RIETI Discussion Paper Series 01-E-005

Careers and incentives of Japanese "fast-track" bureaucrats:A career-path dependent model perspective

TSURU Kotaro
RIETI

The Research Institute of Economy, Trade and Industry
http://www.rieti.go.jp/en/

RIETI Discussion Paper Series 01-E-005
December 2001

Careers and incentives of Japanese "fast-track" bureaucrats
A career-path dependent model perspective

Kotaro Tsuru *

Abstract:

In this paper, we present a path-dependence model for "fast-track" Japanese bureaucrats, especially focusing on its incentive mechanism. Without a performance based pay scheme, the path dependent model can give an incentive to work hard and win "good" promotion to a worker, by linking the rank of his final job to the prize. In particular, the basic path dependent model with equal prize spread can induce the same level of effort at every job post and even "losers" continue to make their efforts to get higher prizes within their opportunities. However, the choice of an incentive scheme may depend on the "amakudari" opportunities of a ministry. Ministries with less "amakudari" opportunities might adopt schemes without revealing the job positions of workers (or the prospect of their prizes) to them. Such strategies can increase the level of effort given the expected prize it should pay, but reduce the welfare of workers.

Key words: Bureaucrats; Careers; Incentives; Path-dependence; Prizes; Promotion; Tournament

JEL classification: H11, J33, J41, M12

* Senior Fellow, Research Institute of Economy, Trade and Industry (E-mail: tsuru-kotaro@rieti.go.jp). The author is grateful for helpful comments and suggestions by Masahiko Aoki, Andrea Boltho, Hideshi Itoh, Margaret Meyer, Isao Ohashi, Margaret Stevens, and seminar participants at Research Institute of Economy, Trade and Industry and Hitotsubashi University.

1 Introduction

1.1 Some basic features of the Japanese employment system

The purpose of this paper is to provide a theoretical model, which may well describe the career system of "fast-track" bureaucrats in Japan. These are candidates for high-ranking government official positions in the central government.

Before we focus on these bureaucrats, we briefly review the basic features of the Japanese employment system, especially in comparison with that of the US (Aoki (1988), Itoh (1994), Tsuru (1996)). The main stylised facts (for employment in large companies or government during the post war period (until the 1980s) are as follows:

(Stylised fact 1)

Long-term employment relationships are more prevalent than in other countries, and most of the executive directors are promoted internally (e.g. Hashimoto and Raisian (1985), Koike (1988), OECD (1993))

(Stylised fact 2)

Age-earning profiles are much steeper ("deferred compensation").

(e.g. Hashimoto and Raisian (1985), Koike (1988), OECD (1993), Tsuru (1996))

(Stylised fact 3)

During the first ten or fifteen years, workers are not so much differentiated in terms of wage and job level especially in comparison with the case of the US. Then, only a limited number of employees are selected to go on to management positions (e.g. Koike (1988), Kato and Rockel (1992)).

(Stylised fact 4)

Performance-based pay schemes are less prevalent.

These facts are mutually complementary. For example, the second, third and fourth facts depend on the first fact, the long-term employment relationships. The second fact is often discussed as evidence of "deferred compensation" (Lazear (1979)). Such an inter-temporal allocation of compensation is only possible because both the employer and employees have committed themselves for a long-term relationship.

The recent development of contract theory and "personnel economics" can well explain the virtue of these arrangements (for a survey, e.g. Gibbons (1997), Gibbons and Waldman (1999), Lazear (1995, 1998), Prendergast (1999)). For example, co-operative behaviour and teamwork among workers are enhanced by long-term relationships ("repeated games") and more equal treatment (Lazear (1989), Prendergast (1992)). Firm-specific investment is also promoted by a long-term relationship ("reputation") (MacLeod and Malcomson (1989)) and by job-based promotion (Prendergast (1993)). In addition, a bureaucratic scheme for wage and promotion policy also minimises influence (or rent-seeking) activities vis-a-vis supervisors (Milgrom and Roberts (1988)) or "favouritism" from them (Prendergast and Topel (1996)).

However, without a performance-based pay scheme, how can an employer give his (young) workers incentives to work hard? This is a puzzle, since they work under the commitment on the long-term relationship and young workers are not so much differentiated. To understand the incentive system in the Japanese employment system, it should be noted that the prospect of a worker's future compensation is usually associated with the rank of his final post in his firm or government. When the selection process starts in his later career stage, it sometimes looks like an "elimination tournament" or an "up or out" scheme. A worker who is not good enough to be promoted may keep staying at his job level until his retirement or is induced to leave "voluntarily" and move to an affiliated firm of his company. Better workers can stay longer in the firm and climb up to the higher hierarchy, thus getting larger benefits than others.

1.2 Basic features of the career system in the "fast-track" Japanese bureaucracy

Next, let us consider the career system of "fast-track bureaucrats" in Japan. The stylised features of the Japanese employment system described in the Introduction are likely to be more applicable to "fast-track" Japanese bureaucracy.

First of all, rank and related wage levels are determined only by seniority and "pay-for-performance" systems are hardly used. During the first twenty years or so, career or reputation concerns are used as an incentive mechanism for "fast track" officials. A "good" official is promoted to a "good" job, but there is no difference in wages between "good" and "bad" jobs at the same level.

Second, however, the amount of a bureaucrat's lifetime compensation depends strictly on the job level at which he leaves his ministry. A separation process starts after he becomes Division Head ("kacho") (around the twentieth years). Once the separation process begins, the lowest evaluated employee is induced to leave voluntarily. In the final career stage (at higher ranks of a ministry), the marginal increase in compensation by promotion is very large (the age (job) – wage profile is extremely steep). In addition, leaving allowances are linked roughly to the level of final compensation multiplied by the years of his service. More importantly, the compensation level of post-retirement or second jobs in the private (quasi-public) sector is also strongly associated with his final job level in the bureaucracy (a second job is called "amakudari", or "descent from heaven"). The level is usually no less than that of the employee's final wage in his ministry and the personnel division can persuade him to leave "voluntarily". Thus, the marginal return to survival in the cohort and promotion to the next job level is so strong as to give a tremendous incentive to "fast track" bureaucrats over their whole career. "Fast track" bureaucrats are likely to put more importance on their future promotion prospects and expected benefits as a determinants of their current effort levels than potential candidates for chief executive positions in large private firms.

One of the distinctive features of this selection process is the adoption of a very strict rule of "up-or-out" or "elimination tournament". In other words, an official that is not promoted must leave his ministry. An "up-or-out" rule can be seen in other countries, but it is usually restricted to the military, academia, and professional partnerships. Japanese large companies also use a similar system, inducing some senior workers to

leave voluntarily from their firm and move to affiliated firms, while others continue to work for their firm as specialists without further promotion. We will discuss the implication of an “up-or-out rule” later.

Third, competition and selection take place only among a small number of homogeneous workers, “the-same-year recruits” or a group of colleagues who joined a ministry in the same year. This is in contrast to what happens in large private firms. Promotion to the highest-ranking official position (a deputy minister, who is like a CEO in a company) takes place only among “the-same-year recruits” (about 20 – 30 persons). This means that a deputy minister is basically selected from a cohort of each year.

Levels of compensation and rank are the same among the members in the same group but strictly different between those of two different groups, since wage levels are linked to seniority. This implies that even an official at the “bottom” of one group can keep a higher rank and compensation level than the best performer who joins the ministry a year later. Thus, junior members can never get ahead of any members who have joined the ministry earlier. Such a rigid seniority rule prevents “losers” from being demoralised. Even though their quality is well known to others, “losers” can still keep their faces in the hierarchy of their ministry. In this sense, a strict “up-or-out” rule is important and can eliminate a demoralising situation in which these senior “losers” are ranked at a lower level than that of junior “winners”.

Next, we present a simple model of job-based promotion (“the career path-dependent model”). In this model, a worker's expected compensation is associated with the rank of

his final job. By updating the prospect of his final post and related compensation, he determines his current effort level for "good" promotion. This model is consistent with these stylised facts of Japanese "fast-track" bureaucrats.

2. The career path dependent model

2.1 Introduction

What is the mechanism that determines the final promotion level of a worker? Apparently, their ability and effort are very important factors. In addition, career history is often used in the selection process. When the compensation system is relatively bureaucratic and independent from a worker's performance, a worker's selection might be a job-based promotion. When he is perceived to have high ability or effort level, he is promoted to a "good" job. In this case, a worker's career path might aggregate all the information that has been used for his promotion decisions (ability, effort, and other factors). Thus, without performance-based compensation scheme, a worker and the firm (the personnel division) care more about the outcome of job-based promotion and career path. Thus, a worker's career path forms his "reputation". If the personnel division uses career path ("reputation") in its promotion policy, careers will become path-dependent.

In this section, we introduce a simple model to formulate the above idea. The most important assumption is that a worker's job tomorrow depends on his job today and thus on his past job history. There are several reasons why this assumption is reasonable. First, the experience of a "good" job might increase his ability and thus increase his productivity when he is promoted to another "good" job. In such a case, it

is reasonable to assume that the quality of his job tomorrow is closely related to that of his job today. Second, such limited choices on next jobs might reduce the transaction and evaluation costs incurred by the personnel division. The path dependent system leads to more natural selection among homogeneous workers in the long run. Third, such a limited job-based promotion prevents "influence activities" of a worker to his supervisor or the personnel division or their "favouritism" to specific workers (e.g. Fairburn and Malcomson (2001), Prendergast and Topel (1996)).

