

《論 文》

# The Analysis of the differences between World Records and Japanese Records in Running

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キーワード :

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[Abstract]

There are many papers concerning to the Modeling of World records in running of Olympic Events.

In this paper, We also analyze the difference between World Records and Japanese Records using Ratio Analysis. And further, the Gompertz Curve analysis of the Speed per Second in each Records.

In the Ratio Analysis, the differences between the World Records and Japanese Records are large the more the locomotive powers are large.

On the other hand, the Speeds per Second in each Event usually are getting decreasing. The decrease can be approximated by Gompertz Curve.

## 1. Introduction

The Olympic Running Events are 100m, 200m, 400m, 800m, 1500m, 5000m, 10000m, and Marathon.

That is from 100m dash to Marathon for men and women. Over the many years, tremendous numbers of studies have made attempts to analyze these running events. For example, Deakin explored progress in the mile record, Chatterjee and Chatterjee for the 100, 200, 400 and 800 meter in Olympic Games (1) (2).

In this paper, We analyze these Olympic

running events by means of World Records comparing to those of Japanese Records. First, We use the Ratio analysis and second, We use the speed per second analysis of each world record and Japanese record. So We first show the World record for man and women and next also show Japanese record for men and women.

## 2. Current running World records (June 2006) and Japanese records (September 2006)

computer program. The programming language is VBA (Visual Basic for Applications).

This language usually operates on the Microsoft Office. Its cannot operate independently.

## 3. Ratio Analysis of Differences between World Records and Japanese Records.

On the other hand, we define the Ratio as following formula.

Ratio=(World record - Japanese record)/World record.

Next we will calculate table 2-1 and table 2-2 data using this formula.

Now, we analyze the differences between World Records and Japanese Records by using Ratio analysis. In this analysis, we also use the

Table 3-1 Shows these results. In this Table, M means Man and W means Woman

In Table 3-1, every records are translated

Table 2-1 Running World Records (June 2006)

Men	Performance	Athlete	Nat.	Place	Date
100m	9.77	Asafa Powell	JAM	Athens (GRE)	4-06-2005
200m	19.32	Michael Johson	USA	Atlanta (USA)	01-08-1996
400m	43.18	Michael Johson	USA	Sevilla (ESP)	26-08-1999
800m	1:41.11	Wilson Kipketer	DEN	Cologne (GER)	24-08-1997
1500m	3:26.00	Hicham EL Guerrouj	MAR	Rome (ITA)	14-07-1998
5000m	12:37.35	Kenenisa Bekele	ETH	Hengelo (NED)	31-05-2004
10000m	26:17.53	Kenenisa Bekele	ETH	Brussel (BEL)	26-08-2005
Marathon	2:04:55	Paul Tergat	KEN	Berlin (GER)	28-09-2003

Women	Performance	Athlete	Nat.	Place	Date
100m	10.49	Griffith-Joyner	USA	Indianapolis (USA)	16-07-1988
200m	21.34	Griffith-Joyner	USA	Seoul (KOR)	29-09-1988
400m	47.60	Marita Koch	GDR	Canberra (AUS)	06-10-1985
800m	1:53.28	Kratochvilova	TCH	Munich (GER)	26-07-1983
1500m	3:50.46	Yunxia Qu	CHN	Beijing (CHN)	11-09-1993
5000m	14:24.53	Meseret Defar	ETH	New YorkCity (USA)	03-06-2006
10000m	29:31.78	Junxia Wang	CHN	Beijing (CHN)	08-09-1993
Marathon	2:15:25	Paula Radcliffe	GBR	London (GBR)	13-04-2003

Table 2-2 Runnig Japanese Records (December 2006)

Man	Performance	Athlete	Date
100m	10.00	Koji Ito	13-12-1998
200m	20.03	Shingo Suetsugu	07-06-2003
400m	44.78	Susumu Takano	16-06-1991
800m	1:46.18	Tomoaki Ono	26-06-1994
1500m	3:37.42	Fumikazu Kobayashi	31-07-2004
5000m	13:13.40	Toshinari Takaoka	01-08-1998
10000m	27:35.09	Toshinari Takaoka	04-05-2001
Marathon	2:06:16	Toshinari Takaoka	13-10-2002

