Social Capital on Net-Bases : A Methodological Note

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Social Capital on Net-Bases:
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Abstract

The common attributes (as regards home town, school, work place, and so on), which we call 'net-bases,' connect the holders each other, often beyond time and physical space. When given two persons are connected through a common net-base, we see the tie as being embedded in a socio-centric network that is ideally defined by all of the attribute holders and their relations. We assume that the overall configuration of net-bases conditions the value accumulation process of social capital. In this conceptual framework, this paper develops a method of analyzing personal network data in order to examine the relationship between net-base configuration and social capital. Analogously as group affiliation of persons, we measure net-base affiliation of personal ties and specify matrices that represent two respects of the net-base configuration: multiplicity and linkage. We examine the relationship of these indices with social capital, and its difference between income strata.

Keywords: Net-base, social capital, social network configuration

1. Social Capital as a Perspective

In these two decades, the traditional concept of social relation has been reformed by new terms in rational choice theory: trust, solidarity, and social capital that this paper focuses on. Trust is the matter of inter-personal evaluation that reduces uncertainty and influences on utilities. Solidarity is the matter of group property that is analogous to collective goods. Comparing with these two, it seems difficult to find a particular place for social capital. It is unlimitedly defined for every beneficial resource in social structure by Coleman (1990), but is specified by Lin (2001) as social resources owned by others in a network. Depending on researchers, the social resource could be trust, social norms, and social networks themselves (Putnum 1993). Its functioning is validated for beneficial outcomes at the individual level like as getting better jobs, or is validated for success of collective action like as sustainable development projects and political movements. Under the same conception, levels and objects of analysis are considerably diverse.

The diversity is in part caused by too easy usage of the concept; on the other hand, it well suggests what 'social capital' shall be. Our idea in this paper is that it is a perspective rather

than a concrete concept, and its focus is to find a market-like mechanism in social relations and their networks. Therefore, depending on what media, what resource, and which aspect of functioning researchers focus on, the mechanism can be variously specified conceptually or can be variously pictured empirically. However, beyond the diversity, this perspective requires every study on social capital to have a common macro viewpoint. Because, as like as the relationship between individual investment behaviors and economic market, social capital is the matter of accumulation or aggregation process through which investment on individual ties can bring surplus value (return).

This macro viewpoint is efficiently secured in terms of that we focus on socio-centric whole networks (simply, 'social networks') rather than ego-centric personal networks. Indeed, the primary field where stock and flow of social resources take place would be a social network. Then, the market-like mechanism is described for overall configuration of social networks in a society, and personal networks can be seen as a kind of 'personal account' through which investment and return are locally observable. A big problem here is that we can never precisely measure social networks. In this paper, by introducing the concept of net-base, we devise a provisional method for measuring the configuration of social networks, being based on personal network data.

2. Net-Base

The net-base conceptualizes a field where social relations, being embedded in it, construct a social network, and social capital works (its investment and return are taken place) on it. Since social capital is a hypothetical mechanism, we cannot empirically follow the value accumulation process. What we can do is getting a clue to surplus profit in 'personal account,' and then inferring the functioning of social capital that should generate the profit. By introducing the net-base for a unit field of the mechanism of social capital, and by analyzing the configuration of various net-bases, we can further question: Under what structural conditions for the mechanism of social capital, do social relations get significance as social capital more vividly?

In fact, the net-base indicates a common attribute that connects people who share it. It means more than a connector, because we emphasize the respect that it latently indicates a particular social network. 'Latently' means that the people may not have active ties each other in fact, but they *could* activate the latent connections if they want. For instance, "2005 alumni of high school S" is a net-base, and it latently indicates a social network that consists of all of the graduates in 2005 from the school. We can also consider highly abstracted net-bases such as "imagined community" (Anderson, 1983); however at moment, we only suppose concrete bases: kinship, alumni, colleagues, same home town, and so on. Of course, it may include various club or association memberships.

Definition 1: The net base is a commonly shared attribution that latently indicates a particular social (socio-centric) network.

In order that social capital is the capital, it is necessary for us to consider a mechanism through which investment at cost makes a stock that will bring return in the future (Yamasaki 2004) [1)]. As is already discussed, we consider that the mechanism primarily exists in social networks, rather than in individual ties. The following two assumptions hypothetically describe the mechanism in details.

Assumption 1.1: A person's investment on social capital stimulates the circulation of value in a social network on the invested net-base. And/or it increases the opportunity for the investor to access the value.

Assumption 1.2: Investment by more persons who share the same net-base accumulates or amplifies the circulating value in a social network on the invested net-base, which makes social capital more profitable.

Let us consider membership in a club. The membership is a net-base that latently indicates a social network consisting of all the members. On the social network, an amount of social resources circulates in proportion to the members' activities and contributions (investment). Probably only a partial network might be activated for the circulation. However, even isolated members or newcomers can easily link to the active network through certain investment, as far as they hold the membership. The additional investment will stimulate the resource circulation or create new value, and will make the net-base more profitable for every member. Membership may not be so strict for more abstract net-bases; however, the basic process is the same. As will be noticed, the mechanism is analogous to the provision of collective goods (Yamasaki 2004).

The provision of collective goods is conditioned by solidarity in the social network (Hechter 1987) and by network closure (Coleman 1990) as well. Therefore, access to highly profitable social capital tends to be limited. Even though, the access cannot be perfectly limited to the people who share the attribute in question. Speaking for the example above, it is possible for someone to link to the active network in the club without getting the formal membership. Sharing another attribute with some member in the club should be sufficient for making it. This is a kind of free rider problem in rational choice context; at the same time, the free riding calls our attention to structural holes (Burt 1992) and weak ties that bridge the holes (Granovetter 1973) in social networks context. Generally, this kind of connection between different net-bases will increase the potentiality as capital for each (Lin 2001:

Chap.5). On the contrary, however, the connection could break solidarity or closure, resulting in decrease of profitability for either or both of the net-bases. It is a critical issue to keep in mind when we investigate the configuration of net-bases.

We aim an empirical study of social capital under the above-mentioned theoretical framework. However, at present in this paper, we fix our purpose on technical discussions in order to bridge between personal network data and social network analysis [2)]. Conceptually the net-base is exactly the bridge; however, it additionally requires technical devices to put the concept in data analysis. In this paper, borrowing the idea of bipartite graph, we develop a consistent method through measurement and analysis.

