BIS Risk Weights and the Emergence of Moral Hazard: Evidence from Taiwan *

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Abstract

This paper estimates the VaRs for marketable assets in order to examine the propriety of the risk weights set by the Basel Accord and compare the capital charges between the standardized and the internal model approaches using the actual positions of institutions. We find that the risk weights exhibit a risk-encouraging concave function of economic risk, and tend to favor the riskier assets more than the riskless assets. Such "supervisory discrimination" in terms of risk weights gives rise to the moral hazard problem in that the regulator fails to reduce the risk-taking incentives of institutions. The internal model approach does not necessarily provide the capital savings to encourage the institutions to develop internal models. Since the capital savings will occur only in the case of low-risk institutions, the high-risk institutions, which need to introduce an internal model to improve their risk management, will choose the standardized method as their tool for calculating capital requirements.

***EFM codes*:** **520**

Keywords: VaR, Risk weight, Standardized approach, Internal model approach, Supervisory discrimination

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1. Introduction

With its worldwide support, the core idea of the Risk-Based Capital Regulation (RBCR) is to relate a bank's capital requirements to the economic risk associated with its assets. Only if the regulatory capital can properly reflect the economic risk of the bank, can the RBCR reduce the insolvency risk of the bank to an acceptable level and achieve the regulatory goal. The discrepancies between the true economic risks of assets and the regulatory measures of risk embodied within the capital requirements are brought into the regulatory capital arbitrage (RCA). As Merton (1995) suggested, the basic insight behind RCA follows from the observation that capital standards are not based on any consistent economic soundness standard. Unless these economic and regulatory measures of risk are brought into closer alignment, the underlying factors driving RCA are likely to remain unabated and this will lower the effectiveness of the RBCR (Jones (2000)). Therefore, seeking ways to more closely align the regulatory measures of risk with a bank's true economic risks becomes the most important task of the supervisor.

To strengthen the soundness and stability of the international banking system, the Bank for International Settlements (BIS) initially developed a common measure of solvency, i.e., the 8% risk-based capital ratio that only provides coverage in relation to credit risk. The 1996 Amendment, however, required banks to measure and hold capital to cover their exposure to market risk in their trading books. Moreover, the banks were permitted to choose between the internal VaR models approach and the standardized approach to determine the required capital associated with market risk. In 2001, the BIS proposed replacing the 1988 Accord with a new capital adequacy framework, known as the Basel II Accord that rests on three pillars. The new Accord releases a three-stage reform process, i.e., an external-based approach, an internal-based approach and internal credit risk models to improve the measurement of credit risk for banks. In addition, the risk coverage is extended to operational risk. From the multi-stage reform process of the Basel Accord, we can find that the Basel Committee on Banking Supervision concentrates on the following directions for achieving the aims of the RBCR. The first is concerned with the way in which the Committee intends to extend the coverage of the different sources of the risk accruing from the operating activities of the bank. The second focuses on how it attempts to refine the techniques of risk measurement. However, the supervisory work involved in risk measurement and management is tremendously difficult.

The existing regulatory capital requirements have received a great deal of criticism. One of main criticisms is that they are only loosely linked to the economic risk associated with the banks' assets (Jorion, 2000, Altman and Saunders, 2001, Linnell, 2001, Saunders, 2001 and Dangl and Lehar, 2004). Jones (2000) discusses the principal techniques of risk unbundling and repackaging, including securitization and credit derivatives, which are used to undertake capital arbitrage under the current capital framework. Altman and Saunders (2001) present some empirical evidence to show that the current Basel "one size fits all" approach is not sufficiently modified in the new approach. The similar "risk-shifting" incentives (i.e., RCA) still exist under the new plan. The current risk based bucketing proposal lacks a sufficient degree of granularity. Altman, Bharath and Saunders (2002) analyze the revised capital requirements for credit risk under the standardized approach proposed by the BIS. It is found that the new Accord overcharges the risk of high-quality debt relative to low-quality debt and still contains inherent risk-taking incentives for banks. However, these developments are all related to the revised credit risk proposal of the new Accord. As with the market risk, there is still little empirical evidence to identify the relationship between the risk weight and the economic risk associated with each asset category when examining the propriety of the capital adequacy of the institutions. This forms the first central topic of our article. To our knowledge, this article is the first to provide a comprehensive analysis of the actual volatility of each asset category. We observe a concave relationship between the capital charges (risk weight) and the economic risk associated with the assets, which is an important contribution made by this study to the existing literature.

The standardized method and the internal model method are the two regulatory capital requirement alternatives attributed to the market risk of the bank assets under the Basel Accord. To build up a more risk-sensitive capital regulation and acquire a better understanding of the current regulation, a comparison and analysis of the two alternatives is required. Dangl and Lehar (2004) develop a continuous time framework to compare the effectiveness of regulations between the building block approach and the VaR-based internal model, and find that the VaR-based capital regulation creates a stronger incentive to reduce asset risk when banks are solvent.

Since the refined method applies superior tools and can explain the riskiness of a portfolio efficiently, we are hereby concerned with whether the internal model method can bring about capital saving, i.e., a reduction in capital charges realized by adopting the internal model instead of the standardized method, in order to encourage the institutions to develop their own internal models. In general, it is believed that any reasonable internal model method can produce different amounts of capital saving depending on the diversification of the portfolios as mentioned in the popular textbooks on risk management (Jorion (2000), Crouhy, Galai and Mark (2003)). However, the available evidence does not necessarily confirm the common belief[1]. Some of the evidence from emerging markets shows that the internal model method generates a larger capital charge than the standardized approach and cannot provide capital saving to encourage the institutions to develop their home-made models (Soczo (2001), Liu, Wu, and Wu (2003)). What, then, contributes to the difference in saving or the addition in the capital charges generated by the two alternatives under the prevailing capital regulatory framework? As far as we know, there is no further evidence that can provide an explanation for this unexpected finding. What is the rationale for the setting of regulatory parameters to achieve our supervisory goal? It is these that are other key issues and also contributions of this study to the existing literature with which we are concerned. In a way that differs from most other studies, we use the institutions' actual trading positions instead of their hypothetical portfolios to compare the capital charges between the standardized and the internal model approaches.