2.2 The basic setting

Let us consider a worker and the personnel division of a ministry. This ministry has n layers of seniority and the t-th layer ($1 \le t \le n$) has t different job categories (Figure 1). These jobs can be ranked according to their "quality". Let J (t, s) be the s-th best job in the t-th layer ($1 \le s \le t$) and Q (J (t, s)) be its quality. Then,

$$Q(J(t,1)) > Q(J(t,2)) > \cdots > Q(J(t,t-1)) > Q(J(t,t))$$

If the job of a worker is J(t,s) today, he will be promoted to a "good" job, J(t+1, s) or to a "bad" job, J(t+1, s+1) tomorrow. At every stage, he gets a fixed wage $\overline{W}$ (for simplicity = 0). When he reaches the n-th layer (J (n, s)), he gets a prize, V_s which is linked to the rank of his job, Q (J (n, s)). Thus,

$$V_1 > V_2 > \cdots > V_{n-1} > V_n$$

Let p (t, s) be the probability of being promoted from job J (t, s) to J (t+1, s). Thus, the probability of being promoted to job J (t+1, s+1) is equal to 1 – p (t, s). For simplicity, a worker incurs a cost of C (p), when he sets his effort level in order to be promoted to a "good" job with the probability of p. C (p) is assumed to be independent from his current job, J (t, s) (We will discuss this assumption later.). A more explicit example of this promotion process will be discussed later. C () is increasing and strictly convex such that

$$C(0) = 0$$
$$C'(0) = 0$$
$$C'(1) = \infty$$

A worker with the job of J (t, s) maximises his expected prize EV (J (t, s)) minus his cost of effort in period t by choosing the probability of "good" promotion, p(t,s).

$$\underset{p(t,s)}{Max}\left(EV(J(t,s)) - C(p(t,s))\right)$$

$$\begin{aligned}
&\underset{p(t,s)}{Max}\left(EV(J(t,s)) - C(p(t,s))\right) \\
&= \underset{p}{Max}\left(p\,EV(J(t+1,s)) + (1-p)\,EV(J(t+1,s+1)) - C(p)\right) \\
&= \underset{p}{Max}\left\{p\left[EV(J(t+1,s)) - EV(J(t+1,s+1))\right] + EV(J(t+1,s+1)) - C(p)\right\}
\end{aligned}$$

Since $EV(J(n,s)) = V_s$,

$$p(n-1,s),\ p(n-2,s),\cdots p(t+1,s)$$
$$p(n-1,s+1),\ p(n-2,s+1),\cdots p(t+1,s+1)$$

$EV(n-1, s), \cdots, EV(t+1, s)$

$EV(n-1, s+1), \cdots, EV(t+1, s+1)$

can be calculated by using backward induction and they are all independent from p(t,s).

Thus, the first-order condition is

$$C'(p) = EV(J(t+1, s)) - EV(J(t+1, s+1))$$

Thus, his efforts level and hence, the probability to be promoted to a "good" job increases with the difference in the expected prize values between two jobs. Thus, the absolute value of the expected prize does not itself affect his effort level. Even if this level is low, he has a good incentive to make an effort when the difference in expected prize values between two jobs available in the next period is large.

However, it should be noted that a worker makes an effort only when the expected increase in his prize is higher than his current cost. Thus,

$$C(p) \leq p\left[EV(J(t+1, s)) - EV(J(t+1, s+1))\right]$$

A worker starts from the first layer with one job category in period 1. In every period, he determines his effort level and thus the probability of being promoted to a "good" job in the next layer, by updating his expected prize. In period n, he gets his prize linked to the rank of his final job.

The important assumption of this model is that a worker's career history is very path-dependent. His job tomorrow depends on his job today, which also depends on his past job experience. For example, a worker who reaches J (n, 1) can be considered as the deputy minister of the ministry, who must have been promoted to a "good" job in every layer. More generally, a worker with the job, J (t, s) in period t must have experienced t – s times of "good" promotion in the last t – 1 periods. Such a worker is only promoted from two job classes, J (t-1, s) or J (t-1, s-1) in period t-1. And as he climbs up the job layers, the expected range of his final job's ranking is narrowed.

2.3 Prize structure and incentives

One of the interesting features of this model is that p (t, s) is determined by the combination of $\{V_1, V_2, \cdots, V_n\}$.

In particular, when each prize spread is equal,

$$V_1 - V_2 = V_2 - V_3 = \cdots = V_{n-1} - V_n = D, \quad V_n = \overline{V}$$

P (t, s) has a constant value, which satisfies the following conditions (Figure 2).

$$p(t, s) = p_D$$
$$C'(p_D) = D$$

This implies that a worker keeps the same level of effort in whatever job he is promoted to. Even though he has lost a chance to become a CEO (reach J (n, 1)), he

does not decrease his effort level, since his marginal benefit to be promoted to a “good” job is always the same in all job categories (equal to D).

This result can be obtained by backward induction.

It is clear that

$$p(n-1, s) = p_D$$

Thus,

$$\begin{aligned} C'(p(n-2, s)) &= (p_D V_s + (1-p_D)V_{s+1}) - (p_D V_{s+1} + (1-p_D)V_{s+2}) \\ &= p_D (V_s - V_{s+1}) + (1-p_D)(V_{s+1} - V_{s+2}) \\ &= D \end{aligned}$$

$$\therefore \quad p(n-2, s) = p_D$$

In this case, the corresponding expected prize is calculated as follows.

$$EV(J(1,1)) = \sum_{k=0}^{n-1} {p_D}^k (1-p_D)^{n-k-1} \frac{(n-1)!}{k!(n-k-1)!} (kD + \bar{V})$$

Simple mathematics provides the following result.

$$EV(J(1,1)) = (n-1)p_D D + \bar{V}$$

More generally, we can obtain

$$EV\left(J(t,s)\right) = (n-t)\,p_D D + (t-s)D + \overline{V}$$

2.4 The promotion mechanism

Next, under the assumption that each prize spread is equal as mentioned above, we introduce a more explicit mechanism for a worker's promotion process. Let us assume that the personnel division sets a target (T) on the output of a worker (x), which is the sum of his ability (a), effort (e) and an error (u)[1]

$$x = a + e + u$$

a: a worker's ability

e: a worker's effort

u: a random variable ($N\left(0, s^{2}\right)$)

When his output is higher than the target, he is promoted to a "good" job. A worker's ability is assumed to be common knowledge and the personnel division knows it. Thus, the worker's maximisation problem at J (t, s) is as follows.

$$\begin{aligned}
&\underset{e}{Max}\left(EV\left(J(t,s)\right) - c(e)\right) \\
&= \underset{e}{Max}\left(p\,EV\left(J(t+1,s)\right) + (1-p)\,EV\left(J(t+1,s+1)\right) - c(e)\right) \\
&= \underset{e}{Max}\left(p\left(EV\left(J(t+1,s)\right) - EV\left(J(t+1,s+1)\right)\right) + EV\left(J(t+1,s+1)\right) - c(e)\right) \\
&= \underset{e}{Max}\left(p\,D + EV\left(J(t+1,s+1)\right) - c(e)\right) \\
&p = \Pr ob(a+e+u > T)
\end{aligned}$$

where c() is the cost of his effort.

The first order condition is

$$\frac{\partial \Pr ob(a+e+u>T)}{\partial e} D = \frac{\partial (1-F(T-a-e))}{\partial e} D = f(a+e-T) D = c'(e)$$

where F and f is the distribution and density function of u respectively.

Thus, the equilibrium effort, e_D, should satisfy the following condition.

$$\frac{c'(e_D)}{f(a+e_D-T)} = D$$

Under the assumption of equal prize spread, the effort level is the same at every job that he is promoted to.

In order to derive the cost with respect to the probability of "good" promotion $(C(p))$,

$$p = 1-F(T-a-e)$$
$$\therefore \quad e = T-a-F^{-1}(1-p)$$

Thus,

$$C(p) = c(e) = c(T-a-F^{-1}(1-p))$$

2.5 The ministry's maximisation problem

Next, we consider the ministry's maximisation problem with a case of the equal prize spread. The ministry is assumed to maximise the ministry's expected benefits, subject

---

[1] Gibbs (1995) adopts the same promotion rule in his simple model.

to a worker's participation constraint (or a long-term commitment), by choosing the appropriate level of D and $\overline{V}$. The important point is that only D affects a worker's incentive. Thus, the ministry chooses the optimal level of D first and determines the level of $\overline{V}$ in order to satisfy participation constraints.

We consider the participation constraints of a worker at J (n-1, n-1), since their constraints are the most binding. A worker continues to stay as long as his pay-off of staying is higher than his pay-off of quitting. This implies that he stays even if his expected pay-off (the expected prize minus total costs) is negative. Since his costs incurred in previous periods are sunk, it is worth while to stay whenever his expected prize is higher than his additional future costs so that he can recoup some of his sunk costs. This constraint is as follows. For simplicity, we assume that an outside opportunity or reservation utility of a worker is equal to zero.

$$\begin{aligned} -(n-2)C(p) &\le EV(J(n-1, n-1)) - (n-1)C(p) \\ &= pD + \overline{V} - (n-1)C(p) \end{aligned}$$

$$\therefore \quad \overline{V} \ge C(p) - pD$$

To minimise its costs, the ministry chooses the level of $\overline{V}$ as follows.

$$\overline{V} = C(p) - pD$$

It should also be noted that a worker makes an effort at every job only if

$$C(p) \le pD$$

Thus, the value of the lowest prize, $\overline{V}$ is negative. In other words, the lowest prize is considered as a penalty. From the viewpoint of the ministry, it extracts "rents" from a worker to the ministry.

