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An Evaluation on the Efficiency of Taiwan Banking Operational Risk Management: Theoretical Consideration and Proposition Development

Hsiang-Hsi Liu
Distinguished Professor, Graduate Institute of International Business
National Taipei University, Taiwan
E-mail: hsiang@mail.ntpu.edu.tw
Tel: +886 932308404

Mauricio Cortés
Master, Graduate Institute of International Business
National Taipei University, Taiwan

Abstract

The aim of this study is to demonstrate that operational risk managerial systems implementation accordingly with Basel parameters improve business efficiency in terms of performance, soundness and resiliency, creating competitive advantage and adding value to the banks. Based on our proposition development and by doing it, this study helps to encourage Taiwan banks, for example, to develop their operational risk management systems (ORMS), positively influencing banks' efficiency and safety. It will not only improve the long-term performance of the companies, but also by reducing the probability of catastrophic events it will contribute to a better economic environment, enlarging opportunities to risk managers as well as for financial institutions, including the expose of competitive advantage and potential synergies that can be seized for M&A and market concentration. In order to fulfill this general objective, some specific objectives need to be attached.

Keywords: Operational Risk, Risk Management, Business Efficiency, Taiwan Banking Industry, Proposition Development.
JEL Classification:

1. Introduction

This study displays the importance of operational risk management (ORM) for the efficiency of Taiwan banks, for example, demonstrating that the application of some core risk managerial strategies influences the risk adjusted return on capital in a way that can improves the soundness and competitiveness of banking industry.

A strong and resilient banking system is the foundation for sustainable economic growth as banks are at the center of the credit and risk intermediation process between savers and investors. Moreover, banks provide critical services to consumers, small and medium-sized enterprises, large corporate firms and governments who rely on them to conduct their daily business, both at a domestic and international level. Any weaknesses in the banking sector would rapidly transmit to the rest of the

economy resulting in contractions of liquidity and credit, leading to loss of confidence, risk aversion and economic paralysis.

Operational risk (OR), defined as the risk of loss resulting from inadequate or failed internal processes, people and systems or from external events, is the first risk that any company faces and one of the most dangerous threatens to the banking industry. A newly-established bank is confronted with OR before get involved in the first market position or realize its first credit transaction; it is a peril that can destroy the company and enhance systemic risk, but its lethal hazards are concealed by low frequency and undercover by numerous low-severity-high-frequency events that generates a false sense of calm, bogging down the development of appropriate management. However, banks long ago have recognize the risk management as their natural business, therefore their operational risk management systems (ORMS) are innately more developed than other economic sectors and scale and scope economies help them to reduce cost by managing the risk more efficiently in a way that can be offered as a service to other firms at an affordable price. Even like that many firms do not take proper care about OR due to nescience, carelessness, lack of resources, overconfidence, negligence or greed leading to financial catastrophes avoidable through risk awareness, training and proper management systems. Between January 1995 and December 2009 Taiwan commercial banks registered 323 operational events of great magnitude accounting for more than NT$6.902 million losses (Lee and Fang, 2010).

The time period, the number of events and the quality of the data makes the analysis of operational risk management (ORM) difficulty, especially in the case of extreme events which are the greatest concern. Nonetheless governments around the world have promulgated regulation leading to register and disclose relevant information about OR that was essential to conduct this study. If Taiwan is to ensure that its financial sector plays its full and proper role in supporting the growth of the overall economy, it is necessary to recognize the strategic importance of ORM in building a service-driven supervisory culture that lead Taiwan banking industry, for example, toward further competitiveness in a liberalized and globalized world.

The remainders of this study are organized as follows. Section 2 describes the state of the art including the background information and related theoretical considerations and procedures. Section 3 depicts the relationships between operational risk management (ORM) and business efficiency evaluation. Section 4 discusses the proposition development (hypotheses formulation) and its implications. Section 5 provides concluding remarks of the study.

2. Theoretical Consideration and Process

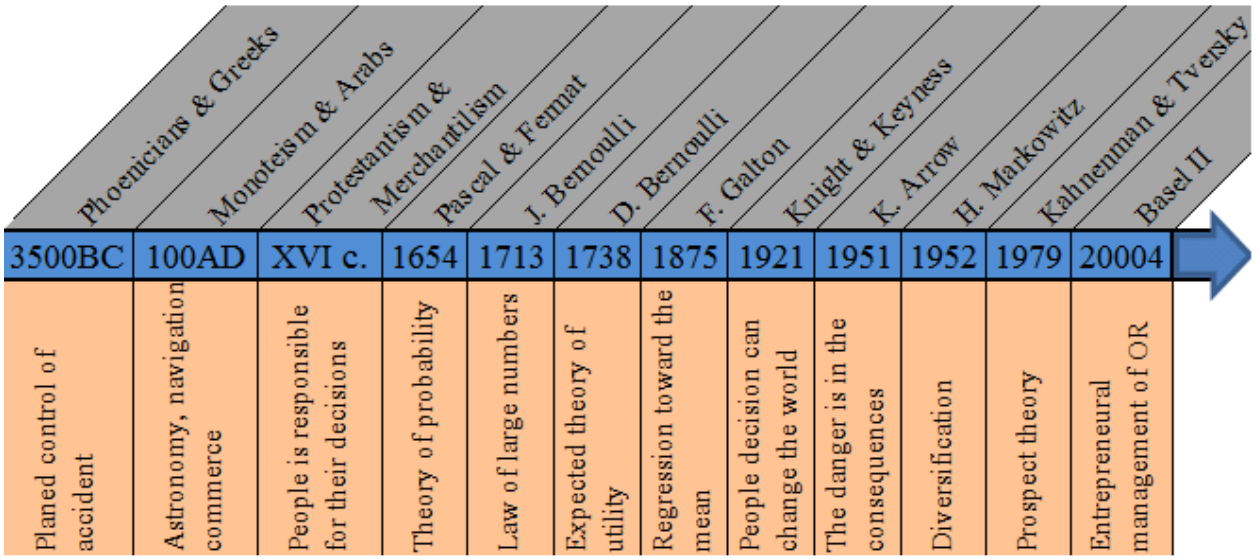
To develop model framework more accurate in our analysis on the relationships between operational risk management (ORM) and efficiency evaluation, the background information and related theoretical considerations and procedures will discuss in this section.