The paper is set up as follows to justify and demonstrate these claims. In the next section, the issues related to the capital charge alternatives to the market risk of the Basel Accord are examined. Section 3 describes our data and methodology. Empirically, we first estimate the VaRs for all marketable financial assets in Taiwan and contrast these VaRs with their corresponding risk weights to examine the propriety of the risk weights set by the Basel Accord. Next, we investigate the diversification effects of portfolios for the institutions and compare the capital charges between the standardized and the internal model approaches in Section 4. In Section 5,

[1] As with the credit risk, many studies conclude that credit risk capital requirements are expected to decrease, when an internal-rating based (IRB) approach is used ((Schwaiger (2002), Saurina and Trucharte (2004), Berger and Gregory (2004), Altman and Sabato (2005)).

we propose the "theoretically correct VaR-based risk weights," which can more precisely reflect the true risk of the trading books and encourage the firms to develop their own internal models. Our concluding remarks are presented in the final section.

2. Capital requirements for the market risk of the Basel Accord

2.1 Standardized approach

2.1.1 Capital charged using the building block method

The standardized approach employs a " building block " methodology. The risk weight, which determines the capital charge ratio for each risk category, is first assigned by the regulator separately. Then the capital charge for each asset category can be obtained by multiplying the market value of the position by its corresponding risk weight. Finally, we simply sum up the measures to obtain the global capital charge for the market risk of the banks.

From the viewpoint of portfolio theory, the implicit assumption behind the building block method is that the asset returns are perfectly positively correlated as we illustrate in equation (4) below. However, the asset returns are partially correlated in the real world such that they overestimate the portfolio risk. That is why the main criticism of the standardized building block approach is that it neglects the diversification benefit of the portfolio. Moreover, it fails to charge appropriate capital for different instruments and leads to capital arbitrage through strategic transactions.

2.1.2 Rationale for risk weights

In view of the attempts of international regulators to introduce more risk-sensitive capital requirements, Kim and Santomero (1988) use a mean-variance framework to theoretically examine the effect of risk-based capital requirements on the risk-taking behavior of banks and derive the "optimal" risk weights based on the solvency goal. The incentive for a bank to increase asset risk, however, declines as the correlation between asset risks and risk weights increases. Only if the risk weights are proportional to the systematic risks, in the sense that they are "market-based," can the RBCR redress the bank's bias toward riskier assets and effectively reduce the insolvency risk to the desired level. Otherwise, a "moral hazard" problem might arise, as with the uniform capital ratio requirement, and fail to achieve the solvency goal

(Rochet (1992)).

Based on the above-mentioned theoretical foundation, we now illustrate the rationale behind the setting of risk weights. To introduce the risk-sensitive capital requirements, building up the risk weight should satisfy the two conditions of “sufficiency” and “correctness”. “Sufficiency” means that the capital requirement can provide enough of a capital cushion to protect against losses arising from fluctuations in the value of the bank’s holdings. “Correctness” indicates that the risk weights can reflect the economic risk accurately. We demonstrate this in what follows by showing that the risk weight should confirm the uniform supervision that proportionately aligns the regulatory capital with economic risk.

Since the riskier asset should be assigned a larger risk weight underlying the RBCR, the risk weight must be an increasing function of economic risk, as measured by VaR in our article. The pattern of the risk weight function involves the supervisory stringency of different assets and can describe the risk attitude of the regulator toward different risk-level assets. The different supervisors’ risk attitudes in relation to the risk weight function are presented in Figure 1. The concave one will encourage the institutions to hold high-risk assets since it charges less capital for the riskier assets than the less risky assets per unit of risk. While the convex risk weight function, which requires more capital for the riskier assets than the less risky assets per unit of risk, will discourage the institutions from holding high risk assets, the linear risk-neutral case, which charges the same amount of capital per unit of risk along the ray, imposes the same stringency of supervision on all instruments independent of the different risk-levels. The non-linear risk weight functions, which are either concave or convex, cause the stringency of supervision to be discriminatory among instruments. As suggested by Kim and Santomero (1988) and Rochet (1992), only the linear risk weight function confirms the uniform supervision that could preclude the opportunity for capital arbitrage.

