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Shigeru MATSUMOTO and Yang CAO

文部科学省私立大学社会連携研究推進拠点
関西大学政策グリッドコンピューティング実験センター

Policy Grid Computing Laboratory,
Kansai University
Suita, Osaka 564-8680 Japan
URL : https://www.pglab.kansai-u.ac.jp/
e-mail : pglab@jm.kansai-u.ac.jp
tel. 06-6368-1228
fax. 06-6330-3304

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Heterogeneity and Communication Networks among Mothers

Shigeru MATSUMOTO [i, ii]

Yang CAO [ii]

Abstract

Heterogeneity influences the transmission of information among group members. By conducting a survey of mothers with children in kindergartens, we examine whether heterogeneity among mothers influences the degree of information exchange in the classroom. We find that mothers exchange information less frequently when there is a larger difference in their ages. Further, we find that wealthy and well-educated mothers utilize information more intensively. The results suggest that the characteristics of mothers determine the ability of social learning.

Keywords: Information Transmission, Heterogeneity, Social Learning.

[i] Department of Economics, Aoyama Gakuin University
[ii] Policy Grid Computing Laboratory, Kansai University

1 Introduction

When agents cannot determine the costs and benefits of possible choices ex ante, they attempt to obtain information to reduce this uncertainty. Usually, agents often contact peers to obtain relevant information. In fact, agents consult peers even when other reliable sources of information are available. Given the fact that agents obtain large amounts of information from their peers, it is natural to examine whether communication with peers actually changes their behavior.

Social scientists have not paid much attention to the influence of communication with peers on behavior, although they have admitted the importance of communication in everyday life. However, in recent years, they have begun to analyze this aspect very intensively.

A bounded rational agent may respond to his/her neighbors' behaviors and may use the information obtained via casual word-of-mouth communication with them. Theoretical studies demonstrate that such social learning tends to significantly alter the prediction of the standard rational agent model. These studies demonstrate whether social learning aggravates or improves economic efficiency.[1]

Empirical studies on social learning have been conducted in various fields.[2]

[1] Banerjee (1992) and Ellison and Fudenberg (1993, 1995) made early contributions to this field of study. Banerjee argues that social learning leads to an inefficient equilibrium when an agent mimics a neighbor's behavior. In contrast, Ellison and Fudenberg argue that economic efficiency is improved if the agent adopts a superior action through social learning.

[2] It is very difficult to quantitatively measure social effects. Manski (2000) clearly explains the underlying problems of the empirical evaluation of social effects. Since two agents move almost simultaneously, it is difficult to identify which agent moved first. Thus, researchers have faced a difficult simultaneity problem. Two agents often share an environment. Researchers cannot identify whether agents behave similarly because they share the same environment or because they influence each other.

The majority of these studies demonstrate that people modify their behavior through social learning. Many authors argue that the academic performance of students is influenced by that of their peers.[3] Other authors argue that employees consult their colleagues about their life plans.[4] Several authors evaluate the impact of social learning on technology diffusion[5] Some of these studies demonstrate that agents utilize information from neighbors to unequal extents. They attach great importance to information obtained from neighbors sharing similar characteristics.

People do not socialize with everyone to the same extent. Many laboratory experiments have revealed that people trust others in varying degrees based on color, ethnicity, gender, and religion.[6] People select their peers independently. Peer selection can influence an economic outcome. For example, DeMarzo, Vayanos, and Zwiebel (2003) and Glaser and Sunstein (2007) characterize the behavior of the agent who uses the signals obtained from his/her neighbors inappropriately. Then, they show that biased social learning leads to extremism.

People select peers independently and use information obtained from them extensively. Therefore, in order to understand the social learning process, we have to determine the manner in which people choose their peers. The object of this paper is to examine how the characteristics of an agent and heterogeneity among group members

[3] See Angrist and Lang (2004), Hoxby (2000), Sacerdote (2001), Zimmerman (2003), Winston and Zimmerman (2003), and Arcidiacono and Nicholson (2005) for discussion on peer effects in school.

