Credential Competition and Workers' Utility

—An Analysis by Simulation—

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Abstract

As everyone knows, in most advanced nations, a person's educational background (i.e., credential) has come to be all-important. Japan is a typical example of such nations. In other words, Japan is what is called a "credential society". This report sketches a model of credential competition, and shows the evil influences caused by the credentialism.

In our model, workers with higher credential produce more output. Higher credential results in a higher wage to the individual, not only from his added production, but also because of the greater estimate of his individual ability, so the private return for additional credential exceeds the additional output. Furthermore, the individual worker is spurred on by knowing that in the group of workers with higher credential he will share the output of workers of greater ability.

An individual worker's traits, talents and skill are not directly observable. Employers are most likely to be ignorant about the potential productivity of an individual worker who has just entered the labor force, and seek the signals to screen the good workers from the bad. The credential is one of the most important signals for screening. An individual worker, knowing himself, or at least knowing more about himself than the emplopyer, has an incentive to pretend to be better than he actually is via the higher credential.

In our model, there are 4 different classes of workers. The utility of workers of class -n, namely U_n depends upon the goods they consume G, and the credential group to which they belong E. The core of this simulation can be written:

$$U_n = G - E - 3/8(E-n)^2 \quad n = 1 \ldots 4$$

where 3/8 is the fraction which shows pain and hardship when an individual moves to the upper credential group.

In summary, the conclusion of this simulation is that everyone except workers of one class is working in the group higher than the optium.

1. Introduction

In most advanced nations, a person's educational background (i.e. credential) has come to be all-important. In these nations the credential has become the new property. Japan is a typical

example of such nations. In other words, Japan is what is called a "credential society". This report sketches a model of the credential competition, with the Japanese educational system in mind, and shows the evil influences caused by credentialism.

The theoretical framework of our model has borrowed heavily from recent contributions to the theory of screening. In particular, we closely follow Akerlof's seminal model (1976) of the competition between individuals on assembly lines, and exploit its "incomplete information" concept within the framework of Williamson, Wachter, and Harris' analysis (1975) of internal labor markets.

The organization of this report is as follows: Section 2 demonstrates, by reference to the incomplete information in the labor market, the need of some signals of an individual's ability. Moreover, section 2 shows that the credential is used as such a signal. Section 3 gives an overview of our credential competition model. Section 4 summarizes and discusses the results obtained.

2. Credential as the most important signal

In the real labor market, contrary to the assumption of many economists, information is neither complete nor costless. On the contrary, given the cost of information and the need for it, in the labor market employers typically make predictions about the ability of job seekers based upon a limited number of easily observable characteristics (Williamson, Wachter and Harris 1975). We say that such a prediction is based upon some "signals". In short, employers seek for "signals" to screen the good individuals from the bad.

Of those "signals", some are immutably fixed, while others alterable. For example, credential is something that the individual can invest in at some cost in terms of time and money. On the other hand, race and sex are not generally thought to be alterable (Spence, 1973).

In order to maximize profit, the first thing the employer has to do is to motivate his workers. From that point of view, the employer must use the signal which is fair and objective in evaluating individuals. Credential is a representative of a fair and objective signal. Employers are concerned with an individual's generalized ability or trainability, and most employers believe that credential is a good indicator of them. For example, a bachelor's degree is taken as a badge of the holder's stability by employers and is apparently a highly prized characteristic of young recruits (Verg, 1971). Therefore credential comes to be regarded as important in the lives of citizens. Moreover, from the standpoint of enlivening the whole society, an objective signal is obviously preferable to a subjective signal. Credential is one of the most objective signals (Amano, 1982). This is why credential has come to loom so significantly in advanced nations such as Japan.

Actually, there is the fact that better-educated people in almost any given job category in many firms are younger than their less-educated peers. It suggests that the better-educated people started higher on the ladder when they joined the firm, and that any correlation of rank with education would probably be the substantially tautological results of recruiting and assignment strategies.