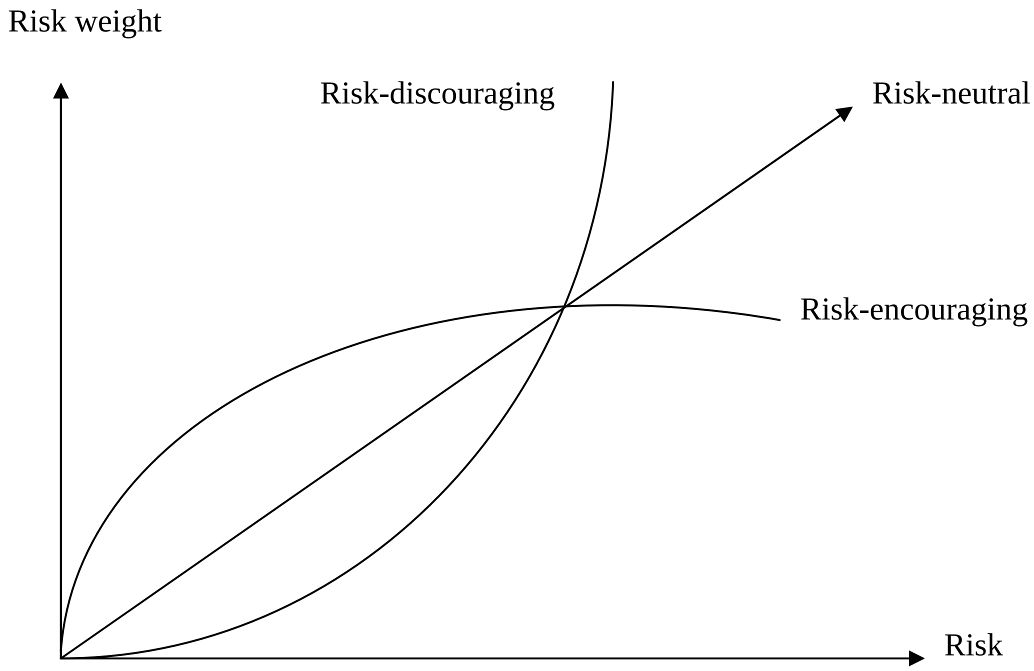

Figure 1 Alternative supervision risk attitudes toward risk weights

Graphically, the linear risk weight function can be exhibited as the iso-stringency line along which the stringency of supervision toward instruments is uniform. The slope of the iso-stringency line, which we define as the "markup", can demonstrate the capital charged per unit of risk and be used to measure the "sufficiency" of capital required. The steeper the iso–stringency line, the greater the "markup", and the more stringent the supervisory standard. A stringent supervisory policy may overcharge capital and interfere with the earnings from operations and hence the survival of the institution, while a relaxed supervisory policy may not provide an appropriate buffer for the institution's asset risk. Figure 2 illustrates different levels of stringency for the uniform supervision of risk weights. The line with the steepest slope represents a stringent supervisory policy, where relatively more capital is charged. The 45 degree line, along which economic risk is equal to regulatory capital, presents the lower bound reference of the capital required. The moderate one should therefore be steeper than the 45 degree line, i.e., the markup is at least greater than 1. In such a case, the capital requirement could provide sufficient coverage for the cumulative losses arising from adverse market conditions over an extended period of time. Conversely, for the case where the iso-stringency line is flatter than the 45 degree line, the capital requirement defined by the risk weights will be insufficient and will not be able to provide appropriate coverage for the possible losses of institutions.

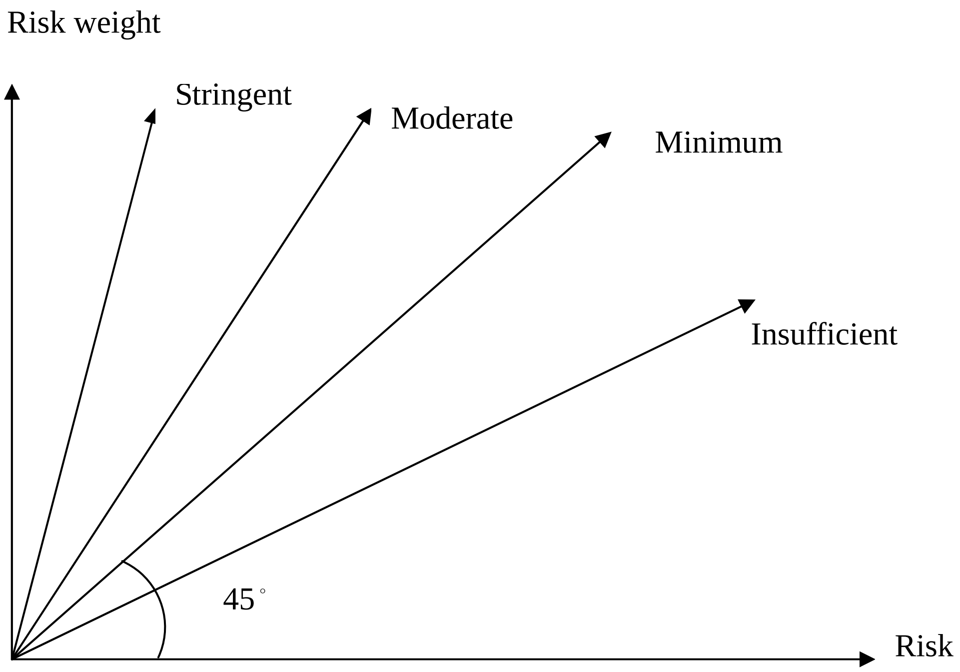

Figure 2 Alternative supervision stringency standards of risk weights

As suggested by Rochet (1992), the "market-based" risk weight should be a linear function of systematic risk. However, there still is no proxy index for the market portfolio across different risk categories, such that the estimation of β for all different kinds of financial assets is unavailable in practice. Under the VaR vs. variance-covariance risk measurement framework, the individual VaR corresponds to the standard deviation of the asset return, while β corresponds to the component VaR. That is, the individual VaR then refers to the total risk while the component VaR refers to the systematic risk. The difference between the two VaRs is the specific risk or diversifiable risk. Since the main problem with the building block approach proposed by the Basel Committee is that it gives no credit for diversification, to maintain the homologue between the risk weight setting and the VaR measurement[2], we hereinafter employ the individual VaR but not the component VaR as the measure

[2] The other reason is that the component VaR of a specific asset will change as the portfolio changes. The unique component VaR of a specific asset is immeasurable.

of risk for instruments.