Women	Performance	Athlete	Date
100m	11.36	Hideko Nihei	14-07-2001
200m	23.33	Sakie Nobuoka	06-06-2004
400m	51.80	Mami Tanno	19-09-2005
800m	2:00.45	Miho Sugimori	05-06-2005
1500m	4:09.30	Yuriko Kobayashi	24-09-2006
5000m	14:53.22	Kayoko Fukushi	08-07-2005
10000m	30:48.89	Youko Shibui	03-05-2002
Marathon	2:19:12	Mizuki Noguchi	25-09-2005

Table 3-1 Working Table Of Table 2-1, 2-2 and VBA Program

Event	100m	200m	400m	800m	1500m	5000m	10000m	42195m
M-Word Record (WR)	9.77	19.32	43.18	1   41.11	3   26	12   37.35	26   17.53	2   4   55
M-WR (second)	9.77	19.32	43.18	101.11	206	757.35	1577.53	7495
M-Japanese Record (JR)	10	20.03	44.78	1   46.18	3   37.42	13   13.4	27   35.09	2   6   16
M-JR (second)	10	20.03	44.78	106.18	217.42	793.4	1655.09	7576
W-Word Record (WR)	10.49	21.34	47.6	1   53.28	3   50.46	14   24.53	29   31.78	2   15   25
W-WR (second)	10.49	21.34	47.6	113.28	230.46	864.53	1771.78	8125
W-Japanese Record (JR)	11.36	23.33	51.8	2   0.45	4   9.3	14   53.22	30   48.89	2   19   12
W-JR (second)	11.36	23.33	51.8	120.45	249.3	893.22	1848.89	8352

```

Sub Track ( )
Worksheets (1). Select
Call Keisan (2)
Call Keisan (4)
Call Keisan (6)
Call Keisan (8)
End Sub
Sub Keisan (K)
I = K
For J = 2 To 4
Cells (I + 1, J) = Cells (I, J) * 1
Next J
M = 5
For J = 5 To 11
Cells (I + 1, M) = Cells (I, J) * 60 + Cells (I, J + 1)
M = M + 1
Next J
Cells (I + 1, M + 1) = Cells (I, J + 1) * 3600 + Cells (I, J + 2) * 60 + Cells (I, J + 3)
Exit Sub
End Sub
    
```

Table 3-2 Working Table of Ratio Analysis using EXCEL

Event	100	200	400	800	1500	5000	10000	42195
M-WR (Second)	9.77	19.32	43.18	101.11	206	757.35	1577.53	7495
M-JR (Second)	10	20.03	44.78	106.18	217.42	793.4	1655.09	7576
W-WR (Second)	10.49	21.34	47.6	113.28	230.46	864.53	1771.78	8125
W-JR (Second)	11.36	23.33	51.8	120.45	249.3	893.22	1848.89	8352
M-Ratio	0.0235	0.0367	0.0371	0.0501	0.0554	0.0476	0.0492	0.0108
W-Ratio	0.0829	0.0933	0.0882	0.0633	0.0817	0.0332	0.0435	0.0279
M-WR- Speed Per Second	10.2354	10.3520	9.2635	7.9122	7.2816	6.6020	6.3390	5.6298
M-JR- Speed Per Second	10.0000	9.9850	8.9326	7.5344	6.8991	6.3020	6.0420	5.5696
W-WR- Speed Per Second	9.5329	9.3721	8.4034	7.0621	6.5087	5.7835	5.6440	5.1932
W-JR- Speed Per Second	8.8028	8.5727	7.7220	6.6418	6.0168	5.5977	5.4087	5.0521

into the second unit. For example, Man's world record of Marathon (2 hours, 4minutes and 55 seconds) is translated as follows.

$$2 \times 3600 + 4 \times 60 + 55 = 7495 \text{ (seconds)}$$

On the other hand, Table 3-2 shows Ratio Analysis using Excel.

If Ratio is small, then Japanese level of any events is near to the world level. In this point of view, Marathon is more near to the world

level for both Men to Women of Japanese runners (0.0108, 0.0279).

As for the Japanese Men records, 100, 200 meter running is more near to the world level in comparison with other running. On the other hand, Japanese women is more near to world level in 5000, 10000 meter.

