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Optimal Term Length When Misinformation Increases with Experience

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I know that most men, including those at ease with problems of the greatest complexity, can seldom accept even the simplest and most obvious truth if it be such as would oblige them to admit the falsity of conclusions which they have delighted in explaining to colleagues, which they have proudly taught to others, and which they have woven, thread by thread, into the fabric of their lives.

-Tolstoy

When even the brightest mind in our world has been trained up from childhood in a superstition of any kind, it will never be possible for that mind, in its maturity, to examine sincerely, dispassionately, and conscientiously any evidence or any circumstance which shall seem to cast a doubt upon the validity of that superstition. I doubt if I could do it myself.

- Mark Twain

Introduction

In many situations good performance requires that a person change his behavior as his environment changes. But aphorisms ("You can't reach an old dog new tricks"), insights by the major figures quoted above, and data (described below) suggest that flexibility declines the longer a person has served in some position.

Consider the performance of elected representatives. Congressmen who have served a longer time respond less to changes in the preferences of their constituents. Thus, Stratmann (2000) finds that as measured by absolute changes in the Americans for Democratic Action (ADA) voting index, voting behavior is more variable early in congressional careers and more stable as tenure increases. Furthermore, he finds that congressmen incompletely change their voting in Congress following a change in their districts caused by redistricting. His explanation, on which my paper builds, is that new congressmen experiment and learn early in their careers.

Glazer and Robbins (1985) also find that though a senator's voting behavior strongly affects his chances of election, senators demonstrate only a limited ability to adapt to changing constituent preferences: their elasticity of response is about 0.05, so that for every 20 points a senator should move to reflect the electorate's preferences as measured by voting for the other senator in a state, a senator moves less than one point. And the best predictor of a senator's ideology in voting is by far his ideology in previous years.

Corroborative findings are given by Glazer, Grofman and Robbins (1987) in their study of redistricting. Though following the 1980 redistricting senior congressmen were slightly more likely than junior congressmen to change their voting in Congress, following the 1970 redistricting, no such effect appears. These results may underestimate how experience ossifies congressmen. Each congressman may become less responsive over time, yet electoral selection weeds out the less responsive ones, so that the most senior politicians are those who were most responsive in the first place. So a finding that senior congressmen more quickly respond to changes in their constituency, or better match their constituents' preferences, is consistent with each congressmen becoming more rigid as his tenure increases. Indeed, Rothenberg and Sanders (2000) find that for most years seniority reduces responsiveness.

The reasoning used here may also apply to organizations, to the extent that either older organizations are led by executives who have longer served in the same positions, or that the organizations have institutional memory. The idea is already found in Schumpeter's (1947) thesis of "creative destruction," suggesting that older organizations can become ossified, so that with aging they miss more market opportunities and avoid fewer pitfalls of the market. Support for this hypothesis is found in Barron, West, and Hannan (1994), who study state-chartered credit unions in New York City from 1914 through 1990. They find that old institutions are more likely to fail, with young and small organizations growing the fastest; organizations forty years old or older have a mortality rate ten times that of newly founded organizations.

Similarly, Ranger-Moore (1997) argues that old organizations lose their ability to respond quickly or appropriately to changing environments. In a study of life insurance firms in New York state, he finds that older firms were more likely to fail. Consistent with my result below that performance declines with age when the environment changes rapidly, Ranger-Moore finds that age effects varied dramatically by environmental period: during the Panics of the 1870s, a time greatly turbulent for the life-insurance industry, a strong liability of aging operated. Studies also find a liability in aging for telephone companies, banks, hotels, health maintenance organizations, and microcomputer manufacturers.¹

Corroborative results appear when studying the behavior of individuals within organizations. Katz (1982) looks at 50 R&D project groups, finding that they became increasingly isolated from key information sources with increasing stability in group membership. Miller (1991), in studying ninety-five firms in Quebec, finds that the longer the tenure of a CEO, the poorer the match between his decisions and the environment he faces.