2.2 Internal model approach

2. 2.1 Capital charged using the VaR-based approach

The internal models use VaR as the capital requirement measure, which imposes a 99 percent confidence level over a 10-business-day horizon. The capital requirement under the internal model method corresponds to the higher of the previous day's VaR and the average for the preceding 60 business days' multiplied by a safety factor k of at least 3 which may increase up to 4 according to the results of back-testing. That is

$$\text{Capital charged for market risk} = \text{Max}\ \{\ \text{VaR}_{-1},\ k\frac{1}{60}\sum_{t=-1}^{-60} VaR_t\ \} \qquad (1)$$

2. 2.2 Solvency parameters of the internal model approach

The length of the holding period should correspond to the time required for corrective action as losses start to develop, which reflects the trade-off between the costs of frequent monitoring and the benefits from the early detection of potential problems. The multiplicative factor is designed to account for potential additional risks in the VaR modeling process. Since there are infinite combinations of the horizon and the multiplicative factor that would yield the same capital charge (Jorion (2000)), we can regard them together as a measure of supervisory stringency. The choice of these supervisory parameters reflects the trade-off concern of regulators between ensuring the soundness of the financial system and the adverse effect of capital requirements on bank returns. They depend on the degree of risk aversion of the supervisory authorities. Higher risk aversion should lead to a higher parameter (Jorion (2000)). Moreover, to achieve a more comprehensive and consistent capital requirement framework, the supervisory parameters of the internal model approach should to some extent align with the risk weights of the standardized approach as we propose hereafter since they are alternatives that determine the capital charged.

2.2.3 The VaR measurements

To analyze the measurement of the different risk and diversification effects, the individual VaR vs. portfolio VaR, general market risk vs. specific risk, as well as the diversification benefits within and across asset classes are defined and described. By taking into account the diversification benefits among components, the portfolio VaR is diversified and can be expressed in dollar terms as

$$VaR_p = Z(\alpha)\sigma_P V_p = Z(\alpha)\sqrt{\mathbf{V'\Sigma V}} \quad (2)$$

where $Z(\alpha)$ represents the standard normal variant at the significance level α, V_P is the initial portfolio value, σ_P is the standard deviation of the portfolio rate of return, $\mathbf{\Sigma}$ is the variance-covariance matrix and $\boldsymbol{V}$ is the vector of initial holdings in terms of dollars.

By taking one component in isolation without any diversification benefits, we can define the individual risk of each component, i.e., individual VaR as

$$VaR_i = Z(\alpha)\sigma_i |V_i| \quad (3)$$

Note that we take the absolute value of the holding value V_i since it can be negative (a short position), whereas the risk measure must be positive.

Lower portfolio risk can be achieved through low individual risk, a large number of assets, or more importantly, low correlation. In general, correlations are typically imperfect so that the portfolio risk (or diversified VaR) must be lower than the sum of the individual VaRs (or undiversified VaRs)

$$VaR_P < \sum_{i=1}^{n} VaR_i$$

The benefit from diversification can be measured by the difference between the diversified VaR and undiversified VaR, which is typically represented in the VaR reporting system.

$$DB = \sum_{i=1}^{n} VaR_i - VaR_P \quad (4)$$

From the perspective of the market model, the total risk of any security, as measured by its variance, consists of two parts: (1) general market (or systematic) risk, and (2) specific (unsystematic or unique) risk. Specific risk can be defined as risk that is due to issuer-specific price movements, after accounting for general market factors[3].

[3] Specific risk includes the risk associated with an individual debt or equity security moving by more or less than the general market in day-to-day trading (including periods when the whole market is volatile), and event risk (where the price of an individual debt or equity security moves precipitously relative to the general market, e.g., on a take-over bid or some other shock event; such events would also include the risk of "default") (Basel, 1996).

If we extend the scope of the portfolio to all assets in the market, i.e., the market portfolio, then this leads to a total-risk decomposition of

$$\sum_{i=1}^{n} VaR_i = VaR_m + DB_T \tag{5}$$

Equation (5) indicates that the sum of the individual VaRs equals the market portfolio VaR plus the diversifiable VaR. Empirically, we then employ the market index VaR, VaR_m, as the VaR measurement for the general market, or the systematic risk, and use the diversifiable VaR, DB_T, as the VaR measurement of the unique, unsystematic, or specific risk.

To examine the source of risk reduction from the perspective of different asset classes, we decompose the total diversification benefits DB_T into two components: the diversification benefits within the asset class DB_w and the diversification benefits across the asset class DB_b. If we consider m asset classes and l asset for each class, the DB_T, DB_w as well as DB_b can be given by

$$\begin{aligned} DB_T &= \sum_{i=1}^{m}\sum_{j=1}^{l} VaR_{ij} - VaR_P \\ &= DB_w + DB_b \end{aligned} \tag{6}$$

where $DB_w = (\sum_{i=1}^{m}\sum_{j=1}^{l} VaR_{iJ} - \sum_{i=1}^{m} VaR_{ip})$

$$DB_b = \sum_{i=1}^{m} VaR_{iP} - VaR_P$$

VaR_{ij} is the VaR of the jth security belonging to asset class i, and VaR_{ip} denotes the ith class VaR. DB_w refers to the intra-class diversification, i.e., the reduction in risk resulting from the portfolio of the same asset class, which can be measured by the difference between the sum of the individual VaRs and the sum of the asset class VaRs. DB_b refers to the inter-class diversification, i.e., the reduction in risk resulting from the portfolio of different asset classes, which can be measured by the difference between the sum of the asset class VaRs and the total portfolio VaR.

3. Data and methodology

We employ three common VaR approaches—the variance-covariance approach, the historical simulation approach, and the Monte-Carlo simulation approach of RiskMetrics to estimate the VaRs of the daily returns for all marketable financial assets, including the equity securities, fixed-income securities, foreign exchange and the related derivatives in Taiwan for the period from 1999/01/01 to 2004/06/30. We then contrast these VaRs with their corresponding risk weights to examine the propriety of the risk weights set by the Basel Accord. According to the guidelines of the Basel Accord, we set the confidence levels needed as 99% and the rolling window length as one year (about 250 business days). RiskMetrics uses the standard exponential weighted moving average (EWMA) method to produce forecasts of variances and covariances[4]. The decay factor λ is set to 0.94 for the daily returns. It is very common for there to be missing or corrupted data in the market-data feeds. RiskMetrics sets the price the same as the previous day (i.e., the return is set as zero) in the case where data are missing. Consequently, the VaR will be underestimated once the missing data become serious. To remedy this problem, we delete the sample observations with missing data for over 10 business days.

