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# PUNCTUALITY: JAPANESE BUSINESS CULTURE, RAILWAY SERVICE AND COORDINATION PROBLEM

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**—Abstract —**

Many people have impression that Japanese are punctual. In fact, we can easily find data and cases supporting this impression. In contrast, many Western people who visited Japan in the second half of 20th century observed that Japanese seemed to be not punctual. So, it can be safely said that we have punctuality-culture and unpunctuality-culture in Japan. To the best of my knowledge, there is no study explaining logically why such contradictory cultures emerge in one society. One of this paper's purposes is to explain this. In order to do so, I adopt game theoretic approach. Specifically, I consider a game where each agent chooses to be punctual or not. Punctuality has an effect like public goods. I prove that there are two Nash Equilibria in this game. In one equilibrium, each agent chooses not to be punctual. On the other hands, each agent chooses to be punctual in the other equilibrium. This explanation sheds a new light on Japanese business activity. In Japan, railway service is very punctual. But in the beginning of the state-owned railway, the service was unpunctual. There are also contradictory cultures. I explain these cultures using Game theory and suggest some hypotheses about factors creating change from the unpunctuality-culture to the punctuality-culture.

**Key Words:** *Punctuality, Culture, Coordination problem*

**JEL Classification:** D02, D62, N75

## 1. INTRODUCTION

Many people have impression that Japanese are punctual. In fact, we can easily find data and cases supporting this impression. Moreover, many Japanese will agree that time discipline became integral to Japan life. In addition, we can state that many Japanese are pressed for time. Levin (1997) compares the personalities of different cultures using three measurement of the pace of life (walking speeds,

postal times and clock accuracy) and says that 'there is, in fact, considerable evidence that Japan may be the fastest country of all'.

Moreover, there are many business activities in Japan that require each agent to be punctual. I think railway is the most suitable example. For example, in a commuter railway line in Tokyo metropolitan (Yamanote-Line), trains run at intervals as short as 2.5 minutes at peak times. Shinkansen is a network of high-speed railway lines. Nowadays, its maximum speed is not world record, but glancing at its timetable, many people may recognize that Shinkansen is world-class system. Table 1 is a time table of Shinkansen at Tokyo Station (weekday, from 8 to 10 am). I think that it is incredible for a train whose maximum speed is 300km/h to depart the station in every 5 minutes in average.

**Table 1**

| Time | Minute |
|---|---|
| 8 | 00 03 10 20 23 26 30 33 40 47 50 56 |
| 9 | 00 03 10 13 20 23 26 30 33 40 47 50 56 |
| 10 | 00 03 10 13 20 26 30 33 40 50 56 |

Home delivery service is also a good example. In Japan, a customer can specify the arriving time for any package. Someone says that one of the reasons behind Japan's economic growth has been the awareness among Japanese of being punctual.

In contrast, many Western people who visited Japan in the second half of 20$^{th}$ century observed that Japanese seemed to be not punctual. Ernest Satow (1843-1929), a British diplomatic attaché who observed Japanese society before and after the Meiji Restoration (1968), wrote that 'neither clocks nor punctuality were common.' Several decades later, Katharine Sansom, the wife of Geroge Sansom, a notable British historian, noted that 'you must slow down your tempo in Japan.' (Satow (1968), *A Diplomant in Japan* and Sansom (1961), *Living in Tokyo*; These passages are cited in Nishimoto, 2002:120)

From these, it can be safely said that Japanese society has punctuality-culture (now) and unpunctuality-culture (past). There are some studies on these contradictory cultures from the historical viewpoint. Sakae Tsunoyama suggests a two-layer structure on the process of the assimilation of time discipline into Japanese society. In early Meiji period, several modern institutions (factories, schools, railway system) introduced from the West must have worked to facilitate

the implementation of punctual and efficient behavior. Since the early Meiji period, punctuality has been strongly encouraged at these institutions. Modern time discipline came to rule fairly early in factories, schools, and the railway system, as well as in the military. Tsunoyama suggests that the assimilation of punctuality into ordinal life took place long after the war. He speculates that the wide circulation of cheap and precise watches due to the development of quartz timekeepers was a key event in spreading punctual behavior among Japanese people (Tsunoyama, 1998).

To the best of my knowledge, however, there is no study explaining logically why such contradictory cultures emerge in one society. One of this paper's purposes is to explain this. In order to do so, I adopt game theoretic approach. Specifically, I consider a game where each agent chooses to be punctual or not. Punctuality has an effect like public goods. That is, the punctuality has a positive effect on each agent. But if some agents choose not to be punctual, then such a positive effect decreases or vanish. I prove that there are two Nash Equilibria in this game. In one equilibrium, each agent chooses not to be punctual. On the other hands, each agent chooses to be punctual in the other equilibrium. The multiplicity of the equilibria enables us to explain the contradictory cultures logically.

