Supervising Operational Risks: A New Index of Key Risk Indicators Approach

Myung-Jig Kim[1]
Hanyang University

Dae-Shik Won[2]
Financial Supervisory Service

Abstract

This paper proposes a new index of Key Risk Indicators (KRI) as an effective framework for the measurement, management, and supervision of operational risks. In doing so, this paper collects thirty core KRI's with unified definitions for the January 2007 - June 2010 period from six large Korean advanced measurement approach (AMA) banks. The core KRI's are selected in such a way to account for the operational risk types categorized by Basel II and the number of assigned core KRI's to each operational risk type is intended to mimic the observed pattern of the actual operational losses experienced by large banks during the 2004-2009 period. The historical banking industry operational risk index (ORI) suggests a downward trend since the Lehman Brothers bankruptcy, and particularly during the first half of 2009, reflecting in part, banks' tighter implementations of operational risk

[1]Professor, Department of Economics and Finance, Hanyang University, Seoul, 133-791 Korea (tel) +82-11-1716-6134 (e-mail) mjkim@hanyang.ac.kr.
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[2]Head, Risk Examination Team, Bank Examination Department I, Financial Supervisory Service, Seoul, 150-743 Korea (e-mail) mt0987@naver.com.
Dae-Shik Won's participation was conducted as part of his dissertation.

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management to survive through a crisis, and thereof economic recession, and in part, tighter monitoring by the supervisors as part of micro-prudential surveillance during a crisis. The empirical results indicate that 35 percent of the variation of 6-month-ahead actual loss events is explained by the current banking industry ORI suggesting its potential usefulness as an early warning system for the state of operational risks. Further, the results suggest that the individual banks' operational risks are closely related to the characteristics of their portfolios.

Keywords : Advanced Measurement Approach (AMA); Basel II; Key Risk Indicators (KRI); Operational Risk; Operational Risk Types

JEL classification : G1; G10

1 Introduction

Operational risks in banks are the risks of suffering losses in processes associated with conducting all business unit activities. The '07/'08 global financial crisis is a good example of the devastating consequences of the mismanagement of such risks. Operational risk is subject to regulatory review under Basel II (BCBS (2006)) and Korean banks have started calculating their BIS ratios reflecting the amount of operational risk capital since 2008. Five large banks have already obtained approval for the use of their advanced measurement approach (AMA) by the Financial Supervisory Service by the end of 2009. BCBS (2006) requires AMA banks to include four data elements in their model: internal loss data (ILD), external data (ED), scenario analysis (SA), and business environment and internal control factors (BEICFs). According to the data provided by 42 AMA banks for the 2008 Loss Data Collection Exercise (LDCE), the percentage direct contributions to capital charge of ILD, ED, SA, and BEICFs are, respectively, 31, 37, 55, and 11 percent (refer to BCBS (2010)). As pointed out by BCBS (2010), BEICFs are of particular interest because they are expected to be operational risk management indicators that provide forward-looking assessments of business risk factors as well as a bank's internal control environment. Measures of BEICFs are often incorporated directly or indirectly into the bank's capital model which may result in BEICF adjustments to the AMA capital charge.

Banks tend to measure their BEICFs identified using metrics known as key risk indicators (KRIs)[3]. KRI is a measure to calibrate the change in the

[3]Refer to Watchorn and Levy (2008) for a brief overview on developing BEICFs for operational risk measurement and management.

nature of risks of a bank, to monitor operational risk, and to provide quantitative criteria and a basis for operational risk management. According to a survey conducted by the Financial Supervisory Service in 2010 on eighteen domestic banks operating in Korea, the average number of KRI's turns out to be 193.4. In addition to the fact that banks compile and monitor a large number of KRI's, their definition varies from one bank to another, making it difficult for supervisors to monitor and compare the distribution and trend of the operational risk for regulatory purpose. Hence, in order to build an effective and timely regulatory framework for operational risk supervision, it has become necessary to standardize the definition, to select the core KRI's of a manageable size, and to aggregate the information in the form of, say, ratings or an index.

There is only a dearth of existing literature addressing the issues and methods of indexing KRI's. Peccia (2004), for instance, proposes an operational risk ratings model at a bank level. For each business activity such as retail banking and trading and sales and for each operational risk type such as internal fraud and external fraud, his model assigns the aggregate ratings scaled from one to five depending on the level of operational risks in the business and control environments. The aggregate ratings are then conveniently placed in terms of what are sometimes called heat maps to represent the operational risk profile of a particular business activity. In order to calibrate the risk, he introduces, so-called, the loss rate Vega to describe the loss rate for the different business and control environments for each operational risk type within a business line. His model does not, however, use KRI's directly to construct the aggregate ratings, nor consider aggregating risks over the whole risk type or business activity.

