

**Risk and Capital Regulations on Financial Institutions in Korea:
With a special reference to measuring credit risk of SME loans***

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Abstract

This paper examines current issues regarding capital regulation in Korean banking industry, focusing on the capital requirement framework for SME exposures. By constructing a multi-factor risk model using large samples of Korean SMEs, the results of the empirical analysis show that the correlation of SME exposures decreases as the asset size of the obligor firm increases. This indicates that the positive relationship between the obligor's size and credit correlations assumed using the risk-weight formula proposed by the Basel Committee cannot be supported in Korea, and financial regulators should be careful when treating small business exposures as retail exposures. Our results also suggest that financial supervisors need to deeply consider the industrial composition of SME exposures, when adopting the New Accord and proposed special treatment of SME exposures using the risk-weight formula. In particular, regulators may require banks to have a higher level of capital for SME portfolios which are concentrated with firms from the construction or service industry.

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I. Introduction

In a global financial market, many emerging market financial systems face serious challenges stemming from two separate but closely related issues. The first challenge is the growing trend toward the conglomeration and convergence of financial services across the global financial markets. In coping with these trends, not only financial institutions but also financial regulators are working diligently to measure the risks brought about by consolidation and concentration, as well as, seeking optimal directions to manage those risks. Second, a new capital adequacy framework is being prepared to replace the original Basel Accord by year-end 2006, and is expected to change the financial regulation system into being more risk sensitive. In fact, the Basel Committee on Banking Supervision is responsible for proposing capital requirements for banks operating internationally; however, countries that are not members of the 13 nations represented in the committee are not required to adopt the guidelines established by the committee. However, pressures from the evaluations of international financial markets have been strong enough to get the attention of financial regulators, and begin preparation plans.

Korea, especially from the perspective of financial system development, as an emerging market country, has not proven to be an exception to these challenges. To address the growing trends of financial globalization and consolidation, there is recognition that it is necessary to replace traditional institution-based regulations on capital with one that is function-based. In this respect, Korean financial regulators launched a project to integrate financial laws into a consolidated legal system based on financial activities. However, the directions of the newly proposed amendments to the financial laws indicate that, though the removal of regulatory asymmetries is necessary, the Korean financial system will maintain the principal regulation of separating the three major financial activities such as banking, insurance, and securities, for the foreseeable future. Thus, the Korean financial regulators seem to have more time to address the challenge of financial consolidation.

In contrast, the challenge of strengthening regulation on capital adequacy, in preparation of adopting the New Basel Accord, appears to have more imminence in the eyes of Korean financial regulators as well as financial institutions. In Korea, any changes in capital requirement in respect to credit risks of SME exposures are a matter of particular interest, reflecting the decrease in the proportion of credit to large corporations from 15.6% at year-end 1997 to 5.3% at year-end 2003. In contrast, household and SME credit increased from 51 trillion won to 249 trillion won and from

92 trillion won to 217 trillion won in the same period, respectively. In light of this, comprehensive regulatory measures have been implemented to curb household lending, as well as, to alleviate the rising threat of default on household loans. Moreover, increasing delinquency rates on SME loans recently, have grabbed the attention of Korean regulators in preparation of the proposals by the Basel Committee.

Loans to small- and medium-size enterprise (SMEs) are generally considered to differ from loans to large businesses. Since lenders face fixed lending costs, lending to small firms is by definition more expensive in terms of per dollar lent. In addition, the relationship between the owner/manager of a SME and a bank is often very close and SMEs are more informationally opaque. Because of these structural features, many comments have been directed at the first draft of the New Accord, in particular, the problem associated with calibrating credit risk for SMEs. Many of the comments argued that the risk-weight curve was too steep and too high, which induced too-high risk-weights for SMEs, since many of these firms are generally characterized by relatively high probabilities of default, relative to large businesses. Indeed, there are concerns that capital charges, which are too large, could lead to credit rationing of small firms, thereby, possibly reducing economic growth, given the importance of SMEs in the Korean economy.¹ In response to these comments and concerns, the Basel Committee (BIS, 2003) introduced major changes in formulating the risk-weight in order to reduce the risk-weight on SME exposures, assuming there is a positive relationship between the obligor's size and correlation, as well as, a negative relationship between PDs and correlation.² However, it may not be rational for bank regulators of emerging market countries to loosen their grip by giving special treatment favorable to SME exposures since adopting the New Accord without any consideration of a country's specific risk correlation in terms of SME portfolios could be problematic in the sense that the mandatory capital requirement may not be sufficient to cover the economic capital for SME portfolios.