Our sample portfolio data consist of the actual composition of 11 trading books, collected from securities firms within Taiwan, as on various dates between December 2000 and June 2004. There are one or two trading books per firm, including equity securities, foreign exchange, fixed-income securities as well as the derivatives which were provided to us on condition of anonymity. The individual books range in net value from NT$49,160 million to NT$9,955 million. The firms are free to run a bullish (long), balanced (market-neutral) or bearish (short) book, depending on market conditions and their business judgment. The ratio of long to short exposure varies from a very bullish 98:2 to a moderately bullish 65:35.

4. Empirical results

4.1 VaRs, risk weights and markups of the Basel Accord

The overall average of individual VaR estimated results for all financial assets in Taiwan and their corresponding risk weights are summarized in Table 1. These VaRs are obtained by means of the following steps. The VaRs are first estimated day-by-day from 2000/01/01 to 2004/06/30 (the original period from 1999/01/01 to 2004/06/30 minus the one-year VaR horizon) for all marketable financial assets in Taiwan using

[4] In RiskMetrics, we assume that the mean value of daily returns is zero. That is, standard deviation estimates are centered on zero, rather than on the sample mean. Similarly, when computing the covariance, deviations of returns are taken around zero rather than the sample mean. (RiskMetrics, 1996)

the three approaches. Next, we calculate the market value weighted average of individual VaRs for different financial asset classes to obtain the daily cross-sectional value weighted average individual VaR series for each asset class, and then compute the simple average of each daily cross-sectional average VaR series for each of the three approaches. Finally, the averages of the VaRs estimated using the three approaches yields the overall average VaR estimates. Since the derivatives, including forwards, futures, and swaps, could be decomposed into a combination of long and short positions and do not correspond to a specific risk weight, we only list the estimated results of primary securities based on the order of their risk-level.

From Table 1 we find that the markups are all greater than one but different, indicating that the capital charges based on risk weight can offer proper coverage for extreme risk but only with "discrimination". However, it is worth noting that the relationship between the VaRs and their corresponding risk weights set by the Basel Accord exhibits a highly nonlinear pattern. The asset risks and their required capital adequacy are described in Figure 3, which displays the risk-encouraging concave function between the VaRs and their corresponding risk weights. The "markup" increases as the risk level of the assets decreases, which illustrates that the riskier assets are charged less capital than the less risky assets per unit of maximum possible loss (VaR). In other words, the risk weights of the standardized method set by the Basel Accord are more favorable to the riskier assets than the riskless assets. This result to some extent corresponds to the finding of Altman, Bharath and Saunders (2002) regarding the revised capital requirements for credit risk under the new Basel Accord. The finding of significant "supervisory discrimination" among different assets confirms our previous concern that the risk weights are unable to properly explain the riskiness of financial assets. As a result, the regulators will fail to reduce the incentives of institutions to take risks to achieve their capital regulation goal. Moreover, this will contribute to the capital saving/addition between the two capital requirement alternatives – the standardized approach and the internal model method – as we will discuss below.

Table 1

Asset risk (VaRs), risk weights and markups based on the Basel Accord

— Average of the three approaches

Degree of risk	Asset class	Assets	VaRs (%)	Risk weights (%)	Markups
High-level	Equity securities	Fully delivered & managed stocks	8.9560	16.00	1.79
		Emerging Stocks	6.9846	16.00	2.29
		OTC stocks	6.9275	16.00	2.31
		TSE stocks	6.2312	16.00	2.57
	Equity index	OTC	4.2565	12.00	2.82
		TSE	4.0446	12.00	2.97
	Equity mutual funds	OTC	4.0594	16.00	3.94
		TSE	3.9483	16.00	4.05
	Government bonds - Long term	Over 20 years	1.9838	6.00	3.02
		15-20 years	1.1366	5.25	4.62
		10-15 years	0.9085	4.50	4.95
		7-10 years	0.7282	3.75	5.15
Medium-level	Foreign exchange	Foreign Currency	1.2230	8.00	6.54
	Government bonds-Medium term	5-7 years	0.4893	3.25	6.64
		4-5 years	0.3382	2.75	8.13
		3-4 years	0.2552	2.25	8.82
		2-3 years	0.2268	1.75	7.72
		1-2 years	0.1262	1.25	9.91
Low-level	Government bonds - Short term	6 months -1 year	0.0375	0.70	18.67
		3-6 months	0.0172	0.40	23.26
		1-3 months	0.0088	0.20	22.73
		Under1 month	0.0019	0.00	0.00
	Bills	6 months -1 year	0.0570	1.70	29.83
		3-6 months	0.0243	0.65	26.75
		1-3 months	0.0124	0.45	36.29
		Under 1 month	0.0065	0.25	38.46