2.1 Background Information

In ancient world people managed to make decisions, Greeks and Phoenicians had a planned control of the accident but without real understanding on risk or the nature of decision-making, genuflection before the gods was the only form of risk management that caught their attention (Bernstein, 1996). Monotheism unifying the standards of the future, the Arabs transforming the Hindu numbering system into astronomy, navigation and commerce, the protestant reformation warning people that they would have to take responsibility for the consequences of their decisions, and mercantilist seeking their own fortune generated the demand for a mathematical theory of probability, created by Blaise Pascal and Pierre de Fermat in 1654 (Basulto and Camúñes, 2007), and further developed by the law of large numbers (Bernoulli, 1713), the risk aversion and risk premium theory, the law of diminishing marginal utility, the expected utility hypothesis (Bernoulli, D; 1738) and the regression toward the mean (Galton, 1986).

Then Knight (1921) distinguishing between the measurable risk and the immeasurable uncertainty, and Keynes (1921) explaining that uncertainty rather than mathematical probability is the ruling paradigm in the real world, convinced people that their decisions can change the world; nevertheless the danger is hided in the consequences of the decision, not in the decision itself (Arrow, 1951), therefore diversification is the way to maximize the probabilities of survival (Markowitz, 1952), but people experience cognitive difficulties that forestall them from "rationality" and Markowitz's prescription (Kahneman and Tversky, 1979). See Figure 1.

Figure 1: ORM Time Line



In 1975, the Committee on Banking Supervision was created to evaluate and analyze risk and prudential regulation for the banking industry. In order to achieve the healthiness of international bank system, stabilize and decrease the unfair competition, in 1988 the Basel Committee issued a report about the asset types for eligible capital and the capital requirements; in 2004 a second accord was published to create international standards that ensure that capital allocation is more risk sensitive, separate OR from credit and market risk, quantifying them, and align economic and regulatory capital more closely to reduce the scope for regulatory arbitrage; Basel II is based on three pillars: minimum capital requirements, supervisory review and market discipline. Basel III (2011) was The Committee answer to the market failures revealed by the financial tsunami (2008); its purpose is to reduce the ability of banks to damage the economy by taking on excess risk. It focuses on improve the ability to absorb shocks arising from financial and economic stress, improve risk management and governance; and strengthen bank's transparency (Gregoriou (2009), Omarova (2016)). See Figure 2.

Risk management has transformed the perception of risk from chance of loss into opportunity for gain, from fate and original design to sophisticated, probability-based forecast of the future, and from helplessness to choice, but it does not mean people have escaped of danger or its consequences; low probability is not the same than nonoccurrence and hedge is not the same than safe.

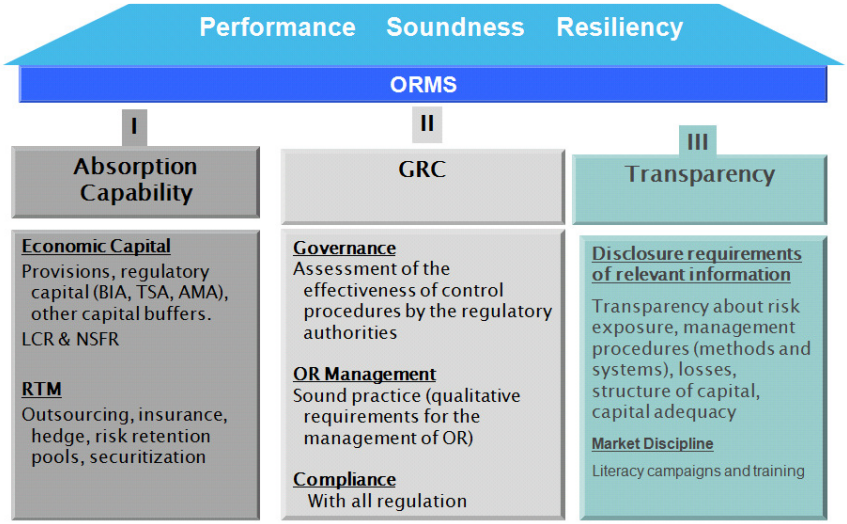
2.2 Related Theoretical Considerations

2.2.1 Decision-Making under Risk and Uncertainty

Decision is the final product of a non-linear recursive process expressed as a single idea, rule or action designed to an application. The inputs of the process include a situation that need to be solved or improved, the available alternatives, the decision-maker goals, constrains and subjective perceptions, and the threats.

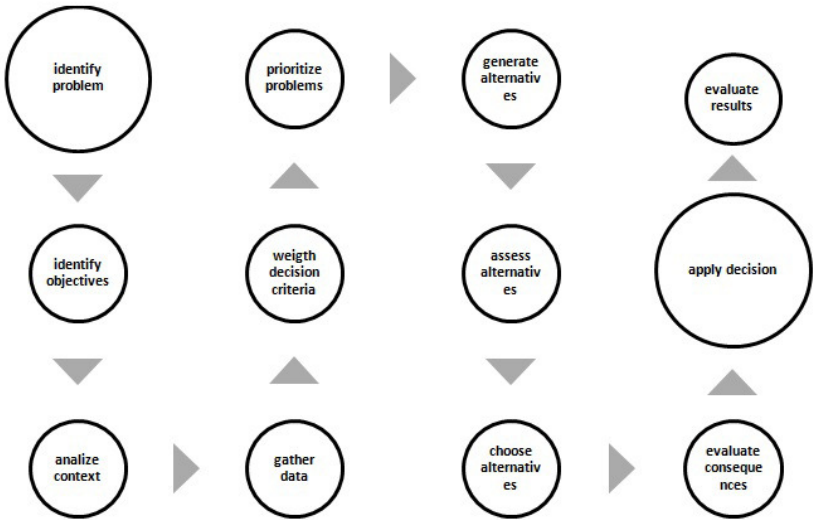
Since decisions must be made within constrained environment, the major challenge of decision making is to reduce uncertainty, but there is not permanent security because it cannot be eliminated, however without taking risks a company cannot grow, improve or even tick over. Managers face the risks of poor performance and failing to measure up to some benchmark that is known to potential investors, so they have incentive to take risks, but they should not go too far in their efforts to beat the market.

Figure 2: ORM Structure



Decisions related to risk involve the objective facts and the subjective view about desirability on what is to be gained or lost by the decision, therefore the firm must have a process that ensures the quality of managers' decisions based on the available information and reflecting stakeholders' preferences so the decision maker cannot separate too much from stakeholders' wishes. The process described in Figure 3 (Russo and Schoemaker, 2001) allows managers to understand whether the risk is necessary or desirable, risk for the right reasons and with an structured plan, don't expect complete success, recognize the trade off and avoid any real risk of catastrophe at any reasonable cost, helping them to choose the company's risk appetite that is the starting point for the risk management process.

