A Principal Component Analysis Approach to Measure Contributions of Shinkin Banks to Regional Economies in Northeast Area of Japan

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Abstract: As one kind of regional finance institutions (RFIs), shinkin banks have closer relations with development of regional economies than city banks. This paper aims to apply principal components analysis to evaluate the performance of shinkin banks' contribution to regional economies in northeast area of Japan. Different from the existing studies, this paper is the first attempt to use principal components analysis to analysis of shinkin banks. Meanwhile, we limit our analysis to 27 shinkin banks in the northeast area of Japan and put our emphasis on extracting an effective indicator to measure the contributions of the shinkin banks to regional economies and clarify the issues for the shinkin banks to improve or strengthen their regional contribution.

Key Words: Regional Finance, Shinkin Bank, Regional Economy, Regional Contribution, Multivariate Analysis.

1. Introduction

1.1 Shinkin Banks and Regional Economies

The Japanese banking system consist of different kinds of financial institutes, including big commercial city banks, trust banks, regional banks, and shinkin banks. Differing from city banks and regional banks that both of them are corporations licensed under the Bank Law, shinkin banks are cooperatives of small and medium sized enterprises (SMEs) licensed under the Shinkin Bank Law. Shinkin banks resemble U.S. credit unions, their business operations are limited strictly into a narrow area such as a few cities, and/or a few towns, and they are not permitted to open a branch out of their licensed area. Shinkin banks make loans primarily to residents and SMEs within their licensed area, but they can accept deposits from anyone.

As of June 2015, shinkin banks have 7,396 branches, more than 9.28 million of memberships, and it is the biggest branch network in Japan. To qualify for membership a firm must have no more than 300 employees or a capitalization no more than 900 million Japanese yen. There were 267 Shinkin banks at the end of 2014 (compared to 480 in 1980) with a loan share of 12.45% and a deposit share of 11.39% in Japanese financing service market.

According to the Small and Medium Enterprise Agency of Japan, there are 4.69 million of SMEs in Japan, constituting 99.7% of all enterprises, accounting for 70% of whole employment. SMEs form the framework of the Japanese economy, and in particularly they play a very important role in the Japanese regional economy development. As one kind of regional finance institutions (RFIs), shinkin banks have closer re-

lations with development of regional economy than city banks. Shinkin banks thus have an essential mission to provide financial services of a universal character, and bringing them closer to SMEs and citizens through different distribution channels. Through their financial services, shinkin banks can provide an impulse to economic and financial development in their areas of action, avoid social and financial exclusion, and return the profits they make to society. As shinkin banks are restricted by regulation to make loans only to local SMEs and individuals, the performances of shinkin banks can be regarded as an indicator of local business developments.

1.2 Literature Review

Because of the deep relationship between shinkin banks and regional economies, many Japanese researchers have paid their attentions to shinkin banks and published a lot of literature in Japanese language. These researches have examined shinkin banks mainly from the following three viewpoints.

- (1) Relation to regional economies: Takigawa [1] defined "Regional Bank" based on three measures (inner-regional lending rate, inner-regional branch rate, inner-regional reflux rate) and constructed an analytic model. He insists that maximizing regional banks' utility depend on not only profit but also inner-regional lending rate. Iwasa [2],[3] gave a sociological discussion on the role of regional banks to induce disparities among regions. Yoshihara [4] collected the performance data of 294 shinkin banks as of March 2006, and investigated the correlation between the shinkin banks' performance and the economy index of the regions where the shinkin banks located, but he could not find any significant correlation relation. On the other hand, Horie [5] showed that there is a significant relation between shinkin banks' operation areas and their profitability.

- (2) Deflation and default of shinkin banks: Several studies

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have contributed to the default analysis of shinkin banks. Recently, Ishikawa [6] gave a detailed examination on the management behaviors and various factors that caused Sogo Shinkin Bank's failure. Shimabukuro [7] conducted an empirical analysis on the causes of shinkin banks' failure and showed that Heisei-Depression (the long stagnation in the 1990s) has given stronger influence on the shinkin banks' failure than the collapse of the bubble economy in Japan from 1986 to 1991.

- (3) Analysis of profitability or other performance measures: there are many reports to analyze shinkin banks' performance or compare them with city banks and other kind of financial institutes. Horie [8] gave several reports on shinkin banks' performance analysis and his recent study investigated the influence of distressed assets' disposal on profitability of shinkin banks. He showed that shinkin banks have to use more than 50% of their profit for distressed assets' disposal. Kozuka [9] applied impulse response function to examine the lending behaviors of shinkin banks and other Japanese financial institutes, and clarified that there were some difference in the lending behaviors to SMEs between shinkin banks and other Japanese financial institutes.

There are also several studies on Japanese shinkin banks published on international journals. The paper by Yamori, etc. [10] described the latest state of Japanese banks and banking regulations, as well as how Japanese banks have responded to the global financial crisis. Kano and Tsutsui [11] made an attempt to give a geographical segmentation of regional banks and shinkin banks in Japanese bank loan markets, but they could only segment the markets for shinkin banks. On the performance analysis of Japanese banks, Liu and John [12] investigated the profitability of Japanese banks following the major financial crisis. According to their result, well-capitalized, efficient banks, with lower credit risks tend to outperform less capitalized, less efficient counterparts with higher credit risks. Second association regional banks and shinkin banks (but not other ownership types) appear to benefit from diversification advantages. They also investigated the relationship between competition and risk [13]. They suggested that risk varies across different types of Japanese banks over the period 2000-2009. Specifically, nationwide (city and trust) banks are riskier on average than regional banks, tier 2 regional banks, shinkin banks and credit cooperative banks.