Taylor (2006) proposes a method for constructing composite indicators of KRI's to help make sense of large amounts of information at the senior management level. He perceives the problem as trying to combine apples and oranges whereby proposing a two-step approach. In the first step, he transforms all KRI's into so-called T-values allowing comparison between KRIs. In the second step, he combines these T-values using the geometric-weighted average along with other parameters representing risk appetites. Davies et al. (2006) further discuss the possibility of indexing KRI's to represent a score for each specific risk exposure. These works focus mainly on indexing and monitoring KRI's at the bank level.

The purpose of this paper is therefore to propose a methodology for constructing an operational risk ratings or a composite index by using KRI's directly with particular attention to the inter-bank comparability of such an index. The method parallels the CAEL ratings system adopted by banking supervisors and deposit insurance corporations around the world. It aims to capture the distribution and trend of the operational risks for each bank and the banking industry as a whole. The composite index of KRI's, which will be referred to as the operational risk index would provide regulatory supervisors with an effective device for routine off-site monitoring of the change in risk characteristics of banks and for generating early warning signals.

This paper is organized as follows: Section 2 explains the proposed methodology of constructing an operational risk index. Section 3 presents the computed banks' operational risk indices and their aggregate using data supplied by six major Korean banks from January 2007 to March 2010, as well as the results on the validation of the index. A brief summary and conclusions are presented in Section 4.

2 Methodology

The idea of constructing an operational risk index used in this paper is very similar, in principle, to the one applied to the CAEL ratings model. It assigns the composite risk ratings of financial institutions by selecting several component variables that represent risk factors, such as capital adequacy (C), asset quality (A), earnings (E), liquidity (L) and the like, and by assigning points for each component variable and weights for each risk factor. The weighted average of constituent series is computed, often referred to as a "rating score," and is mapped to the composite rating scale. Each financial institution is then assigned to one of the five risk groups or ratings. Chang and Kim (2009), for instance, provide a detailed description on the CAEL ratings method and its application to financial industries.

The framework for devising an operational risk index can be developed in four steps: (1) the collection and validation of candidate KRI's and selection of core KRI's, (2) the configuration of rating intervals for each core KRI, (3) the computation of a rating score or composite index for an individual bank, and (4) the validation of the index.

Step 1: the validation and selection of core KRI's

The core KRI's can be selected and classified in accordance with the operational risk types of Basel II by applying the following criteria:

1. Importance: the importance of the specific operational risk type which a candidate KRI is expected to represent.
2. Effectiveness: the extent to which a candidate KRI reflects the level of risk meaningfully and signals the change of risk in advance.
3. Data availability: the extent to which a candidate KRI can be collected through the system at each bank on a monthly basis.

Step 2: the configuration of rating intervals for each core KRI

Since the size of each bank differs, the selected core KRI's are adjusted for by the size proxy variables such as total deposits and total loans at the end of a preceding quarter. The time series of each bank's scale-adjusted core KRI is pooled across all banks and the empirical distribution is examined. In order to configure the rating intervals, the sample mean and standard deviation can be used if the normality of the data is a reasonable description of the empirical distribution. For instance, if the value of a particular bank's core KRI exceeds the sum of the sample mean and one standard deviation, the lowest rating 5 is assigned and if the value of a particular bank's core KRI lies between the mean plus a half the standard deviation and the mean plus one standard deviation, the second lowest rating 4 is assigned. The rating intervals for 1, 2, and 3 can be defined in a similar fashion. The choice of parameters such as one standard deviation and a half the standard deviation would be regarded as reasonable if the resulting distribution of ratings is not concentrated in a particular rating.

If the empirical distribution is skewed, the median and percentiles such as 10^{th}, 25^{th}, and 75^{th} could be used instead of the mean and standard deviation. The choice of percentiles could be adjusted to avoid the concentration of the distribution of ratings. This paper considers the percentile rule as a baseline method and compares the results with the ones from the mean-standard deviation rule.

Step 3: the computation of rating score or a composite index for an individual bank

Once the ratings of all core KRI's for an individual bank are assigned each month based upon the rating intervals table, the composite operational risk index of a bank can be constructed by simply averaging thirty core KRI's ratings of a bank. This would yield an equal-weighted rating or an index. Different weights could be applied to each KRI depending upon the operational risk type which it belongs to and according to its contribution within the same risk type[4]. Since the sample size is relatively small, this paper considers equal-weights. The index of KRI's for the banking industry may be computed again as the simple average of all individual banks' operational risk indices.

Step 4: the validation of the index

For the index of KRI's to be regarded as an effective tool for the measurement and management of operational risk, it must be validated. The significance of the correlations, both contemporaneous and lead-lag between the composite index and the actual operational loss events indicates the validity of the proposed measure.

[4]The principal component analysis may be used to determine such weights within and across risk types.