3. Data and Frame of Analysis

We use two kinds of data. One is a purely pilot survey data that was gathered for 136 undergraduate students in a class at Kyushu University (Fukuoka, Japan), in December 2003 (we call it 'KU survey'). In this case, students responded on the following three personal-net items: (1) your three best friends, (2) connection (net-base) between you and each of them, (3) whether you have received monetary or mental support from them (see **Appendix 1** for the questionnaire in details). Item (2) is a multiple choice among fixed twelve net-base categories, and we cannot know the contents more in details. Therefore, we have to be sure that, even if two students commonly chose 'high school base,' it never means that they graduated the same school. 'High school base' for a net-base category is in fact a set of net-bases. This restriction holds for subsequent data analysis, too. Inversely speaking, we presume that every high school alumni falls into the same category, and is distinguished from other net-bases, as regard the functioning for social capital.

The other is a questionnaire resume in a sampling survey that we conducted in the central district of Fukuoka city, Japan, in September 2004 (we call it 'Fukuoka survey'). We extracted 600 male and female adults by two-stage sampling, and collected 120 samples through postal survey (collection rate at 20%). In the resume we asked: (1) support by (one) best friend, (2) support by someone who was introduced by the best friend, (3) connection between respondent and the best friend, and connection between the friends. Support was divided into three aspects: monetary, mental, and information. Item (3) is a multiple choice among fixed fourteen net-base categories, and we neither can know the contents more in details. (See **Appendix 2** for the questionnaire in details.)

While the purpose is to capture the extension of social capital through direct ties for KU survey, is it through indirect ties for Fukuoka survey. Beyond the difference, we carefully arranged the questionnaires so as to the data falling into the same frame of analysis. The point of the frame is, applying the idea of bipartite graph that represents individual's group affiliation, to sum up the responses for the net-base unit [3)].

Technically, the point is how to make a K×K matrix (let it $\boldsymbol{R}$), where K is the number of net-base categories. $\boldsymbol{R}$ represents the connection between the net-bases; however, it could have different significance according to the focused tie. The following is a simple example. Through the questionnaire above, we know that to which net-base each respondent-friend tie corresponds, and can summarize the information for a matrix $\boldsymbol{A}$, as follows. Locate I respondents in the row (I represents the number), and K net-bases in the column, then, let a_{ik}=1 if the tie between respondent i and his/her friend corresponds to net-base k, or let a_{ik}=0 otherwise. We treat this I×K matrix, $\boldsymbol{A}$, as if an affiliation matrix. Substantially, if a tie corresponds to 'high school base,' we say that the tie *belongs to* 'high school base' (more strictly, *belongs to* a social network in the base category). Now, by calculating $\boldsymbol{R}={}^{t}\boldsymbol{A}\boldsymbol{A}$ (${}^{t}\boldsymbol{A}$ is the transposed matrix of $\boldsymbol{A}$), $\boldsymbol{R}$ (K×K) represents the connection between the net-bases through all of the respondent-friend ties.

Notice that it is a tie, not an individual, which *belongs to* a net-base. Even if a respondent graduated a high school, it does not reflect on our data unless the respondent's best friend is a classmate at the school. Therefore, we cannot regard the affiliation as that of a person. In order to avoid confusion, when we refer to the relationship between respondents and net-bases, we say, "(through a tie) the net-base is *connected* to the respondent."

At first, for KU survey data, after explaining basic indices for sole net-base, we introduce several methods to construct matrix $\boldsymbol{R}$ in order to capture the configuration of plural net-bases.

4. Analysis of KU Survey Data

4.1. Investment and Return

Basic indicators for the level of investment on each net-base are **tie-number** and **connection-number**. When a respondent has two or more friends on net-base k, while tie-number sums up each of them, connection-number counts them together for one. These lead two kinds of investment index. One is **investment rate** for net-base k, which is defined for connection-number of base k divided by the total number of respondents. (For confirmation, it is equivalent to the proportion at which the respondents have a friend on net-base k.) The other is **index of concentration**, which is defined for average tie-number on connection-number. Simply speaking, we regard having a friend as investment. The interpretation will make sense in that having a friend accompanies spending time, labor, and money, or effort to be trustworthy.

With regard to the investment indices above, we do not need to consider whether the respondents actually received support through the ties (or the connections). It is the matter of social capital ability of a net-base, briefly, the matter of return. We simply define return indices by the rate at which support event happened on net-base k. **Index of tie-return** calculates the rate based on tie-number, and does **index of connection-return** based on

connection-number. These are rough measurement of social capital return because it ideally shall be measured for net profit.

Table 1. Investment and Return for Net-Base Category, KU Survey

Net base	Connection-number	Tie-number	Investment rate	Concen-tration	Connection-return	Tie-return
①Relatives	5 (1.5)	5 (1.0)	0.04	1	0.8	0.8
②Home town	32 (9.7)	51 (10.0)	0.24	1.59	0.59	0.49
③Lower school	40 (12.1)	48 (9.4)	0.30	1.2	0.63	0.58
④High school	77 (23.3)	107 (21.1)	0.57	1.39	0.64	0.56
⑤Preparatory school	21 (6.4)	24 (4.7)	0.16	1.14	0.86	0.88
⑥University	119 (36.1)	227 (44.7)	0.88	1.91	0.55	0.51
⑦Part time job	10 (3.0)	11 (2.2)	0.07	1.1	0.7	0.64
⑧Circle, club	9 (2.7)	11 (2.2)	0.07	1.22	0.44	0.36
⑨Volunteer	1 (0.3)	1 (0.2)	0.01	1	1	1
⑩Internet, mobile	6 (1.8)	10 (2.0)	0.04	1.67	0.67	0.8
⑪Friend of friend	7 (2.1)	8 (1.6)	0.05	1.14	0.57	0.63
⑫Other	3 (0.9)	5 (1.0)	0.02	1.67	1	0.8
Total	330(100.0)	508(100.0)	2.44	1.54	0.62	0.56

*) For connection-number and tie-number, the figure indicates frequency, with its proportion in parentheses. When a respondent is connected to a given net-base through plural ties, while the former counts them for one, does the latter each of them.