Figure 3: Decision Process



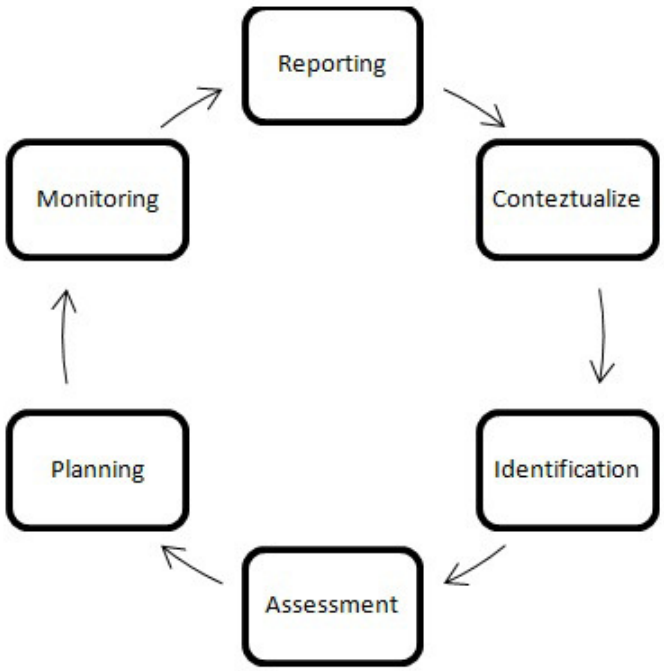
2.2.2 ORM Process and Procedures

ORM is a continual cycling process which include the identification, assessment and prioritization of risks followed by coordinated and economical application of resources to minimize, monitor, and control the probability and/or impact of unfortunate events or to maximize the realization of opportunities deciding to avoid, mitigate, transfer or assume certain risks accordingly with firm's risk appetite in order to increase the organization's short- and long-term value to its stakeholders, and ensure the sustainability and smooth running of the company (Mao; 2012; Pasman, Rogers and Mannan, 2017). Risk management should create value, be an integral part of organizational processes, be part of decision making, explicitly address uncertainty, be systematic and structured, be based on the best available information, be tailored, take into account human factors, be transparent and inclusive, be dynamic, iterative and responsive to change and be capable of continual improvement and enhancement (ISO, 2009).

A good risk management ensures business continuity, stability of shareholders' returns and it is a source of comparative advantage in the everyday more competitive markets. ORM strategy should have high-level goals, aligned with and supporting the organization's mission, operate with effective and efficient use of resources, reporting with financial reliability and compliance with applicable laws and regulations, accepting risk when benefits outweigh the cost, not accepting unnecessary risk, anticipating and managing risk by planning and making risk decisions at the right level (US Department of Defense, 2008).

Time transforms risk and its management process, therefore three levels of ORM have been defined: (A) In depth risk management is used before a project is implemented, when there is plenty of time to plan and prepare; (B) Deliberate risk management is used at routine periods through the implementation of a project or process; and (C) Time critical risk management is used during operational exercises or execution of tasks. ISO 31000 describes the steps for in depth ORM as presented in Figure 4.

Figure 4: ORM Process



Contextualize includes an understanding of the current conditions in which the organization operates on an internal, external and risk management context; establishing a common risk language or glossary; identify common risk within the industry; mapping out the social scope of risk management,

the identity and objectives of stakeholders, the basis upon the risk will be evaluated, the constrains and the entity's risk appetite; planning the process; defining a framework for the activity and an agenda for identification; developing an analysis of risk involved in the process; identify common mitigation or solution of risks using available technological, human and organizational resources.

Identification includes making a documented risk inventory and the representation of areas to the organization may exploit for competitive advantage (Table 1). Common risk identification methods are objectives identification (events that may endanger achieving an objective), scenario identification (events that triggers an undesired scenario), taxonomy identification (common-risk checklist), and risk charting. Each organization faces its own risks that need to be identify and constantly actualized through periodic risk checklist, workshops, meetings and questionnaires using one or more of the mentioned methods.

Table 1: OR Classification

Causes	Business Line	Event Type	Effects
1. People	1. Corporate finance	1. Internal fraud	1. Loss of recourse
2. System	2. Trading & sales	2. External fraud	2. Write-down
3. Processing	3. Retail banking	3. Employment practice & workplace safety	3. Loss of physical asset
4. External causes	4. Commercial banking	4. Clients, products & business practices	4. Restitution
	5. Payment & settlement	5. Damage of physical assets	5. Legal cost / settlement
	6. Agency services	6. Business disruption & system failures	6. Loss of money
	7. Asset management	7. Execution, delivery & process management	7. Loss of important information, etc.
	8. Retail brokerage		
Example:			
Cause	**BL**	**ET**	**Effect**
External cause	Retail banking	External fraud	Loss of money

Assessment includes quantify risks potential severity of loss and the probability of occurrence. Basel present 3 methodologies to quantify OR: basic indicator approach (BIA), standardized approach (TSA) and advanced measurement approach (AMA). (Table 2).

Table 2: OR Quantification Approach

BIA	TSA	AMA
$EC = \frac{1}{n}\sum_{i=1}^{n} \propto * GI_i$ EC = Economic Capital n = number of years α = parameter for the sector, 15% for banking. GI_i = gross income of year i, if that year the income was positive.	$EC = \frac{1}{3}\left\{\sum_{1}^{3} MAX\left[\sum_{1}^{8} \beta_j * GI_i ; 0\right]\right\}$ EC = Economic Capital β_j = Operational risk factor for the specific BL j. GI_i = gross income of year i	Expert Opinions**:** Delphi method, Scenarios Analysis, Stress tests. Causal Methods**:** Bayesian networks, influence diagrams, Fuzzy Logic. Actuarial models**:** Loss Distribution Approach (LDA), Internal Measurement Approach, Risk Drivers and Control Approach and Scenario-based Approach.

BL	β
Corporate finance	18%
Trading and sales	18%
Retail banking	12%
Commercial banking	15%
Payment and settlement	18%
Agency services	15%
Asset Management	12%
Retail Brokerage	12%

Basel III promotes the implementation of the loss distribution approach (LDA), consisting in arrange bank's operational losses data (from at least 3 years) into a 56-cell matrix compound by the 8 BL and 7 ET of Table 1, and then fitting each (ET,BL) combination with appropriate distribution functions for both severity and frequency to finally aggregate both distributions in a single distribution. After that the economic capital for that specific cell can be computed as the sum of expected and unexpected losses of the corresponding point of the aggregated loss distribution (99%). (Figure 5).