3 Empirical Results

3.1 Data and Rating Intervals

Using the criteria cited in step 1, thirty core KRI's were collected from six large Korean banks. Monthly data covering January 2007 to June 2010 yielded a total of 6,299 observations because of the unavailability of one particular bank's KRIs for certain periods within the duration covered. The operational risk types are categorized aligned to the Basel II classifications: (i)internal and external fraud, (ii)execution delivery and process management, (iii)clients, products, and business practices, (iv)business disruption and system failures, (v)employment practices and workplace safety, and (vi)damage to physical assets. The number of core KRI's allocated to each type are, respectively, 13, 10, 4, 2, 1, and 0 as the damage to physical assets is regarded as a relatively trivial problem among Korean AMA banks. Table 1 provides the list of core KRI's as well as their descriptive statistics.

For instance, the number of transactions in convenient handling with large amount, i.e. cases with the amount exceeding 100 million KRW, is selected as one of thirty KRIs to cover the risk type of internal fraud in the domain of deposit. When a customer wants to withdraw money from his/her account in Korea, (s)he should present a valid ID card and depositor's registered stamp at the counter. In practice, however, a regular customer occasionally demands a bypass of such rule. An employee at the bank may abuse this practice of convenient handling and attempt to withdraw money illegally from a client's account without consent from the customer, which may pose a significant operational risk to a bank. Similarly, twenty nine other KRIs in Table 1 are selected to cover important domains such as lending, FX transaction, business process reengineering (BPR), private banking (PB), customer satisfaction (CS), human relations (HR), risk, compliance, and IT. Since the composition and size of portfolios are different across banks, KRI's are scaled by using variables such as total deposits, total loans, and etc as indicated in the fourth column of Table 1. The last column of Table 1 indicates that the assumption for normality is mostly rejected.

Table 1
List of Core KRI's and Descriptive Statistics

Basel II Operational Risk Type	Number of KRI's assigned	Core KRI	Scale Variable	Domain	Mean	Median	SD	JB
Internal and External Fraud	13	Number of transactions in convenient handling with large amount	Per 1 trillion KRW deposits	Deposit	22.4968	24.9975	10.7540	144.86
		Number of not liquidated cases in convenient handling	Per 1 trillion KRW deposits	Deposit	19.9672	3.7284	22.3549	99.99
		Number of cancelled deposit accounts over 30 million KRW before expiration	Per 1 trillion KRW deposits	Deposit	58.1115	57.9078	25.2218	77.19
		Number of accounts cancelled before or after business hours	Per 1 trillion KRW deposits	Deposit	4.9337	3.0699	5.0082	290.35
		Number of overdue custodial accounts	Per 1 trillion KRW deposits	Deposit	36.2879	22.9694	32.3794	83.31
		Number of deposit securities loan brought about after change of customer information	Per 1 trillion KRW deposits	Lending	0.8028	0.6632	0.7115	104.67
		Number of loan accounts with deposit securities which are provided within 2 business days after loan	Per 1 trillion KRW loans	Lending	1.3583	0.9708	1.6007	81.61
		Number of not liquidated FX outward/inward remittances for more than 3 months	Per 1 trillion KRW foreign currency assets	FX	1.2281	0.1522	2.5873	1837.19
		Number of not liquidated inward remittances	Per 1 trillion KRW foreign currency assets	FX	14.6521	12.7753	9.0792	112.45
		Number of received defect notices after normal negotiation of exporting bills	Per 1 trillion KRW foreign currency assets	FX	17.9890	12.1370	19.2982	246.93

		Number of FX transactions cancelled and redone with the same customer, same date and same amount but with different FX rate	Per 1 trillion KRW foreign currency assets	FX	73.8754	65.0608	44.7349	100.87
		Number of credit cards the branch is keeping	Per 1 thousand new issuance	Credit card	15.3751	9.6161	21.0892	228.91
		Number of compensations for illegitimate use of credit card	Per 1 trillion KRW credit card loans	Credit card	50.8406	41.9255	30.3574	106.43
Execution Delivery and Process Management	10	Number of transactions per trader exceeding stop loss limit	Not scaled	Risk	0.2924	0	0.6742	721.32
		Number of transactions per trader breaching position limit	Not scaled	Risk	0.2331	0	0.7151	4176.51
		Number of arrears occurred in retail loans within 6 months of loan start date	Per 1 trillion KRW retail loans	Lending	12.3749	10.6522	7.7824	98.38
		Number of arrears occurred in corporate loans within 6 months of loan start date	Per 1 trillion KRW corporate loans	Lending	5.6430	5.1534	3.9398	139.89
		Number of retail loan documents not sent to center	Per 1 trillion KRW retail loans	BPR	279.9250	26.0955	484.6654	77.19
		Number of securities with expired fire insurance	Per 1 trillion KRW loans	Lending	12.7257	7.9032	15.1746	78.13
		Number of enterprises with overdue reevaluation	Per 1 trillion KRW corporate loans	Lending	101.9952	63.4359	103.3090	73.69
		Number of delayed dispatches of negotiated exporting bills	Per 1 trillion KRW foreign currency assets	FX	1.4927	1.0200	1.5069	98.56
		Number of cases not using the reserved exchange rate	Per 1 trillion KRW foreign currency assets	FX	12.5574	1.6589	23.3762	353.08
		Number of reports to the Financial Intelligence Unit (FIU) on suspicious money-laundering transactions	Per 1 trillion KRW deposits	Compliance	13.2352	11.1394	8.9195	172.98