#### 4. Gompertz Curve Analysis

As a general rule, if the distance of running is getting longer, the speed per second is decreasing.

The two line of Table 4-1 (10.2354, 6.602, 5.6298 and so on) shows these decline.

So, we can analysis these curve analysis by use of Gompertz Curve.

Gompertz function shows as follows.

$$\hat{y} = ab^{c^t}$$

Take the log to both sides and we get next formula

$$\log \hat{y} = \log a + (\log b)c^t$$

Table 4-1 Working Table of Speed per second in Running Using VBA Program

100	200	400	800	1500	5000	10000	42195
10.2354	10.3520	9.2635	7.9122	7.2816	6.6020	6.3390	5.6298
10.74976	9.968152	9.132984	8.240589	7.287046117	6.268164	5.179467	4.016171
10.0000	9.9850	8.9326	7.5344	6.8991	6.3020	6.0420	5.5696
10.7498	9.9682	9.1330	8.2406	7.2870	6.2682	5.1795	4.0162
9.5329	9.3721	8.4034	7.0621	6.5087	5.7835	5.6440	5.1932
10.7498	9.9682	9.1330	8.2406	7.2870	6.2682	5.1795	4.0162
8.8028	8.5727	7.7220	6.6418	6.0168	5.5977	5.4087	5.0521
10.74976	9.968152	9.132984	8.240589	7.287046117	6.268164	5.179467	4.016171

Sub TTrack ( )

Dim A, B, C, S1, S2, S3, C1, SS1, SS2, SS3, AA, BB, CC, B1, A1 As Long  
Worksheets (3). Select

Call KKeisan (2, S1, S2, S3)

C1=(1 / 3) \* Log ((S3 - S2)/(S2 - S1))

C=2.71828 ^ C1

B = ((S2 - S1) \* (C - 1)) / ((C ^ 3 - 1) ^ 2)

A = (1 / 3) \* (S1 - ((S2 - S1) / (C ^ 3 - 1)))

Call KKKeisan (3, C, B, A)

Call KKKeisan (5, C, B, A)

Call KKKeisan (7, C, B, A)

Call KKKeisan (9, C, B, A)

End Sub

Sub KKeisan (K, SS1, SS2, SS3)

SS1 = 0

SS2 = 0

SS3 = 0

I = K

For J = 1 To 3

SS1 = SS1 + Cells (I, J)

Next J

For J = 4 To 6

SS2 = SS2 + Cells (I, J)

Next J

For J = 7 To 8

SS3 = SS3 + Cells (I, J)

Next J

Exit Sub

End Sub

Sub KKKeisan (K, CC, BB, AA)

Worksheets (3). Select

I = K

For J = 1 To 8

Cells (I, J) = AA + BB \* (CC ^ (J - 1))

Next J

Exit Sub

End Sub

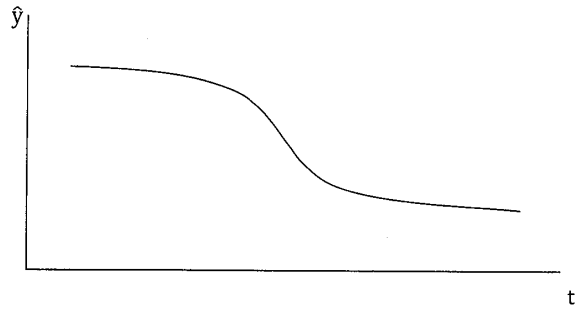


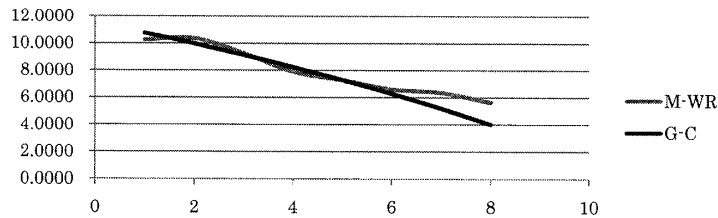
Figure 4-1 Gompertz Curve

We show the general Gompertz Curve above. Of course, the shape of it depends on the a,b,c parameters.