Despite the overall importance of credit correlations in credit risk modeling, but more importantly, when calibrating the risk weight formula under the New Accord, there are few literatures that attempt to compute credit correlations. Lopez (2004) used a

¹ In Korea, for example, there were approximately 3.0 million SMEs employing 10.4 million persons, or 86.7% of the workforce. As for the manufacturing value-added, SMEs accounts for 52% (in 2002) of GDP.

² The most important change was to propose different risk-weight functions for SMEs and large businesses. Indeed, the committee introduced an adjustment in the risk-weight formula for firms with turnover between €5 and €50 million. More precisely, the correlation formula is adjusted by a term that reduces the value of the correlation proportionately to the size of the firm. In addition, banks are allowed to apply the more favorable retail risk-weight formula to very small businesses (with turnover between €1 and €5 million), provided that the bank's total exposure to any one firm remains below €1 million.

KMV type structural model with asymptotic single risk factor approach and equity markets data to provide estimates for large firms. To our knowledge, only Dietsch and Petey (2004) give estimates of correlation especially for SMEs. The authors used a one-factor credit risk model to find that a negative relationship between credit correlation and probability of defaults assumed in formulas in the New Accord cannot be supported by data on French and German SMEs.

In this paper, we examine the current issues regarding capital regulation in Korea, while placing emphasis on the importance of identifying the risk profile of bank lending portfolios for financial regulators to design a sound capital requirement scheme. Using large samples of Korean SMEs with a multi-factor risk model that extends the framework of Merton (1974), this paper investigates the relationships between the obligor SME's size and credit correlation of SME portfolios.

Our paper is organized as follows. Chapter II presents a brief overview of the current system of capital regulation in Korea. Chapter III gives a brief background on the portfolio structure of Korean banking industry, along with concerns related to financial regulators, focusing on SME exposures. Chapter IV presents the multi-factor credit risk model used to compute credit correlations and data, in addition to an analysis on the relationship between credit correlations and size of SMEs in the bank's portfolio. Chapter V concludes this paper.

II. Capital regulation in Korea

1. Economics of capital regulation

Capital is generally regarded as a long-term source of funding for a firm to realize a return for investors, and provide a cushion against losses, expected or unexpected. Such funding is generally accessed through equity or retained earnings. Though it is not theoretically clear as to why the capital structure of a financial institution is much more stringently regulated than that of an ordinary firm, two explanations seem to offer the most convincing argument for this special treatment. First of all, financial institutions, as often pointed out, are special in that they possess highly leveraged and inter-linked balance sheets. These two features are what make economic shocks highly contagious, so that we observe an extremely high correlation in failure of financial institutions in distress. Massive failures in the financial sector are not confined within the sector, but are rapidly transferred to the real sector, which ultimately, ends up hurting the whole economy. The role of capital as a cushion against temporary losses and a safeguard for soundness of a financial institution is particularly emphasized. The other line of argument for stringent regulation of financial institutions, found in Modigliani and Miller (1958), makes the case that in a frictionless world with full information and complete markets, the value of a firm is independent of its capital structure, thereby, making the regulation of a firm's capital structure futile. Since then, research has been directed towards studying the implications of deviating from the perfect world à la Modigliani-Miller, such as taxes, product market imperfection, transaction cost and asymmetric information. In the financial industry, capital structure, in a large part, is made irrelevant due to widespread information asymmetry coupled with the fact that uninformed investors hold most of the debt of financial institutions - especially banks and insurance companies. The principal-agent problem between investors and management is ubiquitous, but the problem is considerably more serious in the financial sector. Due to the very technical nature of financial contracts and activities, it is too expensive for investors to monitor management, directly or indirectly, with a reasonable degree of accuracy. Moreover, asymmetry of information and lack of monitoring by investors, when it is accompanied by an implicit and explicit public guarantee on repayment of debts such as deposit insurances, may create systemic risk by encouraging financial institutions to take overly excessive risks (Genotte and Pyle (1991)). It is generally believed that requiring financial institutions to meet a sufficiently high level

of capital is an effective device to guard against risks stemming from asymmetry of information³.