In the following I analyze the consequences of such ossification, showing the conditions under which it is especially likely to appear, inquiring into optimal lengths of service, and comparing the performance of new to old officials.

One of my central assumptions is that an official is more productive when his action matches the state of nature.² The state of nature, which the official imperfectly observes in each period, follows a Markov chain. I suppose, however, that the official places excessive weight on early observations. (The assumption is further justified below). I model the bounded rationality that places excessive weight on past observations by supposing that officials equally weight all observations.³ This error means that if the state of nature changes rapidly, an official may more likely mis-estimate the current state of nature the longer he had served. An official with few observations may do better. To put it differently, old dogs *can* learn new tricks. The problem is that they remember too many old tricks.

Literature

Excessive attention to early observations is well documented in the psychology literature for a wide range of areas: consumers recalling television commercials (Pieters and Bijmolt (1997), judgments by trained tactical control officers for the Patriot air defense system (Adelman, et al. (1996), and in recall of opera performances (Schulster (1989)).⁴ Research in psychology also shows that people misinterpret new information as supporting previously held hypotheses (Rabin and Schrag (1999).

Of course, the opposite bias may also occur; Hogarth and Einhorn (1992), for example show that under some conditions more recent observations are excessively weighted. This "recency" effect, however, may matter little for the issues discussed here (see Nisbett and Ross (1980, p. 172), who state in an influential book on social judgment that several decades of psychological research show that primacy effects predominate).

In economics, performance over time is the subject of theoretical study of central banking. Waller and Walsh (1996) consider optimal term length for central bankers, emphasizing the tradeoff between the costs of surprises (associated with short terms) and the lock-in effect (associated with long terms). Other theoretical work examines the incentives of a manager who wants to signal his ability by continuing policies he had adopted in the past,⁵ implying that a managers performance declines over time.

Assumptions

States of nature

The state of nature is either A or B. (We can think of a state as the prevalent ideology in the electorate.) The transition probability from state i to state j is p_{ij} ; these probabilities are constant over time. The steady-state probability of state i is called σ_i . If $p_{ij}=p_{ji}$ for all i and j , then $\sigma_A = \sigma_B$. The event that the state of nature is A in period t is called A_t ; the event that the state of nature is B is called B_t .

Officials

In each period the incumbent (say a congressman) imperfectly observes the state of nature. Let the event that he observes state A in period t be a_t ; similar notation holds for an observation of state B. The probability that he correctly observes state A is $\Pr(a_t|A_t) \equiv c_A$; let $\Pr(b_t|B_t) \equiv c_B$.

Assume that $1/2 \leq c_i \leq 1$. The official knows the values of σ_i , c_i , and p_{ij} .

Following his observations, the official must take either action α or β (for example, he may vote on the conservative or liberal side of a bill). The payoff from taking action i in state j is v_{ij} . The official maximizes the expected payoff. To simplify the problem, let $v_{\alpha a} = v_{\beta b} = G > 0$, and let $v_{\alpha b} = v_{\beta a} = 0$. This makes the official's problem one of matching his action to the state of nature.

An official imperfectly processes his observations, equally weighting all. Subject to this type of bounded rationality, the official rationally uses Bayes theorem to update his beliefs about the current state of nature. In the initial period of his tenure, an official takes the prior probabilities as the steady-state probabilities, σ_i .

Results

Consider first the optimal length of service, T . For that purpose, suppose T is set before any official's performance is observed. That is reasonable if observations of outcomes come with a long lag. Also suppose that the intertemporal discount rate is zero, and that all newly-appointed officials are identical. The goal in setting T is thus to maximize average performance per period.⁶

Comparing a new official to a long-serving one

Consider a new official. Let $\sigma_i = 1/2$ and $c_i > 1/2$. Then the official's optimal action in his first period in office is to take the action corresponding to his observation of the state of nature. The expected payoff is $(G/2)(c_A + c_B)$.