3. A model of credential competition

It is plausible that individuals with higher ability produce more output. Also let us assume that there are only able individuals in the high credential group before the credential competition starts. Similarly, individuals with poorer ability are in the lower credential group at the beginning. Higher credential results in a higher wage to the individual, not only from his added production, but also because of the greater estimate of his individual ability, so the private return for additional credential exceeds the additional output. Furthermore, the individual worker is goaded on by knowing that in the group of individuals with lower credential he must share his output with individuals of lesser ability. Similarly, he is spurred on by knowing that in the group of individuals with higher credential he will share the output of individuals of greater ability.

An individual worker's traits and abilities are not directly observable. Employers are most likely to be ignorant about the potential productivity of an individual worker who has just entered the labor force. Because an individual worker's ability is not observable, employers screen the good workers from the bad by "signals". The credential is one of the most important signals as stated above.

Wage differentials induce individuals to increase their levels of education. An individual worker, knowing himself, or at least knowing more about himself than the employer, has an incentive to pretend to be better than he actually is via the higher credential. It is also plausible that individuals' willingness to obtain higher credential is correlated positively with their productivity. A simulation model which was made to illustrate these points is contained at the end of this report.

In this model, there are four different classes of individuals, numbered from 1 to 4. The natural ability of class 1 individuals is the lowest of the four and class 4 individuals' ability is the highest. There are 4 different credential groups from E=1 to E=4. E=1 group is the lowest credential group of the four and E=4 group is the highest.

The part from the 15700th line to 18600th line is the most important part in the model. The credential competition among individuals whose object is maximizing their own utility is illustrated in this part.

The utility of individuals of class n, namely U_n, depends upon output per worker A, and the

credential group to which they belong E. The core of the model can be written:

$$U_n(E) = A(E) - \beta(E-n)^2 \qquad n=1...4 \text{ (see the 17300th line)}$$

where β is the arbitrary fraction which shows pain and hardship when an individual moves to the upper credential group. It is assumed that output per worker A(E) is the average grade of worker in the credential group. For example, if there is only class 1 individuals in the E=2 level,

$$A(2) = 1,$$

and if there is only class 2 individuals in the E=2 level,

$$A(2) = 2,$$

and if there are equal numbers of class 1 individuals and class 2 individuals in the E=2 level,

$$A(2) = 3/2.$$

To summarize, this is the complete specification of the economy. There are different classes of individuals; there are different levels of educational facilities. The solution to the economy consists of matching individuals with credential groups at different levels. In equilibrium no worker will wish to move from the credential group to which he belongs to a credential group at a different level.

In order to illustrate the structure of the simulation model, let us take up the case of $\beta=3/8$ because the calculation in this case is very easy. It is also assumed that four different classes of individuals have equal population.

The utility of individuals of class 1 when they are in the lowest credential group is,

$$U_1(1) = 1-3/8(1-1)^2 = 1,$$

and the utility of individuals of class 2 when they belong to the E=2 group is,

$$U_2(2) = 2.$$

If the class 2 individuals enter the E=1 level marginally,

$$U_2(1) = 5/8.$$

If the class 1 individuals flow in the E=2 level marginally,

$$U_1(2) = 13/8.$$

Therefore individuals of class 2 would not go down to the E=2 where their utility is lower, while class 1 individuals will enter the E=2. The inflow of class 1 individuals will continue until $U_1(2)$ becomes equal to $U_1(1)$. Then,

$$A(2)-3/8(2-1)^2=1,$$

so that,

$$A(2)=11/8.$$

Therefore, when class 2 individuals are in the E=2 group,

$$U_2(2)=11/8-(2-2)^2=11/8.$$

When class 3 individuals belong to the E=3 group,

$$U_3(3)=3.$$

If class 2 individuals flow in the E=3 group marginally,

$$U_2(3)=21/8.$$

If class 3 individuals flow in the E=2 group marginally,

$$U_3(2)=1.$$

Therefore class 3 individuals have no incentive to move from the E=3 group to the E=2 group, while class 2 individuals will move from the E=2 group to the E=3 group. Their migration will stop when:

