observation of performance, and an implicit contract that links today's performance to future wages is designed. Dewatripont, Jewitt and Tirole (1999) extends Holmstrom (1982) model into a more general form, focusing on how different information structures such as sufficient statistic, Blackwell garbling, etc. affect either the explicit or implicit incentives.

However, relatively few papers incorporate career concerns in the context of a searching model. Blatter and Niedermayer (2009) distinguishes jobs into two kinds: high visibility jobs that all employers can observe performance while the low visibility ones allowing only the current employer to observe. This paper answers the question of what impact job visibility has on effort induced by career concerns. Prendergast and Stole (1996) examines individual decision making when reputation over learning matters a lot. Specifically, it points out that whether the manager exaggerates his position or invests too conservatively depends on the speed of learning and the different economic environments. I attempt in this proposal to add more discussion on explaining job rotation or the switches among the insiders and the outsiders due

to the existence of strategy leak, unknown type and career concern. I attempt in this proposal to add more discussion on explaining job rotation or the switches among the insiders and the outsiders due to the existence of strategy leak, unknown type and career concern.

3 Models and Interpretations

3.1 Managerial decision without candidates' interactions

Let us consider a special case of two-armed bandit problem with both arms known. In a two-period world, the board wants to hire a leader that is most favorable to the firms reputation building process, which is cumulative and fully dependent on the leaders' contribution. By cumulativeness, the leader in period t can observe the previous leader's strategies and results in period *t-1*, and adjust his/her own behavior by adopting the strategies that can lead to a higher current result.There are two types of leaders: the insiders and the outsiders. Suppose the insiders have a constant contribution η_1 no matter in normal times or crisis; while the outsiders can contribute only $\eta_2 < \eta_1$ in normal times but $\eta_3 > \eta_1$ in the crisis, which occurs with small probability *1-h* and get known only in the end of each period. Initial hiring (hiring in the first period or switching every time) costs c_i (i=I,O). Suppose further that in the two periods, there is no discounts; denote $m = h\eta_2 + (1-h)\eta_3 < \eta_1$; $\eta_1 - c_I > m - c_O > 0$ which indicates improvement by either hiring the outsiders or the insiders; and $c_I < c_O$. The last inequality $c_I < c_O$ can be explained as the high uncertainty or dissonance the board members encounter caused by the decision of hiring an outsider.

Based on many economic standards, the insiders are superior to the outsiders since they have higher expected returns, lower volatility and lower cost. However, by the nature of cumulativeness in the adjacent period, do these economics standard guarantee that we should directly choose the insiders? Take a closer look at the reputation building process, and we can find the tradeoffs between exploiting the insiders' larger expected contribution and the exploration from obtaining the possible new information in the first period. The following proposition shows that under some circumstances, choosing the outsiders first can have higher total contribution

despite the outsiders' lower expected contribution.

Proposition 1: If $(1)c_O > (1-h)(\eta_3 - \eta_1), (2)\eta_1 - m < c_I < h(\eta_1 - \eta_2), and (3)(2 - h^2)\eta_1 - (2h - h^2)\eta_2 - (2 - 2h)\eta_3 < (1-h)c_I - c_O < 0$, then it is optimal to try the outsiders first, and see if switching is necessary.

Here I point out that even though the insiders have higher expected payoffs and lower costs, the board will first hire the outsiders and switch to the insider when a high contribution is made. The seemingly counterintuitive result that the higher contribution results in the switching is partly due to the fact that the subsequent leader can learn from the last period's strategy and outcome, improving his/her performance, and thus contribution. Another reason is perhaps the inability for the candidates to change their strategies leaving the result of contribution all to the nature. If the candidates can adjust their effort level, the one-period public information will naturally make the outsider reduce their effort, lowering the contribution so that the successor cannot immediately benefit from the information leak.

When there are multiple periods and the information leak can only be benefit for one period, the benefits from hiring the outsider for eliciting the strategies in the crisis is only temporary. Therefore, now the problem is not whom to hire first, but a series of switching decisions. Also, when the probability h is an unknown constant, the hiring decision can gradually make an accurate estimation about the states of the world. Hiring the insider is useless in improving the estimation of h while the outsider will do help. There exists a threshold when the estimation is precise enough to help the board make the decision of which type will be hired for good starting from that point of time.