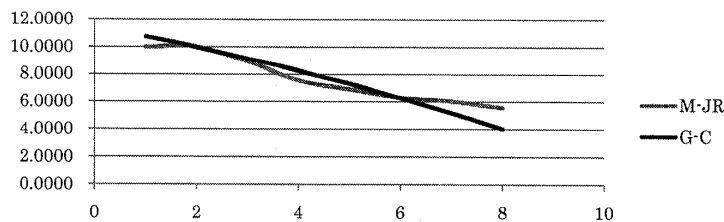
Next we also show the Gompertz Curve

analysis using Table 4-1. The second line of Table 4-1 shows the Men's World Records. Third line shows their Gompertz Curve. Fourth line is Men's Japanese Records. Fifth line is also their Gompertz Curve. Sixth line shows Women's World Records and Seventh line is their Gompertz Curve. Eighth line shows Women's Japanese Records and Ninth line is their Gompertz Curve.

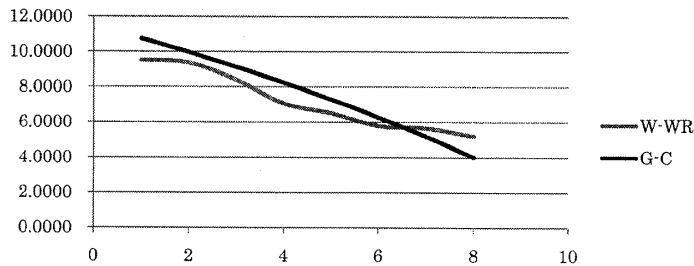
Gompertz Curve depends on the studies of the aging operation.



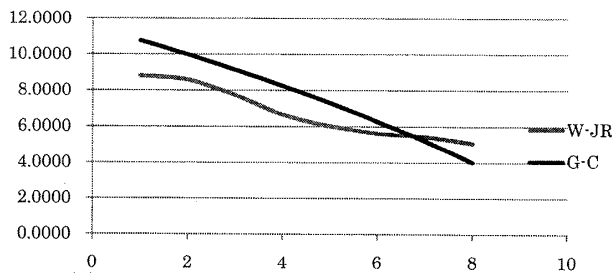
(a) Men World Records and their Gompertz Curve



(b) Men Japanese Records and their Gompertz Curve



(c) Women World Records and their Gompertz Curve



(d) Women Japanese Records and their Gompertz Curve

Figure 4-2 Both Men and Women' World Records and Japanese Records and their Gompertz Curve

Now we proceed the procedure of Gompertz Curve's induction (3).

First We have to order the data (divide the terms into 3).

$s_1$ : first partial sum

$s_2$ : second partial sum

$s_3$ : third partial sum

Then we calculate next formulas.

$$c^n = \frac{s_3 - s_2}{s_2 - s_1}$$

$$\log b = \frac{(s_2 - s_1)(c-1)}{(c^n - 1)^2}$$

$$\log a = \frac{1}{n} \left( s_1 - \frac{s_2 - s_1}{c^n - 1} \right)$$

We calculate these terms in Table 4-1 and also depict Figure 4-2.

Both Men's World Records and Japanese Records are in conformity with Gompertz Curve at glance. On the other hand, we don't use the statistical analysis here.

## 5. Conclusion.

We first analyze the Ratio analysis of difference between World Records and

Japanese Records. In this analysis, if Ratio is small, Both Japanese Men and Women are more near World Level. On the other hand, 100, 200, 400 meter running are next ranks. But Women's levels are very far from world level except 5000, 10000 meter.

Next, We analyze the decreasing of the speed per second in Olympic events in running. The Gompertz Curve analysis is used. The fitness of these Gompertz Curve are remarkable in Men's World and Japanese Records. But We don't use the statistical tools, for example, T testing or F testing. We only judge it on the scatter graph.

## References

- (1) Deakin, M.A.B. "Estimating bound on athletic performance" Mathematics Gazette 51.
- (2) Chatterjee, S. and S. Chatterjee (1982) New lamps for old "An exploratory analysis of running times in Olympic Games". Applied Statistics 31, 14-22.
- (3) Eiichi Moriya "Operations Research" Nihon Rikoh Syuppan Kai (in Japanese).