$$U_2(2)=U_2(3),$$

so that

$$A(3)=14/8.$$

Then,

$$U_3(3)=14/8.$$

If class 3 individuals flow in the E=4 group marginally,

$$U_3(4)=4-3/8(4-3)^2=29/8.$$

The inflow of class 3 will stop when

$$U_3(4)=U_3(3).$$

But even if all individuals of class 3 enter the E=4 level,

$$U_3(4)>U_3(3)$$

because in this case

$$A(4)=7/2,$$

$$U_3(4)=7/2-3/8(4-3)^2=25/8.$$

It is obviously natural that class 3 workers should prefer the E=4 level to the E=3 level as their own credential because

$$U_3(4)>U_3(3).$$

The class 3 individuals will escape from the E=3 group to the E=4 group. Then,

$$U_4(4)=7/2.$$

As class 3 individuals break into the E=4 group, the utility of class 4 individuals decrease from 4 to 7/2. Unlike the other classes of individuals, class 4 individuals have no higher credential group. They must content themselves with this situation because they cannot take refuge in the upper credential group.

In the next step, we must examine the possibility that class 2 individuals may enter the E=4 group. This is important because it has great impact on the utility level of all classes. However, we cannot go into detail because of limited space. The conclusion is that 3/5 of class 2 enter the E=4, when

$$U_2(3)=U_2(4).$$

Then,

$$A(4)=41/13,$$
$$U_2(4)=43/26,$$
$$U_3(4)=289/104,$$
$$U_4(4)=41/13.$$

As stated above, it is assumed that four different clsses of individuals have equal popuation in this case. Under this assumption, all class 2 individuals move from the E=2 level, and all class 3 individuals move from the E=3 level. Therefore, there are only class 1 workers in the E=2 level, and there are only class 2 individuals in the E=3 level. They cannot share the output with individuals of greater ability. Things did not turn out the way we expected. Then,

$$U_1(2)=1-3/8(2-1)^2=5/8$$
$$U_2(3)=2-3/8(3-2)^2=13/8$$

These utilities are lower than their natural credential group. If we assume that individuals can return to their former credrntial level, class 1 individuals will return to the E=1 level. However, class 2 individuals will not return to the E=2 level. If they return to the E=2 level, class 1 individuals will flow in this level, and they will have to share their output with class 2 individuals with lower ability.

Let us arrange the utility of individuals by class before and after credential competition.

class 1	1	:	1
class 2	2	:	43/26 (1.65)
class 3	3	:	289/104 (2.78)
class 4	4	:	41/13 (3.15)

The utility of class 2, class 3 and class 4 decreases. The utility of class 1 remains the same.

4. Conclusions

In the computer simulation, the value of β and the population of each individuals' class were changed. In many cases class 2 individuals entered the E=3 group and class 3 individuals selected E=4. Class 1 individuals were apt to stay in the E=1 level. The utility of at least 2 classes declined. The utility of class 4 decreased most drastically. Some outputs of the simulation are showed in the end of this report.

The solution is nonoptimal because each class of individuals (except for the lowest) works at a higher credential group than in the absence of other individuals, for each class of worker wishes to avoid sharing its output with individuals of the lower class. Individuals raise their credential so as to window out poorer classes. As a result, the utility of many individuals decreases. This can be viewed as the evil influence caused by credential competition.

References

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Spence, M., "Job Market Signaling," Quarterly Journal of Economics, August, 1973, Harvard University.

Verg, I., *Education and Jobs : The Great Training Robbery*, 1971, Praeger.

Williamson, O. E., Wachter, M. L. and Harris, J. E., "Understanding the Employment Relation : the Analysis of Idiosyncratic Exchange," Bell Journal of Economics, Autumn, 1975, American Telephone and Telegraph.