		Number of reports to the Financial Intelligence Unit (FIU) on suspicious money-laundering transactions	Per 1 trillion KRW deposits	Compliance	13.2352	11.1394	8.9195	172.98
Clients, Products, and Business Practices	4	Number of deposit accounts overdue more than a month	Per 1 trillion KRW deposits	Deposit	49.8412	47.8813	21.3659	83.57
		Number of cancelled bank assurances due to customers' complaints	Per 1 million selling commission	PB	1.9326	1.7552	0.9728	64.05
		Number of new over seventy-year-old customers entered into fund	Per 1 trillion KRW deposits	PB	10.2195	6.8204	11.2542	408.83
		Number of customers' complaints received	Per 1 trillion KRW assets	CS	0.4763	0.3635	0.4624	8464.96
Business Disruption and System Failures	2	Internet banking failure time	Minutes	IT	24.9483	0	76.2362	4808.91
		Ratio of failed calls at call center	Per cent	CS	0.0203	0.0117	0.0213	601.33
Employment Practices and Workplace Safety	1	Number of employees on sickness leave	Not scaled	HR	0.2279	0.1901	0.1383	188.24
Damage to Physical Assets	0	na	na	na	na	na	na	na

Operational risk types are in accordance with Basel II. JB denotes Jarque-Bera statistic which is distributed $\chi^2_{(2)}$ under the null hypothesis of normality. Descriptive statistics are based upon core KRI's collected from six large Korean banks for the January 2007 – June 2010 period. Prior to the computation of sample statistics, KRI's are scaled by using scale variables such as total deposits and total loans to adjust for the different composition and size of portfolios across banks. BPR stands for business process reengineering, PB stands for private banking, CS stands for customer satisfaction, and HR stands for human relations.

The number of assigned core KRI's to each operational risk type resembles the observed pattern of the actual operational losses which occurred during the 2004-2009 period. Table 2 compares the portion of the number of core KRI's for each risk type with the number of loss events, the amount of loss events, and the amount of operational risk capital. The portions of operational loss events for two risk types, namely, internal and external fraud and execution delivery and process management are, respectively, 49.1 percent and 23.5 percent, whereas the corresponding figures of the number of core KRI's are, respectively, 43.3 percent and 33.3 percent. The operational risk capital based upon the actual figures of five banks as of fourth quarter of 2009 is illustrated in the last row of Table 2. It shows that these two major risk types account for 68 per cent of total operational risk capital.

Table 2

	Operational Risk Type						
	Internal and External Fraud	Execution Delivery and Process Management	Clients, Products, and Business Practices	Business Disruption and System Failures	Employment Practices and Workplace Safety	Damage to Physical Assets	Total
Number of Core KRI's	43.3	33.3	13.3	6.7	3.3	0	100.0
Number of Loss Events	49.1	23.5	11.0	1.3	9.6	5.4	100.0
Amount of Loss Events	61.4	11.1	21.5	1.1	4.5	0.5	100.0
Amount of Operational Risk Capital	54.3	13.5	22.2	2.5	4.0	3.5	100.0

The table is based upon the actual number of loss events and the amount of loss events by risk types observed during the 2004-2009 period. During this period, the total number of loss events collected from six major Korean banks is 1,124 cases. Operational risk capital is based upon the actual figures as of fourth quarter of 2009 of five AMA banks. Units in the table are all in percent.

Two percentile rules and one mean-SD rule are applied to determine rating intervals and are illustrated in Table 3. Percentile rule 1 refers to 10^{th}, 25^{th}, 50^{th}, and 75^{th} percentiles as thresholds and percentile rule 2 refers to 15^{th}, 30^{th}, 50^{th}, and 75^{th} percentiles as thresholds. The mean-SD rule refers to mean $\pm k \times SD, k = 0.5$ and 1 as thresholds. Table 3 compares the percentage of all cases that falls within a particular rating for each rating intervals rule. The mean-SD rule tends to assign more cases to the middle rating of 3 as expected and relatively less cases to poor ratings of 4 and 5 whereas percentile rules distribute cases relatively evenly across all ratings.