Note: The Markup = Risk weight/VaR

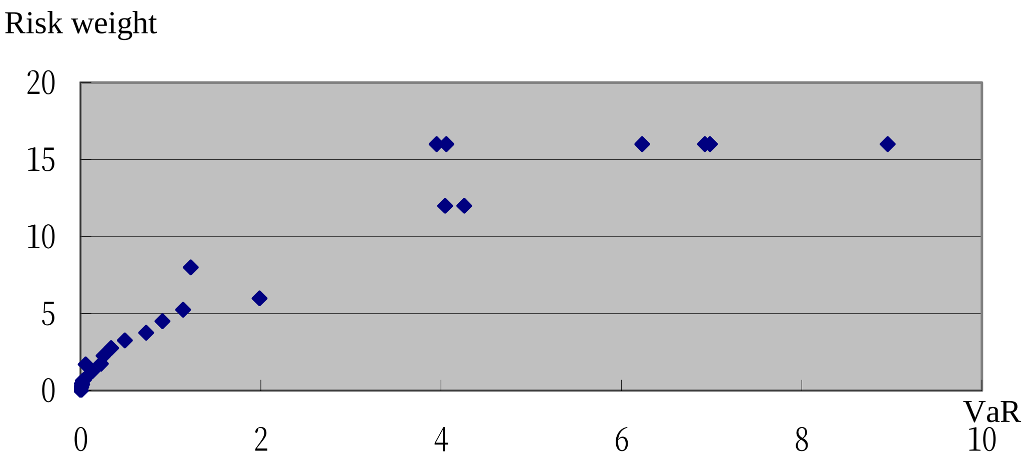

Figure 3 VaRs and the risk weights of the Basel Accord

Now we turn to evaluate the set of risk weights for the general market risk and specific risk. The estimated VaRs for the equities in Taiwan, risk weights and markups set by the Basel Accord for the specific risk and general market risk are displayed in Table 2. The VaRs in relation to the specific risk and general market risk are 2.09% and 4.14% for TSE stocks, and 2.40% and 4.52% for OTC stocks[5]. However, the markups for specific risk and general market risk are 3.83 and 1.93 for TSE stocks, and 3.33 and 1.77 for OTC stocks. Likewise, the risk weights set for the specific risk and general market risk exhibit the same "supervisory discrimination" phenomenon as found previously.

Table 2
Specific risk and general market risk — Equity securities

	Specific risk	General market risk	Total risk
		TSE stocks	
VaRs (%)	2.09	4.14	6.23
Risk weights (%)	8	8	16
Markups	3.83	1.93	2.57
		OTC stocks	
VaRs (%)	2.40	4.52	6.93
Risk weights (%)	8	8	16
Markups	3.33	1.77	2.31

Note: The Markup = Risk weight/VaR

[5] In 2004, there are 695 and 495 stocks in the TSE and OTC markets, respectively.

4.2 VaR estimation for the securities firm portfolios

4.2.1 Portfolio VaR, individual VaR and diversification effects

Table 3 presents the average results of the VaR estimation for the securities firm portfolios using the three approaches. The second to fourth columns are the positions in terms of the percentage of the total portfolio value for the equity position, the interest rate instruments as well as the foreign exchange, respectively. The fifth to seventh columns list the value-weighted averages of the individual asset VaRs, $\overline{VaR_{ij}}$, the value-weighted averages of the class asset VaRs, $\overline{VaR_{iP}}$, and the total portfolio VaRs, VaR_p, in order. The values vary between 6.27% and 0.71% for average individual asset VaRs; between 1.51% and 0.38% for average class asset VaRs; and between 1.38% and 0.23% for the total portfolio of institutions, which indicates that the different business strategies across the firms lead to a significant difference in the degree of portfolio risk even within the same asset class.

The diversification benefits range from 4.77% to 0.15% for the “within the asset class,” from 0.36% to 0.09% for the “between the asset classes,” as well as from 4.89% to 0.37% for the overall portfolio. As with the ratios of the diversification benefits “within the asset class” compared to those “between the asset classes,” the values range from 97.41:2.59 to 42.24:57.76. The widely-differing degrees of risk diversification show the importance of risk management in the institutions. Notice that the hedging effects result mainly from the firms’ issues of warrants, as a result of which the short position of equities contributes to considerable risk reduction benefits. This is the reason why the diversification benefits within the asset class for some firms are very large.

Table 3

VaR estimation for securities firm portfolios－Average of three approaches

Unit: %

Portfolio	Position			Individual asset	Class asset	Total portfolio	Diversification effects		
	Equities	Interest rates	FX	$\overline{VaR_{ij}}$	$\overline{VaR_{iP}}$	VaR $_p$	Within class DB $_w$	Between classes DB $_b$	Total DB $_T$
A	37.79	60.29	1.93	6.27	1.51	1.38	4.77	0.12	4.89
B	31.06	51.56	17.38	4.08	0.93	0.84	3.15	0.09	3.24
C	31.02	66.62	2.36	4.53	1.17	0.93	3.37	0.24	3.60
D	28.69	67.35	3.96	5.21	0.86	0.64	4.35	0.22	4.57
E	26.81	68.28	4.91	3.04	0.64	0.43	2.41	0.21	2.61
F	10.13	84.14	5.73	1.61	0.99	0.62	0.62	0.36	0.98
G	9.98	87.72	2.30	1.00	0.72	0.48	0.28	0.24	0.53
H	9.21	88.88	1.91	1.71	0.58	0.39	1.13	0.18	1.32
I	6.85	90.80	2.34	0.94	0.38	0.23	0.56	0.15	0.71
J	5.34	87.63	7.03	1.20	0.49	0.34	0.71	0.15	0.85
K	5.31	94.69	0.00	0.71	0.55	0.34	0.15	0.21	0.37
Average	18.38	77.09	4.53	2.75	0.80	0.60	1.95	0.20	2.15
STDEV	12.53	14.58	4.71	1.97	0.33	0.34	1.71	0.07	1.69

Notes: The positions and VaRs are both reported in terms of percentages (or loss rates), i.e., VaR (%)＝VaR (dollars)/portfolio value.