The ministry's maximisation problem is

$$\underset{D,\overline{V}}{Max}\left[(n-1)\, e_D - EV\left(J(1,1)\right)\right]$$
$$s.t.\ \overline{V} = c\left(e_D\right) - p(e_D)D$$

$$= \underset{D,\overline{V}}{Max}\left[(n-1)\, e_D - \left((n-1)\, p(e_D)D + \overline{V}\right)\right]$$
$$s.t.\ \overline{V} = c\left(e_D\right) - p(e_D)D$$

$$= \underset{D}{Max}\left[(n-1)e_D - c\left(e_D\right) - (n-2)\, p(e_D)D\right]$$

The first-order condition is

$$\frac{\partial}{\partial D} = (n-1)\left(1 - c'\left(e_D\right)\right)\frac{\partial e_D}{\partial D} - (n-2)\, p(e_D) = 0$$

Thus, $c'\left(e_D^*\right) = 1 - \dfrac{(n-2)\left(1 - F\left(T - a - e_D^*\right)\right)}{(n-1)\,\partial e_D^* / \partial D}$

Thus, marginal cost of a worker's effort is less than its marginal benefit to the ministry (equal to one) and the effort level is inefficient.

The ministry can set D in the following way.

$$D^* = \frac{1}{f\left(a + e_D^* - T\right)}\left(1 - \frac{(n-2)\left(1 - F\left(T - a - e_D^*\right)\right)}{(n-1)\,\partial e_D^* / \partial D}\right)$$

Then, the ministry chooses the level of $\overline{V}$, which satisfies the above constraint, given the level of D*.

$$\overline{V}^* = \left[c\left(e_D^*\right) - \left(1 - F^{-1}\left(T - a - e_D^*\right)\right)D^*\right]$$

2.6 More general path-dependence models

Here, we consider more general models of career path with three periods (Figure 3). A prize structure is as follows.

Period 1	Period 2	Prize
Good (or pass)	Good	V_1
Good	Bad (or fail)	V_2
Bad	Good	V_3
Bad	Bad	V_4

These prizes should satisfy the following conditions.

$V_1 \geq V_2 \geq V_4$
$V_1 \geq V_3 \geq V_4$

In the standard path-dependence model, we implicitly assume that V_2 is equal to V_3.

We consider more general cases in which V_2 and V_3 are different.

$$V_2 - V_3 = E \neq 0$$

For simplicity, the prize spread between V_1 and V_2, and that between V_3 and V_4 is equal to D.

Thus,

$$V_1 = 2D + E + \overline{V}$$
$$V_2 = D + E + \overline{V}$$
$$V_3 = D + \overline{V}$$
$$V_4 = \overline{V}$$

Thus, we obtain the following result by simple calculation.

$$C'(p(2,1)) = C(p(2,2)) = D$$
$$C'(p(1,1)) = D + E$$

The result implies that

$$E > 0 \Rightarrow p(1,1) > p(2,1) = p(2,2)$$

$$E < 0 \Rightarrow p(1,1) < p(2,1) = p(2,2)$$

Early selection ($V_2 > V_3$) (Figure 3(1))

When V_2 is larger than V_3, early "good" promotion is more important than that in the later period, the level of effort and the probability of "good" promotion is higher in period 1 than that in period 2. This case is considered as "early" selection. Once he is

promoted to “bad” job in period 1, he will never reach the final post that an early winner can win. Thus, the outcome in the first period is much more crucial to determine his later career path and he makes significant effort in the earlier period.

Late selection ($V_2<V_3$) (Figure 3(2))

When V_2 is smaller than V_3, “good” promotion in the later period is considered more valuable and a worker makes less effort in period 1 than period 2.This case can be considered as a “consolation match”, since later success is more important than earlier success. Let us think two extreme cases further.

The merit system

One is a case that $V_1=V_3$. This means that if a worker makes a success in the later period, his performance in the earlier period is ignored. This arrangement looks like “the merit system” or “the plus points system”. We consider the following example (Figure 3(3)).

$$V_1 = V_3 = 2D + \overline{V}$$
$$V_2 = D + \overline{V}$$
$$V_4 = \overline{V}$$

$\therefore$
$$C'(p_m(2,1)) = D$$
$$C(p_m(2,2)) = 2D$$
$$C'(p_m(1,1)) = (1 + p_m(2,1) - 2p_m(2,2))D < D$$

Compared with the standard path-dependence model ($V_2=V_3$), the effort level at J(2,2)

is higher and that at J (1,1) is lower.

The demerit system

Next, we present the other extreme case with $V_2=V_4$ and the following prize structure (Figure 3(4)). This implies that once a worker fails to be promoted a "good" job in the later period, his "good" promotion in the early period has no value. This arrangement can be called as "the demerit system" or "the minus points system".

$$V_1 = 2D + \overline{V}$$
$$V_3 = D + \overline{V}$$
$$V_2 = V_4 = \overline{V}$$

$$\therefore$$
$$C'(p_d(2,1)) = 2D$$
$$C(p_d(2,2)) = D$$
$$C'(p_d(1,1)) = (2p_d(2,2) - p_d(2,1))D < D$$

Compared with the standard path-dependence model ($V_2=V_3$), the effort level at J (2,1) is higher and that at J (1,1) is again lower.

In summary, when we loosen the assumption of the standard path-dependent model ($V_2=V_3$), we can consider three kinds of models.

"Early" selection:

This model has a positive value of E, in other words, early promotion is more important. In this model, a worker exerts more effort in the earlier period.

"Late" selection with "the merit system":

This model has a negative value of E. Thus, promotion in the later period is more valuable. In this case, a difference between V_1 and V_3 is smaller than that between V_2 and V_4. The model with "the merit system" provides a higher incentive to make effort to a "loser" in period 2.

"Late" selection with "the demerit system":

This model has also a negative value of E, but a difference between V_2 and V_4 is much lower. This scheme gives a "winner" the highest level of effort in period 2.

These results suggest that the ministry might choose a different scheme depending on the relative importance of a worker's effort that the ministry focuses on. However, when teamwork or co-operation is important among workers in different jobs, the ministry may want to minimise a difference in effort levels among workers, since the existence of a worker with less effort level might demoralise a worker with high effort level. In such a case, the ministry has an incentive to choose the standard path-dependence model with equal prize spread. Thus, we consider the standard path-dependent model with equal prize spread as a basic scheme for "fast-track" government officials in Japan.

2.7 Summary

In the career dependent model, prizes are given at the end of contract and are linked to

the rank of his final job. A fixed wage in every period is assumed to be zero. Thus, the inter-temporal compensation pattern is extremely “deferred” and this pattern gives a worker a strong incentive to stay within firm until he gets a prize and an ministry can support such an incentive by considering the participation constraint

Without pay-for-performance scheme, however, a worker has an incentive to work hard in every period for “good” promotion, which would increase the expected prize. His effort level and the probability of “good” promotion are determined by a *difference* in his expected prize between two jobs available in the next period. These features of this model are consistent with the career system of “fast-track” government officials in Japan as we have seen in Introduction.

3 The application of the career path dependent model to “fast-track” Japanese bureaucrats

3.1 The applicability of the career path dependent model to the incentive system of “fast-track” Japanese bureaucrats

The path-dependent model might explain an incentive system of a private firm, but is more likely to applicable to “fast-track” Japanese bureaucrats. First, path-dependence in promotion process can mitigate some problems related to a fundamental difficulty in evaluating the performance of government officials. Under these circumstances, the personnel division could have a discretionary power to evaluate officials and would invite more “influence activities” and “favouritism”. To avoid these inefficiencies, “tying

their hands" (a more bureaucratic and rigid arrangement on promotion rules) is one solution. In addition, a path-dependent scheme can differentiate between workers with the same quality in the long run. Thus, when the ability of workers is relatively homogeneous but a selection mechanism is also necessary, the path-dependent model might be appropriate.

Second, the opportunity of getting a profitable job after retirement ("amakudari") gives a bureaucrat a stronger incentive to be promoted to a higher job level in his ministry than workers in large private employers, since the wage level of his second job is normally no less, and sometimes higher, than that of his final post in his ministry. This is actually one of the important determinants on the recruit's choice of a ministry and can be considered as a sort of prize in the career path dependent model. The opportunity of "amakudari" that a ministry can provide depends on the amount of rents that could be shared with the related private sector. For example, a regulatory ministry can create such rents by imposing entry restriction in the regulated industry. When the amount of rents taken by the government is larger, the opportunity for "amakudari" is also greater.

Thus, increasing or at least keeping the amount of ministry-specific rents for the future is a fundamental objective of every member in the ministry. Such rents produce a large positive externality for all members of the ministry. Theoretically, such an externality could lead to multiple equilibria of the member strategy, but, in reality, a co-operative equilibrium is likely to emerge in an infinite-lived ministry and among its members. Every bureaucrat co-operates with other members to maximise the rents of his ministry and maintain "dynastic control", by considering the welfare not only of "the same year

recruits" but also of their "ancestors" and "descendants". This creates a strong loyalty or attachment to his ministry.

3.2 The opportunity of "amakudari" and different selection systems

As we have seen in the last section, the employer can set the level of prizes (differences in prizes) so that it will induce the optimal level of effort.

However, in the case of ministry, the total (expected) payment of prizes (the expected size of the prize per worker multiplied by the number of workers) might often be less than its optimal size due to the limited opportunities for "amakudari". In other words, ministries are more likely to be "financially-constrained". In such a case, does a ministry choose a different selection system?

For simplicity, let us consider the career path-dependent model (three periods) (Figure 4). There are two ministries A and B. Ministry A has large opportunities of "amakudari" and uses the optimal scheme with equal prize spread by raising the size of E_A, (per worker) such as to induce the optimal level of effort[2]. (Figure 4(1)).

$$V_1^A = 2D_A + \overline{V}_A, \quad V_2^A = D_A + \overline{V}_A, \quad V_3^A = \overline{V}_A$$
$$C'(p^*) = D_A$$
$$E_A = EV(J(1,1)) = 2p^* D_A + \overline{V}_A$$
$$C(p^*) = p^* D_A + \overline{V}_A$$

[2] Thus, we assume that E_A is equal to the minimum level of "amakudari" opportunities such as to induce the optimal level of effort.