This explanation sheds a new light on Japanese business activity. As mentioned before, punctual operation has been attained by railway in Japan. But in the beginning, the service was unpunctual. There are also contradictory cultures: punctuality-culture and unpunctuality-culture. I explain these cultures and suggest some hypotheses about factors creating change from the unpunctuality-culture to the punctuality-culture.

## 2. PUNCTUALITY and COORDINATION PROBLEM

Why is someone punctual and why is another one unpunctual? If there is no interaction between agents and each agent tries to maximize his or her net benefit, we can easily formulate this problem. Let $B$ the benefit from being punctual and $C$ the cost to be punctual. Then if $B$-$C$>0, then the agents should be punctual; if $B$-$C$<0, then the agents should be unpunctual.

From this formulation, we can say the following. New technology, bringing large benefit and/or reducing cost, makes the agent to be punctual. Or preference, estimating benefit high and/or cost low, results in the agent's punctuality. Innovation could make agents to be punctual. Chang in preference could do so.

From this point of view, the agents' behavior is fully explained by circumstances.

This interpretation, however, cannot explain an agent who is punctual in his or her office but not in his or her house or one who is punctual among his or her friends but not among strangers.

I try to explain such behavior focusing on the interaction between agents. Here, the interaction means that the external effects of punctuality. This is as follows. Assume that all the agents in a group are punctual. Then the agents in the group can start their meeting on time and make decision efficiently. Next consider workers in a factory. If all the works are punctual, part supply in the factory can be smooth. On the contrary, assume that someone is unpunctual. Then all the agents in the group cannot start the meeting on time, and in the factory, part supply will stop, even if the other agents are punctual.

In order to represent such effects, we define an external effect as follows. Denote by $a_i$ the agent $i$'s action. If the agent $i$ is punctual, then $a_i$=1 and if the agent $i$ is unpunctual, then $a_i$=0. We define the external effect by

$E \times \min\{a_1, a_2, \ldots a_3\}$ .

This has the same property as weakest link property defined by Hirshleifer (1987).

Here, if $a_i$=1 for any $i$, the agent $i$'s net benefit is $B$+$E$-$C$; if $a_j$=0 for some $j$, the agent $i$'s net benefit is $B$-$C$ or 0 for any $i$. The following is the pay-off matrix for the two-agent case.

**Table 2**

| | | agent 2 | |
|---|---|---|---|
| | | being punctual | being unpunctual |
| agent 1 | being punctual | $B+E-C$, $B+E-C$ | $B-C$, 0 |
| | being unpunctual | 0, $B-C$ | 0, 0 |

Suppose that $B$-$C$>0 holds. This game has a unique Nash equilibrium, [being punctual, being punctual]. So, only punctuality-culture prevails in the society.

Next suppose that $B$-$C$<0 and $B$+$E$-$C$>0 hold. It is easily proved that this game has two Nash equilibria. One is [being punctual, being punctual] and the other is [being unpunctual, being unpunctual]. This game has the property of coordination games.

From this multiplicity of equilibria, we can say that if the former equilibrium

realizes, then we observe the punctuality-culture; if the latter equilibrium realizes, then we observe the unpunctuality-culture. So, in Japan, the latter equilibrium realized in the past but the former one has realized recently.

Since $B+E-C>0$, the Nash equilibrium [being punctual, being punctual] is Pareto superior to the Nash equilibrium [being unpunctual, being unpunctual]. So if the latter equilibrium realizes, we have coordination failure. In this sense, Japanese faced coordination failure problem in previous time.

## 3. RAILWAY in JAPAN and PUNCTUALITY

I explained co-existence of two cultures in one society from the view point of coordination problem. In this section, I describe business culture in Japan railway, especially co-existence of the punctuality-culture and the unpunctuality-culture.

As mentioned before, in Japan, railway service is very punctual now. But at least until 1910, the delay of train was not rare case. The first railway opened in 1872, which was operated by the state-owned railway. It should be noted that the state-owned railway tried to ensure on-schedule operation. So, the railway refused military use, transport of military personnel, in order to maintain its on-schedule operation. This would be unbelievable when viewed in hindsight. But it could not realize on-schedule operation in those days. (See Nakamura (2002).)