Recently, there are two papers published and their focus is directly on the performance analysis of shinkin banks. Asaf, etc. [14] analyzed the productivity and efficiency of shinkin banks and the various prefectures in Japan. They confirmed that the efficiency growth and productivity growth of shinkin banks have not been improved significantly over the period from 2000 to 2006. Dai [15] assessed productivity changes in Japanese shinkin banks during the fiscal years 2001 to 2008 where the Malmquist index was used as the measure of productivity change. His result showed that in the latter half of the study period, productivity has significantly declined, primarily because of deterioration in technical efficiency, but scale efficiency has been significantly improved.

1.3 Aim and Contribution of This Study

Although many researches on shinkin banks have been reported, some issues remain to be examined more deeply and detailed.

- (1) Many Japanese researchers have put their focus on performance analysis of shinkin banks, but they applied mainly case study methods, or classical business analysis methods such as comparison analysis and trend analysis. With the limit of the research methods, these analyses depend large on the analyzers' experience. It is necessary to apply advanced methods to analyze shinkin banks' performances more deeply.
- (2) Several analytical methods such as regression analysis, data envelopment analysis (DEA) have been applied to compare shinkin banks with city banks or other financial institutions. These comparison studies are helpful and useful to comprehend the characteristics and position of shinkin bank industry in Japanese banking system. However, this kind of analysis is too rough to obtain any insight directly available to the management of a shinkin bank.
- (3) As shinkin banks have deep relationship with regional economies, and there are disparities among regions, it is difficult to obtain any meaningful insight if all of shinkin banks are treated just as one homogeneous group. It is necessary to divide shinkin banks into distinctive groups according to their characteristics such as geographical location, capitalization, business environment, etc.

Furthermore, most of Japanese researchers published their reports on Japanese universities' bulletins in Japanese language; it is not easy for the researchers outside Japan to understand these reports.

This study uses Principal Components Analysis (PCA) to evaluate the performance of shinkin banks' contribution to regional economies. We limit our analysis to 27 shinkin banks in the northeast area of Japan and put our emphasis on extracting an effective indicator to measure the contributions of the shinkin banks to regional economies, and clarify the issues for them to improve or strengthen their regional contribution. Comparing to the previous researches, this paper makes the following contributions to the literature.

- (1) PCA is a powerful tool for analyzing high-dimensional data. It can identify patterns in data, and express the data in such a way as to highlight their similarities and differences. There are several reports that used PCA for comparing the performance of Chinese banks [16], evaluating on-line banking performance in Taiwan [17], assessing the potential strength of a bank capital channel in Europe [18], assessing the effect on technical efficiency of bad loans in banking industry [19], analyzing bank capital regulation cross-country [20] and etc. However, to our knowledge, PCA has not been used to analyze the performance of shinkin banks, and therefore this study is the first attempt.
- (2) We do not treat all of shinkin banks as one homogeneous group to compare them with other kind of financial institutions. We limit our analysis to 27 shinkin banks in the

northeast area of Japan and furthermore, our object is to clarify the difference among them in performance of regional contribution instead of whole performance analysis.

- (3) As our emphasis is different from other researchers, we collect the performance data related to the shinkin banks' regional contribution. Based on the principal component scores, we define an index to measure the shinkin banks' contribution to regional economies.

The rest of the paper is organized as follows: we introduce the shinkin banks to be considered here and give a brief description of their performance data in section 2. At section 3 we conduct the principal components analysis and decide the names of the principal components. After giving some examination and discussion on the PCA results in section 4, we define an index to assess shinkin banks' regional contribution at section 5. Finally, we summarize our research in section 6 and give some concluding remarks.

2. Shinkin Banks and Their Data

2.1 Shinkin Banks

Two considerations lead us to limit our analysis to the shinkin banks in the northeast area of Japan. The first one is that the northeast area is suffering from the Great East Japan Earthquake Disaster, which occurred on March 11, 2011, and triggered the greatest tsunami ever recorded in Japan and caused tremendous and infinite damage. We intend to examine the state of shinkin banks in this area after the disaster. The second consideration is that the regional economies in the northeast area is comparatively homogeneous and there are fewer disparities among the regions.

According to the above considerations, we chose the following 27 shinkin banks (SBs) from the six prefectures in the northeast area of Japan.

- Fukushima prefecture: Fukushima SB (F1), Himawari SB (F2), Koriyama SB (F3), Siragawa SB (F4), Abukuma SB (F5), Sugakawa SB (F6), Aizu SB (F7), and Nihonmatsu SB (F8).
- Miyagi prefecture: Mori No Miyako SB (M1), Ishinomaki SB (M2), Kisenuma SB (M3), Sennan SB (M4), and First Bank Miyashin (M5).
- Iwate prefecture: Morioka SB (I1), Ichinoseki SB (I2), Mizusawa SB (I3), Kitagami SB (I4), Hanamaki SB (I5), and Miyako SB (I6).
- Yamagata prefecture: Tsuruoka SB (Y1), Yonezawa SB (Y2), Yamagata SB (Y3), and Shinjo SB (Y4).
- Akita prefecture: Ugo SB (A1) and Akita SB (A2).
- Aomori prefecture: Aoi Mori SB (A3) and Too SB (A4).

2.2 Data

In order to clarify the latest state of 27 shinkin banks' contribution to regional economies and define an effective index to measure their contributions, we choose 26 items of performance that have close relation to regional contributions. We collected

these data from the disclosure information of the shinkin banks as of March 31, 2015. These data can be classified into the following six categories.

(1) Performances represented by balance amount

- Deposits balance (DB): Overall amount of deposits balance.
- Regional loans balance (RLB): outstanding loans balance to regional customers excluding local public entities, finance and insurance firms.
- Lending to SMEs (LSME): outstanding loans lent to SMEs.
- Equity capital (EC): Amount of equity capital at the end of fiscal year of 2014.
- Performing loan (PL): Calculated by subtracting non-performing loans balance from overall loans balance. As some shinkin banks apply partial direct method to write off non-performing loans and the others do not, we added the amount of partial direct write-offs up to non-performing loans.