The last equality is the participation constraint.

We introduce a specific cost function, whose first derivative is a quadratic one.

$$C(p)=\frac{K}{3}p^3,\ p\in[0,1/2+\Delta]$$

Since

$$C(p)=\frac{K}{3}p^3=\frac{K}{3}(1-F(T-a-e))^3=c(e)$$

The optimal level of effort e* and p* should satisfy the following condition:

$$K\left(1-F\left(T-a-e^*\right)\right)^2 f\left(T-a-e^*\right)=1-\frac{1-F\left(T-a-e^*\right)}{2\,\partial e^*/\partial D}$$

$$p^*=1-F\left(T-a-e^*\right)$$

Thus,

$$D_A=C'\left(p^*\right)=K\left(p^*\right)^2$$

It should be noted that

$$C(p)=\frac{K}{3}\left(p^*\right)^3<K\left(p^*\right)^3=p^*D_A$$

Since

$$\overline{V}_A=C(p)-pD_A$$

$$\therefore \quad \overline{V_A} = -\frac{2}{3}K\left(p^*\right)^3$$

Thus,

$$EV\left(J(1,1)\right) = 2p^* D_A + \overline{V_A} = \frac{4}{3}K\left(p^*\right)^3$$

We can calculate D_A, V_3^A and these can be expressed as a function of E_A.

$$D_A = \frac{3}{4}\frac{E_A}{p^*}$$
$$\overline{V_A} = -\frac{1}{2}E_A$$

Ministry B has less "amakudari" opportunity and can raise only E_B for the expected payment of the prize per worker, where E_B is less than E_A. Ministry B can choose several schemes, given the amount of E_B.

The first scheme (Scheme 1) (Figure 4(2)) is the same scheme of Ministry A.

$$V_1^B = 2D_1 + \overline{V_1}, \quad V_2^B = D_1 + \overline{V_1}, \quad V_3^B = \overline{V_1}$$
$$C'\left(p_1\right) = D_1$$
$$E_B = EV\left(J(1,1)\right) = 2p_1 D_1 + \overline{V_1}$$
$$C\left(p_1\right) = p_1 D_1 + \overline{V_1}$$

$$p_1 = p^* \left(\frac{E_B}{E_A} \right)^{1/3}$$
$$D_1 = \frac{3}{4} \frac{E_A^{1/3} E_B^{2/3}}{p^*}$$
$$\overline{V_1} = -\frac{1}{2} E_B$$

Apparently, the probability of "good" promotion, or the effort level, is less than the optimal one of Ministry B. Thus, Ministry B considers the following two schemes. The main idea of these schemes is that the personnel division makes a worker's job position in period 2.unknown to him.

Scheme 2 (Figure 4(3)) uses a scheme with an equal prize spread, while a worker does not know his post in period 2. However, this does not affect his effort level, since he knows that his effort level should be the same at every job. On the other hand, a worker cannot update his expected prize in period 2, and he has no alternative but to stay in the ministry. Thus, the ministry only considers the participation constraint at J(1,1) and has no drop-out. In this scheme,

$$V_1^B = 2D_2 + \overline{V}_2, \quad V_2^B = D_2 + \overline{V}_2, \quad V_3^B = \overline{V}_2$$
$$C'(p_2) = D_2$$
$$E_B = EV(J(1,1)) = 2p_2 D_2 + \overline{V}_2$$
$$2C(p_2) = EV(J(1,1))$$

The last equality is the participation constraint at J (1,1).

Thus, we obtain

$$p_2 = p^* \left(\frac{2E_B}{E_A} \right)^{1/3}$$

$$D_2 = 2^{2/3} \frac{3}{4} \frac{E_A{}^{1/3} E_B{}^{2/3}}{p^*}$$

$$\overline{V_2} = -2E_B$$

In this scheme, the effort level is higher than that of scheme 1. Thus, Ministry B might prefer scheme 2 to scheme 1. The prize spread of scheme 2 and the absolute value of the lowest prize is greater than those of scheme 1. Thus, the effects of both "carrots and sticks" are stronger

The third scheme (scheme 3) (Figure 4(4)) considers a situation in which Ministry B also strategically conceals the job position of a worker in period 2 but uses a different prize scheme. Only the best job offers a prize and the other two posts give the same penalty. Ministry B asks a worker to choose his probabilities of "good" promotion (or effort) in period 1 and period 2 in advance. Ministry B again considers only the participation constraint at J (1,1), since a worker has no opportunity to update his expected pay-off and quit the ministry. The worker's maximisation problem is as follows. Let us assume that $p_{3,1}, p_{3,2}$ are the probability of "good promotion" in the first and second periods respectively.

$$\underset{p_1,\, p_2}{Max} \left(p_{3,1}\ p_{3,2}\ D_3 - C\left(p_{3,1}\right) - C\left(p_{3,2}\right) \right)$$

The first order conditions are

$$C'(p_{3,1}) = p_{3,2}\ D_3$$
$$C'(p_{3,2}) = p_{3,1}\ D_3$$

There is a symmetric equilibrium such that

$$p_{3,1} = p_{3,2} = p_3$$
$$C'(p_3) = p_3\ D_3$$
$$E_B = EV(J(1,1)) = p_3^{\ 2}\ D_3 + \overline{V_3}$$
$$2C(p_3) = EV(J(1,1))$$

Thus, we obtain the following results.

$$p_3 = p^* \left(\frac{2E_B}{E_A} \right)^{1/3}$$
$$D_3 = 2^{1/3} \frac{3}{4} \frac{E_A^{\ 2/3} E_B^{\ 1/3}}{(p^*)^2}$$
$$\overline{V_3} = -\frac{1}{2} E_B$$

The probability of "good" promotion of scheme 3 is equal to that of scheme 2, and greater than that of scheme 1. To facilitate a comparison among these schemes, we assume that E_B.is just a half of E_A.

Then, we obtain

$$p_1 = \left(\frac{1}{2}\right)^{1/3} p^*$$
$$D_1 = \left(\frac{1}{2}\right)^{2/3} \frac{3}{4}\frac{E_A}{p^*}$$
$$\overline{V_1} = -\frac{1}{4}E_A$$

$$p_2 = p^*$$
$$D_2 = \frac{3}{4}\frac{E_A}{p^*}$$
$$\overline{V_2} = -E_A$$

$$p_3 = p^*$$
$$D_3 = \frac{3}{4}\frac{E_A}{\left(p^*\right)^2}$$
$$\overline{V_3} = -\frac{1}{4}E_A$$

The first prize of scheme 3 is always higher than that of scheme 2, since

$$D_3 + \overline{V_3} - \left(2D_2 + \overline{V_2}\right)$$
$$= \frac{3}{4}\frac{E_A}{\left(p^*\right)^2} - \frac{1}{4}E_A - \left(\frac{3}{2}\frac{E_A}{p^*} - E_A\right)$$
$$= \frac{3E_A\left(1-p^*\right)^2}{4\left(p^*\right)^2} > 0$$

Thus, if Ministry B cares about the level of the first prize (for example, if a worker in Ministry B is risk-taking), it might choose scheme 3.

In summary, Ministry B, which has less “amakudari” opportunities and is financially constrained, may choose schemes 2 or 3. In particular, Ministry B can induce the

optimal level of effort (of Ministry A) by using only half the amount of E_A. under the assumption of our cost function. These schemes ask potential "drop-outs" to continue to make an effort in the second period. Hence, the employer can set the absolute value of the lowest prize (the penalty) at a high level and increase the prize spread (scheme 2) or give a prize only to a worker winning the best position (scheme 3). As a result, these arrangements increase a worker's efforts.

It should be noted, however, that the worker's net expected prize (the expected prize minus the cost of effort) is reduced to zero in scheme 2 and 3. Thus, Ministry B with schemes 2 or 3 may have some difficulties in attracting qualified workers than Ministry A that can guarantee the positive expected prizes for them. In this sense, Ministry A does not want to adopt scheme 2 or 3 even if they can further increase the worker's effort.

Ministry A might be analogous to the Ministry of Finance in Japan. The Ministry of Finance still has plenty of opportunities for "amakudari" in the financial sector. Candidates for deputy minister position are usually selected quite early. Sometimes, their first job in the Ministry (or their examination record) is considered as a very important signal for their future promotion. The mainstream jobs are those in the Budget Bureau, in which every candidate for a deputy minister post should work several times in his career. Since most of the career routes of a "fast-track" MoF official are very path-dependent, it is relatively easy to project his future career path given his career history. However, even "losers" in career competition still have a strong incentive to move up to a higher job level, since the differences in the prizes available to "losers"

are equally large and their marginal returns are thus high.

On the other hand, Ministry B could be associated with MITI (the Ministry of International Trade and Industry, currently METI, Ministry of Economy, Trade and Industry). Most industries (manufacturing) which MITI supervises have been de-regulated MITI has smaller rents shared with the private sector and thus fewer opportunities of “amakudari” than MoF. Compared with MoF, it is often said that MITI’s selection process is slower and more uncertain. Around the fifteenth year of their career, candidates for deputy minister are reduced by half (to about ten). However, after that, there is no explicit “golden route” to become a deputy minister except for a few posts at the very latest stages. Thus, competition for a deputy minister in MITI is likely to be strategically “ambiguous” in order to keep incentives very high until the last minute of final promotion.

4 Concluding remarks

In this paper, we have presented the path-dependence model for “fast-track” Japanese bureaucrats, especially focusing on its incentive mechanism. Without a performance based pay scheme, the path dependent model can give an incentive to work hard and win “good” promotion to a worker, by linking the rank of his final job to the prize. In particular, the basic path dependent model with equal prize spread can induce the same level of effort at every job post and even “losers” continue to make their efforts to get higher prizes within their opportunities.