Table 3

Panel (a) Percentile rule 1

Rating	Intervals	KRI	
		Total Cases (number)	Portion (%)
Rating 1	X < 10 percentile	490	7.78%
Rating 2	10 percentile < X ≤ 25 percentile	1,422	22.58%
Rating 3	25 percentile < X ≤ median	1,511	23.99%
Rating 4	median < X ≤ 75 percentile	1,434	22.77%
Rating 5	X > 75 percentile	1,442	22.89%
Total		6,299	100.0%

Panel (b) Percentile rule 2

Rating	Intervals	KRI	
		Cases (number)	Portion (%)
Rating 1	X < 15 percentile	771	12.24%
Rating 2	15 percentile < X ≤ 30 percentile	1,413	22.43%
Rating 3	30 percentile < X ≤ median	1,245	19.77%
Rating 4	median < X ≤ 75 percentile	1,440	22.86%
Rating 5	X > 75 percentile	1,430	22.70%
Total		6,299	100.0%

Panel (3) Mean-SD rule

Rating	Intervals	KRI	
		Cases (number)	Portion (%)
Rating 1	X < (mean - SD)	466	7.40%
Rating 2	(mean - SD) < X ≤ (mean - 0.5 SD)	1,551	24.62%
Rating 3	(mean - 0.5 SD) < X ≤ (mean + 0.5 SD)	2,874	45.63%
Rating 4	(mean + 0.5 SD) < X ≤ (mean + SD)	498	7.91%
Rating 5	X > (mean + SD)	910	14.45%
Total		6,299	100.0%

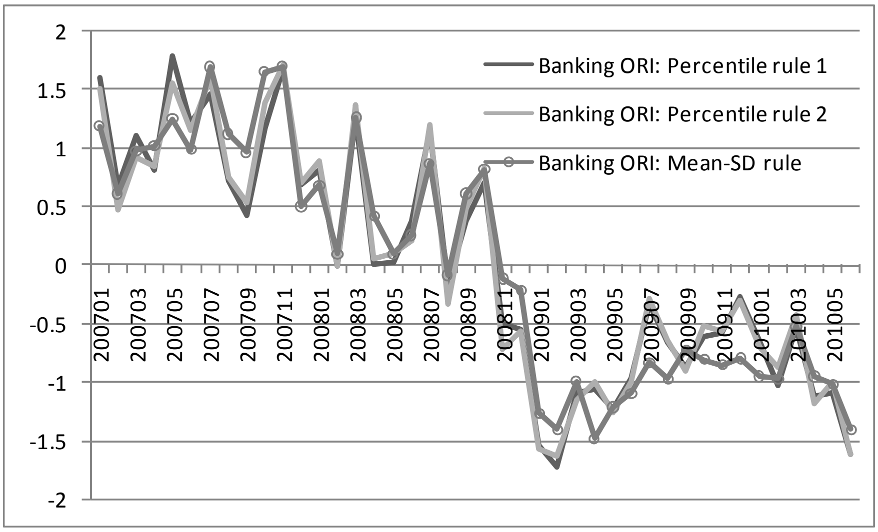
X denotes the value of scaled KRI. SD denotes the standard deviation computed from the empirical distribution of scaled KRI's.

3.2 Computation and Validation of Operational Risk Index

The ratings of each core KRI of a bank are assigned over time according to the rating intervals of rating assignment rules reported in Table 3. The equal-weighted operational risk index of a bank is then computed as a simple average of all core KRI's ratings of a bank each month and is expressed in decimals. The equal-weighted banking industry operational risk index (ORI) is also computed as a simple average of the individual banks' operational risk indices. Since the core KRI's are already adjusted for their scale, the additional information from computing the value-weighted industry operational risk index, say by the size of total assets, may not be materially significant.

Three versions of banking industry ORI's that correspond to each rating assignment rules are illustrated in Figure 1. The correlation between banking industry ORI's computed from using different percentile rules, namely 10-25-50-75^{th}-percentile rule and 15-30-50-75^{th}-percentile rule, was 0.994. The correlations between these indexes and the one computed from using the mean $\pm k \times SD$ rule are about 0.960. Hence, three versions of ORI tend to exhibit similar time series patterns despite the different rating assignment rules applied to their construction.

Figure 1: Banking Industry Operational Risk Index - Three different rating assignment rules



Three versions of banking industry ORI's correspond to different rating assignment rules of Table 3, which are based upon 10-25-50-75^{th}-percentile rule (rule 1), 15-30-50-75^{th}-percentile rule (rule 2), and mean $\pm k \times SD$ rule. Series are normalized by using their sample means and standard deviations.

To validate the index, the association between ORI and actual loss events may be examined. For instance, Figure 2 depicts the banking industry ORI computed from using the mean $\pm k \times SD$ rule, superimposed by the operational risk events (OR Loss Event). OR Loss Event data are collected by Korea Operational Riskdata Exchange Committee (KOREC) of Korea Federation of Banks (KFB) and shared among contributing banks. It represents the number of loss events that have been experienced by six large Korean banks for such cases that have resulted in losses exceeding KRW 10 million.