*) Investment rate = connection-number ÷ number of respondents (135), indicating the proportion of the investor on the net-base. 2.44 (=330÷135) for 'total' indicates the average number of net-bases that are connected to a respondent.

*) Concentration = tie-number ÷ connection-number, indicating the average amount of investment on the net-base per connection.

*) Connection-return = number of connections that provided support ÷ connection-number, indicating the proportion of profitable connections on the net-base.

*) Tie-return = number of ties that provided support ÷ tie-number, indicating the proportion of profitable ties on the net-base.

By summing up 'personal accounts' in this way, we numerically capture input and output of the process where a set of social networks corresponding to a given net-base, by being invested, works for social capital (accumulates value to provide profits). Table 1 summarizes the indicators and the indices for KU survey data. Here, we included all of the ties and connections for three friends in summations; however, it is possible to make the calculation for a focused friend (for example, No.1 friend among the three) [4)], as we will later do for Fukuoka survey data. As a matter of course, those net-bases to which the students' ties most frequently belong (therefore, that show the highest investment rates) are university base and high school base, and they are followed by lower school base and home town base. Since index of concentration is relatively higher for these bases, the investment is concentrated on these bases in double sense. On the contrary, indices of tie-return and connection-return for these bases are not high so much. In a sense, this should be the investment of low efficiency.

4.2. Multiplicity of Net-Base

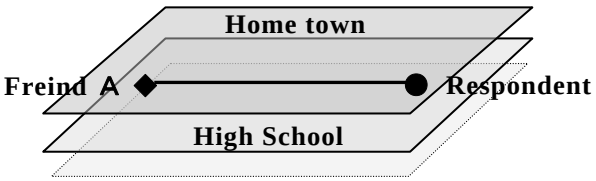

Figure 1. Multiplicity

When a tie belongs to plural different net-bases, as illustrated for Figure 1, we call the characteristic multiplicity. Connection by a tie with higher multiplicity will be stronger, just because it implies more cumulative friendship. In order to distinguish from the distance-base dichotomy between strong tie and weak tie, we use another dichotomy between **solid tie** and **fragile tie** to designate the difference of multiplicity. However, this terminology is primarily for characterizing the connections that a network has. So that, when a net-base has more connections that consist of solid ties, we say that multiplicity of the net-base is higher.

For the purpose to measure multiplicity we make a K×K matrix, $\boldsymbol{M}$, in the following way (K is the number of net-base categories. K=12 for KU survey data). Let T the total number of respondent-friend ties and assign a sequential number, from 1 to T, for every tie. Then, we define $\boldsymbol{M_t}$ for each tie, fixing the element (k, l) for 1 only if t^{th} tie belongs to k^{th} and l^{th} net-base at the same time, or fixing it for 0 otherwise. $\boldsymbol{M_t}$ represents multiplicity of t^{th} tie. The matrix $\boldsymbol{M}$ that represents multiplicity between net-bases overall, is the matrix summation of these $\boldsymbol{M_t}$ over t (t=1, 2,…,T).

Table 2. Multiplicity Matrix $\boldsymbol{M}$ and the Indices for KU Survey Data

	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	Multiplicity	
													Level	Range
①Relatives	5	0	0	0	0	0	0	0	0	0	0	0	0	0
②Home town	0	51	23	34	4	4	0	2	0	2	1	0	1.37	7
③Lower school	0	23	48	22	2	1	0	2	0	1	0	0	1.06	6
④High school	0	34	22	107	10	10	0	1	1	1	0	0	0.74	7
⑤Preparatory school	0	4	2	10	24	3	0	0	0	1	0	1	0.88	6
⑥university	0	4	1	10	3	227	4	3	1	5	2	1	0.15	10
⑦Part time job	0	0	0	0	0	4	11	0	0	1	0	0	0.45	2
⑧Circle, club	0	2	2	1	0	3	0	11	0	0	0	0	0.73	4
⑨Volunteer	0	0	0	1	0	1	0	0	1	0	0	0	2	2
⑩Internet, mobile	0	2	1	1	1	5	1	0	0	10	0	0	1.1	6
⑪Friend of friend	0	1	0	0	0	2	0	0	0	0	8	2	0.63	3
⑫Other	0	0	0	0	1	1	0	0	0	0	2	5	0.8	3

*) The figure is the number of ties for each combination of multiplicity. The diagonal indicates tie-number.

As the main diagonal in $\boldsymbol{M}$ represents just tie-number for each net-base, the diagonal cells have nothing to do with multiplicity. The **level of multiplicity** of k^{th} net-base is defined for sum of the cells in k^{th} row except for the main diagonal cell, divided by the tie-number of k^{th}

net-base. Moreover, after transforming the figure in every non-zero cell into 1 (leaving zero-cells as they are), the **range of multiplicity** of k^{th} net-base is defined for sum of the cells in k^{th} row except for the diagonal cell.

Table 2 indicates the matrix ***M*** for KU survey data, and reports the indices for multiplicity defined above. With regard to the multiplicity of university base, the main net-base for the students, the range is high but the level is considerably low. In other words, the connections of university base mainly consist of fragile ties, suggesting that the fragility might explain low connection-return of the base.

4.3. Linkage of Net-Base

For KU survey, linkage highlights the respect that three ties belonging to different net-bases link each other, being intermediated by a respondent (see Figure 2 for an illustration). Focusing on respondents who have ties belonging to k^{th} net-base, linkage of k^{th} net-base is stronger when the respondents' other ties more widely disperse on different net-bases. On the contrary, when their ties are more concentrated on k^{th} base, the linkage is weaker. Thus, strong linkage means that the net-base is open because it has many bridges (respondents, here) that mediate between the base and other different bases. Inversely, weak linkage means that the net-base is closed [5)].