The total economic capital is the sum of every cell expected and unexpected losses concerning the correlation between ETs and BLs for one year as follows:

$$\mathrm{VaR}_{\mathrm{OR}} = \mathrm{EL}_{\mathrm{OR}} + \mathrm{UL}_{\mathrm{OR}} \tag{1}$$

where,

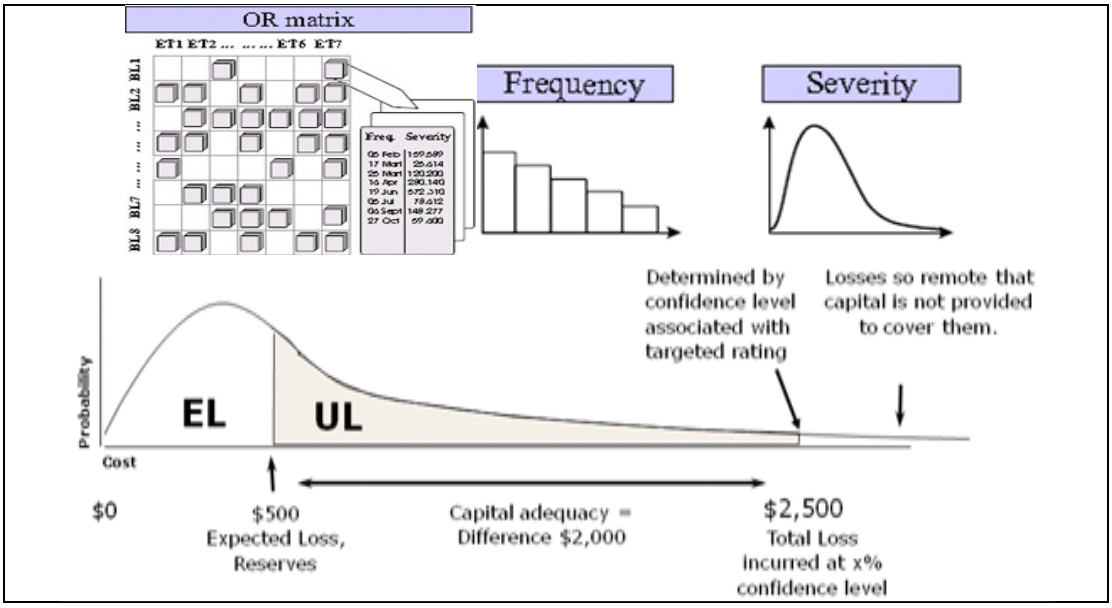
EL = Expected Losses = mean

UL = Unexpected Losses = VaR − EL

$$\mathrm{VaR}_{99\%} = \sum_{a} \mathrm{EL}_{a} + \sqrt{\sum_{\substack{\mathrm{ET,BL} \\ a \neq b}} \rho_{\mathrm{ET,BL}} (\mathrm{EC}_{\mathrm{ET}} - \mathrm{EL}_{\mathrm{ET}})(\mathrm{EC}_{\mathrm{BL}} - \mathrm{EL}_{\mathrm{BL}})} \tag{2}$$

The difficulties to quantify OR have led OR managers to first draw a OR framework, known as self-assessment, that allow them to rank the risks accordingly to the influence on the firm objectives by using the composite risk index to assess risks events on a scale of 1 to 5, (usually in terms of financial losses), and likewise the probability of occurrence on a scale from

Figure 5: Loss Distribution Approach



1 to 5 (Table 3). These axis may be expressed in either mathematical terms (event occurs once a year, once in ten years, once in 100 years etc) or time-words (event has occurred here very often; event has been known to occur here; event has been known to occur in the industry etc). The composite index thus can take values ranging from 1 through 25.

Composite Risk Index (E) = Probability (E) x Consequence (E) (3)

E = Event

Probability⇨ Frequency⇨ Control

Consequence⇨ Severity⇨ Mitigation

Table 3: Risk Assessment Criteria in Terms of their Impact and Probability

Level	Probability	Impact
1	< 1%	Without material impact
2	1~5%	Material impact, without generating significant and sustainable risk to the entity
3	5~25%	Significant risk for the entity
4	25~50%	Potential organizational damage
5	> 50%	Catastrophic damage

Risks ownership should be assigned to personnel who have the authority and resources to manage them effectively and assume responsibility for them; also the controls. Preventive controls (or "front-line") are aimed at preventing the causes of risk in a very early stage, such as business planning processes, prudential policies to recruit new employees, or other guidelines provided by the board of directors about risk management associated with GRC. By contrast detection controls (or "back-stop") are usually less frequent and take place periodically (monthly, quarterly, etc). It should be noted that a control can be designed to do not completely eliminate the risk because there are other controls that already consider the risk, because the entity decided to take that risk, or because it is uneconomical to remove it. In order to gain fast visual understanding colors may be used to evaluate the design and performance of the controls as presented in Table 4.

Table 4: Parameters to Evaluate the Design and Performance of the Controls

Design	Green	designed to eliminate the risk.
	Yellow	designed to reduce the major impacts for the risk
	Orange	designed to reduce some aspects of the risk
	Red	poorly designed, it provides little protection even when well implemented
Performance	Green	the control is properly applied according to its design
	Yellow	the control is operating but is sometimes not applied the right way
	Orange	the control is sometimes applied
	Red	the control is not applied, or applied incorrectly

The next step is to compare the estimated inherent evaluation with the current control environment in order to estimate the residual risk profile (after applying controls) of the entity. It is critical to make the best educated guesses possible in order to properly prioritize the implementation of the risk management plan and the formulation of the results in terms of impact on the organization's key performance metrics what can be done using a heat map as it is shown in Figure 6, that will tell which risks should be addressed first. The blue area presents negligible events which are usually covered by the cost of the business, since they are not of a big influence on the OR capital charge they are only periodically reviewed. The green region is for low priority events that form the basis for calculating the expected losses and they can be reduced with appropriate management control; they are under monitoring process. Yellow zone is considered as the UL; these events are very important for the ORM because their reduction is sometimes very difficult to obtain and, hence, they are subject of mitigation. The orange area is for high priority events that may cause organizational damage, some of them are out of the domain of risk capital charge so these losses should be under risk sharing mechanism (RTM) or/and other form of mitigation since firm cannot deal with these risk exposures by itself. The red area is for urgent events that may harm the organization in a catastrophic way above the normal risk management plan, they need to be managed immediately avoiding if possible, or if not applying available resources to mitigate, control and prepare for crisis, alerting crisis and business recovery plans or even triggering them if any risk reach this level in its residual form.