As we have seen, ministries with less “amakudari” opportunities might adopt schemes without revealing the job positions of workers (or the prospect of their prizes) to them. Such strategies can increase the level of effort given the expected prize it should pay, but reduce the welfare of workers (net benefits or rents for workers) and fail to attract qualified workers. Thus, ministries with plenty “amakudari” opportunities may not want to adopt these “non-revealing” strategies even if they can further increase the worker’s effort level.

These arrangements have successfully provided a strong incentive to work hard for “good” promotion to “fast-track” government officials. Under the path-dependent career model, a worker, who continues to be promoted to a “good” job at every step, should become deputy minister. Indeed, it is very common that ministries have a series of so called “mainstream” jobs (posts), which most top officials have experienced in their promotion process. Thus, a “good” worker who is seen as a candidate for a future high-ranking post, should have experienced a series of “good” jobs called “main stream”.

However, the very bureaucratic promotion rule seen in the career path dependent model may not work when the economic circumstances surrounding government change very rapidly. The good “reputation” of a worker, which has been given to him by past standards (career path), may not be relevant to an ability to cope with current or future difficulties. This implies that in such a situation the path-dependent promotion system might lead to human resource misallocation.

In this sense, the selection at the top of a “different type” has recently occurred in some

ministries. For example, the candidate that was expected to be chosen as deputy minister of the MOF was not selected in the last promotion exercise under the influence of some scandals prevailing the financial world. “Reputation” judged by past standards might not be a useful reference for “fast-track” bureaucrats in a changing environment. In addition, regulatory rents or “amakudari” opportunities are expected to decline in future. “Future prizes” will thus have less impact on incentives in the absence of a performance based pay scheme. This implies that incentives for “fast-track” officials to work hard may no longer be guaranteed.

Appendix: Competition and co-operation: The role of "the-same-year recruits"

The role of "the same year" recruits (competition among a small number of homogeneous participants) could give some relevance to the tournament model, combined with the following co-operation rule among them. In this appendix, we consider competition and co-operation among "the-same-year recruits" in the context of the tournament model.

The tournament model predicts that competition among limited and homogeneous members induces more efforts by the members, but will also have a negative effect on co-operation among them (Lazear (1989). The seniority based job rank and wage system can enhance co-operative behaviour during the earlier career stages. However, once the selection process has started, direct competition among the members might be fiercer and thus, make co-operation and team work more difficult.

To prevent these potential problems, some commentators stress the following implicit rule among "fast-track" government officials (e.g.Kawakita (1999) in Japanese). "Only if the total performance of the group is sufficiently good, will the group be considered to be "competent" as a whole and a deputy minister will be selected from this group".

A deputy minister usually has a large margin of manoeuvre to allocate second jobs to retired officials, and he keeps such a power even after his retirement. Thus, if a group cannot produce a deputy minister, the prospects of all members for their second or third post-retirement jobs would be much worse. This feature can clearly enhance co-operation among the members of the same-year group.

In order to consider such an implicit rule for co-operation, let us reconsider the tournament model with two homogeneous workers A and B. The worker that wins the tournament gets the prize of V. Following the treatment of Lazear (1989), we introduce sabotage activity (s) and use the same notation as in Section 1.

$$x_A = e_A - s_B + u_A$$
$$x_B = e_B - s_A + u_B$$
$$c_A = c_B = c(e_t, s_t)$$
$$u_A, u_B \propto N(0, s_u^2)$$

Worker A's maximisation problem is

$$\underset{e_A, S_A}{Max}(\Pr ob(A\ wins)V - c(e_A, s_A))$$

The first order conditions are symmetric, and we obtain the following results as shown by Lazear (1989).

$$g(0)V = c_1(e^*, s^*)$$
$$-g(0)V = c_2(e^*, s^*)$$

, where $g()$ is the density function on the random variable u_A and u_B $(u_A, u_B \propto N(0, s_u^2))$.

To solve the first order conditions explicitly, we introduce a quadratic cost function c ().

$$c(e, s) = \frac{1}{2} e^2 + \frac{1}{2} s^2 + a\, e\, s - b\, e - b\, s \qquad (a, b > 0)$$

The value of a (a = c_{12}, c_{21}) is assumed to be positive, thus, the marginal cost of making an effort (a sabotage activity) increases with the level of a sabotage activity (an effort). This assumption is common in the multitask literature (e.g. Holmostrom and Milgrom (1991), Drago and Garvey (1998)).

The first order conditions are rewritten as follows.

$$g(0)V = c_1(e^*, s^*) = e^* + a\, s^* - b \qquad (1)^*$$

$$-g(0)V = c_2(e^*, s^*) = s^* + a\, e^* - b \qquad (2)^*$$

Assume that $0 < a < 1, \quad g(0)V > b$. Then, we can get positive equilibrium values of e and s.

$$e^* = \frac{a\,(g(0)V - b)}{1 - a^2}$$

$$s^* = \frac{2b - a(g(0)V - b)}{1 - a^2}$$

Next, we introduce a penalty for sabotage behaviour. The “competence” of the pair of A and B might depend on the extent to which they minimise their sabotage activities. Thus, the prize (the opportunities of “amakudari”) can be reduced by the sum of their sabotage activities (multiplied by a constant (k> 0)) from the initial level with no sabotage activity. Worker A’s maximisation problem is

$$\underset{e_A, s_A}{Max}\left(\Pr ob(A\ wins)\left(V - k\left(s_A + s_B\right)\right) - c\left(e_A, s_a\right)\right)$$

The first order conditions are

$$\frac{\partial P}{\partial e_A}\left(V - k\left(s_A + s_B\right)\right) + P\left(-k\left(\frac{\partial s_A}{\partial e_A} + \frac{\partial s_B}{\partial e_A}\right)\right) = c_1$$
$$\frac{\partial P}{\partial s_A}\left(V - k\left(s_A + s_B\right)\right) + P\left(-k\left(\frac{\partial s_A}{\partial s_A} + \frac{\partial s_B}{\partial s_A}\right)\right) = c_2$$

In a Nash symmetry equilibrium,

$$\frac{\partial P}{\partial e_A} = g(0),\quad \frac{\partial P}{\partial s_A} = -g(0),\quad \frac{\partial s_A}{\partial e_A} = -1,\quad \frac{\partial s_A}{\partial s_A} = 1,\quad \frac{\partial s_B}{\partial e_A} = \frac{\partial s_B}{\partial s_A} = 0,\ P = \frac{1}{2}$$

Thus, the first order conditions are rewritten as follows.

$$g(0)V + b + \frac{k}{2} = e^{**} + \left(a + 2kg\right)s^{**} \qquad (1)^{**}$$

$$-g\ (0)V + b - \frac{k}{2} = \left(1 - 2kg\right)s^{**} + a\ e^{**} \qquad (2)^{**}$$

When we add both equations, we have

$$\frac{2b}{1+a} = e^{**} + s^{**}$$

Thus, a new equilibrium $\left(e^{**}, s^{**}\right)$ is also on that line (Figure 5).

Since k >0,

$e^{**} > e^{*}$

$s^{**} < s^{*}$

By introducing a penalty for sabotage activities (a reduction in the total amount of the prize), workers reduce the level of their sabotage activities and thus increase that of their effort.

Reference

Aoki, M. (1988), *Information, incentives, and bargaining in the Japanese economy*, Cambridge University Press

Fairburn, J. and J. Malcomson (2001), "Performance, promotion and the Peter principle", *Review of Economic Studies* 68(1), pp 45-66

Gibbons, R. (1997), "Incentives and careers in organization", in D. Kreps and K. Wallis, eds., *Advances in economic theory and econometrics*, Cambridge University Press

Gibbons, R. and M. Waldman (1999), "Careers in organizations: Theory and evidence", in O. Ashenfelter and D. Card eds., *Handbook of labor economics* Volume 3B, North Holland

Gibbs, M. (1995), "Incentive compensation in a corporate hierarchy", *Journal of Accounting and Economics* 19, pp 247-277

Hashimoto, M. and J. Raisian (1985), "Employment tenure and earning profiles in Japan and the United States", *American Economic Review* 75, pp 721-735

Kato, T. and M. Rockel (1992), "Experiences, credentials and compensation in the Japanese and U.S. managerial labor markets: Evidence from new micro data", *Journal of the Japanese and International Economies* 6, pp 30-51

Itoh, H. (1994), "Japanese human resource management from the viewpoint of incentive theory", in M. Aoki and R. Dore eds., *The Japanese firm: Sources of competitive strength*, Oxford University Press

Koike, K. (1988), *Understanding industrial relations in modern Japan*, Macmillan Press

Lazear, E. (1979), "Why is there mandatory retirement?", *Journal of Political Economy* 87, pp 1261-1284

Lazear, E. (1989), "Pay equality and industrial politics", *Journal of Political Economy*

97, pp 561-580

Lazear, E. (1995), *Personnel economics*, MIT Press

Lazear, E. (1998), *Personnel economics for managers*, Wiley

MacLeod, W. and J. Malcomson (1989), "Implicit contracts, incentive compatibility and involuntary unemployment", *Econometrica* 57, pp 447-480

Milgrom, P. and J. Roberts (1988), "An economic approach to influence activities in organizations", *American Journal of Sociology* 94, pp S154-S179

OECD (1993), *Employment Outlook*, OECD

Prendergast, C. (1992), "Career development and specific human capital collection", *Journal of the Japanese and international economies 6*, pp 207-227

Prendergast, C. (1993), "The role of promotion in inducing specific human capital acquisition", *Quarterly Journal of Economics* 108, pp 523-534

Prendergast (1999), "The provision of incentives in firms", *Journal of Economic Literature* 37(1), pp 7-63