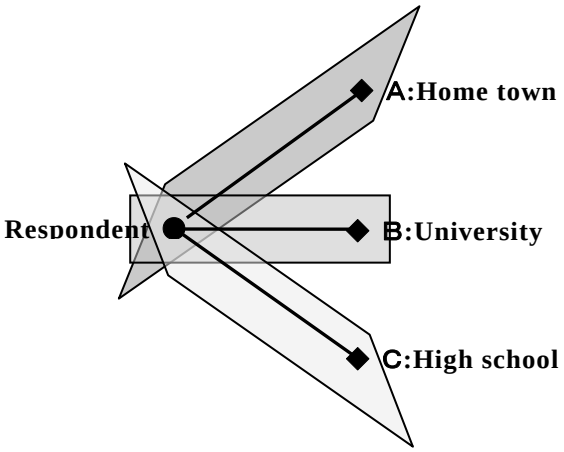

Figure 2. Linkage

In addition to this respondent-intermediate linkage, we will see later another type for Fukuoka survey, friend-intermediate linkage. The difference is illustrated for Figure 3. When we stand on the respondent's point of view, the significance of respondent-intermediate exists in that the respondent, as a bridge, can have selective access to different social networks. On the other hand, the significance of friend-intermediate exists in that, by utilizing friend A, the respondent can get a chance to access to another net-base that he/she does not have direct connection. What does the difference mean from the viewpoint of net-base? Since "who the mediators is" has no significance for a net-base, both types describe the same linkage channel. However, influence of the channel on social capital will be differently described, because observation points (the respondent's positions in the channel) are different. To observe the channeling effect on social capital, while respondent-intermediate fixes the observation point exactly on the channeling position, friend-intermediate fixes it on the user's position. As either of them has its proper significance, ideally, we need to measure each and analyze them together [6)].

Figure 3. Respondent-intermediate (left) and Friend-intermediate (right) Linkage

Table 3. Linkage Matrix ***C*** and the Indices for KU Survey Data

	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	Linkage	
													Level	Range
①Relatives	5	2	2	1	1	4	0	0	0	0	0	0	2	5
②Home town	2	32	19	25	6	27	1	2	0	2	1	0	2.66	9
③Lower school	2	19	40	31	6	30	3	2	0	1	1	0	2.38	9
④High school	1	25	31	77	14	61	7	5	1	2	4	0	1.96	10
⑤Preparatory school	1	6	6	14	21	19	0	0	0	1	0	1	2.29	7
⑥university	4	27	30	61	19	119	8	7	1	5	5	3	1.43	11
⑦Part time job	0	1	3	7	0	8	10	1	0	2	0	0	2.2	5
⑧Circle, club	0	2	2	5	0	7	1	9	0	0	0	0	1.89	5
⑨Volunteer	0	0	0	1	0	1	0	0	1	0	0	0	2	2
⑩Internet, mobile	0	2	1	2	1	5	2	0	0	6	0	0	2.17	6
⑪Friend of friend	0	1	1	4	0	5	0	0	0	0	7	1	1.71	4
⑫Other	0	0	0	0	1	3	0	0	0	0	1	3	1.67	3

*) The figure is the number of respondents who bridge over the bases for each combination. The diagonal indicates connection-number.

The calculation of linkage of a net-base follows the next procedure. We make a K×K matrix, $\boldsymbol{C}_n$, being correspondent to every respondent (n=1, 2,…,N: N is the number of respondents. K is the number of net-bases). For element (k, l) in $\boldsymbol{C}_n$, let it 1 if either of three respondent-friend ties makes a link between k^{th} base and l^{th} base, or let it 0 if the ties make no link between the bases. Thus, we have N matrices that represent linkage as regards every respondent. The matrix ***C*** that represents linkage between the net-bases overall, is the matrix summation of these $\boldsymbol{C}_n$ over n. The number of ties does not a matter here; so that, the diagonal in ***C*** represents connection-number for each net-base, and has nothing to do with linkage. The **level of linkage** of k^{th} net-base is defined for sum of the cells in k^{th} row except for the main diagonal cell, divided by the connection-number of k^{th} net-base. Moreover, after transforming the figure in every non-zero cell into 1 (leaving zero-cells as they are), the **range of linkage** of k^{th} net-base is defined for sum of the cells in k^{th} row except for the diagonal cell.

Table 3 indicates the matrix ***C*** for KU survey data, and reports the indices for linkage defined above. University base and high school base, the students' main net-bases, show wide ranges of linkage, but the levels are lower (especially for university base). This indicates that

these net-bases have fewer bridges (respondents, here) that are located on channeling positions. It might additionally explain low connection-return of these bases.

4.4. Social Network Configuration and Social Capital

Now we are ready to look at the social network configuration from two angles: multiplicity and linkage. By Pearson's correlation coefficients, Table 4 roughly examines relationship of investment and social network configuration with return [7]. As expected by lower return of the main net-bases (especially of university base), the indices for investment (investment rate and concentration) reveal the reverse correlation with return. Investment by more students, or through more ties at once, never corresponds to the social capital ability of the invested social network. Probably under the influence of university and high school bases, too, the range indices also inversely related to return. Being connected to other net-bases more diversely through solid ties, or through bridges, never corresponds to the social capital ability of the social network.

Table 4. Correlation of Investment and Network Configuration with Return

	Connection-return	Tie-return
Investment rate	−. 41	−. 46
Concentration	−. 22	−. 31
Multiplicity		
Level	. 33	. 34
Range	−. 46	−. 44
Linkage		
Level	−. 01	. 03
Range	−. 55	−. 56

In fact, only index that reveals positive correlation with return is the level index of multiplicity. As regards ties on a net-base, the higher the proportion of solid ties among them, the more profitable the corresponding social network. This result supports our previous hypothesis that low social capital ability of the students' main net-bases is caused by fragility of the bases. However, being against another hypothesis, it cannot be explained by the closed characteristic of the bases. Because, linkage must be positively related to return if the hypothesis generally holds; although the level of linkage has nothing to do with return.

'Making the multiplicity higher, but the range narrower.' This phrase states the condition for functioning of social capital that is derived through the above analysis. This condition cannot be identified with such notions as strong tie, closure, and commitment. However, the implied situations seem to be very close to each other, at the very least, compared with those situations implied by weak ties and general trust. Of course, the result might be biased by simpler life environment for (local) university students.

5. Analysis of Fukuoka Survey Data

5.1. Investment and Return

The difference of Fukuoka survey from KU survey is; 1) net-base categories, specifically for job and neighbor related ones, 2) distinction between three aspects of support (return), 3)

information on indirect ties (friend of friend), instead of limited information on only one direct friend, as a result, 4) type of linkage channel for friend-intermediate. The indicators of investment and return, and indices of social network configuration as well, are applicable here; however, we need to refine them according to the above-mentioned difference. For convenience, we indicate a respondent by O, his/her direct friend by X, and his/her indirect friend by Y.