[4] Duflo and Saez (2002) show that the savings decisions of university employees are influenced by the choices of their colleagues. Sorensen (2006) show that a new employee consults his or her colleagues about the choice of a health plan.

[5] Foster and Rosenzweig (1995) and Munshi (2004) studied technology diffusion in the Indian Green Revolution. Then, they demonstrated that farmers take into account their neighbors' experiences when adopting new technologies.

[6] Eckel (2007) provides an excellent summary of the findings of laboratory experiments.

influence the establishment of a communication network.

In this study, we have conducted a survey of mothers with children in kindergarten. We asked mothers to report the facilities that were introduced by other mothers in the kindergarten classroom. By enumerating the number of facilities reported, we measured the ease of establishment of a communication network among the mothers. The mothers were found to report a higher number of facilities when their communication network was strong. We examine how the characteristics of the mothers and heterogeneity in the classroom influence the establishment of a communication network.

The remainder of this paper is organized as follows. In the following section, we explain our survey methodology. In Section 3, we describe our data. We specify our empirical model in Section 4 and report the results in Section 5. We find that mothers exchange information less frequently when there is a larger difference in their ages. Further, we find that wealthy and educated mothers use information from friends more frequently. Section 6 presents the conclusions.

2 Survey Methodologies

We conducted our survey from June 16 to July 10, 2006 in cooperation with the private kindergartens located in Suita City. Suita City is a bedroom town of Osaka City, which is the second largest city in Japan. We attended the annual meeting of the Suita Private Kindergarten Association on June 26, 2006 and asked the directors of all the

kindergartens to assist in our survey.[7] At a later date, we contacted each kindergarten via telephone and asked whether it would participate in our survey. After completing these procedures, we obtained cooperation from seven kindergartens.[8]

A preliminary survey was conducted in one kindergarten, and a main survey was conducted in the remaining six kindergartens. In the following analysis, we use the results obtained from the main survey. We instructed the kindergartens to distribute a questionnaire to their pupils and collect them within 10 business days. In the six kindergartens, 2,237 questionnaires were distributed and 1,541 questionnaires were collected. Therefore, the collection rate was approximately 68.9%.[9] After eliminating the inappropriate questionnaires, we obtained 1,492 samples.

3 Data

3.1 Explained Variables

Before using a new facility, mothers may consult their friends to enquire about its quality. In this survey, we focused on word-of-mouth communication among mothers. In particular, we asked them the following question:

> Is there any private/public facility that was introduced by the mothers in your child's classroom?
>
> If yes, please specify the name of the facility.

[7] All private kindergartens located in Suita City are a part of this association.
[8] There are 17 private kindergartens in Suita City. One kindergarten was used for the pilot survey.
[9] We distributed one questionnaire to each kindergarten student but collected only one questionnaire from each household. The questionnaires were discarded in cases when brothers and sisters attended the same kindergarten. Therefore, the actual collection rate was slightly higher than 68.9%.

The survey result shows that 27.2% of the mothers started using a new public facility through introduction by other mothers. On the other hand, 18.6% of the mothers started using a new private facility.

There was a variation in the number of the facilities reported in the questionnaire. Some mothers reported four facilities, while others reported no facility. In total, 588 public facilities and 378 private facilities were reported.

3.2 Explanatory Variables

3.2.1 Control Variables

If a mother has an older child who goes to elementary school, then she may obtain information from other mothers whose children study in that elementary school. The value of information obtained in kindergarten classrooms is low. In the survey, we asked mothers about the number of children they had.

We also queried about the number of relatives living at close proximity to their houses.[10] If they had relatives living close by, they could obtain relevant information from them. Thus, we expect that mothers use information obtained in kindergarten classrooms less frequently.