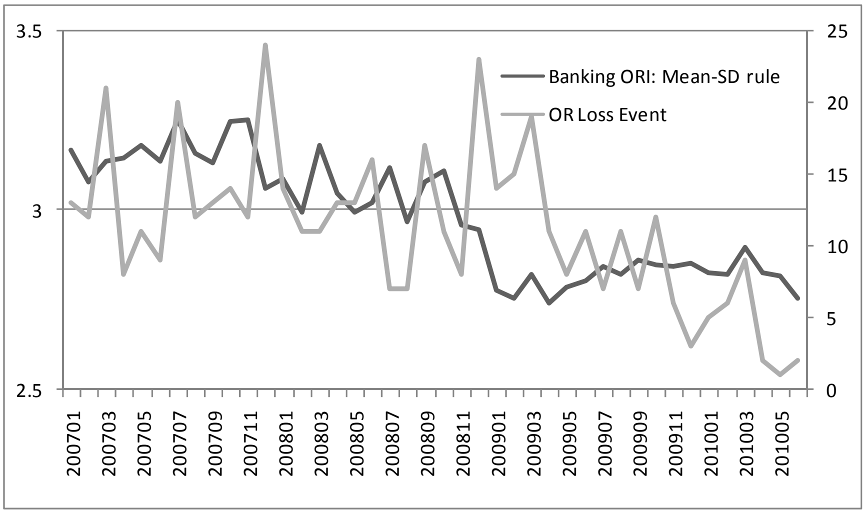
The magnitude of the contemporaneous correlations turns out to be rather small. However, the ORI seems to lead the actual loss events by about six months. For example, the correlations between all ORIs and OR Loss Events were greatest at a six-month-lead and particularly so when the mean $\pm k \times SD$ rule was used. This magnitude was 0.530, and in terms of goodness-of-fit measured by adjusted R-squared ($\overline{R}^2$) from six-month-ahead predictive regression reported in Table 4, it amounts to 35%, compared to 32.8% and 30.6% when other percentile rating assignment rules are used.

Both ORI (x_t) and OR Loss Events (y_t) appear to contain a unit root. Hence, the regression in Table 4 may be interpreted as a co-integrating relationship. When the vector error correction model (VECM) was estimated, the result was very similar to that of OLS. Namely, when the mean $\pm k \times SD$ rule was used for x_t, VECM has yielded

$$\Delta y_t = \underset{(-4.518)}{-\,0.81258}(y_t + \underset{(3.936)}{58.7506} - \underset{(-4.680)}{23.1769}x_{t-7}) + e_t, \overline{R}^2 = 0.370,$$

where figures in parentheses denote t-values. Since our sample is limited, it may be too early to judge the usefulness of the ORI. Nevertheless, the empirical evidence suggests that it contains statistically significant information for future operational risk events at the industry level that would provide supervisors with a reasonable lead time to determine appropriate preemptive measures beforehand.

Figure 2: Banking Industry Operational Risk Index (ORI) and Operational Loss Events



OR Loss Events represents the number of loss events that have been experienced by six large Korean banks. The cases that resulted in losses exceeding KRW 10 million are collected by Korea Operational Riskdata Exchange Committee (KOREC) of Korea Federation of Banks (KFB) and shared among contributing banks. ORI represents the banking operational risk index computed from using the mean $\pm k \times SD$ rule and 30 KRI's of six large Korean banks. The correlation between OR Index at t and OR Loss Events at $t + 6$ is 0.53.

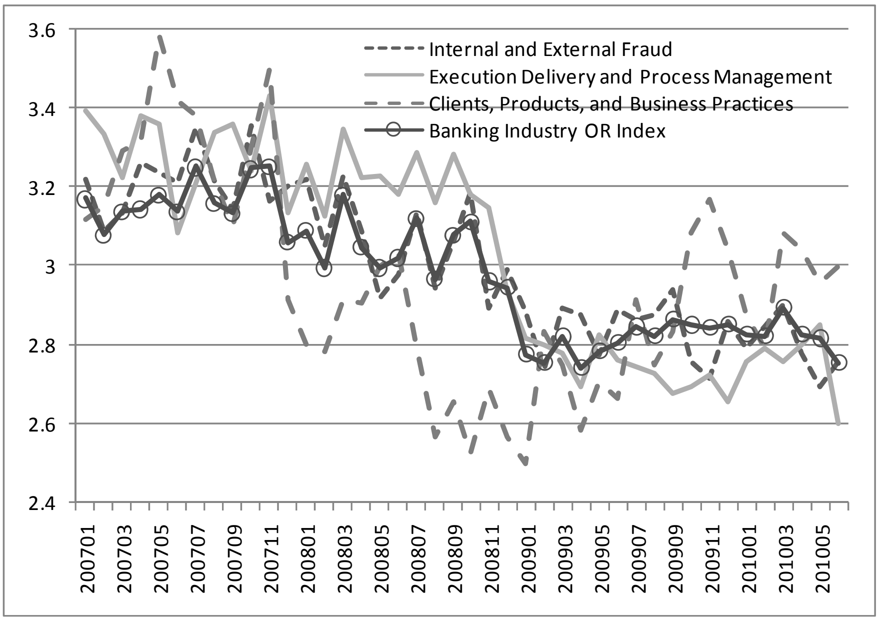
Table 4. Predictive Ability of Banking Industry Operational Risk Index (ORI) for Future Operational Loss Events