Table 5. Investment and Return for Net-Base Category, Fukuoka Survey

Net base	Tie O-X				Tie X-Y			
	Connection-number (Investment rate)	Connection-return			Connection-number (Investment rate :%)	Connection-return		
		Money	Mental	Info.		Money	Mental	Info.
①Home town	11 (.08)	0.09	0.73	0.64	5 (.05)	0.2	0.6	0.2
②Lower school	8 (.06)	0.25	0.63	0.5	4 (.04)	0.5	0.5	0.5
③High school	14 (.10)	0	0.5	0.57	9 (.09)	0.11	0.44	0.44
④University	15 (.11)	0	0.6	0.67	12 (.11)	0.08	0.33	0.25
⑤Work place	23 (.17)	0	0.70	0.48	15 (.14)	0	0.2	0.13
⑥Occupational association	6 (.04)	0.16	0.33	0.5	7 (.07)	0	0.29	0.29
⑦Business contact	6 (.04)	0	0.67	0.83	13 (.12)	0	0.23	0.62
⑧Neighbor	11 (.08)	0.09	0.64	0.82	5 (.05)	0	0.2	0.6
⑨Community association	8 (.06)	0	0.75	1	5 (.05)	0	0.6	0.8
⑩Social activity	2 (.02)	0	0.5	0.5	2 (.02)	0	0	0
⑪Circle, club	13 (.10)	0.08	0.54	0.85	13 (.12)	0	0.46	0.38
⑫Internet, email	0 (0)	0	0	0	1 (.01)	0	0	0
⑬Friend of kin	5 (.04)	0	0.8	0.6	5 (.05)	0	0.4	0.2
⑭Other	13 (.10)	0.08	0.92	0.77	9 (.09)	0	0.11	0.33
Total	135 (1.0)	0.07	0.65	0.64	105 (1.0)	0.05	0.32	0.36

*) High school (③) includes preparatory school.

Table 5 summarizes investment and return for each of O-X and X-Y. Since either of X and Y is one person, connection-number coincides with tie-number (therefore index of concentration has no significance), and its proportion (%) indicates investment rate. For the same reason, connection-return coincides with tie-return. (These redundant results are omitted in Table 5.) An additional comment is required for connection-return through X-Y. For the questionnaire in **Appendix 2**, we expected that only the respondents who had received support from Y would make responses. But many respondents answered ‘connection’ of X-Y regardless of ‘no’ support from Y. We regarded these cases as non-profitable X-Y ties to calculate connection-return [8)].

Connection-return for each net-base shows difference between three aspects. As a rule,

only a few net-bases provide monetary return, among which, unexpectedly, lower school base relatively works well. Moreover, lower school base shows good performance for mental return, as well as home town base and colleague base do. On the other hand, information return tends to be provided by net-bases that are related to business, neighborhood, and circles. Specifically in regard to X-Y ties, as is anticipated by the discussion on weak ties, these net-bases work well in information aspect; in addition, do they work in mental aspect.

Through Table 6 that indicates Pearson's correlation coefficient between investment rate and connection-return, we can confirm that, being different from the result for KU survey, investment is proportionally related to return, at least in mental and information aspects. The result suggests the validity of assumption 1.2 in general; on the other hand, it leaves us a task to consistently explain negative evidences for KU survey students and for monetary aspect in Table 6.

Table 6. Correlation between Investment and Return, Fukuoka Survey

Investment rate	Connection-return through O-X				Connection-return through X-Y			
	Some	Money	Mental	Info	Some	Money	Mental	Info
On O-X	. 26	−. 04	. 47	. 32	. 19	. 03	. 25	. 12
On X-Y					. 16	−. 22	. 11	. 18

*) "Some" is the proportion of all supportive connections in any of the three aspects.

5.2. Multiplicity and Linkage

As far as we treat O-X and X-Y separately, it is easy to calculate the multiplicity matrix $\boldsymbol{M}$ for Fukuoka survey data. As the respondents pick up only one friend for each, the distribution of responses on 'connection' (for a multi-response variable) directly gives the distribution of ties on the net-base. Let A_{OX} the multi-response variable for O-X, and A_{XY} that for X-Y. Then, cross-tabulation with itself ($A_{OX}\times A_{OX}$ or $A_{XY}\times A_{XY}$) gives multiplicity matrix, $\boldsymbol{M_{OX}}$ or $\boldsymbol{M_{XY}}$, respectively [9].

Table 7 indicates the matrices, with the multiplicity indices that we introduced for KU survey previously. Be sure that diagonal cells are ignored in making row summation for the indices, because they only indicate tie-numbers (that equal connection-numbers, here). Also be sure that the level of multiplicity calculates the proportion of solid ties, among respondent-friend ties for $\boldsymbol{M_{OX}}$, and among friend-friend ties for $\boldsymbol{M_{XY}}$. It is possible to extend the notion of multiplicity to indirect relation O-X-Y (that is, $\boldsymbol{M_{OXY}}$); however, it rather is a matter of linkage.

Table 7. Matrix and Index of Multiplicity for Fukuoka Survey Data

(1) $\boldsymbol{M_{OX}}$

		①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	Multiplicity	
																Level	Range
Home town	①	11	4	2	1	1	0	0	1	1	0	4	0	0	1	1.36	8
Lower school	②	4	8	2	1	2	1	0	1	0	0	2	0	1	0	1.75	8
High school	③	2	2	14	5	2	1	0	0	0	0	1	0	1	0	1	7
University	④	1	1	5	15	3	1	0	1	0	0	3	0	1	0	1.07	8
Work place	⑤	1	2	2	3	23	2	2	0	1	0	3	0	2	1	0.83	10
Occupational association	⑥	0	1	1	1	2	6	2	0	0	0	0	0	1	0	1.33	6
Business contact	⑦	0	0	0	0	2	2	6	0	0	1	0	0	1	1	1.17	5
Neighbor	⑧	1	1	0	1	0	0	0	11	2	1	0	0	0	1	0.64	6
Community association	⑨	1	0	0	0	1	0	0	2	8	1	2	0	0	0	0.88	5
Social activity	⑩	0	0	0	0	0	0	1	1	1	2	0	0	0	0	1.5	3
Circle, club	⑪	4	2	1	3	3	0	0	0	2	0	13	0	0	0	1.15	6
Internet, email	⑫	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Friend of kin	⑬	0	1	1	1	2	1	1	0	0	0	0	0	5	2	1.8	7
Other	⑭	1	0	0	0	1	0	1	1	0	0	0	0	2	13	0.46	5