Figure 6: Heat Map

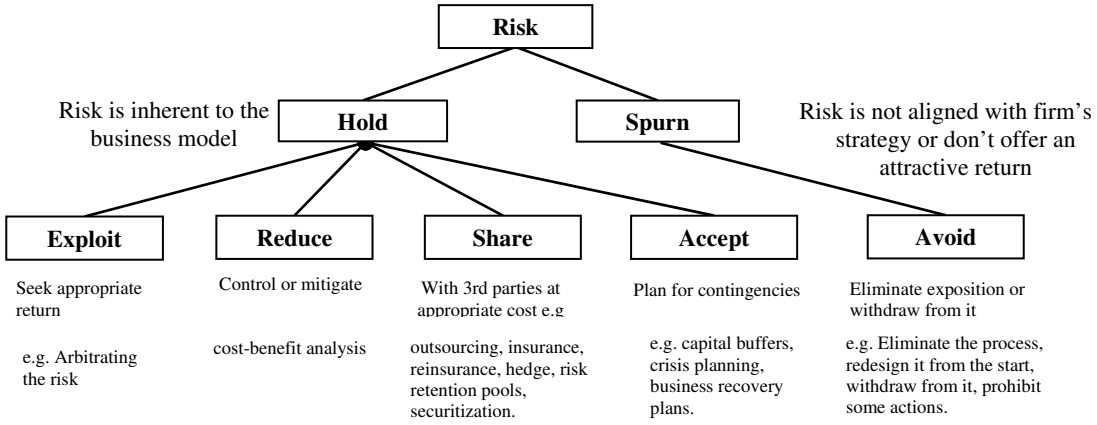
Prob.						
5	5	10	15	20	25	Urgent
4	4	8	12	16	20	High
3	3	6	9	12	15	Medium
2	2	4	6	8	10	Low
1	1	2	3	4	5	Negligible
	1	2	3	4	5	

Severity

The financial benefits of risk evaluation are less dependent on the formula used but are more dependent on the frequency and how risk assessment is performed. Risk and its factors are dynamic so it is absolutely necessary to periodically re-assess risks and intensify/relax mitigation measures as necessary.

Planning involves making a risk management plan to address each assessed risk accordingly with the company mission, vision, risk appetite, business plan and strategy through avoidance, exploiting, reduction, sharing or acceptance as presented in Figure 7.

Figure 7: Risk Management Treatments



Monitoring involves taking care of the proper implementation of the risk management plan accordingly with the established procedures and the continual measurement and monitoring of the risk environment and the performance of the risk management strategies, it is a continuous process. There are three level of monitoring: internal control, auditing and supervisory review. Risk drivers and control approach (RDCA) is one of the most efficient methods for internal control, it uses key risk indicators and dashboards to establish thresholds and ranges of tolerance for various risks; Auditing is the independent examination of the system's internal control with the aim of expressing an opinion on its validity and reliability based on work done on a test basis,; Supervisory review is the governmental examination on banks' (C) capital adequacy, (A) asset quality, (M) management, (E) earnings, (L) liquidity, and (S) sensitivity to market risk (CAMELS) (Jin, Kanagaretnam, Lobo and Mathieu (2017)). Supervisory authorities also exercise their control through a series or requirements asked to the banks for implementing OR quantification methods, for examples, in Taiwan the Financial Supervisory Commission (FSC) ask for the following requirements:

a) General requirements: Board of directors must actively participate in the ORM process; the ORMS must be conceptually solid and apply for the whole institution, the banks must provide enough resources to use the methodology in all BL and, control and auditory process.
b) Qualitative requirements*:* The bank must have an OR management unit that is responsible for the design and application of OR management framework of the entity, including

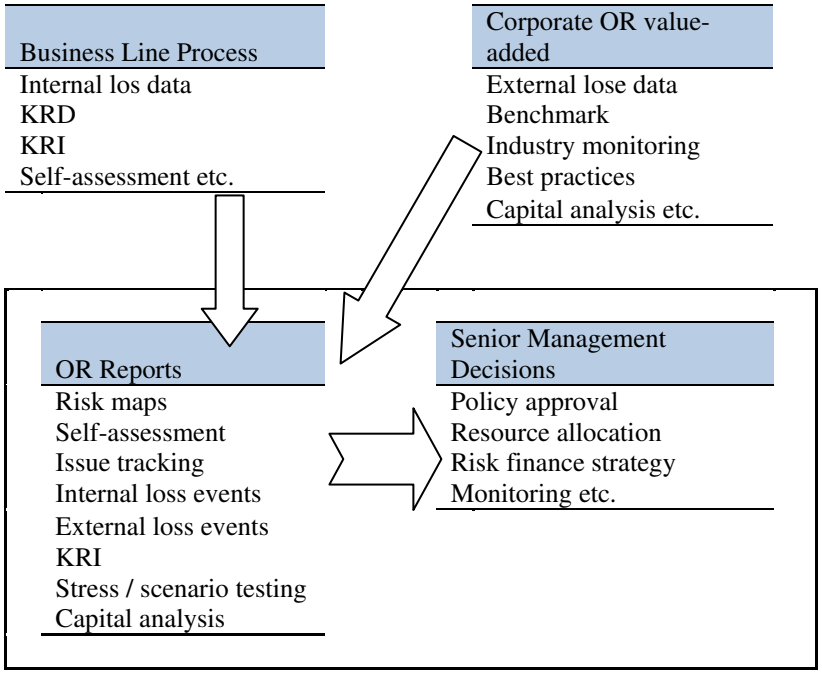
compiling policies and procedures, design and implement the methodology of measuring the OR, design and implement an information system on OR and develop strategies to identify, assess, monitor and control/mitigate OR. The internal OR quantification approach must be closely integrated into normal management processes of the OR; its output must be actively used for monitoring and controlling the bank's OR profile. The bank must have techniques to distribute the OR capital between the main BL, creating incentives to improve the ORM across the institution. OR exposure, OR events and losses data must be informed periodically to the BLs, the management team and the board. The bank must have procedures for taking the necessary actions to lower the information contained in these reports, guaranty its quality and proper update. Bank's ORMS must be well documented; it must have a mechanism to ensure regular performance of a documented set of policies, internal controls and procedures relating to the ORMS that must include policies for the treatment of aspects that do not comply. External and/or internal auditors shall conduct periodic reviews of the OR management processes and measurement systems. These tests must include both BLs operations and the independent risk unit activities. The validation of OR measurement system carried out by the external auditors and/or supervisory authorities must include checking the proper functioning of the internal validation processes, checkout of transparency and accessibility of the data stream associated with the risk measurement system, and processing. In particular, it is necessary that auditors and supervisors can easily access the specifications to the system parameters, whenever they deem necessary and under appropriate procedures.

c) Quantitative Requirements: Soundness criteria: The bank must demonstrate that its method identifies events located in the tails of the probability distribution, those that generate severe losses, it must show that its OR estimate meets a soundness standard comparable to that required in the internal rating credit risk method (one year period with 99% confidence interval). Detailed criteria: Its method must be consistent with the definition of OR from Basel committee. *ork* will be the sum of EL and UL unless the bank can demonstrate that it has calculated its exposure to EL and has taken it into account in its internal business practices. The measurement system must be sufficiently disaggregated to identify the main OR factors influencing the shape of the distribution tails for estimated losses. Internal estimates on OR losses correlations will be allowed only if the bank can demonstrate that their systems for determining correlations are appropriate, apply in its entirety and take into account the uncertainty surrounding the estimates of correlation. It must include the use of internal data, relevant external data, scenario analysis and factors reflecting the business environment and internal control systems.
d) The bank must have a credible, transparent, well documented and verifiable method for weighting these fundamental elements in its overall OR measuring system. The AMA model used by a bank will be subject to a period of initial monitoring by the supervisor before it can be used for regulatory capital purposes.