Prendergast and Topel (1996), "Favoritism in Organizations", *Journal of Political Economy* 104(5), pp 958-978

Tsuru, K. (1996), *The Japanese Market Economy System: Its Strength and Weakness*, LTCB International Library Selection No. 4, LTCB International Library Foundation

Figure 1 The career path-dependent model

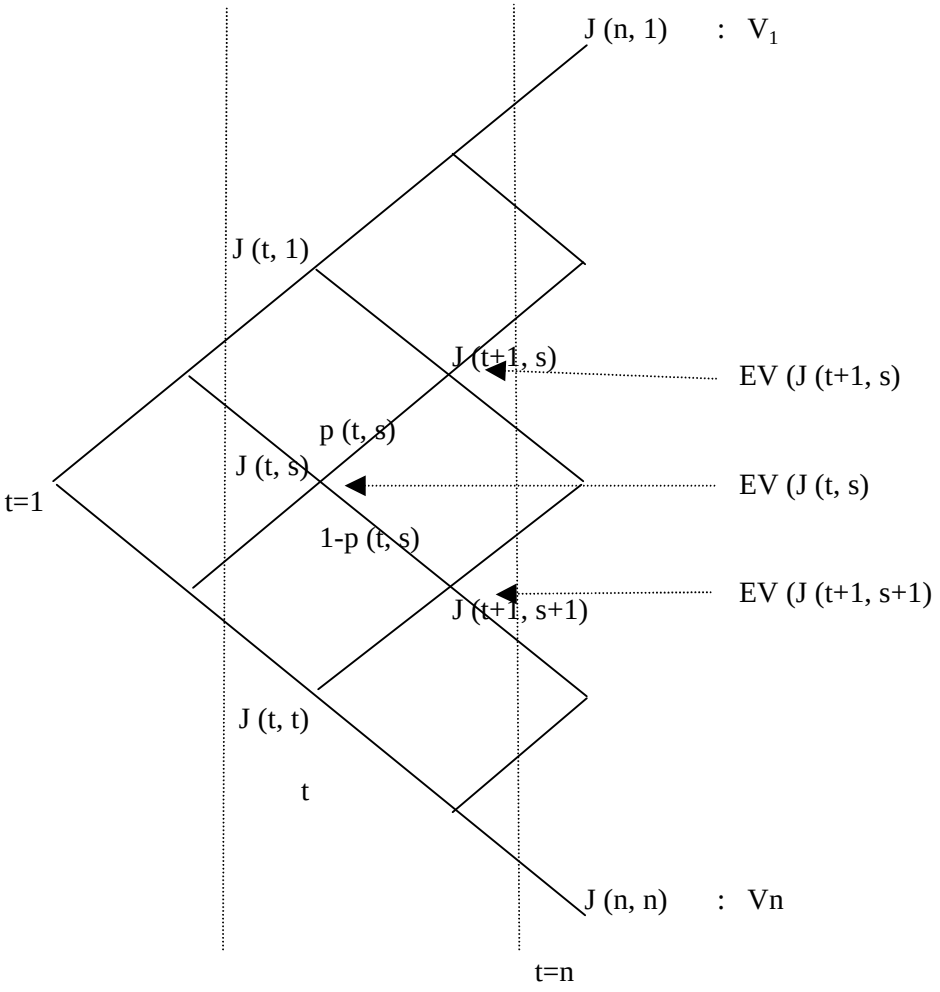


Figure 2 A scheme with an equal prize spread

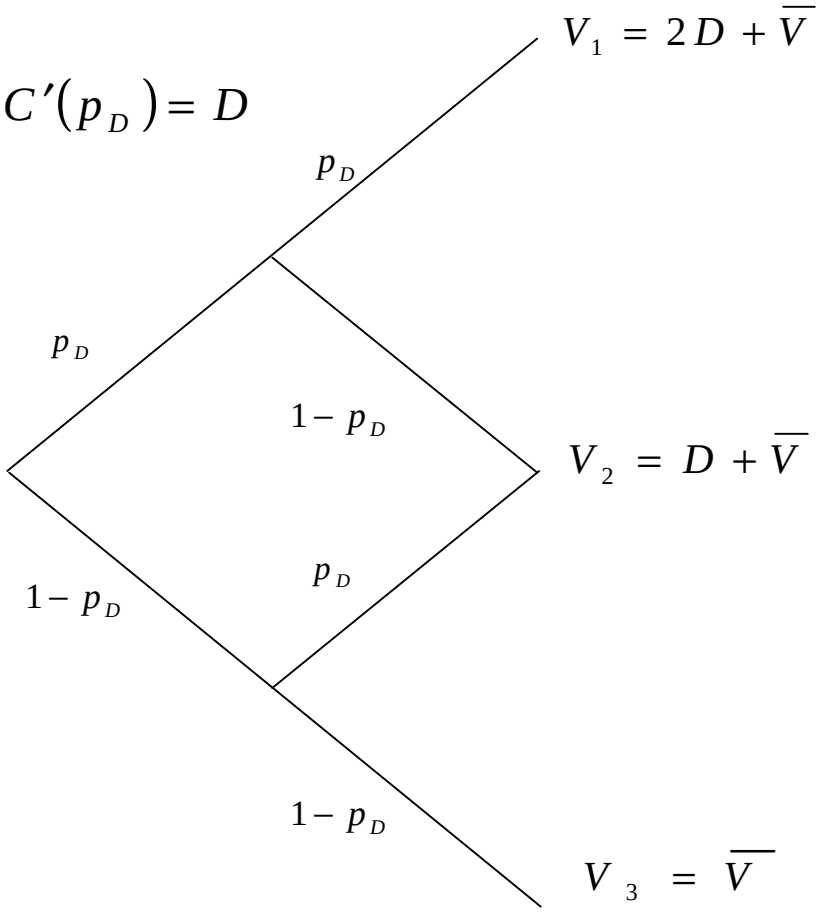
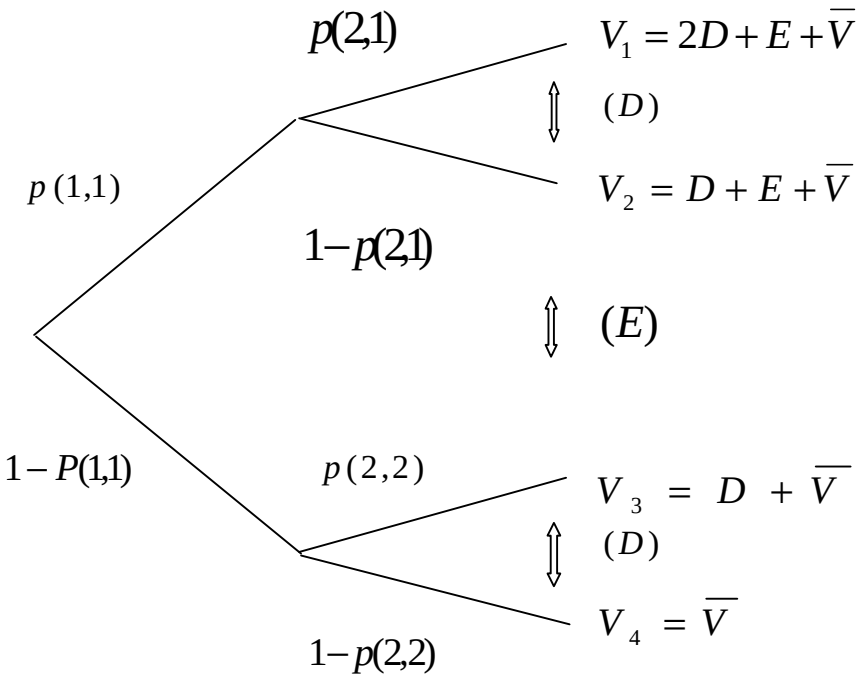


Figure 3 The extent of path dependence in different models

(1) Early selection

$(V_2 > V_3,\ E > 0)$

$$C'(p(2,1)) = C(p(2,2)) = D$$
$$C'(p(1,1)) = D + E > D$$
$$E > 0 \quad \Rightarrow \quad p(1,1) > p(2,1) = p(2,2)$$