4.2.2 Comparison of capital charges between the standardized and the internal model method approaches

The VaRs of 11 actual portfolios of the securities firms are estimated to compare the capital charges for various portfolios based on the two alternatives. Among the riskier assets, the equity risk is the dominant risk factor in the market risk of the securities firms. To take account of the financial leverage effects of considering the margin transactions, we hereby illustrate the risk position of equity in terms of both its original position value and the contract value position. Table 4 compares the capital charges between the standardized and internal model approaches. It can be seen that the capital savings arising from the internal model approach tend to occur in the case of relatively low-risk (VaR) portfolios, namely, portfolios D, E, H, J, K and I, which suggests that the internal model method is relatively more favorable to safer portfolios and more unfavorable to riskier portfolios. By contrast, the standardized method is relatively more favorable to high-risk institutions and more unfavorable to low-risk institutions. This might thus be inferred from our previous findings regarding the “supervisory discrimination” among different assets in the Basel Accord to the effect that the risk weights used in the standardized method set by the Basel Accord favor the riskier assets more than the riskless assets. Since the capital requirement of the standardized method is based on the risk weight whereas that in the internal model is VaR-based.

Our conclusion based on this comparison is that the internal VaR-based model approaches do not necessarily result in capital savings as compared with the standardized method. Whether the internal model approaches can give rise to capital savings or not depends on the characteristics of the portfolios of the institutions. The capital savings will be realized in the case of low-risk institutions and will be high only when the portfolio is highly diversified across assets, across maturities and across countries, and more importantly well hedged in a VaR sense, i.e., where the VaR exposure is small, so that only the low-risk institutions will choose the internal model approach and the high-risk institutions will still choose the standardized method as the methods used to calculate the capital charges. The Accord fails to provide incentives for high-risk institutions to develop their own internal models.

Table 4

Comparison of capital charges between the standardized and the internal model approaches

Unit: %

Portfolio	Equity position		VaR	Internal models (1)	Standardized method (2)	Difference (3)=(1)-(2)
	Original value	Contract value				
A	37.79	45.16	1.38	13.08	7.42	Addition (5.66)
C	31.02	32.16	0.93	8.83	6.73	Addition (2.10)
B	31.06	29.42	0.84	8.00	7.15	Addition (0.85)
D	28.69	23.9	0.64	6.05	7.03	Saving (-0.98)
F	10.13	10.18	0.62	5.91	4.39	Addition (1.52)
G	9.98	9.86	0.48	4.52	4.22	Addition(0 .30)
E	26.81	15	0.43	4.08	6.34	Saving (-2.26)
H	9.21	7.28	0.39	3.73	5.42	Saving (-1.69)
J	5.34	5.51	0.34	3.26	6.64	Saving (-3.38)
K	5.31	5.18	0.34	3.22	3.36	Saving (-0.14)
I	6.85	6.33	0.23	2.19	4.91	Saving (-2.72)
Average	8.38	17.27	0.60	5.72	5.78	Saving (-0.07)

Note: The ratios reported in the table are in terms of the percentage of the original value of the overall portfolio.

5. The derivation of "VaR-based risk weights"

In this section, we attempt to propose the "VaR-based risk weight" which captures economic risk by means of the VaR measure and links the solvency parameters of the internal model to those of the standardized method. In such a way, we can resolve the problem of "supervisory discrimination" among the risk weights of different assets and ensure that there are capital savings within the internal VaR-based model that will provide incentives for institutions, especially the high risk-taking institutions, to develop their own internal models.

As found previously, the relationship between the VaRs and their corresponding risk weights set by the Basel Accord exhibits the concavity which illustrates the existence of significant risk-encouraging "supervisory discrimination" among different assets as shown in Figure 4. The capital requirements of low-risk assets will be overcharged whereas those of high-risk assets will be undercharged based on the risk weights set by Basel. Only if the risk weights of the assets are set in proportion to their economic risk, can they redress the supervisory discrimination in the Basel Accord's risk attitude toward risky assets and reduce the insolvency risk to an acceptable level. That is, the regulator should establish a linear relationship between the risk weights and VaRs to align regulatory capital with economic risk to provide uniform supervision stringency among different risk-level instruments, in the sense that they are "VaR-based".