The working conditions of mothers may influence the frequency of communication. We asked them about their monthly incomes. Only 6.7% of the mothers replied that their monthly incomes exceeded ¥100,000 ($833). This implies that only a few mothers had a full-time job. We applied a dummy variable for mothers

[10] This refers to the number of relatives living within 10-minutes walking distance.

with incomes exceeding ¥100,000 ($833). Table 1 presents the summary statistics of the control variables, along with the summary statistics of the main explanatory variables.

3.2.2 Heterogeneity among Mothers

We will now examine whether heterogeneity among mothers whose children are in kindergarten classrooms influences the degree of information exchange among them. In particular, we examine whether the number of facilities recorded in the questionnaires varies depending on mother's age, mother's educational background, and spouse's income. For example, we examine whether mothers exchange information more frequently when there is a smaller difference in their ages or vice versa.

There are 77 classrooms in the six kindergartens. In each of the classrooms, we calculated both the mean and standard deviation of the mother's age and educational background and the spouse's income. The statistics of "classroom means" and "classroom standard deviations" are presented in Table 2. For example, the table shows that the mean age of mothers in the classroom with the youngest mothers is 32.50 years, while that of the oldest mothers is 37.59. The maximum classroom standard deviation is 5.16, while the minimum classroom standard deviation is 1.86.

Figures 1.a and 1.b. describe our hypothesis. In these histograms, the mother's age is assigned to the horizontal axis, and the frequency of each age, to the vertical axis. Figure 1.a. corresponds to the case in which there is a large age variation. Figure 1.b

corresponds to the opposite case. The shaded area represents the probability of mother i to interact with the mothers in her cohort group. This shaded area decreases with an increase in the age variation in the classroom. Therefore, we expect that an increase in the classroom standard deviation reduces the opportunity of information exchange and decreases the number of facilities reported in the questionnaires.

3.2.3 Mothers' Deviation from the Classroom Mean

If a mother is very different from the average mother in the classroom, it becomes difficult for her to locate communication partners. For example, if a young (old) mother is assigned to the classroom composed of old (young) mothers, then she may not be able to actively communicate with other mothers. Therefore, a mother's deviation from the classroom mean can influence her behavior. To measure a mother's deviation from the classroom mean, we calculate the t-statistics. We first subtract the classroom mean from mother i's value. This is depicted as the distance from the classroom mean in Figure 1.a. Then, we calculate the t-statistics by dividing this distance by the classroom standard deviation.

4 Model

Since the number of facilities reported is defined for nonnegative integer values, we estimate the following negative binomial model by the maximum likelihood method.

$$\Pr ob(Y = y_i) = \left[\frac{\Gamma(y_i + 1/\alpha)}{y_i!\Gamma(1/\alpha)}\right]\left[\frac{1}{1+\alpha\lambda_i}\right]^{\frac{1}{\alpha}}\left[\frac{\alpha}{1+\alpha\lambda_i}\right]^{y_i} \quad (1)$$

where i indexes the mother, Γ represents the gamma function, y_i denotes the number of public/private facilities recorded in questionnaires, and α denotes the dispersion parameter. The mean and variance of this model are

$$E\left[y_i|\mathbf{X}_i,\boldsymbol{\beta}\right]=\lambda_i=\exp\left(\mathbf{X}_i'\boldsymbol{\beta}\right) \quad (2)$$

and $$Var\left[y_i|\mathbf{X}_i,\boldsymbol{\beta}\right]=\lambda_i\left(1+\alpha\lambda_i\right) \quad (3)$$

respectively, where $\mathbf{X}_i$ denotes the vector of explanatory variables that include control variables, classroom standard deviations, mother's deviation from the classroom means, and dummy variables for five kindergartens. We simultaneously estimate the dispersion parameter α and the parameters $\boldsymbol{\beta}$ for the explanatory variables by the maximum likelihood method. This is the approach proposed by Cameron and Trivedi (1990).