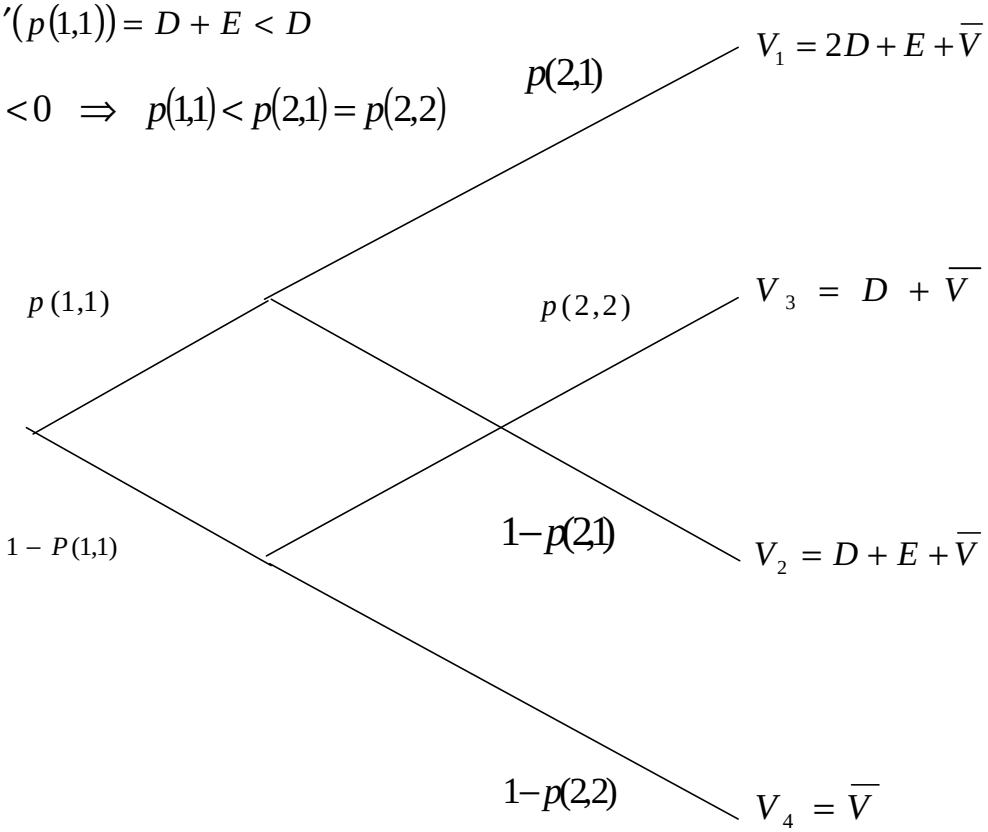
(2) Late selection

$(V_2 < V_3,\ E < 0)$

$C'(p(2,1)) = C(p(2,2)) = D$

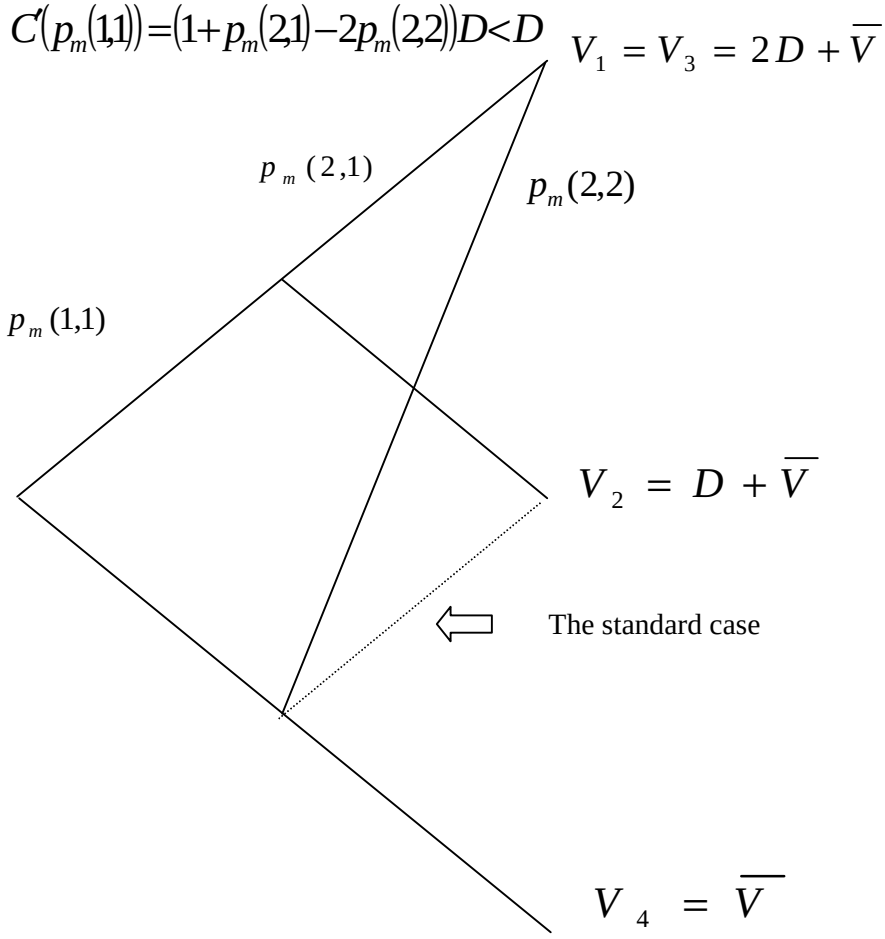
$C'(p(1,1)) = D + E < D$

$E < 0 \Rightarrow p(1,1) < p(2,1) = p(2,2)$



(3) Late selection with the merit system

$$C'(p_m(2,1)) = D$$
$$C(p_m(2,2)) = 2D$$
$$C'(p_m(1,1)) = (1 + p_m(2,1) - 2p_m(2,2))D < D$$



(4) Late selection with the demerit system

$C'(p_d(2,1)) = 2D$

$C'(p_d(2,2)) = D$

$C'(p_d(1,1)) = (2p_d(2,2) - p_d(2,1))D < D$

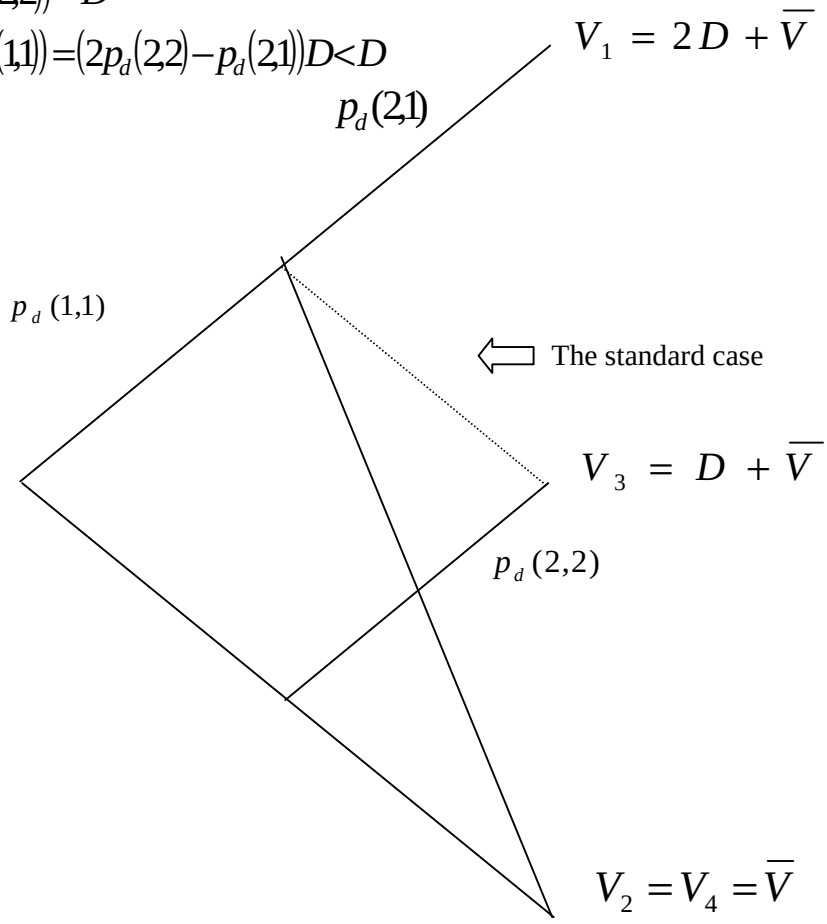
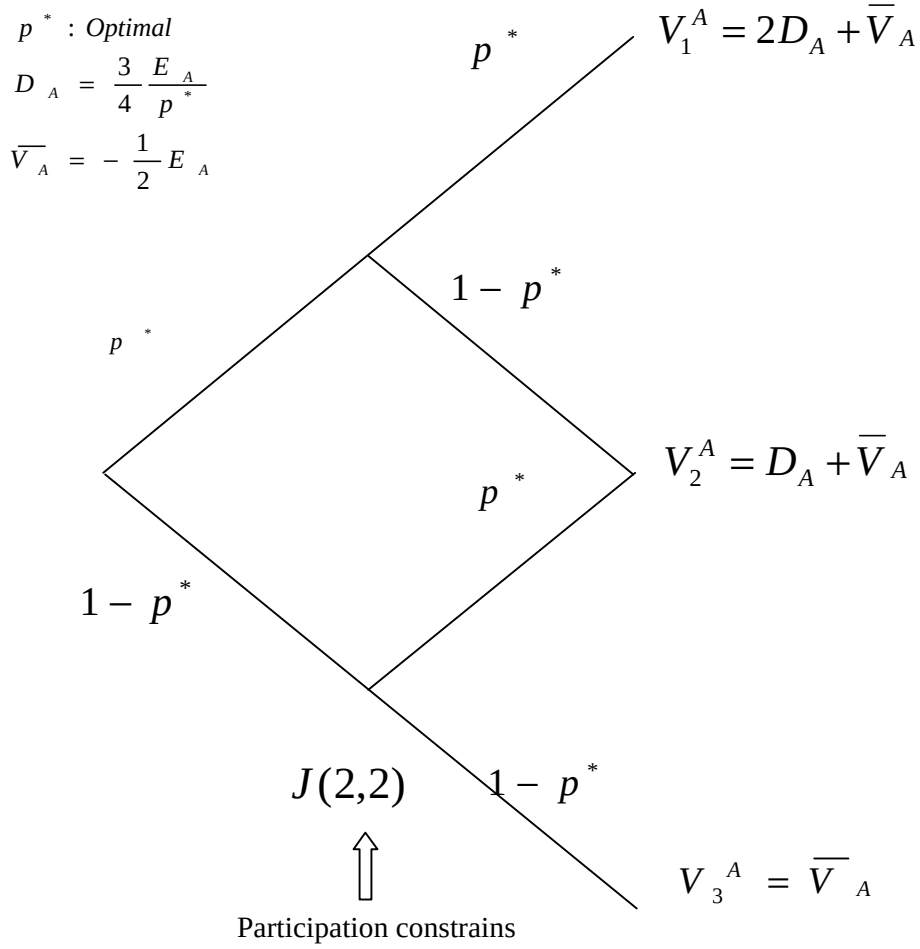