(2) Performances represented by number

- Number of regional borrowers (NRB): number of borrowers within the business area of each shinkin bank.
- Number of borrowers from SMEs (NBSME): Number of borrowers that is a SME.
- Number of branches (NB).
- Number of permanent officers or employees (NPOE).

(3) Performances represented by ratio (performance of regional financing intermediation)

- Regional loan-deposit ratio (RLDR): the ratio of regional loans balance for overall outstanding deposits balance, $RLDR = RLB/DB$.
- Ratio of regional loans balance (RRLB): the ratio of outstanding loans balance lending to the regional customers for overall outstanding deposits balance.
- Ratio of lending to SMEs (RLSME): ratio of outstanding lending to SMEs for overall outstanding deposits balance.
- Ratio of regional borrowers (RRB): ratio of regional borrowers for overall borrowers.
- Ratio of SMEs (RSME): ratio of SMEs for overall borrowers.

(4) Profit

- Net business profit (NBP): net operating profit.
- Current net profit (CNP): net income in fiscal year.

(5) Safety and soundness

- Overall profit margin (OPM): interest margin for total fund interest rate.

- Capital-to-asset ratio (CAR): capital adequacy ratio.
- Ratio of performing loan (RPL): ratio of performing loan to overall loan balance or 1- ratio of non-performing loan (RNPL).

(6) Efficiency

- Return on Asset (ROA): Calculated by dividing a shinkin bank's annual earnings by its total assets.
- Deposits balance per branch (DBPB): Calculated by dividing overall amount of deposits balance by branch number.
- Loans balance per branch (LBPB): Calculated by dividing overall amount of loans balance by branch number.
- Deposits balance per officer or employee (DBPOE): Calculated by dividing overall amount of deposits balance by number of officer or employee.
- Loans balance per officer or employee (LBPOE): Calculated by dividing overall amount of loans balance by number of officer or employee.
- Net business profit per officer or employee (NBPPOE): Calculated by dividing net business profit by number of officer or employee.
- Current net profit per officer or employee (CNPPOE): Calculated by dividing current net profit by number of officer or employee.

3. Principal Component Analysis

3.1 Principal Components Extraction

Using IBM SPSS Statistics 20.0, we applied the PCA method to the dataset described in the previous section. In order to determine the number of meaningful components, we used the eigenvalue-one criterion. We also used Varimax with Kaiser Normalization as the rotation method to identify the final principal components.

Generally, to make sure that the dataset is suitable for PCA analysis, the overall KMO (the Kaiser-Meyer-Olkin Measure of Sampling Adequacy for the overall dataset) should be above 0.50, and the Bartlett's test of sphericity should be significant. When applying the PCA method to all of the 26 items of performance measures, we obtained the overall KMO=0.161. Because of this low value of KMO, we removed three performance measures: RRLB, RLSME and RRB, which have low values of communality, from the dataset. Finally, we conducted the PCA based on the 23 items of performance measures, obtained the overall KMO=0.554 and the *p*-value of Bartlett's test of sphericity is 0.0%. These results indicate that the PCA result is admissible on the dataset.

Table 1 shows the main results of the PCA. We could extract five principal components; these components explain together 89.2% of the global data dispersion. That is, the information contained in the 23 original performance measures can thus be summarized by the five principal components. Among them, the first principal component (PC1) accounts for 36.9%, and the second principal component (PC2) accounts for 21.8% of the variance of the 23 original performance measures. The other three components (PC3-PC5) account for 12.9%, 12.6% and 5.0% of the total variance respectively.

3.2 Naming of Principal Components

Table 2 shows the structure matrix for the PCA, where large coefficient (the absolute value >0.45) for each variable to every component are highlighted in bold. As structure matrix represents the correlations between the variables and the principal components, we can interpret the principal components according to these correlation coefficients.

- The first principal component (PC1): PC1 correlates strongly with three performance measures that represent shinkin banks' business sizes: DB (deposits balance), NB (number of branches) and NPOE (number of permanent officers or employees). In addition, it also correlates to four measures that indicate how a shinkin bank has endeavored at region-based relationship banking: RLB (regional loans balance), LSME (lending to SMEs), NRB (number of regional borrowers) and NBSME (number of borrowers from SMEs). PC1 scores are not only proportional to shinkin banks' business sizes but also depend on their achievement of region-based relationship banking. Therefore, PC1 gives a measure of shinkin banks' business size targeting region-based relationship banking. Based on this consideration, we name PC1 the measure of regional financial business size.
- The second principal component (PC2): PC2 positively correlates with CNP (current net profit), CAR (capital-to-asset ratio), DBPOE (deposits balance per officer or employee), and CNPPOE (Current net profit per officer or employee). Meanwhile, it negatively correlates with RLDR (regional loan-deposit ratio). The former four performances express how a shinkin bank could increase its profit and self-owned capital, and obtain deposits efficiently. PC2 scores increase proportionally to increasing of profit and efficiency. The negative relation between PC2 and RLDR means that a shinkin bank can achieve higher score of PC2 through decreasing RLDR (regional loan-deposit ratio). We can consider PC2 as a measure whether a shinkin bank has a higher ability to make profit or increase capital not through lending money to regional customers. That is, PC2 indicates the ability of profit making through lending to local public entities, finance and insurance firms. We name PC2 the measure of profit-making ability from non-regional customers.
- The third principal component (PC3): PC3 correlates positively to OPM (overall profit margin), ROA (return on asset) and NBPPOE (net business profit per officer or employee). A shinkin bank can achieve higher score of PC3 if it can manage its funds and make more profit effectively. PC3 provides an indicator to measure the capital efficiency or investment efficiency of a shinkin bank. We name PC3 the measure of capital efficiency.
- The fourth principal component (PC4): PC4 correlates strongly with DBPB (deposits balance per branch) and LBPB (loans balance per branch), and correlates positively with LBPOE (loans balance per officer or employee). As these three performance measures are deposits and loans balance for one branch or one person, it is natural to name PC4 the measure of business efficiency.