Reporting involves collecting, managing and distributing the information to the required statements (Figure 8) paying special attention to guarantee the data quality, including relevance, clarity, consistency, timeliness, accuracy, completeness, accessibility, and cost. The reporting process can be improved through information management, i.e., retrieving, acquiring and maintaining information by the development, execution and supervision of plans, policies, programs and practices that control, protect, deliver and enhance the value of data and information assets. Finally, data governance ensures that data can be trusted, putting people in charge of fixing and preventing issues with data so that the enterprise can become more efficient. The main goal of information management is to increase consistency and confidence in decision making, decrease the risk of regulatory fines, improve data security, maximize the income generation and potential of data, designate accountability

for information quality, enable better planning by supervisory staff, minimize or eliminate re-work, optimize staff effectiveness, establish process performance baselines to enable improvement efforts, acknowledge and hold all gains.

Figure 8: Operational Risk Reporting Process



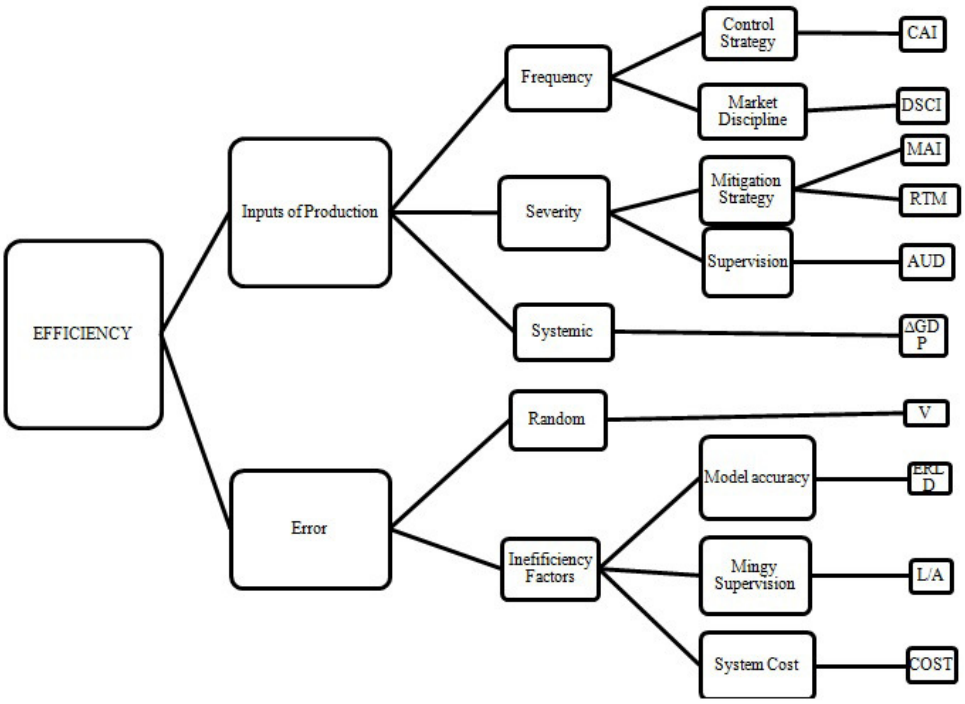
The aim of the ORM process is to inculcate a risk management culture in the bank and create guidelines that will delimitate the processes, actions and decisions of all stuff, all the time, under any condition, even those for which there is no plan. That is defined as risk governance, and helps to reduce operational losses, low compliance/auditing costs, early detect unlawful activities, and reduce exposure to future risk, among others.

3. The Relationships between Operational Risk Management (ORM) and Efficiency Evaluation

Combining the concepts of Chapelle et. all (2005) on the assessment of banks' ORM efficiency through RAROC and Battese and Coelli (1995) on stochastic frontier approach (SFA), the conceptual framework for model setup contains three parts that fit the structure of the SFA: On the left the performance measure of operational efficiency for ORM is defined as the RAROC *(Stoughton and Zechner, 2007; Chorafas, 2004)* of bank i at time t. Then the right side of the equation contains a vector of independent variables (X) that each bank can control through management decision, therefore they are called managerial variables, and the error term (e) that groups the elements out of control by the bank, including the technical inefficiency (u) derived from a vector of inefficient factors (Z) plus a random term (w), and the random effect (v) (see levels 1, 2 and 3 of Figure 9).

Following Basel concepts, the managerial variables are grouped in three blocks that work together to improve and support the ORM (see level 4 of Figure 9). The first block is the loss absorption capacity (X_1, AC), it integrates the elements that give the bank shock absorption ability like economic capital and RTM, Basel II addresses in detail the capital requirements whilst Basel III expand the scope to other capital buffers such as LCR and NSFR; Supervision of GRC is the second block (X_2, GRC), including the concepts of supervisory review from Basel II, corporate governance and compliance from Basel III, essential for the operational risk control; The third block is transparency (X_3, CTI), including disclosure requirements and voluntary disclosure of financial items with emphasis on those important for ORM. Basel II uses market discipline to improve supervision at a low cost, whilst Basel III extends the concept of transparency to create a risk management culture.

Figure 9: Conceptual Framework



The error term(e) associated to management decisions (U) is also attached to these three blocks but describing its technical inefficient component. The first technical inefficiency factor is capital requirements (Z_1, ork) referring to the opportunity cost arising from the capital that banks have to stock due to compulsory capital requirements established by FSC, which cannot be invested in (potentially) more profitable options. Leniency (Z_2, len) is the second factor because sparse governance reduces the efficiency of the control strategy, generating inefficiency arising from the increase of operational events frequency. The third factor is opacity (Z_3, opa) that generates inefficiency by making difficult to discover the risks until they materialize, increasing the severity of the operational events. Technical inefficiency also arises by chance; these causes are compiled within an error term (w). Finally the random component is huddled in the second block of the error term (v).