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10000  '
10100  '    ****************************************
10200  '    *                                      *
10300  '    *       CREDENTIAL COMPETITION         *
10400  '    *                                      *
10500  '    *                                      *
10600  '    *        FILE NAME : CRECOM4           *
10700  '    *                                      *
10800  '    *               by Hiroyuki Shiraishi  *
10900  '    *                                      *
11000  '    *                 on 1993.4.23         *
11100  '    *                                      *
11200  '    ****************************************
11300  '
11400  '
11500   SCREEN 3,0,0,1
11600   CONSOLE 0,25,0,0
11700   CLS 3
11800   OPTION BASE 1
11900  '
12000   PRINT "Please Input Movement Parameter."
12100   INPUT "BETA=";BETA
12200   PRINT
12300  '
12400             DIM NUMBER(4,4),CHECK(4,4),A(4),U(4,4)
12500  '
12600   PRINT "Please Input Number of Workers."
12700  '
12800   FOR E=1 TO 4
12900     FOR N=1 TO 4
13000       PRINT "NUMBER(";E",";N;")=";
13100       INPUT NUMBER(E,N)
13200     NEXT N
13300   NEXT E
13400  '
13500   INPUT "SEIDO=";SEIDO
13600  '
13700      LPRINT "BETA =";
13800      LPRINT USING "##.###";BETA
13900      LPRINT
14000      LPRINT "SEIDO=";
14100      LPRINT USING "#.###";SEIDO
14200      LPRINT
14300      LPRINT
14400  '
14500      GOSUB *KEISAN
14600  '
14700      LPRINT " Before Movement."
14800      LPRINT
14900      GOSUB *HYOUJI
15000  '
15100      LPRINT
15200      LPRINT
15300      LPRINT SPC(8);"--------------------"
15400      LPRINT
15500      LPRINT
15600  '
15700      FOR E=1 TO 3
15800        TOTNUM=0
15900        FOR F=1 TO 4
16000          TOTNUM=TOTNUM+NUMBER(E,F)
```

```
16100        NEXT F
16200        IF TOTNUM=0 THEN 18600
16300        FOR N=1 TO 4
16400          IF NUMBER(E,N)=0 THEN 18500
16500          TOTNUM=0
16600          TOTSAN=0
16700          FOR F=1 TO 4
16800            TOTNUM=TOTNUM+NUMBER(E,F)
16900            TOTSAN=TOTSAN+NUMBER(E,F)*F
17000          NEXT F
17100          IF TOTNUM=0 THEN 18500
17200          A(E)=TOTSAN/TOTNUM
17300          U(E,N)=A(E)-BETA*(E-N)^2
17400  '
17500          GOSUB *GOUP
17600          IF U(E,N)>=TEMPU1 THEN 18500
17700          NUMBER(E,N)=NUMBER(E,N)-SEIDO
17800          IF NUMBER(E,N)>=0 THEN 18200
17900          NUMBER(E+1,N)=NUMBER(E+1,N)+NUMBER(E,N)+SEIDO
18000          NUMBER(E,N)=0
18100          GOTO 18500
18200          NUMBER(E+1,N)=NUMBER(E+1,N)+SEIDO
18300          GOTO 18500
18400  '
18500        NEXT N
18600      NEXT E
18700  '
18800      CHECK=1
18900      FOR E=1 TO 4
19000        FOR N=1 TO 4
19100          IF CHECK(E,N)=NUMBER(E,N) THEN TEISUU=1 ELSE TEISUU=0
19200          CHECK=CHECK*TEISUU
19300        NEXT N
19400      NEXT E
19500  '
19600      IF CHECK<>0 THEN 20600
19700  '
19800      FOR E=1 TO 4
19900        FOR N=1 TO 4
20000          CHECK(E,N)=NUMBER(E,N)
20100        NEXT N
20200      NEXT E
20300  '
20400      GOTO 15700
20500  '
20600      ERASE A,U
20700      DIM A(4),U(4,4)
20800      GOSUB *KEISAN
20900  '
21000      LPRINT " After Movement."
21100      LPRINT
21200      GOSUB *HYOUJI
21300  '
21400     CLS 3
21500  '
21600     END
21700  '
21800  *HYOUJI
21900      LPRINT "  Number of Workers"
22000      LPRINT
```