Table 1 Total Variance Explained

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.629	37.519	37.519	8.480	36.871	36.871
2	5.201	22.612	60.131	5.019	21.822	58.693
3	2.995	13.024	73.155	2.970	12.912	71.605
4	2.575	11.197	84.352	2.896	12.591	84.195
5	1.109	4.821	89.173	1.145	4.978	89.173
6	0.804	3.494	92.667			

Table 2 Structure Matrix

Variable	Component				
	PC1	PC2	PC3	PC4	PC5
DB	0.94	0.24	-0.09	0.14	-0.02
RLB	0.97	-0.05	-0.02	0.20	-0.01
LSME	0.95	-0.05	-0.03	0.26	0.03
EC	0.45	0.84	-0.04	0.06	-0.01
PL	0.94	0.01	-0.03	0.29	-0.08
NRB	0.97	-0.03	-0.03	-0.16	-0.15
NBSME	0.96	-0.07	0.00	0.03	0.10
NB	0.91	0.11	-0.09	-0.34	-0.01
NPOE	0.96	-0.04	-0.14	-0.13	-0.07
RLDR	0.00	-0.83	0.39	-0.03	0.00
RSME	-0.31	0.06	-0.08	0.28	0.80
NBP	0.81	0.16	0.41	0.13	-0.03
CNP	0.25	0.87	0.17	0.05	0.00
OPM	-0.01	-0.13	0.94	-0.12	-0.06
CAR	-0.34	0.83	-0.04	-0.14	0.07
RPL	-0.23	-0.03	-0.04	0.52	-0.66
ROA	-0.07	-0.09	0.95	-0.02	0.00
DBPB	0.08	0.35	-0.20	0.79	0.03
LBPB	0.15	-0.24	-0.05	0.92	0.00
DBPOE	0.01	0.88	0.02	0.43	0.07
LBPOE	0.13	0.40	0.20	0.68	0.09
NBPPOE	-0.08	0.40	0.82	0.07	0.02
CNPPOE	-0.12	0.89	0.19	0.04	0.00

Fig. 1 Relation between RSME and RNPL

4. Performance Assessment and Discussion

4.1 Ranking of Regional Financial Business Size (PC1)

Based on the component loadings matrix shown in Table 2, we calculated scores of each shinkin bank on each principal component. Table 3 shows PC1 scores of each shinkin bank and its related performance measures, where DB, RLB, LSME and PL are given by 100 million of Japanese yuan. From Table 3, it is clear that:

- The fifth principal component (PC5): PC5 has a strongly positive correlation with RSME (ratio of SMEs for overall borrowers). Meanwhile, it correlates negatively with RPL (ratio of performing loan to overall loan balance). That is, the score of PC5 increase with increasing ratio of non-performing loan (RNPL). In comparison with large or major companies, SMEs have a higher risk to default. The more borrowers of SMEs, the more amount of non-performing loans. Figure 1 shows the relation between RSME and RNPL. Except for three outliers: A1 (Ugo Sb), A3 (Aoi Mori SB) and M5 (First Bank Miyashin SB), there is a comparatively strong correlation between RSME and RNPL. The correlation coefficient between RSME and RNPL is 0.53 with p -value=0.72% while the three outliers were not taken into account. Therefore, if a shinkin bank makes its efforts to increase borrowers from SMEs, it has to struggle with a comparatively high ratio of non-performing loans. From this viewpoint, PC5 indicates how a shinkin bank place importance on loan business to SMEs. We name PC5 awareness of the importance of lending to SMEs.
- As Aoi Mori SB (A3) has the largest amount of DB (deposit balance), RLB (regional loans balance) and LSME (lending to SMEs) among the 27 shinkin banks, it ranks the first and its score is 3.695. This means that Aoi Mori SB overwhelms others largely in regional financial business size. Mori No Miyako SB (M1) places second with score of 2.225. Fukushima SB (F1) comes third with score of 1.309. These top three shinkin banks have larger DB (deposit balance), NB (number of branches) and other related performance measures.
- There are 20 shinkin banks their PC1 scores are less than zero. Miyako SB (I6) gets the lowest score of -0.959 because of its smallest NPOE, RLB, LSME, NRB, and PL, as well as less DB and NB (number of branch). In comparison, Shinjo SB has the smallest DB (deposit balance) of 6.22 billion Japanese yuan but it ranks the fourth to the lowest. This is because Shinjo SB has larger NRB (number of regional borrowers) and NBSME (number of borrowers from SMEs) than the bottom three shinkin banks.
- Although Ishinomaki SB and Abukuma SB have comparatively larger DBs of more than 20 billion Japanese yuan, their RLB (regional loans balance) and LSME (lending