Losses cushioned by capital arise from risks, which firms are exposed to in their business activities. Those risk factors are usually classified into several groups for the convenience of theoretical analysis and regulatory practice. Different researches use different schemes of classification. For example, GAO (1998) identifies risks with six categories: credit risk, market risk, liquidity risk, operational risk, business/event risk and insurance/actuarial risk. Different forms of financial institutions face different risk profiles. A bank's major concerns may come from credit risk, liquidity risk and market risk, while operational risk is less of a factor. Life insurers pay attention mostly to liquidity and market risks even though credit and insurance risks are also important factors. A property and casualty insurance company usually focuses on insurance/actuarial and liquidity risks. On the other hand, the most important risk factors investment companies usually face come from market and operational risks. The modern approach to capital regulation is to quantify the degree of risks regulated bodies face, and require them to accumulate a sufficient amount of capital thought to cover the risks. The degree of sophistication in risk-based capital regulation is widely different across various financial sub-sectors. Banks are regulated in the most sophisticated manner, as documented by the Basel Committee on Banking Supervision. Recently, a new and 'advanced' version of supervisory standards⁴ has been circulated. In case of insurance companies, both the European style fixed ratio and American style risk-based capital requirement are used in practice. However, neither approach can provide the theoretical or logical justification to take one method over the other. For further details on capital regulation of insurance companies in Europe and U.S., see Shin (2004). Capital regulation of investment firms is cruder compared to insurance companies. The main objective of capital regulation of investment firms is to maintain solvency in response to market and credit risks it is, in most cases, exposed to.

Facing the global trend of consolidation of financial institutions operating in different sectors, regulators from different countries and sectors have taken significant measures to harmonize the breadth and strength of capital regulation across countries and sectors. At an individual country level, the Financial Services Authority (FSA) of the United Kingdom is undergoing the process of integrating standards and practice of prudential regulations for banks, insurance companies and investment firms⁵.

³ However, Furlong and Keely (1989) question the adverse effect of too stringent capital standards.

⁴ See 'The New Basel Accord: Consultative Document (CP3)' by BIS (2003).

⁵ See 'Integrated Sourcebook of Prudential Regulation' by FSA (2003).

Another form of capital regulation deserving serious consideration is regulation on the initial level of capital. It is a universal practice to require a potential financial service provider to set aside a minimum amount of capital to obtain a license. But in fact, the regulation incidentally sets up an entry barrier by sheltering incumbents from competitive pressures generated by potential competitors. To be sure, this harms social welfare. Then, why have an initial capital requirement at all? The problem of providing financial services, such as selling life insurance or pension products and offering financial advice, is simply asymmetric information. Lack of expertise on the part of buyers means that they find it hard to assess the true quality or 'type' of individual products and suppliers. That leads to a situation under which consumers are very vulnerable to fraud, theft, and non-contractual wealth transfers like churning or turnover of portfolios to generate additional commission. These elements present a serious challenge to financial regulators whose main mission includes the protection of consumers in financial markets. In addition to criminal activities, consumers are also exposed to the risk of poor quality of services that can be reflected in negligence, incompetence, and dishonesty. In this kind of asymmetric information situation where non-sophisticated ordinary financial consumers have a hard time in distinguishing the good from the bad, a pooling equilibrium is bound to exist, in which the commissions suppliers receive reflect the reputation of the industry's quality as a whole. Moreover, it is likely to result in widespread adverse selection and moral hazard in the markets.

As Akerlof (1970) shows in his seminal paper, a more serious consequence of asymmetric information on the true type of a service provider may lead to non-existence of the market itself. Various measures can be taken to avoid the worst case scenario. If the interactions between suppliers and consumers are repetitive games, consumers accumulate a credibility record of each individual supplier, in which the true type of each supplier becomes public knowledge. On the other hand, if a good type supplier can find a signaling device to send a message of its true type to consumers and no bad type supplier can mimic the signal the good type supplier sends without incurring significant costs, a non-existent market dilemma can be averted. Both reputation and signaling equilibrium present solutions that can be provided by the market under certain conditions. In some cases, suppliers form a voluntary regulatory body (self-regulatory organization) to provide information on the true nature of individual suppliers. The government may also intervene to screen out bad suppliers from the market. It may require individual suppliers to pass an exam or attain a certain achievement in the market. Moreover, by setting a minimum level of initial capital to be operational, the government can effectively prescribe bad type suppliers from entering the market. The

presumption is that there should be a strong negative correlation between the quality of supplier and cost of capital; that is, cost of financing one unit of capital should be much cheaper for good type suppliers.

The role of the initial capital requirement is not confined to being a screening device. As discussed above, it is needless to say that funds transferred to a financial institution as an initial capital constitutes an important portion of the buffer against which various risks are hedged by the company.