5 Results

Table 3 presents the regression results. The result for public facilities is presented in the first column, while the result for private facilities is presented in the second column. The last column presents the result of the aggregated data.

The classroom standard deviation of the mother's age becomes significant in all three estimations. The parameter sign is negative, which implies that mothers exchange information less frequently when there is a large difference in their ages. Young mothers do not communicate with senior mothers in the classroom and vice versa. The classroom standard deviation of the spouse's income becomes significant in the aggregated model. The parameter sign is positive, which implies that mothers

exchange information more frequently when the income variation in the classroom is large.

The spouse's income becomes a significant factor with regard to the mother's deviation. The positive sign implies that wealthy mothers use information from friends more actively. It is also worth reporting that the parameter size in the private facility model is smaller than that in the public facility model. Perhaps having a higher income allows wealthy mothers to use new private facilities.

The mothers' deviation with regard to their educational background becomes significant. The sign of this variable is positive, which implies that mothers with high educational backgrounds use information from friends more actively. The sizes of the parameters are almost the same between public and private facilities.

6 Conclusions

Heterogeneity influences the frequency of communication among group members. When members have common characteristics, they establish a communication network. This implies that information is exchanged more efficiently in a homogeneous group.

An agent obtains new information from other group members. The degree of use of group information varies among group members. Our empirical results demonstrate that the relative position of the agent in the group determines his/her degree of information usage. It was found that wealthy and well-educated individuals use group information more actively.

In this paper, we focused on the ease of establishment of a communication

network. We then argued that the establishment of this network becomes difficult with an increase in heterogeneity. We ignore the value of information exchanged among heterogeneous group members. However, communication among heterogeneous group members could be more valuable than that among homogeneous group members. In future research on social learning, it is necessary to investigate the kind of information collected by people, from whom they obtain this information, and in what setting.

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Figure 1.a. Example of Large Heterogeneity