Consider in contrast an official who has served an indefinitely long time. By assumption equally weights past observations. At the limit, for a long-serving official $\text{pr}(A_t) = \sigma_A$ and analogously for B. If $\sigma_i = 1/2$ and $c_A = c_B$, then the official is equally likely to have seen each type of signal. He can do no better than taking action A; his expected payoff in each period is $G/2$.

By assumption, $c_A > 1/2$ and $c_B > 1/2$. Therefore $c_A + c_B > 1$, and so $(G/2)(c_A + c_B) > G/2$: annual performance of an official in periods long after he came into office is worse than the performance of a new official, who observed the state of nature only once. The optimal term length must be finite.

Comparing a new official to a middle-aged one

We saw that $T=1$ dominates large values of T . But it remains to be seen if a finite term length can dominate a term of 1. To see that the answer is Yes, I shall consider performance in period 2 under some special assumptions.

Let the transition probabilities p_{ii} be close to 1, so that in period 2 the state of nature is almost certainly the same as in period 1.⁷ With probability σ_A the state of nature is A. With probability c_A^2 the official sees $a_1 a_2$, he takes action α , and the payoff in period 2 is G . Similarly, with probability c_B^2 the official sees $b_1 b_2$, takes action β , and the payoff in period 2 is G . With probability $(1 - c_A)c_B + (1 - c_B)c_A$ he sees different signals in the two periods. If $\sigma_A \geq 1/2$, he should take action α , and if the state of nature in period 2 is A the payoff is G . Thus, the

expected payoff in period 2 is

$$\sigma_A G (c_A^2 + (1-c_A)c_B + (1-c_B)c_A) + \sigma_B G (c_B^2). \quad (1)$$

Note that if $c_A \geq c_B$, the value of (1) exceeds $G(c_A^2 + c_B^2)$. For $c_A > 1/2$ and $c_B > 1/2$, this in turn exceeds the expected payoff of $(G/2)(c_A + c_B)$ in period 1. In short, performance in period 2 exceeds performance in period 1, and the optimal term length is not 1.

Pattern of official's performance

The next topic to examine is the pattern of an official's expected performance over time. Under what conditions does performance monotonically improve with experience? Under what conditions does it monotonically decline? How does the optimal term length vary with the accuracy of observations? Is expected performance at the end of an optimal term (or in the year the official is fired) better than his average performance or better than the performance of a newly appointed official?

I can answer some of the latter questions analytically. Let an official's performance in period t of his tenure be $Y(t)$. Maximizing average performance per year with an infinite horizon and with each official serving T periods requires maximizing $\int_0^T Y(t)dt / T$. The first-order condition for a maximum requires that $Y(T) = \int_0^T Y(t)dt / T$. That is, performance in the terminal period on the job should equal an official's average performance over his career on the job. Call the optimal term length T^* . The second-order condition requires that $Y'(T^*) < 0$, so that the official is replaced when his performance is below its peak value.

Furthermore, if $T^* > 1$, then $Y(T^*) = Y(T^*)/T^* \geq Y(1)$: a new official's initial performance is worse than the immediate past performance of his predecessor.

Clearly, the faster the state of nature changes, the shorter is the optimal term length. As an extreme case, let $p_{AA} = p_{BB} = 0$, so that $p_{AB} = p_{BA} = 1$. Then knowing the state of nature in the previous period or in any particular period allows estimating the current state of nature. But knowing the fraction of periods that the state of nature was A rather than B, while equally weighting all observations, is useless. The official can therefore use his observation from period 1 to improve his estimate of the state of nature in period 2. But in periods 3 and after, his past observations (with equal weighting of them) are useless: since half of the time the state of nature is A, any observations that give a different fraction merely inform the official that some of his past observations were wrong. Thus, in periods 3, 4, ... expected performance is the same as in period 1. The optimal term length is 2.