In 1881, the Nihon Railway Company that is the first private company was established. After then, the first railway boom came and many private companies were established. In the beginning of the 20$^{th}$ century, numerous commuter lines united the city centers with the surrounding regions. Increased freight volumes and train traffic movement that accompanied the industrial revolution and the full-scale development of connected transportation among railway companies forced the state and private railways to realize on-schedule operation. With this change, the state and private railways initiated full-scale, serious efforts to establish on-schedule operation after 1900. For example, the Nihon Railway Company tried to secure smooth system operation through a series of steps including the revision of its train movement control systems, significantly expanding the number of employees owning watches, enforcing tight discipline on its employees including stricter regulations on delays, and establishing a pension system for the purpose of keeping experienced labor. But the railways could not maintain on-schedule operation at the beginning of the 20$^{th}$ century. (See Nakamura (2002).)

In 1906, the Diet promulgated the Railway Nationalization Low. Based on this

Low, Japanese Government Railway was established and many private railways were brought under nation control. With World War I and the remarkable development of the Japanese economy, transportation volume increased dramatically. The transportation capacity of the Japanese Government Railway reached its limit. Because of this limitation, Railway tried to realize on-schedule operation in earnest. In addition, the Railway constructed double-track lines, studied time and motion, and changed to the automatic coupling system throughout the entire railroad network, which was entirely new even compared with the railroad in the West. In 1930s, on-schedule operation was realized. (See Takekuma (2002).)

## 4. PUNCTUALITY in RAILWAY and COORDINATION PROBLEM

In this section, I explain the above-mentioned history of the on-schedule operation from the view point of coordination problem.

Railways made some efforts in order to establish on-schedule operation and realized such operation in 1930. Ohshima points out extraordinary intensification of labor (Ohshima (1956 pp.45-46)). This intensification probably involved strict punishment. But I do not think that such intensification and punishment can explain continuation of punctuality-culture observed now because the workers seem to try to be punctual voluntarily now. In addition, I present the old story. In 15 August 1945, Japanese people heard "Jewel Voice Broadcast" through radio broadcast, announcing that the Japanese Government had accepted the Potsdam Declaration demanding the unconditional surrender of the Japanese military at the end of World War II. Almost every Japanese people were sure to be utterly absent-minded. But a train departed on schedule (Miyawaki (1980)). I cannot explain such performance by forcing pressure to workers. It would be unable without each worker's voluntarily motivation. I think that every worker in railways has been proud of their time consciousness.

Takekuma (2002) emphasizes innovation, especially the introduction of the automatic coupling system. I think that new technology could be necessary condition. In fact, such a new technology reduces the cost to be punctual. But reduction of cost does not always result in punctuality-equilibrium. As proved in the section 2, even with small $C$, if $B-C<0$ and $B+E-C>0$ hold, then there are two equlibria, that is punctuality-equilibrium and unpunctuality-equilibrium. If small $C$ implies $B-C>0$, then we have only punctuality-equilibrium. But if this was true,

punctuality-culture could be observed everywhere. (Notice that new technologies spread among every country as time passes.)

In addition to the new technology, Takekuma evaluates the understanding of the concept of operation research. This also reduces the cost, but I think this is only necessary condition.

Next I turn to the market environment. It should be noted that the railway faced the epochal increase in transportation demand and the transportation capacity was limited. In such situation, on-schedule operation made it possible to increase supply. This achieved high revenue for railway and high benefit for each worker and implies large $B$ and $E$. Large $B$ and $E$ had a similar effect to small $C$.

I think that the above-mentioned factors, affecting the benefit and/or cost, are necessary conditions but not sufficient ones as long as $B-C<0$ holds. As explained, the game has two equilibria, the punctuality-equilibrium and the unpunctuality-equilibrium. These factors, however, change the structure of the game. If

$$(B+E-C)(B+E-C)>(<)(B-C)(B-C) \ (\Leftrightarrow \ 2B+E-2C>(<)0)$$

holds, the punctuality-equilibrium risk dominates the unpunctuality-equilibrium. If $E$ is high and/or $C$ is low, the punctuality-equilibrium is likely to risk dominate the unpunctuality-equilibrium.

Kandori, Mailath and Rob (1993) analyze an evolutionary model with a finite number of players and with noise or mutations. They prove that for 2-by-2 symmetric games with 2 symmetric strict Nash equilibria, the equilibrium selected satisfies the criterion of risk-dominance. Based on this result, we can say that the innovation and/or the increase in transportation demand makes the punctuality-equilibrium to be more likely to risk dominant and to be more stable in evolution. So the punctuality-culture emerged in 1930s.