3.2 Managerial decision with candidates' unknown type

Now we make a slightly different setting by assuming that the state of the world is revealed and known to all each period beforehand. The insiders always contribute η_1 regardless of the normal time or crisis, while the outsiders' abilities are unknown to all. They can only produce η_2 in the normal time, yet are capable of contributing η_3 with a certain probability in the crisis. The good type outsiders have higher

possibility of achieving η_3, and denote the expected payoff in the crisis m_G and m_B respectively.

There is also no learning from the predecessor in the adjacent period, meaning that the insider can only contribute η_2 even though η_3 is achieved in the last period by the outsider. The exploration is now to see if the outsider is excellent enough. Suppose there are infinitely long periods of time and the discount rate is β. Switching to the insider costs c_I, and c_O for the outsider. We assume $c_I < c_O$ because of the outsiders' possible bold revolution. We will endoginize it and see why they may behave bolder in the third model.

In each period, the board updates their information on the type of the outsiders by former information set $F = ((normal^i, crisis^i), (\eta_2^i, \eta_3^i)), i = 1, 2, ..., t$ and the Bayesian rule. Choosing the insider cannot help the board gain additional information on the outsiders, and once the board believes the payoff from the insider is larger than the expected payoff from the outsider, they will hire the insider for good. Suppose $\eta_1 = h\eta_2 + (1-h)(\frac{1}{2}m_G + \frac{1}{2}m_B)$, thus if the ex-ante belief on the outsider is $\lambda < \frac{1}{2}$, the board will hire the insider forever and nothing will be learned about the outsider; while otherwise the outsider will be hired first and switch if necessary. The switching point is achieved when $E_t = \sum_{i=1}^{+\infty} \beta^i \cdot [h\eta_2 + (1-h)[m_G Pr(\theta = G|F_{t-1}) + m_B(1 - Pr(\theta = G|F_{t-1}))]] \leq -c_I + \sum_{i=1}^{+\infty} \beta_i \eta_1$ is satisfied.

More generally stated in the language of bandit problems, at each period, the decision maker chooses among two arms $a_t = K = \{1, 2\}$ and achieves the random payoff X_t^k, where X_t^1 is known with certainty and X_t^2 follows some distribution with the parameter unknown. The state of the information is described by the estimate of the probability of a payoff on the second agent, that is, the posterior probability distribution on θ_t^G. When hiring the second agent, the board receives, in addition to a random payoff, information which allows them to revise the estimate. In this model's setting, the optimal policy is in the form of a stopping rule, answering the question when information on the unknown arm is so disappointing that should be switched. The board will maximize $E\sum_{i=1}^{+\infty} \beta^{i-1} \cdot X^{a_t}(\theta_i^G)$. In terms of multiple arms, the Gittins index theorem will do great help to simplify the solution.

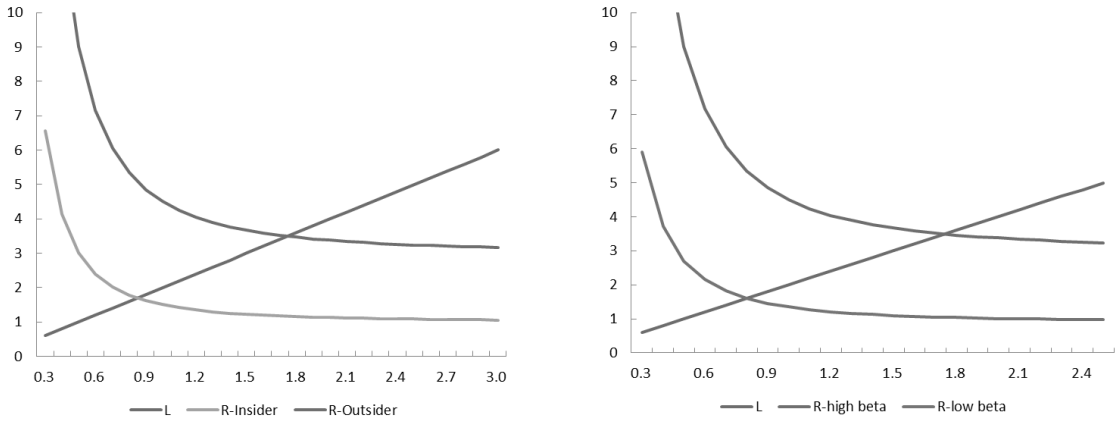
In this model setting, the uncertainty is represented in the unknown type of the outsider. When the proportion of the good type is relatively high, or the good type outsiders can perform extraordinarily well in the crisis, or the probability of crisis is rather high, hiring the outsider will bring higher contribution to the firm, in another word, the benefit from exploration outweighs that from the exploitation.