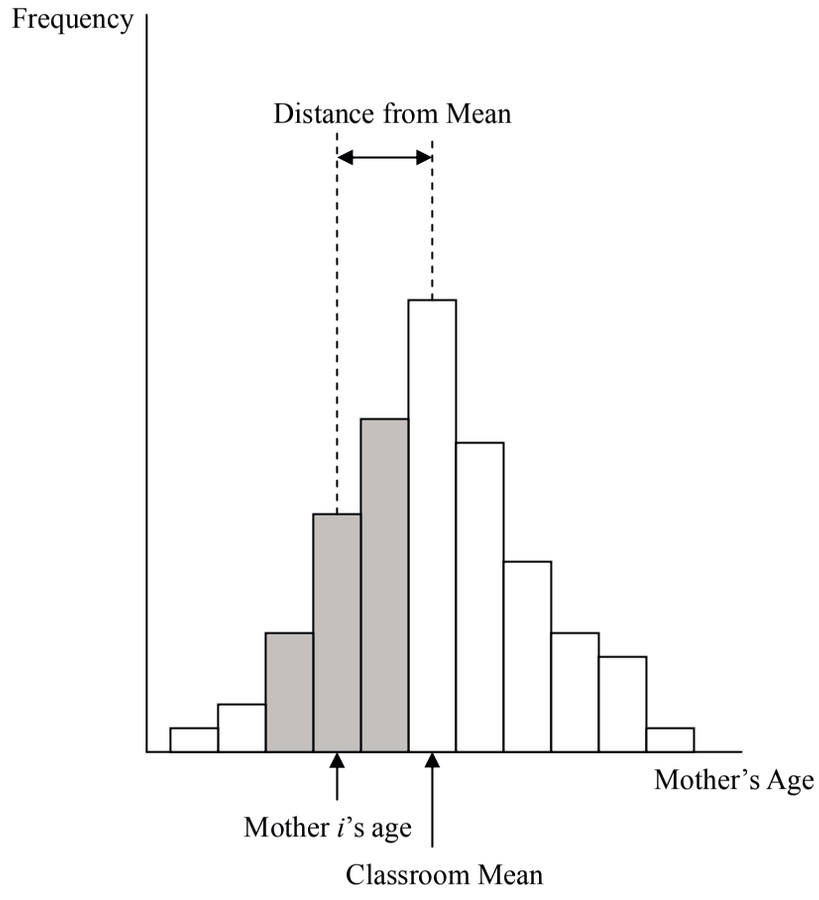

Figure 1.b. Example of Small Heterogeneity

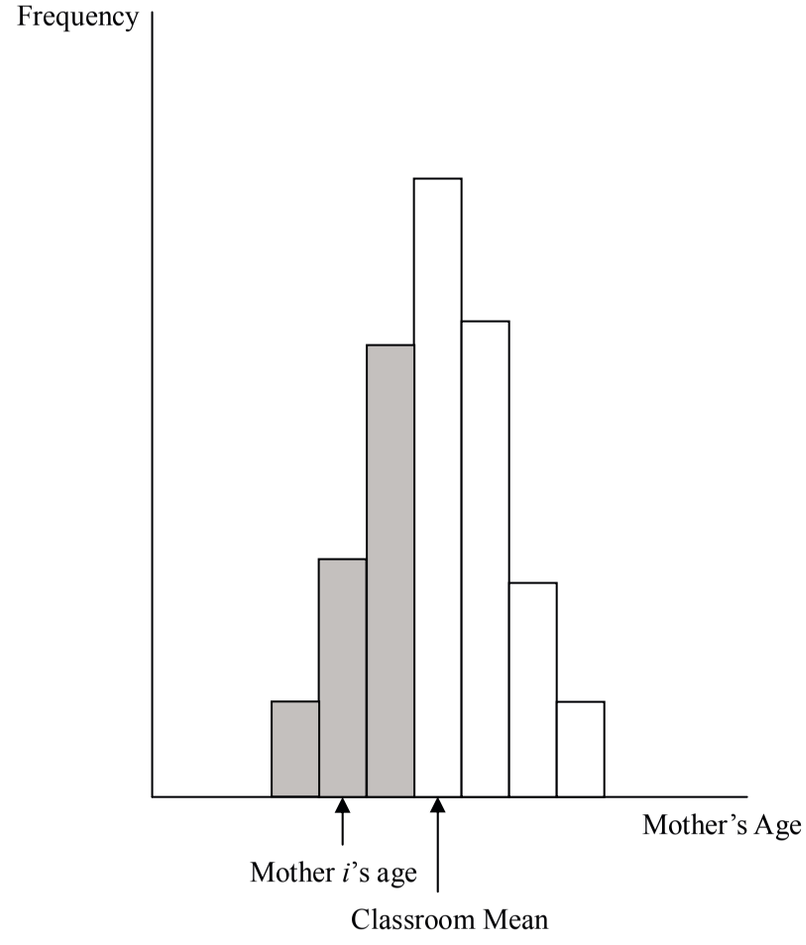

Table 1. Descriptive Statistics

	Mean	Standard Deviation	Max	Min	Number of Observations
Mother's Age	34.97	3.75	51	24	1471
Mother's Education [a]	3.64	1.11	7	1	1420
Spouse's Income [b]	4.88	1.79	9	1	1360
Number of Children	1.95	0.61	4	1	1486
Number of Relatives	0.22	0.42	2	0	1444

Note.

a. Last school attended: 1 = middle school, 2 = high school, 3 = technical school, 4 = community college, 5 = college, 6 = graduate school.

b. Monthly income: 1 = below ¥10,000 ($833); 2 = ¥100,000～¥199,999 ($833～$1665); 3 = ¥200,000～¥299,999 ($1,666～$2,498); 4 = ¥300,000～¥399,999 ($2,499～$3,333); 5 = ¥400,000～¥499,999 ($3,334～$4,167); 6 = ¥500,000～¥599,999 ($4,168～$5,000); 7 = ¥600,000～¥699,999 ($5,001～$5,833); 8 = ¥700,000～¥799,999 ($5,834～$6,667); 9 = above ¥799,999 ($6,668).