4. Discussions of Proposition Development (Hypothesis Formulation*) and* Implications

Based on the conceptual framework (Figure 10) outlined above, this study presents the proposition development (hypothesis formulations) and implications as follows:

***$PD_1(H_1)$: Absorption Capability (AC)* Strengthens Banks' Operational Efficiency.**

AC refers to how well a bank responds to risks materialization maintaining its profitability, soundness and resiliency. The main tool of absorption capability is the economic capital, composed by general provisions and capital buffer; other tools that enhance shock absorption capability are risk transfer mechanism (RTM). Then, hypothesis **$PD_1(H_1)$** is proposed.

$PD_2(H_2)$*: Governance, Risk Control and Compliance* (GRC) Improves Banks' Operational Efficiency

Good corporate governance based on the principles of fairness, transparency, accountability and responsibility creates shareholder value and reduces non-financial risk for investment (risk of loss of investor value due to mismanagement or abuse by blockholders) such as expropriation by insiders including cash flow diversion (transfer pricing), dilution of minority shareholders, asset stripping,

delay or nonpayment of dividends, inability of dispersed shareholders to control management, lack of board effectiveness and "true" independence, weak internal controls and risk management, excessive executive compensation, financial short termism; etc (Standard & Poors, 2008). The Financial Examination Bureau (FEB) established the financial examination rating (Omarova, 2016) to assign different risk grades to reflect their overall business soundness and the degree of their compliance with supervisory concerns according with the parameters presented in Table 5. *Furthermore, FSC determined the requirements mentioned in monitoring for banks to upgrade their ork.* The variable GRC will be defined to grasp the power effect of the supervisory review on RAROC. This reasoning leads to **$PD_2(H_2)$**.

Table 5: Approximations to the FEB Financial Examinations Ratings

Rating	Criteria
A	The corporate governance processes and practices at the company provide a very strong protection against potential governance related losses in value. A company in these rating categories has few weaknesses in any of the major areas of governance analysis.
B	The corporate governance processes and practices at the company provide strong protection against potential governance related losses in value. A company in these rating categories has some weaknesses in certain of the major areas of governance analysis.
C	The corporate governance processes and practices at the company provide moderate protection against potential governance related losses in value. A company in these rating categories has weaknesses in several of the major areas of governance analysis.
D	The corporate governance processes and practices provide weak protection against potential governance related losses in value. A company in these rating categories has significant weaknesses in a number of the major areas of governance analysis.
E	The corporate governance processes and practices provide very weak protection against potential governance related losses in value. A company in these rating categories has significant weaknesses in most of the major areas of analysis.

$PD_3(H_3)$*: T*ransparency (CTI) Enhances Banks Operational Efficiency

A corporation is transparent when through the disclosed information stakeholders can truly understand the state of the business, whether the organization's activities are consistent with regard stakeholders interest, whether these activities are institutionalized (integrated into the organization values, policies and process), and weather the information can be verified and in which degree of objectivity. All economic agents need to generate revenues and avoid bankruptcy; the mutual constrains freely imposed for them in order to achieve their personal goals are called market discipline (Nal, 2006). In a free-market it helps to reduce the occurrence and impact of operational events because properly informed stakeholders and marketplace participants would reward companies that fulfill their needs in terms of profitability and safety, and penalize those that do not, forcing banks to set their risk profiles accordingly to cash flows that satisfy stakeholders' requirements and internal process that ensure these cash flows. The variable CTI will be defined to capture the effect of transparency on RAROC. Therefore, hypothesis **$PD_3(H_3)$** can be developed.

$PD_4(H_4)$*: Operational Risk Compulsory Capital Requirements (ork) Increase Bank's Technical Inefficiency*

Banks need capital to run their business, pay its bills, and invest in loans, securities, structured products, etc., activities that accelerate the economy. Of course, some reserves are required to guaranty depositors withdrawals, own liquidity and public confidence, however it should be a managerial decision instead of a legal imposition. According to Rime (2001) regulatory pressure induce banks to increase their capital, but does not affect the level of risk, and Van den Heuvel (2008) considers that capital requirements reduces the ability of banks to create liquidity, founding that the welfare cost of current capital adequacy regulation is equivalent to a permanent loss in consumption of between 0.1% and 1%. We have similar thought. Government constrains and continuous interventionisms corrupt the

normal functioning of the market reducing companies' opportunity to achieve efficiency and international competitively. Hence, the hypothesis **$PD_4(H_4)$** is proposed.

$PD_5(H_5)$*: Leniency* (*len*) Boosts Banks' Technical Inefficiency

Leniency (*len*) is the softness in the enforcement of the duties or in punishing offenses. In this thesis it refers to the sparsity of GRC processes. **G**overnance is the way through which the administration board manage the organization combining information management and hierarchical structures, ensuring the completeness, accuracy and timely of the information to enable appropriate decision-making, and ensuring that their strategies, directions and instructions are carried out systematically and effectively; **R**isk management is the set of processes through which management identifies, analyses and responds appropriately to the risks faced by the company; **C**ompliance is conformity with stated requirements, and can be achieved through management processes which identify the applicable requirements (defined in laws, regulations, contracts, strategies and policies), assess the state of compliance, assess the risks and potential costs of non-compliance against the projected expenses to achieve compliance, and hence prioritize, fund and initiate any corrective actions deemed necessary. In ORM this systems are designed to reduce the frequency of operational events by setting process that reduce errors and by finding out potential failures in the process before risks materialization, when there is not enough control some errors or potential failures are passed over, increasing the probability of risk materialization. Firms have to take a trade-off in their governance and audits process, strict GRC may lower their capital raising costs and operational losses, or lenient GRC may reap benefits derived from reduction in the cost of the processes, ease decision making through cutting bureaucracy and the opaqueness gains. Anyway *leniency* (*len*) reduces the probability of find out weakness on the processes or stop potential harmful activities creating X-inefficiency which effect will be captured by the factor *len*. Based above discussion, hypothesis **$PD_5(H_5)$** can be constructed.

$PD_6(H_6)$: Opacity (*opa*) Swells Banks' Technical Inefficiency

Opacity (*opa*) frequently complicate efforts by financial stakeholders to ensure that management is acting in their interests, it facilitates to hide weakness, mistakes, failures, crimes, and other risky activities, increasing the provability of single rare but extreme loss events which account for the largest amount of operational losses, thus bloating technical inefficiency. Therefore, hypothesis **$PD_6(H_6)$** can be developed.

It should be noted that the above hypotheses we developed in this study could also be thought as proposition development, meaning that the statement in terms of a truth to be demonstrated, or of an operation to be performed or testified (identified) in related case studies, and furtherly give the strategic implications for the efficiency of (Taiwan) banking operational risk management.