Table 3 PC1 scores and related performances

Shinkin Bank	PC1	DB	NB	NPOE	RLB	LSME	NRB	NBSME	PL
Aoi Mori	3.695	5,957	63	722	2,043	1,253	46,800	4,580	1,945
Mori No Miyako	2.225	3,943	29	346	1,839	1,247	27,894	4,316	2,032
Fukushima	1.309	3,454	25	314	1,262	753	17,305	3,008	1,382
Morioka	0.461	2,384	25	255	811	598	14,052	1,953	992
Ugo	0.382	1,332	35	218	535	358	15,596	2,422	501
Himawari	0.258	2,218	16	206	833	651	7,961	1,711	855
Koriyama	0.103	2,099	19	230	723	459	8,081	1,615	728
Too	-0.008	1,532	21	202	636	410	15,731	1,181	765
Ichinoseki	-0.087	1,970	15	245	661	436	10,330	1,517	773
Tsuruoka	-0.120	1,714	19	132	642	429	9,642	1,709	727
Sennan	-0.157	1,540	16	170	669	468	10,507	1,808	697
Aizu	-0.158	1,833	18	182	616	351	9,446	1,634	733
Yamagata	-0.159	1,156	15	179	671	409	8,064	1,665	638
Siragawa	-0.161	2,020	18	189	573	402	8,177	1,246	888
Sugakawa	-0.169	1,884	13	197	761	542	7,913	1,442	823
Akita	-0.312	1,262	18	176	542	301	9,023	1,579	600
Ishinomaki	-0.370	2,064	12	145	550	361	6,584	1,243	565
Mizuaawa	-0.399	1,148	10	157	457	345	5,106	736	481
Yonezawa	-0.458	1,165	13	155	458	298	8,691	1,485	468
Abukuma	-0.510	2,293	17	109	400	293	4,393	796	598
First Bank Miyashin	-0.619	1,193	13	159	460	365	3,975	919	586
Kisenuma	-0.646	1,479	12	119	387	312	4,405	766	415
Kitagami	-0.659	793	9	110	388	279	5,913	898	414
Shinjo	-0.699	622	9	93	342	226	5,509	785	334
Nihonmatsu	-0.859	1,024	7	98	389	249	5,345	637	412
Hanamaki	-0.924	739	9	113	319	245	4,168	599	379
Miyako	-0.959	747	9	85	250	177	3,744	714	253

to SMEs) account for a very small proportion of their DBs (deposit balance). Because of this, these two shinkin banks got negative scores for PC1. This means that the regional financing business sizes of these two shinkin banks don't match with their size of deposit balance.

4.2 Profit-Making Ability from Non-Regional Customers and Capital Efficiency

Table 4 shows the ranking list of the shinkin banks by PC2 scores. As described above, PC2 scores represent profit-making ability from non-regional customers. The higher PC2 score, the more profit a shinkin bank could obtain from non-regional customers. From Table 4, we can observe that:

- Among the top five shinkin banks in the list of PC2 scores, four shinkin banks, Abukuma SB (F5), Kisenuma SB (M3), Ishinomaki SB (M2) and Miyako SB (I6), suffered long-standing deflation as well as the Great East Japan Earthquake Disaster, they received many public funds.
- Except for the above four shinkin banks, there are five shinkin banks whose scores for PC2 are greater than zero. These five shinkin banks made comparatively more profit not through returns of investments in their regional customers. For example, Tsuruoka SB (Y1) made 21.36% of net business profit through service fee income and government bond trading profits etc., the return incurred by loans to regional customers accounted for 78.64% of ordinary profit. Siragawa SB (F4) obtained 32.89% of net business profit not though lending to the regional customers.
- In comparison, 18 out of 27 shinkin banks have PC2 scores that are less than zero. This means that these shinkin banks

made their profit primarily through lending to regional customers. Yamagata SB (Y3) has the lowest score for PC2, it made only 6.34% of net business profit not though lending to the regional customers.

According to the ranking list of the shinkin banks by PC3 scores shown in Table 5, we can examine the capital efficiency for each shinkin bank.

- As Shinjo SB (Y4) has the highest overall profit margin (OPM) and ROA among 27 shinkin banks, it has the highest score for PC3 and thus it is the best shinkin bank in capital efficiency. In contrast, Hanamaki SB (I5) and Sugakawa SB (F6) place at the bottom two because these two shinkin banks have negative overall profit margin (OPM) and very low ROA.
- Shinjo SB (Y4) has a very low score for PC2, which means it obtains a few profit from non-regional customers. At the same time, it has the top score for PC3, which means it could achieve very high overall profit margin. As the result, Shinjo SB is excellent at obtaining profit through serving its regional customers.
- Although the overall profit margin (OPM) and ROA of Abukuma SB (F5) is not very high, it has the third highest score for PC3. This is mainly because it has the highest value of NBPPOE (net business profit per officer or employee), which come from the injection of public funds.
- More than half of the shinkin banks have negative scores for PC3. This result derives from the fact that most of the shinkin banks have comparatively lower overall profit

Table 4 PC2 scores and related performances

Shinkin Bank	PC2	EC	RLDR	CNP	CAR	DBPOE	CNPPOE
Abukuma	3.989	29,273	17.44	3,779	40.39	21.04	34.67
Kisenuma	1.279	18,895	26.17	971	33.76	12.43	8.16
Ishinomaki	1.071	23,657	26.65	398	33.53	14.23	2.74
Tsuruoka	0.709	17,917	37.46	591	27.66	12.98	4.48
Miyako	0.657	11,656	33.47	526	36.76	8.79	6.19
Siragawa	0.497	13,941	28.37	757	21.78	10.69	4.01
Aoi Mori	0.456	26,763	34.30	1,378	12.43	8.25	1.91
Aizu	0.195	11,236	33.61	757	17.81	10.07	4.16
Fukushima	0.156	16,017	36.54	1,097	12.42	11.00	3.49
Ugo	-0.148	8,758	40.17	713	16.37	6.11	3.27
Koriyama	-0.197	10,123	34.44	428	14.81	9.13	1.86
Morioka	-0.235	10,627	34.02	229	11.06	9.35	0.90
Ichinoseki	-0.238	10,554	33.55	569	13.98	8.04	2.32
Too	-0.326	8,609	41.51	377	13.40	7.58	1.87
Himawari	-0.383	7,188	37.56	686	8.81	10.77	3.33
Mori No Miyako	-0.388	16,004	46.64	957	8.56	11.40	2.77
Mizuaawa	-0.389	8,727	39.81	181	13.43	7.31	1.15
Nihonmatu	-0.415	5,149	37.99	226	12.86	10.45	2.31
Yonezawa	-0.432	7,136	39.31	312	15.50	7.52	2.01
Hanamaki	-0.466	7,003	43.17	169	20.31	6.54	1.50
Sennnan	-0.504	7,558	43.44	329	13.21	9.06	1.94
Sugakawa	-0.583	9,670	40.39	303	11.31	9.56	1.54
Akita	-0.665	6,161	42.95	154	12.12	7.17	0.88
Kitagami	-0.669	5,497	48.93	134	16.09	7.21	1.22
First Bank Miyashin	-0.732	5,337	38.56	229	9.27	7.50	1.44
Shinjo	-1.006	4,404	54.98	210	10.70	6.69	2.26
Yamagata	-1.233	5,142	58.04	259	9.67	6.46	1.45