Predictor (ORI's at lag 6)	Coefficient	t-value*	$\bar{R}^2$
ORI 1: 10-25-50-75th-percentile rule	20.9868	4.245	0.328
ORI 2: 15-30-50-75th-percentile rule	18.8493	4.307	0.306
ORI 3: mean $\pm k \times SD$ rule	21.2320	4.113	0.350

The results are based upon the six-month-ahead predictive least squares estimation where operational loss events (OR Loss Events) depicted in Figure 2 is used as the dependent variable. The sample covers from January 2007 to June 2010. * denotes Newey-West (1987) heteroscedasticity-consistent t-values.

Operational risk types contribute consistently to the ORI. For example, Figure 3 depicts three operational risk sub-indices for internal and external fraud (consisting of 13 component KRI's), execution delivery and process management (consisting of 10 component KRI's), and clients, products, and business practices (consisting of 4 component KRI's). The first principle component of three sub-indices, which may be interpreted as the state of operational risks, explains 70.8% of the total variation and their factor loadings are 0.635, 0.624, and 0.455, respectively. T sub-index for business disruption and system failures (consisting of 2 component KRI's) also contribute consistently to ORI, but employment practices and workplace safety (consisting of only one component KRI) yielded a small, but negative factor loading. However, the value-weighted ORI that uses factor loadings as weights or ORI that excludes employment practices and workplace safety did not improve the predictive ability of ORI for future operational risk events.

Figure 3: Operational Risk Sub-indices by Operational Risk Types

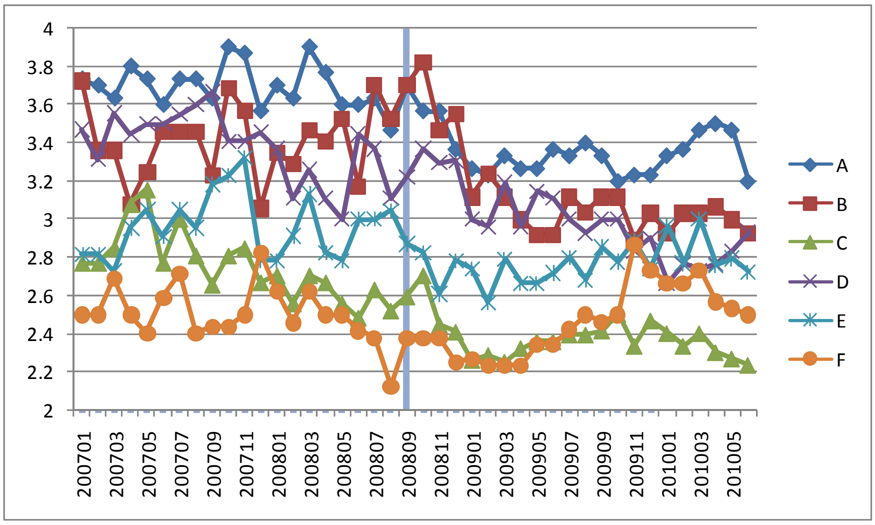


The classification of three operational risk sub-indexes - (i)internal and external fraud, (ii)execution delivery and process management, and (iii)clients, products, and business practices - are in accordance with Basel II classifications.

3.3 Supervision of Operational Risks at Bank Level

The trend and distribution of individual bank's ORI can be monitored to supervise operational risks at bank level. Figure 4, for example, illustrates individual bank's equal-weighted operational risk index constructed from using the mean $\pm k \times SD$ rule. A superimposed vertical line indicates the collapse of Lehman Brothers on September 2008, which triggered the 2008 liquidity crisis in Korea. Since the Lehman Brothers bankruptcy, the downward trend of individual bank's ORI is apparent particularly during the first half of 2009. It may be attributable, in part, to the banks' increasing awareness of the importance of operational risk management and tighter implementations to survive through a crisis and thereof economic recession. The downward trend and a narrower distribution of bank ORIs may also be attributable to a tighter monitoring by the supervisors as part of their micro-prudential surveillance during a crisis.