Next, I analyze the game focusing on a point that is not considered before. In 1893, stationmaster, assistant stationmaster, conductors and locomotive engineers were required to carry their own watches (Nakamura (2002, pp.24)). After 1900, the number of employees owning watches was significantly expanded (this is referred in Section 3). I think that this had a profound effect. Consider the case where some agent does not have a watch or his watch is set wrong if he has. Then, the external effect vanishes even if all the agents are punctual. Let $p$ be the

probability that agent has a correct watch. Then the payoff matrix changes as follows.

**Table 3**

| | | agent 2 | |
|---|---|---|---|
| | | being punctual | being unpunctual |
| agent 1 | being punctual | $pB+p^2E-C$, $pB+p^2E-C$ | $pB-C$, $0$ |
| | being unpunctual | $0$, $pB-C$ | $0$, $0$ |

If $p$ is small and $pB+p^2E-C<0$ holds, this game has a unique Nash equilibrium, the unpunctuality-equilibrium. So it changes the structure of games weather each agent has a correct watch or not. In this sense, it is significant that every railway worker has his own watch. In Japan, workers are lent a watch by Company. (This system partially started in 1893). Without this, realization of on-schedule operation would be more difficult task.

## 5. CONCLUSION

In this paper, I explain the co-existence of the punctuality-culture and the unpunctuality culture in one society from the view point of coordination problem. Using result from explanation, I analyze on-schedule operation of railway in Japan. I agree that the factors pointed out by existing studies are important but argue that the factors are necessary condition but not sufficient condition. I think there was the transition of the equilibria. So the change in the game structure and each agent's belief is more important. This is my conclusion.

Last, I discuss another point of coordination problem. In the above game, each agent's action is to be punctual or to be unpunctual. Consider the case where the set of actions is {to be extremely punctual, to be moderately punctual, to be unpunctual}. Assume that the payoff matrix is as follows. Here, $E^E$ is the external effect when each agent is extremely punctual; $C^E$ is the cost to be extremely punctual. Assume that $E^E>E$ and $C^E>C$. If $E^E-C^E>E-C$, $B+E-C>0$ and $B-C<0$ hold, then we have three equilibria, [extremely punctual, extremely punctual], [moderately punctual, moderately punctual], and [unpunctual, unpunctual]. Here, [extremely punctual, extremely punctual] is a Pareto dominant Nash equilibrium.

**Table 4**

| | | agent 2 | | |
|---|---|---|---|---|
| | | extremely punctual | moderately punctual | unpunctual |
| agent 1 | extremely punctual | $B+E^E-C^E$, $B+E^E-C^E$ | $B+E-C^E$, $B+E-C$ | $B-C^E$, 0 |
| | moderately punctual | $B+E-C$, $B+E-C^E$ | $B+E-C$, $B+E-C$ | $B-C$, 0 |
| | unpunctual | 0, $B-C^E$ | 0, $B-C$ | 0, 0 |

Next, assume that there is a peer pressure. That is, an agent who is relatively unpunctual feels pressure from the other agents. Denote by PS this pressure and rewrite the payoff matrix is as follows.

**Table 5**

| | | agent 2 | | |
|---|---|---|---|---|
| | | extremely punctual | moderately punctual | unpunctual |
| agent 1 | extremely punctual | $B+E^E-C^E$, $B+E^E-C^E$ | $B+E-C^E$, $B+E-C-PS$ | $B-C^E$, $0-PS$ |
| | moderately punctual | $B+E-C-PS$, $B+E-C^E$ | $B+E-C$, $B+E-C$ | $B-C$, $0-PS$ |
| | unpunctual | $0-PS$, $B-C^E$ | $0-PS$, $B-C$ | 0, 0 |

When $E^E-C^E>E-C-PS$ and $E^E-C^E<E-C$ hold, there also are three equilibria. In this case, [moderately punctual, moderately punctual] is a Pareto dominant Nash equilibrium. So, the realization of the extreme-punctuality-culture is not socially optimal. But, if we seriously evaluate punctuality and the extreme-punctuality-culture realizes, then such a culture satisfies us and closes the door to more desirable culture. (See also Matsuyama (1996, pp.148-149)).

On 25 April 2005, a tragic railway-accident occurred in Amagasaki, Hyogo Prefecture, near Osaka. In this accident, 106 passengers were killed and 562 injured. Many investigations report that this accident was caused by speeding. The driver increased the train speed in order to recover delay under the pressure to be on time. I infer the extreme-punctuality-culture behind this accident. The punctuality-culture is desirable in many cases. But we should not believe in only one culture idolatrously and should seek diversity.

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