Table 5 PC3 scores and related performances

Shinkin Bank	PC3	OPM	ROA	NBPPOE
Shinjo	3.712	1.10	1.22	7.32
Fukushima	1.166	0.35	0.52	5.87
Abukuma	0.933	0.28	0.36	7.41
Kitagami	0.886	0.26	0.42	6.06
Mori No Miyako	0.840	0.26	0.38	4.65
Yamagata	0.788	0.43	0.42	3.01
Mizuaawa	0.758	0.26	0.31	7.20
Too	0.203	0.34	0.29	3.27
Ugo	0.054	0.28	0.27	2.82
Miyako	0.049	0.13	0.33	5.14
Himawari	0.030	0.19	0.28	3.52
Aizu	-0.030	0.25	0.30	3.48
Tsuruoka	-0.124	0.10	0.19	3.98
Kisenuma	-0.164	0.17	0.30	4.51
Sennnan	-0.255	0.19	0.22	2.62
Siragawa	-0.378	0.10	0.27	3.44
Akita	-0.485	0.17	0.17	2.09
Ishinomaki	-0.531	0.17	0.23	3.85
Aoi Mori	-0.588	0.15	0.15	2.40
Morioka	-0.672	0.08	0.17	2.44
Yonezawa	-0.680	0.08	0.20	2.01
Koriyama	-0.743	0.07	0.18	2.19
Nihonmatu	-0.798	0.10	0.16	1.63
First Bank Miyashin	-0.848	0.05	0.18	1.60
Ichinoseki	-0.904	0.11	0.18	1.81
Hanamaki	-0.953	-0.04	0.09	2.19
Sugakawa	-1.265	-0.03	0.07	1.10

margin and ROA. There are only four of 27 shinkin banks that overall profit margin is larger than 0.3%. Meanwhile, there are also only four ones that ROA is larger than 0.4%. Therefore, it is an urgent business issue for most of the

shinkin banks to manipulate their funds effectively and improve their capital efficiency.

4.3 Business Efficiency and Awareness of the Importance of Lending to SMEs

Table 6 shows the ranking list of the shinkin banks by PC4 scores. As PC4 is most strongly correlated with LBPB (loans balance per branch, principal component loading=0.92) and second strongly correlated with DBPB (deposits balance per branch, principal component loading=0.79), PC4 scores represent mainly the business efficiency for each branch. From Table 6, we can observe that:

- Mori No Miyako SB (M1), Sugakawa SB (F6), Himawari SB (F2), Fukushima SB (F1) and Nihonmatu SB (F8) have high scores for PC4 and rank the top five in the list. This is mainly because these five shinkin banks have more than 5.8 billion Japanese yuan of loans balance each branch, and also have more than 13 billion Japanese yuan of deposits balance each branch, and thus their business efficiency is very high.
- Nihonmatu SB (F8), which has the smallest branch number of seven, ranks the fifth by PC4 scores. In contrast, Ugo SB (A1), Aoi Mori SB (A3) and Miyako SB (I6) are the top three in branch's number, but these three shinkin banks place the bottom 3 by PC4 scores. Because the operations of shinkin banks are limited strictly into the licensed area, the more their branch's number, the narrower the area and the less the customers for each branch's operation. This suggests that there should be an appropriate number of branch for a shinkin bank.

Table 6 PC4 scores and related performances

Shinkin Bank	PC4	LBPB	DBPB	LBPOE
Mori No Miyako	2.208	73.62	135.97	6.17
Sugakawa	1.392	66.00	144.92	4.36
Himawari	1.231	65.38	138.63	5.08
Fukushima	1.130	58.88	138.16	4.69
Nihionmatu	1.021	63.71	146.29	4.55
Ishinomaki	0.780	52.83	172.00	4.37
Siragawa	0.481	51.00	112.22	4.86
Abukuma	0.294	37.41	134.88	5.83
First Bank Miyashin	0.272	46.69	91.77	3.82
Ichinoseki	0.268	53.33	131.33	3.27
Tsuruoka	0.265	42.95	90.21	6.18
Sennan	0.190	45.31	96.25	4.26
Mizuaawa	0.090	54.50	114.80	3.47
Kitagami	0.014	50.67	88.11	4.15
Aizu	-0.013	42.39	101.83	4.19
Yamagata	-0.078	47.53	77.07	3.98
Morioka	-0.217	44.24	95.36	4.34
Koriyama	-0.227	47.16	110.47	3.90
Kisenuma	-0.365	39.08	123.25	3.94
Hanamaki	-0.422	43.67	82.11	3.48
Shinjo	-0.526	41.00	69.11	3.97
Yonezawa	-0.637	40.31	89.62	3.38
Akita	-0.721	35.72	70.11	3.65
Too	-0.818	37.48	72.95	3.90
Miyako	-1.149	33.00	83.00	3.49
Aoi Mori	-1.685	37.62	94.56	3.28
Ugo	-2.778	19.40	38.06	3.11

- Ugo SB (A1) got the lowest score of PC4. This is because that the LBPB of Ugo SB is only 1.9 billion Japanese yuan and its DBPB is just 3.8 billion Japanese yuan; both of these two performances are much less than other shinkin banks. This means that Ugo SB should revise its branch location and it is desirable to merge or close several branches in order to improve its operations efficiency and simultaneously not impair the convenience of its customers.