(2) $\boldsymbol{M_{XY}}$

		①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	Multiplicity	
																Level	Range
Home town	①	5	1	2	0	0	1	0	0	0	0	1	0	0	0	1	4
Lower school	②	1	4	1	0	0	0	0	0	0	0	0	0	0	0	0.5	2
High school	③	2	1	9	3	1	0	0	0	0	0	0	0	0	0	0.78	4
University	④	0	0	3	12	4	2	2	0	0	0	0	0	2	0	1.08	5
Work place	⑤	0	0	1	4	15	2	2	0	0	0	2	0	2	0	0.87	6
Occupational association	⑥	1	0	0	2	2	7	3	0	0	0	1	0	2	0	1.57	6
Business contact	⑦	0	0	0	2	2	3	13	0	0	1	2	0	2	0	0.92	6
Neighbor	⑧	0	0	0	0	0	0	0	5	2	0	0	0	0	0	0.4	1
Community association	⑨	0	0	0	0	0	0	0	2	5	0	1	0	0	0	0.6	2
Social activity	⑩	0	0	0	0	0	0	1	0	0	2	0	0	0	0	0.5	1
Circle, club	⑪	1	0	0	0	2	1	2	0	1	0	13	1	1	2	0.85	8
Internet, email	⑫	0	0	0	0	0	0	0	0	0	0	1	1	1	1	3	3
Friend of kin	⑬	0	0	0	2	2	2	2	0	0	0	1	1	5	1	2.2	7
Other	⑭	0	0	0	0	0	0	0	0	0	0	2	1	1	9	0.44	3

The linkage matrix $\boldsymbol{C}$ is obtained based on cross-tabulation $A_{OX}\times A_{XY}$. This cross-tabulation by itself is not $\boldsymbol{C}$ because it never distinguishes quasi-linkage due to multiplicity from linkage in a pure sense. For instance, when O-X that belongs to ‘home town base’ links to ‘neighbor base’ through X-Y, the ‘linkage’ could include following two patterns.

[1]. O-{home town}-X-{neighbor}-Y : A pattern without multiplicity

[2]. O-{home town and neighbor}-X-{neighbor}-Y : A pattern with multiplicity for O-X

If we define linkage in such limited sense as extension of access to a net-base that is not connected to the respondent, [1] is linkage, but [2] is not. Because, in [2], the respondent is already connected to neighbor base by the multiplicity of O-X. In other words, it is multiplicity, not linkage, which bridges over the two net-bases. As this kind of multiplicity does not reflect on A_{OX} (when O-X belongs to *n* bases, the multiplicity is resolved into *n* different ties), we cannot distinguish [1] from [2] in the cross-tabulation $A_{OX} \times A_{XY}$.

The distinction is accomplished by examining three-fold cross-tabulation $A_{OX} \times A_{OX} \times A_{XY}$ to find pattern [2], the quasi-linkage [10]. Table 8 is the result of that we deducted the case of quasi-linkage from the original cross-tabulation $A_{OX} \times A_{XY}$. Exceptionally, the diagonal cells are kept as they were, because they have proper significance as the number of cases in which the net-base is commonly shared by the three persons. (Of course, deduction of quasi-linkage should make every diagonal cell zero.) This is the linkage matrix ***C*** that we want. The column 'none' indicates the number of respondents who have O-X ties, but do not answer on X-Y connections. This column, as well as the diagonal cell, is not included in row summation for linkage indices on the right side of the table. And be sure that the sum must be divided by the corresponding connection-number (in Table 5), because the row sum including a diagonal cell and 'none' cell for Table 8 does not necessarily coincide with the connection- number (due to multiplicity for X-Y).

Table 8. Linkage Matrix ***C*** and the Indices for Fukuoka Survey Data

A_{OX} \ A_{XY}		①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	none	Linkage	
																	Level	Range
Home town	①	1	0	0	1	0	1	2	0	0	0	1	1	1	1	3	0.73	7
Lower school	②	0	2	1	1	0	1	2	0	0	0	0	0	0	0	1	0.63	4
High school	③	0	0	4	1	1	1	3	0	0	0	0	0	1	1	2	0.57	6
University	④	1	0	1	7	1	0	2	0	0	0	0	0	0	1	2	0.4	5
Work place	⑤	0	0	0	2	11	1	3	0	0	0	1	0	0	3	3	0.43	5
Occupational association	⑥	0	0	0	0	0	4	2	0	0	0	0	0	0	0	0	0.33	1
Business contact	⑦	0	0	0	1	1	1	5	0	0	0	0	0	0	0	0	0.5	3
Neighbor	⑧	1	0	1	1	0	0	0	4	1	1	1	0	0	0	3	0.55	6
Community association	⑨	0	1	0	0	0	0	0	0	4	0	1	0	0	1	2	0.38	3
Social activity	⑩	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0
Circle, club	⑪	1	1	1	0	1	1	2	0	0	0	9	1	1	2	0	0.85	9
Internet, email	⑫	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Friend of kin	⑬	1	0	1	1	0	1	1	1	0	0	0	0	3	0	0	1.2	6
Other	⑭	1	0	1	2	1	1	0	1	0	0	2	0	0	4	4	0.69	7

Now, let us examine the relationship of multiplicity and linkage with return. Table 9

summarizes Pearson's correlation coefficient between each index and connection-return, respectively for O-X and for X-Y. First of all, it is noticed that the level index of multiplicity is positively related to O-X return, but is negatively related to X-Y return. If the connections that each net-base opens to the respondents consist of solid ties, they are more profitable for O-X, but are less for X-Y. The range index indicates almost the same tendency (although the result is contradictory with that for KU survey). For a consistent explanation for these results, we need further analysis, taking care of the relationship with the strength of weak tie.