For further results I must turn from analytical to Monte Carlo solutions. For such solutions I assume that $G=1$, and assume symmetry ($p_{AA} = p_{BB}$, $p_{AB} = p_{BA}$, and $c_A = c_B$). Let performance peak in period T^P of service; the corresponding performance is $Y(T^P)$. The term length which maximize average performance is T^* . Table 1 shows values of T^* , $Y(T^*)/T^*$ (maximum average performance), $Y(T^*)$ (productivity at the end of the optimal term), T^P , and $Y(T^P)$ for some values of p_{AA} and of c_A .

Table 1: Performance Characteristics

$p_{AA}=p_{BB}$	$c_A=c_B$	T^*	$Y(T^*)/T^*$	$Y(T^*)$	T^P	$Y(T^P)$
0.8	0.55	1	0.5517	0.5517	1	0.5517
0.9	0.55	8	0.5577	0.5563	5	0.5607
0.95	0.55	21	0.5744	0.5757	9	0.5819
0.8	0.6	1	0.6011	0.6011	1	0.6011
0.9	0.6	9	0.6115	0.6124	5	0.6234
0.95	0.6	17	0.6434	0.6467	9	0.6606
0.8	0.7	3	0.6803	0.6864	3	0.6864
0.9	0.7	7	0.7084	0.7139	5	0.7285
0.95	0.7	13	0.7516	0.7528	9	0.7716

The Table shows, as expected, that performance increases with p_{AA} (the probability the state of nature will persist) and with c_A (the accuracy of observations). Also as expected, the optimal term length increases with p_{AA} , or increases with the stability of nature. Peak performance can come much before the optimal end of a term; in one example the term length is almost double the year of peak performance. Perhaps surprisingly, the optimal term length decreases with c_A . The intuition is that with high accuracy of observations, a new official can well estimate the current state of nature, without needing many past observations.

Conclusion

This paper explored the assumption that officials over-weights past observations, showing the conditions under which such imperfections eventually cause an agent's performance to decline with experience, and cause the optimal term length to be short.

I also note that life-time tenure for judges is an exception that proves the rule: we want judges to apply old precedents, and therefore do not want them to forget old rulings.

The custom in the US for a new president to replace all top officials (even when his predecessor was of the same party) thus can lead to better performance, and need not reflect only a president's desire to share the spoils or to ensure personal loyalty.

Lastly, term limits on politicians may in part be explained by the model presented here: average performance may increase by forcing people in authority to leave after a certain number of years. Of course, under some conditions rational voters do not need such constitutional provisions: they can replace an official at the appropriate time. But we also saw that the performance of a new

official will initially be worse than the immediate past performance of his predecessor. When voters have sufficiently long time horizons, this causes no problem; but when their horizon is suboptimally short, constitutional provisions can be useful.

Notation

A_t Event that state of nature is A in period t

a_t Event that official observed signal that state of nature is A in period t

B_t Event that state of nature is B in period t

b_t Event that official observed signal that state of nature is B in period t

c_i Probability that official correctly observes the state of nature i

G Payoff in period when correct action taken

p_{ij} Transition probability from state of nature i to state of nature j

T Term length

t Number of periods official has served

α Optimal action for state A

β Optimal action for state B

σ_i Steady-state probability of state i

Footnotes

¹See references in Ranger-Moore (1997).

² A different interpretation which leads to similar results is that an official is more productive the more predictable his actions. The state of nature would then be the official's type, and a good match means that people correctly estimate the official's type.

³Similar assumptions are made by Bray (1982).

⁴ For studies looking at learning over a short period, psychologists use the term ``primacy effect" when excessive weight is placed on early observations. The opposite bias is termed the ``recency effect."

⁵ See Boot (1992), Prendergast and Stole (1996), and Brandenburger and Polak (1996).

⁶ For concreteness, we can think of a constitutional provision setting term limits on elected officials.

⁷ That *is* consistent with the statement that over time the state of nature almost certainly changes.

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