Table 7 shows the ranking list of the shinkin banks by PC5 scores, which represent awareness of the importance of lending to SMEs. According to the result of table 7, it is clear that:

- The top three in the list are Himawari SB (F2), Koriyama SB (F3) and Ugo SB (A1). These three shinkin banks have comparatively higher RSME (ratio of SMEs for overall borrowers) of more than 15%. In particular, they have the lowest RPL (ratio of performing loan to overall loan balance). In other word, these three SBs are the top three worst in the ratio of non-performing loans, which range from 18.26% to 26.01%.
- Because Too SB (A4) has the lowest RSME (ratio of SMEs for overall borrowers) of only 7.48% and at the same time, it has the highest RPL (ratio of performing loan to overall loan balance) of 97.10%, it got the lowest score for PC5. From the viewpoint of risk management, it is desirable to avoid occurring of non-performing loans or to raise RPL. To do this, some financial institutions including some shinkin banks have been engaged in curbing loans to SMEs because SMEs have higher risk to default. This leads to the weakening of shinkin banks' role in the regional economies.

Table 7 PC5 scores and related performances

Shinkin Bank	PC5	RSME(%)	RPL(%)
Himawari	2.207	21.44	81.74
Koriyama	1.694	19.93	81.39
Ugo	1.386	15.50	73.99
Yamagata	1.128	20.62	89.46
Miyako	0.925	18.98	85.16
First Bank Miyashin	0.713	23.01	96.59
Ishinomaki	0.680	18.84	89.08
Tsuruoka	0.628	17.70	89.23
Kisenuma	0.266	17.33	88.34
Yonezawa	0.170	17.05	89.43
Fukushima	0.114	17.36	93.95
Mori No Miyako	-0.046	15.46	95.21
Sugakawa	-0.046	18.16	95.86
Akita	-0.101	17.47	93.25
Kitagami	-0.202	15.15	90.64
Mizuaawa	-0.236	14.37	88.34
Abukuma	-0.281	18.00	93.96
Sennan	-0.308	17.17	96.07
Morioka	-0.389	13.87	89.70
Aizu	-0.414	17.25	96.00
Shinjo	-0.434	14.22	90.60
Aoi Mori	-0.576	9.78	82.20
Siragawa	-0.884	15.20	96.65
Ichinoseki	-1.093	14.66	96.59
Nihionmatu	-1.099	11.89	92.35
Hanamaki	-1.126	14.35	96.25
Too	-2.675	7.49	97.10

- Aoi Mori SB (A3) has the fourth worst RPL of 82.20% or the fourth highest ratio of non-performing loan to overall loan balance. However, it ranks only the sixth from the bottom in the ranking list of the shinkin banks by PC5 scores, because it has the second worst RSME.

From the above results, it is clear that PC5 scores can be used to assess whether a shinkin bank has tolerated the regional risk to make its endeavor to serve regional SMEs.

5. Evaluating Regional Contribution

5.1 Regional Contribution Index

We have obtained five principal components in section 3; each of them provides a measure to express a principal feature of the original dataset. Because there is zero correlation between these components, we can define an index to evaluate shinkin banks' regional contribution based on the scores of these five principal components. Among the five components, PC2 indicates the profit-making ability from non-regional customers; PC3 provides a measure for shinkin banks' capital efficiency or investment efficiency, and PC4 scores are the measure of business efficiency, these three components do not directly relate to shinkin banks' regional contribution. Whereas, PC1 scores give a measure of shinkin banks' business size targeting region-based relationship banking, PC5 is a measure of how shinkin banks are aware of the importance of lending to SMEs. Thus, the scores of PC1 and PC5 are two measures directly relating to shinkin banks' regional contribution.

According to the interpretation of PC1 and PC5, and also considering the scores for each component have been standardized to zero mean and unit variance, we can define shinkin banks' regional contribution index, RCI, as the following equation (1).

$$RCI_i = PC_{1i} \times W_1 + PC_{5i} \times W_5; i = 1, 2, \dots, 27 \quad (1)$$

where subindex i stands for the i th shinkin bank, RCI_i is the regional contribution index, PC_{1i} is the score for PC1 and PC_{5i} is the score for PC5. W_1 and W_5 are weights on PC1 scores and PC5 scores respectively, their values are decided according to proportion of the variance that PC1 and PC5 have accounted for. If PV_1 and PV_5 be the proportion of the variance accounted through PC1 and PC5 respectively, we have:

$$W_k = \frac{PV_k}{PV_1 + PV_5}; k = 1, 5 \quad (2)$$

In this study, we could obtain $W_1 = 0.881$ and $W_5 = 0.119$.