Linkage index, regardless of level or range, consistently shows positive relation with return, as inversely as the result for KU survey. This result is explained by that Fukuoka survey captures the effect of linkage from the user's viewpoint, as we discussed before.

Table 9. Correlation between Network Configuration and Return, Fukuoka Survey

	Connection-return through O-X				Connection-return through X-Y			
	Some	Money	Mental	Info	Some	Money	Mental	Info
Multiplicity: Level	.44	.33	.33	.20	−.45	−.23	−.23	−.51
Range	.42	.25	.59	.34	.02	−.26	.22	−.14
Linkage: Level	.33	.19	.64	.44	.49	.16	.56	.25
Range	.34	.11	.61	.53	.44	.11	.49	.24

*) Multiplicity indices are for $\boldsymbol{M_{OX}}$ in the left (O-X) part and for $\boldsymbol{M_{OX}}$ in the right (X-Y) part.

6. Conclusive Discussion for Future Analysis

We have discussed the concept and measurement of net-base in relation with social capital. Our key idea is that the net-base ideally defines a whole network on which social capital works, and that personal network data, with some measurement devices, can be analyzed in order to capture the macro-level configuration of net-base categories. In a sense of social capital measurement, in addition to three main methods: name generator (Cambell and Lee 1991), position generator (Lin and Dumin 1986), and resource generator (Snijders 1999), we could propose our method as 'net-base generator.'

There are two principal problems for the data analysis method introduced in this paper. The first is the reality of a net-base category as a set of similar kind of social networks. In fact, it states a purpose of our analysis, rather than a problem. One necessary analytical orientation is to see the distributional relationship between net-base and other social strata or social group compositions. Indeed, it is a merit of our method that we can easily examine the relationship between them in a consistent manner. For the purpose to preview analysis to be made in this direction, we present Table 10. This table indicates the indices of investment and return for each net-base category for the sample of Fukuoka survey divided into three strata according to the household income level. Investment rate is no more than the cross-tabulation between A_{OX}

(multi-response variable for O-X) and the income variable. Connection-return compares it with the same cross-tabulation for beneficial (for any of the three aspects) connections, by taking a ratio between corresponding cells.

Let us make a brief comment for the table. Overall, for the Fukuoka survey sample, the efficient chance of social capital seems to be more widely available for the middle income stratum, specifically through such bases as university, work place, and neighbor. As regards these three, in addition to that they are the main bases (in a sense of frequency), the share of investment is highest for the middle stratum and the investment is returned at high rate over 80%, respectively. Being compared with the middle stratum, the lower stratum seems to have restricted investment chance, especially on lower school base, business contact base, and neighbor base (though the return rates are not so low). Inversely, the upper stratum is characterized by inefficient investment overall, except for business contact base where the stratum clearly show its advantageous position.

Table 10. Social Capital on Net-Base by Income Strata: Fukuoka Survey

	Investment rate (O-X)			Connection-return (O-X)		
	Lower	Middle	Upper	Lower	Middle	Upper
①Home town	0.12	0.10	0.12	0.67	1	1
②Lower school	0.04	0.10	0.16	1	1	0.75
③High school	0.12	0.16	0.20	0.67	0.60	0.60
④University	0.19	0.19	0.16	0.80	0.83	0.50
⑤Work place	0.27	0.32	0.20	0.71	0.90	0.60
⑥Occupational association	0.08	0.07	0.08	0.50	1	0
⑦Business contact	0.04	0.07	0.12	1	1	1
⑧Neighbor	0.08	0.16	0.16	1	1	0.75
⑨Community association	0.12	0.10	0.08	1	1	1
⑩Social activity	0	0.03	0.04	0	1	1
⑪Circle, club	0.15	0.13	0.16	0.50	0.75	0.75
⑫Internet, email	0	0	0	0	0	0
⑬Friend of kin	0.04	0.03	0.08	1	1	0.50
⑭Other	0.31	0.03	0.08	1	1	1

*) For income strata, ‘lower’=under 500 million yen, ‘middle’=500~900 million yen, ‘upper’=900 million yen and over, as regards annual household income.

Thus, social network configuration and income strata influences on each other. In order to clarify the relationship more closely, Table 11 examines the correlation between social network configuration and social capital. Focusing on the correlation between multiplicity and O-X return, as well as between linkage and X-Y return, expected positive correlation is seen only for lower income stratum. The level indices suggest that social capital is effective for the middle class; however, it is the lower class that utilizes the network configuration. (We have

not found the reason for the negative correlations as regards investment.)

Table 11. Correlation between Network configuration and Social capital, by Income strata

	Income	Investment in O-X	Investment in X-Y	Return from O-X	Return from X-Y
Multiplicity	Lower	−.73	−.46	.16	.39
	Middle	−.01	.02	−.14	.08
	Higher	−.23	.20	−.51	−.11
Linkage	Lower	−.04	−.36	−.16	.45
	Middle	−.08	−.16	−.10	−.30
	Higher	.38	−.17	−.23	.01

*) Pearson's correlation coefficients.

The second problem of our analysis is a technical one and is impossible to be directly solved: inapplicability of statistical test (also see footnote 7). For the second best method, however, we might be able to transform results for the net-base unit into hypotheses to which ordinary statistical test for the individual unit is applicable. For instance, if the positive relationship between linkage and return is true, we can expect that the more a respondent has bridges, the more he/she gets return. This hypothesis should be testable by making some devices on questionnaires.

Additionally, it is possible to theoretically extend our data analysis method in order to make the results richer. Let us think about transforming every element in the multiplicity matrices for Fukuoka survey into dichotomous value, 0 or 1, and calculating $\boldsymbol{M_{O*Y}}=\boldsymbol{M_{OX}}\boldsymbol{M_{XY}}$. The matrix $\boldsymbol{M_{O*Y}}$ indicates accessibility from O's net-base to Y's net-base, through overlapping multiplicity on X. (Strictly, "O's net-base" means a net-base that is connected to O though O-X tie). Of course, this calculation does not make sense in the real world because it requires a premise that every respondent can freely utilize other respondents' ties. However, it might theoretically make sense to define $\boldsymbol{M_{OX}}$ and $\boldsymbol{M_{XY}}$ differently for social groups and to examine degree of inter-group inequality that the multiplicity configuration generates. Moreover, by introducing linkage, we might be able to theoretically examine the conditions under which the lower (or minority) group can access to beneficial net-bases that are mainly connected to the upper (or host) groups.