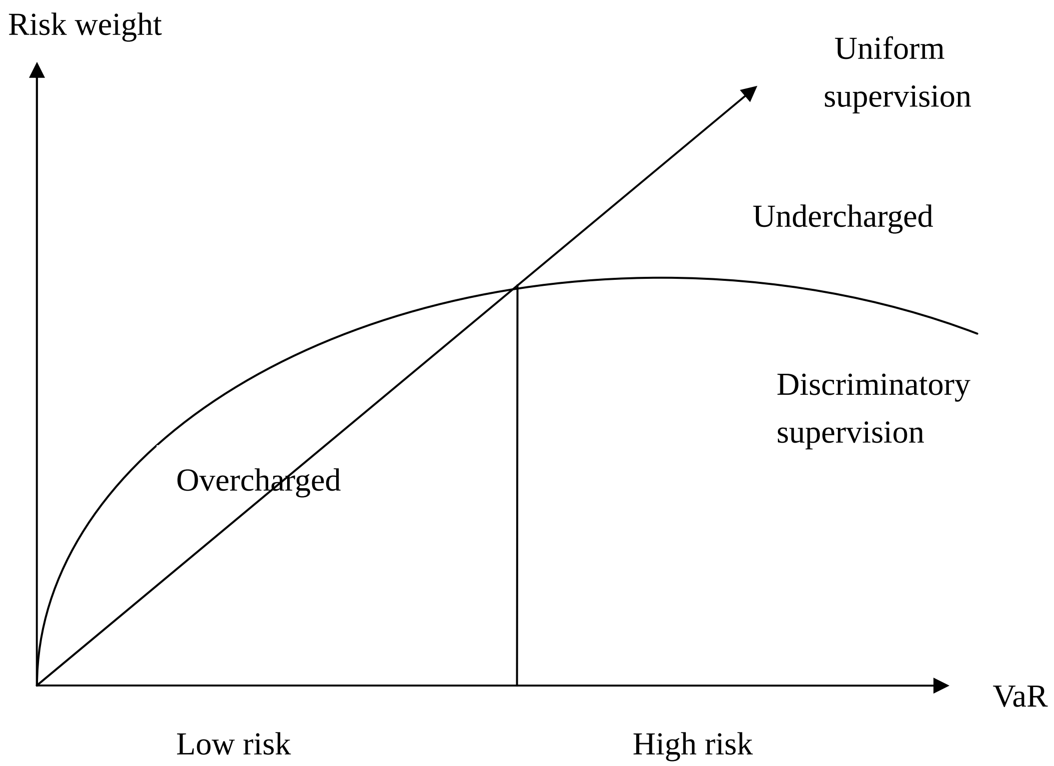

Figure 4 Basel's discriminatory supervision of risk weights

In designing the "theoretically correct risk weight," we start with the rationale for capital requirements whereby we stated previously that the risk weights should be set based on VaR in compliance with the uniform supervision standard. To do so, the “markup” (which can be regarded as the supervisory price of unit risk) for all assets should be the same and the risk weight should satisfy

$$m = m_i = \frac{W_i}{VaR_i} \qquad (7)$$

That is, by setting a linear relationship between the risk weights and VaRs

$$W_i = m \cdot VaR_i \qquad (8)$$

where m_i : the markup of asset *i*.

m: the same common markup for all assets under the standardized approach.

W_i : the risk weight attached to asset *i*.

VaR_i : the value-at-risk of asset i.

The capital requirement according to the standardized approach should be as follows

$$CS = \sum_{i=1}^{n} V_i m VaR_i = m \sum_{i=1}^{n} V_i VaR_i \qquad (9)$$

On the other hand, the capital charge under the internal model approach is given by

$$CI = V_p\, VaR_p \sqrt{T}\, M$$

$$= \sum_{i=1}^{n} V_i VaR_i (1 - D) \sqrt{T}\, M \qquad (10)$$

where V_p : the initial portfolio value.

T: the holding period of VaR.

M: the multiplication factor of the internal model approach.

D: the magnitude of the diversification effect in terms of the percentage of the initial portfolio value, so that $0 < D < 1$.

The major advantage of the capital requirement of the internal model method relative to the standardized building block approach is the diversification effect. To enable the diversification effect to result in capital savings for the internal model approach, we combine equation (9) with equation (10) to set the same common markup for the risk weights of all assets as

$$m = \sqrt{T}\, M \qquad (11)$$

such that $CI = (1 - D)\, CS$

$$S = CS - CI = D * CS \qquad (12)$$

From equation (12) we obtain that the capital savings *S* arising from the internal model approach relative to the standardized approach simply depend on the magnitude of the portfolio diversification effect. The larger the portfolio diversification effect, the greater the capital savings resulting from using the internal model approach. Substituting equation (11) into equation (7) yields the “theoretically correct VaR-based risk weights” as

$$W_i^* = VaR_i \sqrt{T}\, M \tag{13}$$

where the VaR_i of different assets can be estimated from historical data, while the value settings of the two solvency parameters, namely, the holding period T and the multiplication factor M of the internal model approach, are determined by means of the supervisory solvency standard. In concrete terms, whether or not the capital regulation can achieve its solvency goal depends on the joint impact of the propriety of the risk weights used in the standardized approach and the multiplication factor that forms an integral part of the internal model. The risk weights refer to the relative supervisory stringency among different assets, while the risk weights together with the multiplication factor refer to the relative supervisory stringency between the standardized approach and the internal model method.

6. Conclusion

The regulatory authorities set capital requirements to cover the positions of firms and to protect against losses arising from fluctuations in the value of their holdings. To achieve these objectives, capital requirements should precisely reflect the risk, or volatility, of a firm’s trading book. The internal VaR-based model approach provides well-capitalized institutions with a stronger incentive to reduce asset risk than the building block method, which is driven by a reward that takes the form of lower capital requirements for low-risk institutions. As the internal VaR-based model provides the firm with stronger incentives as far as risk management is concerned, less of an auditing effort is required to maintain the risk reduction behavior. Such an approach may thus benefit both the regulatory authority and the equity holders.

However, our empirical findings suggest that the risk weights set by the Basel Accord do not properly reflect the financial risk. The risk weights under the standardized method exhibit a risk-encouraging concave function of economic risk, and are more favorable to the risk assets than to the riskless assets. Such “supervisory discrimination” in relation to risk weights gives rise to the moral hazard problem in that the regulators fail to reduce the risk-taking incentives of institutions in achieving their regulatory goal. The internal VaR-based model approach does not necessarily provide capital savings to encourage the institutions to develop their own internal models that can efficiently reflect the riskiness of a portfolio. Whether or not the internal model approach can provide capital savings depends on the characteristics of the portfolios of the institutions. The capital savings will occur only in the case of low-risk institutions. In developed countries, most large international institutions have well-diversified low-risk portfolios. However, in the emerging markets the portfolios of domestic institutions may not be so well-diversified and may also entail high risk. Such institutions will thus choose the standardized method as their calculation tool in regard to the capital requirements. Since one of the main goals of the new Basel Capital Accord is to improve the efficiency of the institutions' risk management, it is more important for the high-risk institutions to develop their own internal model as a superior risk management tool. The implementation of the internal model involves many technological investments in order to obtain up-to-date data for their trading books and VaR models. Unless the high cost involved can be compensated for by a lower capital charge, the institutions will have no incentive to develop their home models.

We propose the adoption of "VaR-based risk weights" that link the solvency parameters of the internal model with those of the standardized method. Thus, these weights can resolve the moral hazard problem of "supervisory discrimination" that arises from the risk weights adopted internationally being set in accordance with the Basel Accord. In addition, these weights can ensure that capital savings result from the internal VaR-based model, thereby encouraging the institutions to develop their own internal models.

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