3.3 Managerial decision with candidates' career concern

As the second model illustrates, the assumption of outsiders' unknown types is quite close to the real world, yet due to the ignorance of candidates' own type, they may exert effort above what they do, should they know exactly their own type. Therefore, the question boils down to the efforts the candidates choose and the sequence the board pick them with. I build the following model on the basis of Holmstrom (1999).

As before, I assume there are two states of the world: normal time and crisis, which occur in the probability h and *1-h* respectively. The insider's type η is known to the board and himself/ herself, whereas the outsider's is unknown to all and follows $N(m_t, h_t)$. In the normal time, the output is determined by $y_t^N = \eta + i_t + \varepsilon_t$, while in the crisis, effort is not that useful and $y_t^C = \eta + i_t - s(i_t) + \varepsilon_t$. Without loss of generality, let's assume $s(i_t) = \frac{1}{i_t}$. In an expectation point of view, the output can be written as $y_t = hy_t^N + (1-h)y_t^C = \eta + i_t - \frac{1-h}{i_t} + \varepsilon_t$, where $\varepsilon_t \sim N(0, h_t)$. If the firm hires the candidate, it has a total payoff of $\sum_{i=1}^{+\infty} E(y_t) - w_t + (1-h)\eta_t$. The last term can be interpreted as in the crisis, a well-known leader with high ability can reduce some of the loss, say, people may have more faith on them. Given the perfect competition among the firms, the wage paid to the candidate is $w_t = E[y_t|y_1, ..., y_{t-1}]$, and the total payoff becomes $\sum_{i=1}^{+\infty}(1-h)\eta_t$. Assume the cost function is $c_i = i_t^2$.

For the insider, the only uncertainty comes from the disturbance term, and he/she will maximize $\sum_{j=1}^{+\infty} \beta^{j-1}[\eta + i_j - (1-h)\frac{1}{i_j} - i_j^2]$, which is equivalent to choosing the optimal investment level in every period: $\forall j$, max $i_j - \frac{1-h}{i_j} - i_j^2$. Hence, the insider will choose the same effort or investment in each period which satisfies the F.O.C.: $2i = 1 + \frac{1-h}{i^2}$.



Now consider the outsider's effort or investment level when η is not known. In the equilibrium $i_1^*, i_2^*, ...$, denote $z_t = y_t - i_t^* + \frac{1-h}{i_t^*}$, and thus on the equilibrium path, $z_t = \eta + \varepsilon_t$. Applying the property of the normal distribution and solving differential equations, we can get $m_{t+1} = \frac{h_1 m_1 + h_\varepsilon \sum_{s=1}^{t} z_s}{h_1 + t h_\varepsilon}$ and $h_{t+1} = h_1 + t h_\varepsilon$. By applying one-shot deviation, we can check that i_t^* is an equilibrium. Thus the optimal wage is $w_t = m_t + i_t^* - \frac{1-h}{i_t^*}$.

Proposition 2: There exists a unique non-stochastic non-contingent equilibrium when i_t solves $2i_t = \sum_{s=1}^{+\infty} \frac{\beta^s h_\varepsilon}{h_t + s h_\varepsilon}[1 + \frac{1-h}{i_t^2}]$.

The uniqueness is not rigorously proved here, and the formulas along with the figures above can provide a sketchy view. From the point of view of time t, the outsider will maximize $-2i_t + \sum_{s=1}^{+\infty} \frac{\beta h_s}{h_t + s h_s}[i_t - \frac{1-h}{i_t}]$. Since $E(m_{t+s}) = m_t + \frac{h_\varepsilon}{h_t + s h_\varepsilon}(i_t - \frac{1-h}{i_t} - i_t^* + \frac{1-h}{i_t^*})$, the maximization problem becomes $-2i_t + \sum_{s=1}^{+\infty} \frac{\beta^s h_\varepsilon}{h_t + s h_\varepsilon}(i_t - \frac{1-h}{i_t})$, and the F.O.C. leads to the proposition directly. The intersections of the curves by the left and right side of the F.O.C. is drawn in the above panel, with the left figure comparing the investment levels between the insider and the outsider given h, β and t, while the right figure comparing the results in different β. Compare the equilibrium with the F.O.C. deduced by the insiders optimal strategy, we have:

Proposition 3: Compare the insider and the outsider with the same ability; we find that when β is large, that being said, career concern is strong, the outsider will take higher efforts. When β is small enough, that being said, the career concern is gone or weak, the outsider will take lower efforts.