Concluding Remarks

The main motivation of this study is to promote improvements in the operational risk management systems (ORMS) of Taiwan banks, for example, so as to ensure their soundness and sustainability while economic efficiency is achieved. OR is inherent in doing business and operations of the organization itself; a single incident may lead a well-known bank to bankruptcy and cause systemic seism; even like that many firms do not take proper care about it due to nescience, carelessness, lack of resources, overconfidence, negligence or greed leading to financial catastrophes avoidable through risk awareness, training and proper management systems. This research wants to show bankers the importance of ORM for their own benefit, regulator authorities its importance for the economic growth and stability, and general population the need to understand OR and play their role in the market discipline.

This study, based on the proposition (or hypotheses) development, indicates that shock absorption capability strengthens operational efficiency and banks with larger own capital have

stronger absorption capability; governance, risk management and compliance improve operational efficiency and banks with more advanced OR assessment models have better GRC; transparency enhances operational efficiency and market discipline fosters transparency; leniency in risk controls boosts operational events number and makes the credit spread more expensive increasing technical inefficiency; and opacity swells operational losses, reducing public confidence and deposits and increasing technical inefficiency due to rising capital cost.

In conclusion, based on our knowledge, for example, the Taiwan banking main problems are the excessive market dispersion, the consequent financial muscle shortage and the embryonic stage of development in the GRC systems. Specifically, for OR there exist scanty use of ORM tools for control and mitigation, scarcity of OR data and opacity. ORMS, as a tool that accumulates company's knowledge and expertise in their business, can provide wide and accurate information for directors and boards so they can take educated decisions accordingly with their risk appetite, management style and special aims. The government has to play its role through FSC, protecting the public order and safety by focusing on reducing the adverse selections due to asymmetric information, balancing external costs and compensations, producing and administrating public goods, and avoiding excessive interventionism. Market discipline is a much cheaper alternative because it places the cost on the final users, but the effects of market discipline are reduced when banks enjoy high degree of government support. FSC should promote accurate information disclosure, empower private-sector corporate control of banks, and foster incentives for private agents to exert corporate control.

References

[1] Arrow, K. J. (1951). Alternative Approaches to the Theory of Choice in Risk-Taking Situations. *Econometrica*, 19(4): 404-437.

[2] Battese, G and T. Coelli (1995). Model for Technical Inefficiency Effects in a Stochastic Frontier Production Function for Panel Data. *Empirical economics*, *20*(2): 325-332.

[3] Bernstein, P. (1996). *Against the gods: The remarkable story of risk,* New York: Wiley.

[4] Basulto, J. and J. Camúñes (2007). *The Geometry of Chance. The Correspondence between Pierre de Fermat and Blaise Pascal*. Nivola Libros, 304.

[5] Bernoulli, D. (1738). Exposition of a New Theory on the Measurement of Risk. *Econometrica*, 22(1): 23-36.

[6] Bernoulli, J. (1713), The Art of Conjecturing. *Newman*, 1988. pp. 1425-1432.

[7] Chapelle, A., Y. Crama, G. Hauber and J. Peters (2005). Measuring and managing operational risk in the financial sector: an integrated framework. http://ssrn.com/abstract=675186.

[8] Chorafas, D. N. (2004). *Measuring and Managing Operational Risk in the Financial Sector: An Integrated Framework*. Elsevier, Butterworth-Heinemann, Elsevier

[9] Farrell, M. (1957), The Measurement of Productive Efficiency. *Journal of the Royal Statistical Society, Series A*, 120(3): 253-290.

[10] Galton, F. (1886). Regression Towards Mediocrity in Hereditary Stature," *The Journal of the Anthropological Institute of Great Britain and Ireland*, 15(1): 246-263.

[11] Gregoriou, G. (2009). *Operational Risk Toward Basel III: Best Practice and Issues in Modeling, Management and Regulation*, John Wiley & Sons.

[12] International Organization for Standardization (2009). *ISO 31000: Risk Management: Principles and Guidelines*. ISO.

[13] Jin, J. Y., K. Kanagaretnam, G. J. Lobo and R. Mathieu (2017). Social Capital and Bank Stability. *Journal of Financial Stability*, 32(1): 99-114.

[14] Keynes, J. (1921). *A Treatise on Probability*. London: Macmillan.

[15] Knight, F. (1921). *Risk, Uncertainty and Profit*. New York: Century Press.

[16] Kahneman, D. and A. Tversky (1979). Prospect Theory: An Analysis of Decision Under Risk, *Econometrica*, 47(2): 263-292.

[17] Kumbhaker, S. and C. Lovell (2000). *Stochastic Frontier Analysis*. Cambridge University Press.
[18] Lee, W. C. and C. J. Fang (2010). The Measurement of Capital for Operational Risk in Taiwanese Commercial Banks. *The Journal of Operational Risk.* 5(2): 79-102.
[19] Markowitz, H. (1952). "Portfolio Selection," *The Journal of Finance,* No 7. pp.77–91.
[20] Mao, Y. (2012). *An Assessment on the Efficiency of Operational Risk Management for Banking Industry Operating in Taiwan: An Application of Stochastic Frontier Approach: An application of stochastic frontier approach*, Master Thesis, Taipei: National Taipei University.
[21] Nal, O. (2006). *Strategic Behaviors in Financial Markets and the Market Discipline Mechanism,* Ph. D. Thesis, Rice University. US.
[22] Omarova, S. T. (2016). Optimal Capital Allocation Using RAROC and EV. Alabama *Law Review*, 68(4): 1029-1070.
[23] Pasman, H. J., W. J. Rogers and M. S. Mannan (2017). Risk Assessment: What Is It Worth? Shall We Just Do Away with It, or Can It Do a Better Job? *Safety Science*, 99(1*)*: 140-155.
[24] Rime, B., (2001). Capital Requirements and Bank Behavior: Empirical Evidence for Switzerland. *Journal of Banking and Finance*, 25 (40): 789-805.
[25] Russo, E. and P. Schoemaker (2001). *Winning Decisions: Getting It Right the First Time*. New York: Doubleday, Crown Business.
[26] Standard and Poors. (2008). *Criteria: GAMMA Scores*.
[27] Stoughton, N. M. and J. Zechner (2007). Optimal Capital Allocation Using RAROC and EVA. *Journal of Financial Intermediation*, *16*(3): 312-342.
[28] Taleb, N. N. (2010). *The Black Swan*: *The Impact of the Highly Improbable***.** Penguin. Second Edition.
[29] US Department of Defense (2008). *Naval Safety Center ORM*.
[30] Van den Heuvel, S. (2008). "The Welfare Cost of Bank Capital Requirements," *Journal of Monetary Economics*, Vol. 55, No. 2, pp. 298-320.