Table 2. Variation across Classrooms

	Min	Max	Mean [a]	STD [b]	Number of Observations
Classroom Mean					
Mother's Age	32.50	37.59	34.96	1.17	77
Mother's Education [c]	2.88	4.45	3.65	0.30	77
Spouse's Income [d]	3.86	6.60	4.87	0.46	77
Classroom Standard Deviation					
Mother's Age	1.86	5.16	3.65	0.59	77
Mother's Education [c]	0.52	1.42	1.09	0.16	77
Spouse's Income [d]	0.83	2.50	1.76	0.36	77

Note.

a. It implies the mean of 77 classroom means and standard deviations.

b. It implies the standard deviation of 77 classroom means and standard deviations.

c. Last school attended: 1 = middle school, 2 = high school, 3 = technical school, 4 = community college, 5 = college, 6 = graduate school.

d. Monthly income: 1 = below ¥10,000 ($833); 2 = ¥100,000～¥199,999 ($833～$1665); 3 = ¥200,000～¥299,999 ($1,666～$2,498); 4 = ¥300,000～¥399,999 ($2,499～$3,333); 5 = ¥400,000～¥499,999 ($3,334～$4,167); 6 = ¥500,000～¥599,999 ($4,168～$5,000); 7 = ¥600,000～¥699,999 ($5,001～$5,833); 8 = ¥700,000～¥799,999 ($5,834～$6,667); 9 = above ¥799,999 ($6,668).

Table 3. Heterogeneity and Network among Mothers

	Public Facility		Private Facility		Aggregated	
Mother's Own Characteristics						
Number of Children	−0.07	(0.09) [a]	−0.25**	(0.12)	−0.11	(0.08)
Number of Relatives	−0.13	(0.13)	−0.02	(0.19)	−0.07	(0.12)
Mother's Job	0.09	(0.23)	0.00	(0.35)	0.08	(0.22)
Classroom Heterogeneity [b]						
Mother's Age	−0.33***	(0.09)	−0.38***	(0.11)	−0.30***	(0.08)
Education	0.10	(0.32)	−0.15	(0.36)	0.24	(0.27)
Spouse's Income	0.16	(0.15)	0.23	(0.18)	0.28***	(0.14)
Mother's Deviation from Classroom Mean [c]						
Mother's Age	−0.07	(0.06)	0.03	(0.08)	−0.03	(0.06)
Mother's Education	0.28***	(0.06)	0.29***	(0.08)	0.28***	(0.06)
Spouse's Income	0.10*	(0.06)	0.21***	(0.07)	0.15***	(0.05)
Kindergarten Fixed Effects (Dummy Variables)						
Kindergarten 2	0.43*	(0.23)	0.11	(0.34)	0.33	(0.24)
Kindergarten 3	−0.14	(0.16)	0.04	(0.19)	−0.05	(0.14)
Kindergarten 4	−0.28*	(0.17)	–0.01	(0.19)	−0.11	(0.15)
Kindergarten 5	−0.12	(0.17)	–0.27	(0.22)	−0.10	(0.15)
Kindergarten 6	−0.44*	(0.24)	–0.68**	(0.31)	−0.49**	(0.21)
Overdispersion α	0.95***	(0.20)	1.51***	(0.33)	1.25***	(0.15)
Number of observations	1281		1281		1281	
Log likelihood	−1055.04		−784.53		−1389.12	

Note.

a. Numbers in the parentheses indicate standard errors.

b. Classroom standard deviations

c. Mother's deviation = (mother's own value − classroom mean)/classroom standard deviation.

d. * denotes significance at the 10% level; **, at the 5% level; and ***, at the 1% level.