Provided $\sum_{s=1}^{+\infty} \frac{\beta^s h_\varepsilon}{h_t + s h_\varepsilon} = \sum_{s=1}^{+\infty} \frac{\beta^s}{h_1/h_\varepsilon + t - 1 + s} = g(\beta, h_1/h_\varepsilon, t)$, when $\beta \to 1$, the whole expression approaches to infinity. Since $2i$ is increasing in i, once the above expression is larger than 1, the i solved for the outsider is higher. Also, since $h_1/h_\varepsilon + t - 1 > 1$ starting from the second period, $\sum_{s=1}^{+\infty} \frac{\beta^s}{h_1/h_\varepsilon + t - 1 + s} < \frac{1}{(h_1/h_\varepsilon + t - 1)(1-\beta)}$. When β is small enough, the whole expression will be less than 1. Likewise, the i solved for the outsider is lower.

The intuition here is that when career concern is strong, the outsider has incentives to exert additional effort to make the board believe that he/she has very high capability in managing the firm, bringing more profits for the board especially in crisis. However, when career concern is weak, the reputation building is useless, the precision of the estimate is low (so that the board cannot tell if the low output is due to the low type or random effect), and thus the outsider will put more weight on the cost of the effort, leading to the myopic behavior. As t increases, $g(\beta, h_1/h_\varepsilon, t)$ becomes smaller, meaning that the outsider will take less effort, and once $g(\beta, h_1/h_\varepsilon, t)$ is smaller than one, the effort exerted is even smaller than the insider's with the same true type. The revealing type makes the outsider turn to the insider, and may be replaced with other potential outsiders.

Now let's see the firm's decision. We can take the generally stated version in the second model. Viewing from time t, the profit brought by the insider is certain as $\sum_{s=1}^{+\infty} \beta^s \eta$, while the expected profit brought by the outsider is updating in different time period as $\sum_{s=1}^{+\infty} \beta^s E[m_{t+s}]$. The firm's optimal hiring strategy is thus to find a stopping rule that given hiring the outsider first, switching will occur at most once. If the optimal switching occurs in the infinity, the outsider apparently is superior to the insider. If not, the board can calculate the total expected profit from both parties and decide which party to hire in the first period.

4 Further Discussion and Conclusion

The discussion on the managerial problem of hiring either the outsider or the insider in this proposal is coarse and incomplete at this point. The models explain three possible reasons why hiring the outsiders may hit a success: the information leak even in the short time, the exploration of the unknown type of the outsiders, and

the higher efforts exerted due to the career concern. The common thing here is to allow the board to open the Pandora's Box as gaining more information, and decide if continuing to accrue more accurate information is worthwhile.

However, several areas can be researched further. In the first model where strategy can be learned in the near period, it is necessary to scrutinize in an infinite periods of time setting so that the optimal strategy is not merely a stopping rule, but possibly switching multiple times. In the second model, there is no clear information on the outsider's type, but it is possible that his/her previous working performance can serve as an imperfect signal of how well he/she can do in this new industry. In all these models, y_t can be known exactly. In reality, quality or brand building process sometimes may be hard to fully verified, resulting in the problem of partial revealing plus the unknown type. Information updating will thus be less effective and ultimately in a range if the y_t is rather coarse. Also, when the type is getting richer (not absolute insider or outsider), multiple -armed bandit problem should be adopted. Furthermore, when the state of the world in period t is related to the performance in period *t-1*, the arms will get dependent on each other. The last point that can be reconsider is what if the board is not risk neutral when there is asymmetry: it is easier to leave a bad impression just for one period bad performance, while recovering to good position takes much longer time.

The problem is not confined to the leader-hiring issue alone, and can explain many other related phenomenon. Job rotation seems to be routine in many firms. Employee's frequent job-hopping and high mobility may not necessarily be regarded as bad news to a certain firm. The switch from previous partner or picking the third party to cooperate is also in the realm of this topic. In China, officials usually have to be instated from other provinces, partly due to the fear of faction, but also partly due to the career concern that he/she needs to be rooted in the new land by initial effort or revolutionary policies. The managerial decision is complex as the information structure varies and many dependent factors should be incorporated to uncover which party is better. More rigorous and comprehensive models need to be refined in the work afterwards.

5 Reference

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