5.2 Ranking of Shinkin Banks by RCI

Based on equation (1), we could calculate the regional contribution index RCI for each shinkin bank and give the ranking of shinkin banks by RCI as shown in Table 8. From this table, it is clear that:

Table 8 Ranking of Shinkin Banks by RCI

Shinkin Bank	RCI	Rank by RCI	Rank by PC1
Aoi Mori	3.626	1	1
Mori No Miyako	2.219	2	2
Fukushima	1.322	3	3
Ugo	0.547	4	5
Himawari	0.520	5	6
Morioka	0.415	6	4
Koriyama	0.305	7	7
Yamagata	-0.025	8	13
Tsuruoka	-0.045	9	10
Sugakawa	-0.175	10	15
Sennan	-0.194	11	11
Aizu	-0.208	12	12
Ichinoseki	-0.217	13	9
Siragawa	-0.266	14	14
Ishinomaki	-0.289	15	17
Akita	-0.324	16	16
Too	-0.326	17	8
Mizuaawa	-0.427	18	18
Yonezawa	-0.438	19	19
First Bank Miyashin	-0.534	20	21
Abukuma	-0.544	21	20
Kisenuma	-0.614	22	22
Kitagami	-0.683	23	23
Shinjo	-0.751	24	24
Miyako	-0.849	25	27
Nihionmatu	-0.989	26	25
Hanamaki	-1.058	27	26

- As PC5 contributes only 4.978% of the total variance, the rank order of 27 shinkin banks by RCI is very similar to the ranking by PC1 scores. 13 out of 27 shinkin banks are the same rank orders in the RCI ranking as in the PC1 ranking. The rank orders of seven shinkin banks in the ranking by RCI are only one order different from their orders in the ranking by PC1 scores.
- The top three in the ranking by RCI are Aoi Mori SB, Mori No Miyako SB and Fukushima SB because these three shinkin banks have very high scores for PC1. This suggests that if the regional financial business size of a shinkin

bank is very large, it plays a very important role in the regional economies and has as well a very large contribution to the regional development.

- Comparing to the rank order by PC1 scores, the rank order of Yamagata SB and Sugakawa SB in the ranking by RCI improved five orders. This is because that these two shinkin banks have comparatively higher RSME (ratio of SMEs for overall borrowers). It suggests that these two shinkin banks have made more efforts to lending to SMEs, relative to their regional financial business size.
- On the contrary, there are two shinkin banks: Ichinoseki SB and Too SB that their rank order in the ranking by RCI are much lower than their orders in the ranking by PC1 scores. This means that these two shinkin banks have not provided enough lending to SMEs proportional to their regional financial business size.
- There are only seven shinkin banks out of 27 that their RCI are positive, 20 shinkin banks have negative RCI values. This means that there is a large difference in the regional contribution among the 27 shinkin banks and most of them are facing the issue to expand their regional business size and pay more attention to lending to SMEs.

6. Conclusion

This paper aimed to apply principal components analysis to examine the performance of shinkin banks' contribution to regional economies in northeast area of Japan. Different from the existing studies, this paper is the first attempt to use principal components analysis to analysis of shinkin banks. Meanwhile, we limit our analysis to 27 shinkin banks in the northeast area of Japan and put our emphasis on extracting an effective index to measure the contributions of the shinkin banks to regional economies.

The main results can be summarized as the following:

- (1) According to the KMO test, we selected 23 out of 26 performance measures to conduct PCA. As the result, we could extract five principal components, which summarized 89.17% of the information contained in 23 original performance measures. The first principal component (PC1) accounts for 36.87% and the second principal component (PC2) accounts for 21.82% of the variance of the 23 original performance measures.
- (2) According to the component loadings matrix, we named PC1 the measure of regional financial business size, PC2 the measure of profit-making ability from non-regional customers, PC3 capital efficiency, PC4 business efficiency, and PC5 awareness of the importance of lending to SMEs.
- (3) From the viewpoint of regional financial business size, Aoi Mori SB (A3) is overwhelmingly the largest among 27 shinkin banks. Mori No Miyako SB (M1) places second and Fukushima SB (F1) comes third in the ranking. In contrast, the PC1 scores of 20 shinkin banks rang from -0.959 to -0.008 and there are comparatively less difference in the regional financial business size among them.

- (4) Except for four shinkin banks suffered long-standing deflation as well as the Great East Japan Earthquake Disaster and received many public funds, 18 out of 27 shinkin banks have PC2 scores that are less than zero. It suggests that most of the shinkin banks have lacked channels to make profit from non-regional customers.
- (5) According the scores for PC3, Shinjo SB has the extreme score of 3.712 and it is excellent at obtaining profit through serving its regional customers. However, more than half of the shinkin banks suffered from very low capital efficiency. It is an urgent business issue for most of the shinkin banks to manipulate their funds effectively and improve their capital efficiency.
- (6) From the viewpoint of business efficiency, the best five are Mori No Miyako SB (M1), Sugakawa SB (F6), Himawari SB (F2), Fukushima SB (F1) and Nihonmatsu SB (F8). On the contrary, Ugo SB (A1) is the worst. Ugo SB (A1) merged Akita Fureai Shinkin bank in 2009 and then it remains an issue to revise its branch location and improve the operation efficiency for each branch.
- (7) According the scores for PC5, we can make clear how a shinkin bank has endeavored to lending to regional SMEs. Among 27 shinkin banks, the best three are Himawari SB (F2), Koriyama SB (F3) and Ugo SB (A1). Too SB (A4) has a very large negative score of -2.675 and ranks the lowest place.
- (8) Based on the scores for PC1 and PC5, we proposed an index RCI to assess the performance of shinkin banks' regional contribution. According to RCI values, Aoi Mori SB, Mori No Miyako SB and Fukushima SB are the top three and they have contributed largely to the regional economies.

The above results were obtained on the condition that we limited our analysis to 27 shinkin banks in the northeast area of Japan. The analyzing method and process used in this paper are also applicable to analyze shinkin banks in other areas. However, as there is a wide variety in regional economies, the results of PCA vary usually in accordance with areas.

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