```
22100     LPRINT SPC(6);"n";SPC(2);
22200     FOR X=1 TO 4
22300       LPRINT SPC(1);X;SPC(2);
22400     NEXT X
22500     LPRINT SPC(3);"A"
22600     LPRINT SPC(4);"E"
22700     FOR X=1 TO 4
22800       LPRINT SPC(3);X;SPC(2);
22900       FOR Y=1 TO 4
23000         LPRINT USING "###.##";NUMBER(X,Y);
23100       NEXT Y
23200       LPRINT USING"####.##";A(X)
23300     NEXT X
23400     LPRINT
23500   '
23600     LPRINT "  Utility"
23700     LPRINT
23800     LPRINT SPC(6);"n";SPC(2);
23900     FOR X=1 TO 4
24000       LPRINT SPC(1);X;SPC(2);
24100     NEXT X
24200     LPRINT SPC(3);"A"
24300     LPRINT SPC(4);"E"
24400     FOR X=1 TO 4
24500       LPRINT SPC(3);X;SPC(2);
24600       FOR Y=1 TO 4
24700         LPRINT USING "###.##";U(X,Y);
24800       NEXT Y
24900       LPRINT USING"####.##";A(X)
25000     NEXT X
25100     RETURN
25200   '
25300   *KEISAN
25400     FOR E=1 TO 4
25500       TOTNUM=0
25600       TOTSAN=0
25700       FOR F=1 TO 4
25800         TOTNUM=TOTNUM+NUMBER(E,F)
25900         TOTSAN=TOTSAN+NUMBER(E,F)*F
26000       NEXT F
26100       IF TOTNUM<.01 THEN 26700
26200       A(E)=TOTSAN/TOTNUM
26300       FOR N=1 TO 4
26400         IF NUMBER(E,N)<.01 THEN 26600
26500         U(E,N)=A(E)-BETA*(E-N)^2
26600       NEXT N
26700     NEXT E
26800     RETURN
26900   '
27000   *GOUP
27100    TOTNUM=SEIDO
27200    TOTSAN=0
27300    FOR F=1 TO 4
27400      TOTNUM=TOTNUM+NUMBER(E+1,F)
27500      TOTSAN=TOTSAN+NUMBER(E+1,F)*F
27600    NEXT F
27700    TOTSAN=TOTSAN+N*SEIDO
27800    TEMPA1=TOTSAN/TOTNUM
27900    TEMPU1=TEMPA1-BETA*(E+1-N)^2
28000    RETURN
```

examples of output

BETA = 0.500

Before Movement.

Number of Workers

n E	1	2	3	4	A
1	4.00	0.00	0.00	0.00	1.00
2	0.00	3.00	0.00	0.00	2.00
3	0.00	0.00	2.00	0.00	3.00
4	0.00	0.00	0.00	1.00	4.00

Utility

n E	1	2	3	4	A
1	1.00	0.00	0.00	0.00	1.00
2	0.00	2.00	0.00	0.00	2.00
3	0.00	0.00	3.00	0.00	3.00
4	0.00	0.00	0.00	4.00	4.00

After Movement.

Number of Workers

n E	1	2	3	4	A
1	2.50	0.00	0.00	0.00	1.00
2	1.50	0.00	0.00	0.00	1.00
3	0.00	3.00	0.00	0.00	2.00
4	0.00	0.00	2.00	1.00	3.33

Utility

n E	1	2	3	4	A
1	1.00	0.00	0.00	0.00	1.00
2	0.50	0.00	0.00	0.00	1.00
3	0.00	1.50	0.00	0.00	2.00
4	0.00	0.00	2.83	3.33	3.33

BETA = 0.750

Before Movement.

Number of Workers

n E	1	2	3	4	A
1	1.00	0.00	0.00	0.00	1.00
2	0.00	1.00	0.00	0.00	2.00
3	0.00	0.00	1.00	0.00	3.00
4	0.00	0.00	0.00	1.00	4.00

Utility

n E	1	2	3	4	A
1	1.00	0.00	0.00	0.00	1.00
2	0.00	2.00	0.00	0.00	2.00
3	0.00	0.00	3.00	0.00	3.00
4	0.00	0.00	0.00	4.00	4.00

After Movement.

Number of Workers

n E	1	2	3	4	A
1	0.75	0.00	0.00	0.00	1.00
2	0.25	0.28	0.00	0.00	1.53
3	0.00	0.72	0.00	0.00	2.00
4	0.00	0.00	1.00	1.00	3.50

Utility

n E	1	2	3	4	A
1	1.00	0.00	0.00	0.00	1.00
2	0.78	1.53	0.00	0.00	1.53
3	0.00	1.25	0.00	0.00	2.00
4	0.00	0.00	2.75	3.50	3.50