Figure 4 The opportunity of “amakudari” and different selection systems

(1) Ministry A

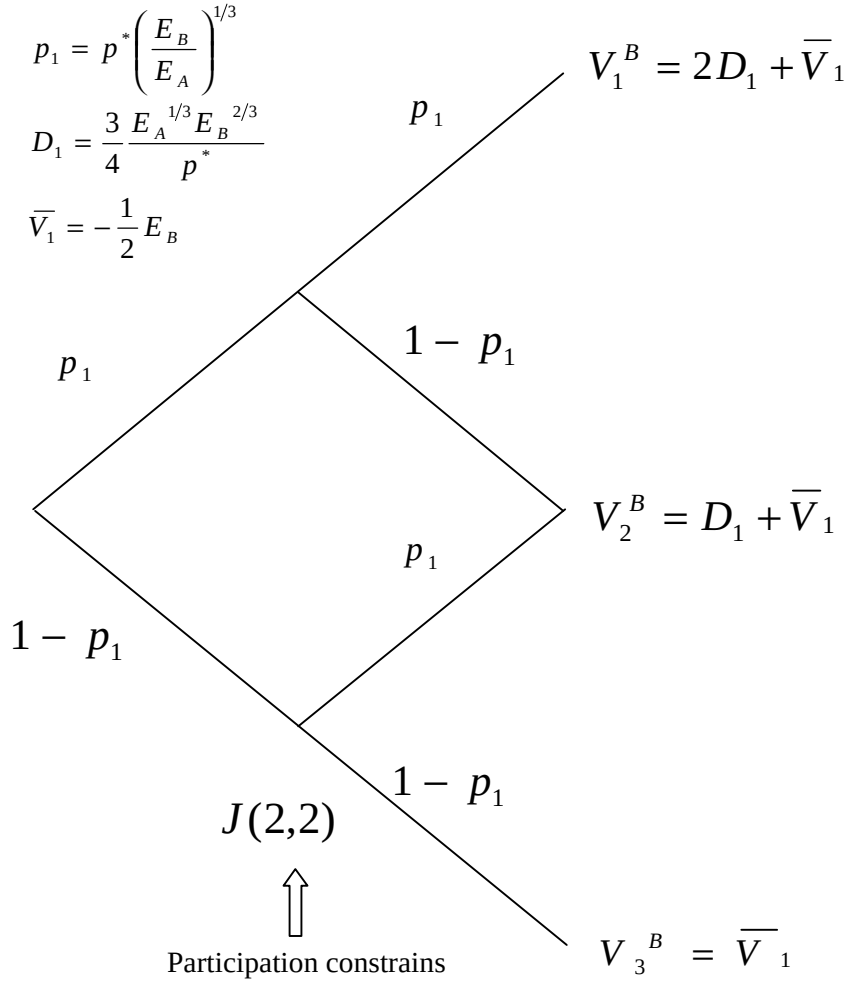


(2) Ministry B (Scheme 1)

$$p_1 = p^* \left(\frac{E_B}{E_A} \right)^{1/3}$$

$$D_1 = \frac{3}{4} \frac{E_A{}^{1/3} E_B{}^{2/3}}{p^*}$$

$$\overline{V_1} = -\frac{1}{2} E_B$$

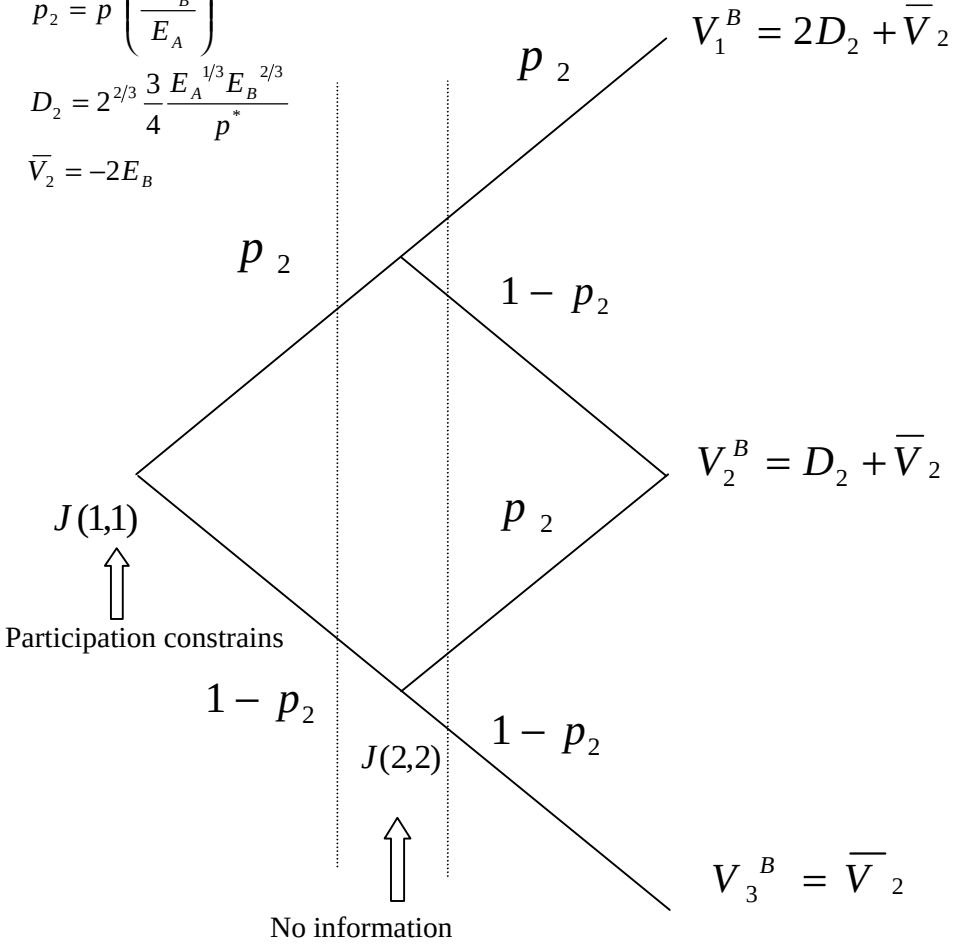


(3) Ministry B (Scheme 2)

$$p_2 = p^* \left(\frac{2E_B}{E_A} \right)^{1/3}$$

$$D_2 = 2^{2/3} \frac{3}{4} \frac{E_A{}^{1/3} E_B{}^{2/3}}{p^*}$$

$$\overline{V}_2 = -2E_B$$



(4) Ministry B (Scheme 3)

$$p_3 = p^* \left(\frac{2E_B}{E_A} \right)^{1/3}$$

$$D_3 = 2^{1/3} \frac{3}{4} \frac{E_A^{2/3} E_B^{1/3}}{\left(p^*\right)^2}$$

$$\overline{V}_3 = -\frac{1}{2} E_B$$

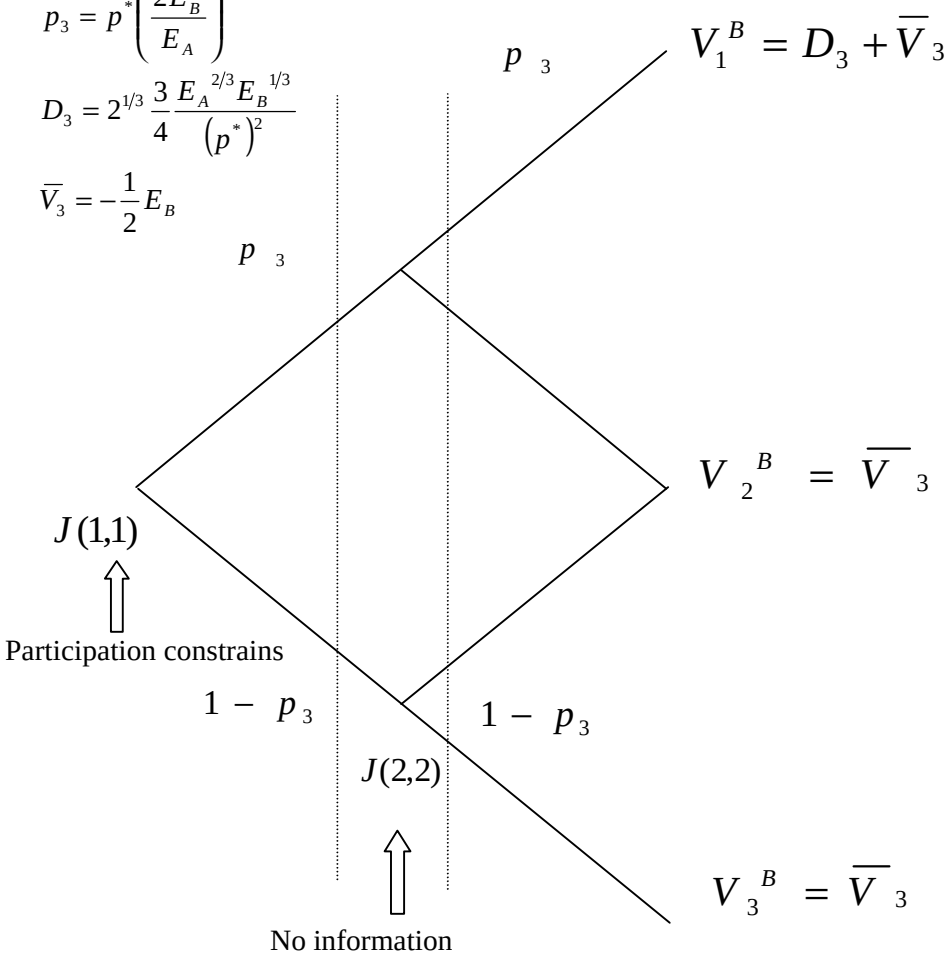


Figure 5 Competition and co-operation among “the same year recruits”