* The original Japanese version of this paper is, "Kaso Whole-net to siteno Shakai-kankei-kiban: Shakai-kankei-shihon no Bunseki-hoho Shiron," in Misumi, Kazuto (ed.) *Formalization ni yoru Shakaigaku-teki Dento no Tenkai to Gendai-shakai no Kaimei* (*Formalization for Neoclassical Theorizing and Analysis of Modern Society*), Working Papers: Grant-in-Aid for Scientific Research (B)(1) No.14310084, 2005: pp.17-34. The author translated it into English adding refinement over all. Specifically, the analysis for Table 10 and Table 11 is not included in the original paper. The

present version was presented at Brown Bag at Department of Sociology, University of Arizona (August 2005), and XVI World Congress of ISA (Durban, July 2006), and it was once published in *Bulletin of the Graduate School of Social and Cultural Studies, Kyushu University* Vol.14 (March, 2008), pp.49-63. I applied the paper for Cooperative Repository for Universities in Kyushu District and refined it partially in order to reply for a referee's comment. This is the final version. I thank for the referee especially for his valuable suggestion about mathematical definition of the matrices. (September, 2008)

Footnotes

1) Some researchers point out additional problems as 'capital' (Arrow 2000; Solow 2000; Schuller et al. 2000). Suppose that an individual X spent a lot of time to develop friendship with Y, and eventually could get useful job information from Y. Then, (1) what is the investment? If we see the time spent as investment, how can we compare it with information to calculate pure profit? Or, shall we see the time as cost and think that it is trust or emotion which was invested? Additionally, how shall we treat expressive value of the friendship itself? (2) What is the object of investment? Is it emotion of Y, or his/her resources and reputation? It could be a norm or trust that relates to the friendship. (3) How can we capture accumulation and stock of value? How about depreciation? If the units are different between investment and return, stock of what? Every point is fundamental and cannot be overlooked; on the other hand, we think that it is worthy to treat the concept of social capital as a perspective, leaving these problems behind at moment.
2) See Misumi (2005) for a substantial analysis in this framework, which is based ordinary statistical analysis.
3) For a brief introduction of bipartite graph and its algebraic treatment by affiliation matrix, see Kobayashi et al. (2000: Chap.6). Breiger (1974) is also an excellent reference to know its sociological implications.
4) If we ask the order of closeness between the three friends, we could examine the difference of indices according to the order.
5) Further consideration shall be required for the conceptual relation of 'to be open' here with structural holes or weak ties, as well as for the relation of 'to be closed' with closure, solidarity, or commitment (Yamagishi 1998). Especially in that a net-base cannot be resolved into concrete social networks, the levels or the dimensions seem to be different from each other.
6) Although it is an impossible task in this paper, because we cannot combine the two surveys.
7) Be sure that it is not respondent-base correlation. Throughout the analysis in this paper, we sum up responses in the respect of net-bases; therefore, neither sampling theory nor statistical test can have significance any more.
8) As a result of course, not a few respondents who did not answered for it along with our expectation will be missing.
9) As regards KU survey, we have three $A_{OX}\times A_{OX}$ cross-tabulations ($\boldsymbol{M_{OX}}$) for three friends, respectively. Summing up those matrices leads the multiplicity matrix $\boldsymbol{M}$ in Table 2.
10) This check cannot be perfect, however, because neighbor base being a common attribute for the three does not mean that they live(d) exactly in the same neighborhood. It is probable that X knew Y

in the past neighborhood, but it is a different neighborhood from the current one as the base for O-X. This is rather a matter of linkage, but is not counted for linkage for Table 8. In general, Table 8 could underestimate the cases of linkage. Moreover, the possibility of underestimation should not be the same between the net-base categories. On the contrary, the possibility of overestimation (counting quasi-linkage incorrectly) is low. (For strict judgment on these points, we have to know whether X commonly shares the base for X-Y; though the information is not available for Fukuoka survey.)

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Appendix 1. Questionnaire for KU Survey

Please recall your three best friends (excluding parents and siblings). Let them A, B, and C in order of

recalling. If you would not recall three, put × in [ ] for the rest.

(1) Let us know the 'connection' between you and them, respectively. Please put a line between ● of the person and ● of the corresponding connection. If there are plural connections, put a line for everyone.

(2) In this couple of years, have you received monetary or mental support from them? Please put ○in [ ] for the person who provided the support.

	● Relative
	● Home town
[ ] **A** ●	● Elementary or junior high school
	● High school
	● Preparatory school
[ ] **B** ●	● Class or circle at the university
	● Part time job
	● Club (off campus)
[ ] **C** ●	● Volunteer (off campus)
	● Mobile or internet
	● Introduction by family or friend
	● Other

Appendix 2. Questionnaire for Fukuoka Survey

Please recall your best friend (excluding parents, siblings, and relatives). Let the person X.

(1) In this couple of years, have you received the following support directly from X? ①Monetary support (borrowing money, asking a guarantor), ②Mental support (consultation on sufferings), ③ Information support (important information as regards job, school, and life planning).

①Monetary support…….. 1. Yes 2. No 3. DK
②Mental support……. 1. Yes 2. No 3. DK
③Information support….. 1. Yes 2. No 3. DK

(2) Then, have you received support ①～③ from other person with whom you got acquainted through X (let the person Y).

①Monetary support…….. 1. Yes 2. No 3. DK
②Mental support……. 1. Yes 2. No 3. DK
③Information support….. 1. Yes 2. No 3. DK

(3) Please let us know the 'connection' between you and X, from the column below. If there are plural connections, indicate every number. Similarly, please let us know the 'connection' between X and Y, if you would know it.

a) Connection between You and X… [ ] [ ] [ ] [ ] [ ] [ ]
b) Connection between X and Y…… [ ] [ ] [ ] [ ] [ ] [ ]

1. Home town	**6**. Occupational association	**12**. Email, internet
2. Elementary or Junior high school	**7**. Business contact **8**. Neighborhood	**13**. Introduction by family or relative
3. High school or Preparatory school	**9**. Community association, PTA **10**. Volunteer, social activity	**14**. Other
4. College or university	**11**. Circle, club	**99**. DK
5. Work place		