Figure 4: Trend and Distribution of Operational Risk Indices

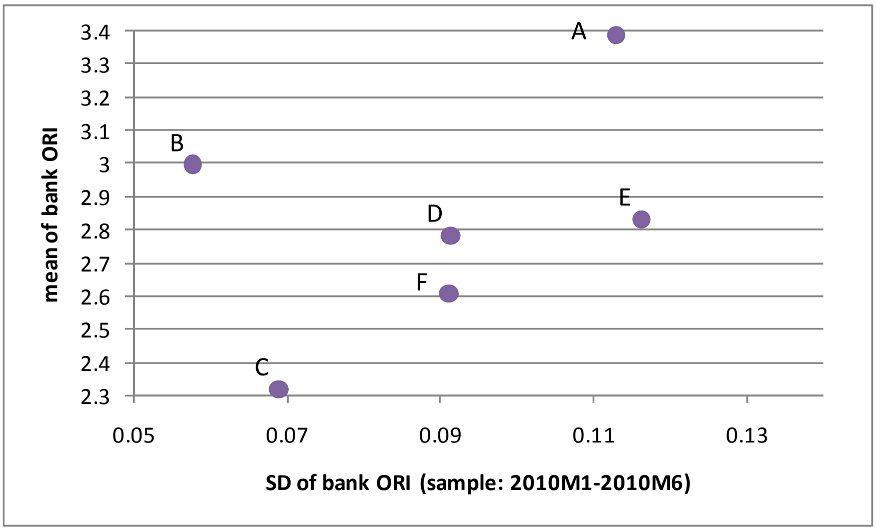


Each line represents individual bank's equal-weighted operational risk index constructed from using the mean $\pm k \times SD$ rule. The vertical line indicates the occurrence of Lehman Brothers bankruptcy that triggered the 2008 financial crisis in Korea.

Figure 4 also shows that bank A recorded on average the poorest rating throughout the sample period, followed by bank B. Complex factors would have interacted to result in this result, but a substantial portion of the poor rating may be explained by the characteristic of bank A's loan portfolio that

has a higher concentration of SME than others, and therefore, is more vulnerable through business cycles. Similarly, bank B has a higher concentration of retails than others.
Since individual bank ORIs tend to frequently intersect each other, it is sometimes not obvious determining which bank is more susceptible to operational risk. One simple but elegant method would be a scatter diagram charting the sample means and SD's of bank ORIs. Figure 5, for instance, illustrates these using observations for 2010 clearly demonstrating that banks A and E in the north-eastern region, along with bank B which exceeds the industry average, have been more exposed to operational risks than the others in the sample.

Figure 5: Mean and SD of Individual Bank Operational Risk Index



The sample means and SD's of individual bank operational risk index are computed from using six individual banks' equal-weighted operational risk indices depicted in Figure 4 for the 2010M1 - 2010M6 period. The average of the banking industry ORI for the same period was 2.823.

4 Summary and Conclusions

Since the introduction of the new Basel accord (BCBS (2006)), banks have started defining, collecting, and monitoring key risk indicators (KRI's) as a measure for calibrating the change in the nature of risks of a bank, monitoring operational risk, and providing quantitative criteria and a basis for operational risk management. Nevertheless, the number of KRI's compiled by banks adopting the advanced measurement approach (AMA) is typically more than a hundred, making it difficult to understand the state of operational risks through a simple monitoring of these KRI's. Additionally, the definitions of KRI's differ from one bank to another, and therefore, monitoring the trend of operational risk at the industry level and comparing the state of operational risks among banks has been a daunting task to supervisors.

The purpose of this paper is, therefore, to propose an effective framework for operational risk management and supervision using various own and established KRI's. As such it becomes necessary to standardize the definition among banks under supervision, to select the core KRI's of a manageable size, and to aggregate the information in the form of an index. This paper collects thirty core KRIs with unified definitions from six large Korean AMA banks. The core KRIs are selected in such a way to account for the operational risk types categorized by Basel II (the number of KRI's in parentheses): internal and external fraud (13), execution delivery and process management (10), clients, products, and business practices (4), business disruption and system failures (2), employment practices and workplace safety (1), and damage to physical assets (0). The number of assigned core KRIs to each operational risk type resembles the observed pattern of the actual operational losses experienced by large banks during the 2004 -2009 period.

Using the indexing methodology that parallels the CAEL ratings method and data from six AMA banks in Korea from January 2007 to June 2010, this paper computes the banking industry operational risk index (ORI), its sub-indices for risk types, and individual bank's ORI. The historical industry ORI suggests that a downward trend is apparent since the Lehman Brothers bankruptcy, and particularly during the first half of 2009, reflecting, in part, banks' increasing awareness of the importance of operational risk management and tighter implementations to survive through a crisis and thereof economic recession, and in part, a tighter monitoring conducted by the banking supervisors as part of their micro-prudential surveillance during a crisis.

The results from a regression analysis indicate that 35 percent of the variation of 6-month-ahead actual loss events is explained by the current banking industry ORI, suggesting its potential usefulness as a prudential early warning system for the state of operational risks. Further, the individual banks' ORI's may be conveniently evaluated by expressing them in their means-standard deviations space using an x-month moving window. When a 6-month moving window was used to assess the individual banks' ORIs, they seemed to behave consistently with the characteristics of their portfolios: namely, banks with higher concentration of retails and SME loans tended to be more vulnerable to operational risks over this business cycle.

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