2. Current bank regulation system in Korea

The minimum amount of capital to obtain a license to provide financial services widely varies. Two different levels of initial capital are set by law to establish a bank, depending on the geographic coverage of operation. For initial capital, 100 billion won is required for a bank with national operations, and 25 billion won for a provincial bank. Those amounts seem to be reasonable considering the importance and broad array of functions banks perform. In reality, the initial capital requirement for a bank is high enough to be an effective entry barrier. Considering the fact that it is difficult to find a bank possessing the ability to mobilize funds matching the initial capital requirement other than industrial conglomerates, *chaebols*, it is highly likely that various restrictions on ownership of a bank's share prohibits a potential entrant funded by firms other than those in the financial industry from entering the market. However, empirical studies⁶ show that competition among incumbents has been able to maintain a competitive atmosphere, whereby direct evidence on negative effects caused by the initial capital requirement is not found.

The insurance industry in Korea is divided into three areas according to product: life, non-life and the third.⁷ Life insurance companies are prohibited from underwriting or selling insurance contracts provided by non-life insurance companies and *vice versa*. However, both life and non-life insurance companies are allowed to handle any product falling under the area of the third insurance. One can obtain a license to provide the whole range of products belonging to life, non-life or the third insurance by mobilizing 30 billion won for the license. It is also possible to obtain a license for providing a limited array of products in one of the three areas. In that case, the required level of initial capital ranges widely between 5 billion won to 30 billion won. Different levels of

⁶ For example, Kim (2003) shows that competition in Korean banking sector has not decreased in spite of a significant decrease in the number of banks after foreign exchange crisis in 1997.

⁷ See Appendix 1 for the list of products each can handle.

required initial capital reflect the degree of risks the licensee faces in daily operation, as well as, the need for consumer protection.

The initial capital requirement for securities companies differs from 3 billion won to 500 billion won depending on the range of functions the company plans to perform. For example, if a company wants to perform a whole range of functions such as underwriting, dealing and brokering securities, it is required to arrange at least 50 billion won in capital.

Contrary to the case of the bank, initial capital requirements for insurance and securities companies are not likely to present serious entry barriers that hamper competition in the markets. Since, minimum amounts are set at much lower levels than banks, and there are diverse combinations of products or functions an entrant can choose from. Moreover, because chaebuls can own insurance and securities companies, the threat of potential entrants must be much stronger.

Other than regulations on the initial level of capital, the most important element in the capital regulation of banks in Korea is the capital adequacy ratio (CAR) suggested by the Bank for International Settlement (BIS), which is the ratio of capital and risk weighted asset. Capital consists of shareholders' equity such as capital stock, capital surplus, retained earnings, and capital adjustment (Tier 1), in addition to other funds which provide a buffer against temporary losses, such as subordinate debt and deferred tax payments (Tier 2). All assets owned by a bank are classified into five categories, and one out of five weights – 0, 10, 20, 50, 100 – is assigned to each category according to the credit risk based on historical default tendencies. The total amount of assets in a category is multiplied by the risk weight, and five categories of risk weighted assets are aggregated. Additional amount is considered to accommodate market risk. In the calculation of CAR, the denominator is attained by the sum of credit and market risk weighted assets. The ratio was originally designed for banks that had main offices in 10 initial member countries of BIS and actively participated in international transactions. However, it is now an internationally accepted indicator of a bank's financial soundness. It was first introduced in Korea in 1992. After the foreign exchange crisis in 1997, the practice of risk management in Korean financial institutions went through radical changes. The ratio became one of the most important monitoring measures in supervision process. If the ratio falls below 8%, the minimum required by the Korean bank regulators as well as BIS, the regulator has to determine whether to take prompt corrective measures as soon as possible. <Table 1> illustrates the recent trend in BIS capital adequacy ratio for banks. As can be seen, the ratio hovers around 10~11% for both of the groups.

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As for insurance companies in Korea, regulation focuses on the maintenance of liquidity rather than solvency. Since the majority of the debt on the balance sheet of a typical insurance company has a long-term maturity and the lion's share of cash outflow can be estimated with reasonable accuracy, the main objective of capital regulation on insurance companies is centered on the ability to meet the duty specified in insurance contracts. Insurance companies are required to maintain a certain level of reserves. The minimum amount of reserves is determined using a fixed rate of expected cash outflow that depends on the size of total contracts underwritten by the company⁸. The qualified items for reserve are capital stock, reserves for participating insurance, provisions for loss, subordinate debt and other items recognized by the regulator. An indicator of risk-based capital is customarily included in the financial report of most insurance companies but is not required by law. If an insurance company cannot meet the required level, it may invite regulatory intervention such as prompt corrective actions.

Capital regulation of securities companies in Korea is based on a risk-based approach that considers mainly market and credit risks. The companies are required to maintain at least a 150% of net capital ratio. The ratio can be calculated by dividing net capital with total risk equivalent. In this case, net capital means shareholders' equity after some adjustments. The total risk equivalent is assessed by aggregating expected loss due to market risk, counter-party risk and credit risk for total asset. In any case, failure to achieve the required standard invokes regulatory intervention.

⁸ The formula is given as $1.5 * [(\text{surrender charge of policy reserves} * \text{portion of risk coefficient of policy reserves}) + (\text{amount at risk} * \text{portion of insurance risk coefficient})]$ in case of life insurance and $1.5 * [\max((0.178 * \text{premium for a year}), (0.252 * \text{average loss for three years}))]$ in case of non-life insurance.

III. Features of Korean banking industry

1. Changes in portfolio structure of Korean banking industry

Before the crisis of 1997, Korean banks concentrated on lending to industrial conglomerates (*chaebol*), making it difficult for consumers and SMEs to secure credit. Afterwards, Korean banks strengthened their commercial orientation, allowing them to refocus their activities on their most profitable lending opportunities. Indeed, Korean consumer credit has risen rapidly during the post-crisis years, in which outstanding household loans increased from 51 trillion won at the end of 1997 to 249 trillion won at the end of 2003.

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A large part of this increase was due to structural changes in the banking sector. Following the crisis, banks became increasingly aware of the risks associated with lending to *chaebol*-affiliated firms, at which time, the banks were focused on reducing their debt. Consequently, this led to intense competition between banks to increase lending in the high-profit and low-risk household sector.⁹ The rising share of household loans was accompanied by an expansion in total lending, as the financial health of banks were restored as a result of the successful restructuring program. Moreover, rising real estate prices raised the collateral value of households, allowing them to borrow more money.

In addition, loans to SMEs expanded quite substantially in the post-crisis period. Although bank loans to large businesses decreased slightly due to the reduced demand for funding by large companies, there was heightened demand for short-term funding among SMEs in order to increase their production activities, as the domestic economy recovered from the crisis. In particular, following the government's measures to rein in household lending, banks having difficulties in identifying suitable targets for the operation of their funds, extended their loans to service-oriented businesses and small-business proprietors, which was a contributing factor in expanding loans to SMEs. During the 5 years following the crisis, from the end of 1998 to 2004, Korean banks' SME loans more than doubled, increasing from 89 trillion won to 217 trillion won.

⁹ Household loans carry higher interest rates than corporate loans and are exempt from the burden of contributions to the Korea Credit Guarantee Fund (0.3% p.a.). Loans secured by housing collateral also attract a lower risk weighting (50%, corporate loans 100%) in the calculation of the BIS capital adequacy

Indeed, the figures show that as total corporate loans increased from 121 trillion won to 245 trillion won in the same period, the share of SME loans increased from 73.7% to 88.7%, while loans to large companies decreased from 32 trillion won to 28 trillion won.¹⁰

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2. Risk management of banks and regulatory response

These changes in the portfolio structure of the Korean banking industry suggest that the appropriate credit risk management of household loans and SME loans is key in maintaining the soundness of banks. With respect to household credit, various measures have been taken by the Korean financial supervisory authority to lessen the negative impact of a possible massive default among existing household loans. As household credit rapidly increased as described in the previous section, concerns surfaced that the soundness of banks were at risk due to the looming threat of default among household loans. In the second half of 2002, delinquency rates for household loans started to rise, and since then, the Korean government has worked to curb household lending among banks.¹¹ The financial supervisory commission raised mandatory provisions for household loans (April 23 and October 11, 2002) and made adjustments by lowering the loan-to-value ratio for loans secured using housing collateral (September 9 and October 11, 2002). Those measures, by and large, succeeded in curbing the upward trend of household loans or accelerating its downward trend afterwards. Considering that these measures taken by the regulatory authority were expected to help Korean banks in alleviating the cost burden related with managing household credit risk, the somewhat generous treatment of household or individual consumer exposures under the modified risk weights formula recently proposed by the Basel Committee (BIS, 2003), seems suitable for Korean banks in this respect.¹²

ratio.

¹⁰ During the same 5 years (1999-2003), the total loans of Korean banks increased from 196 trillion won to 515 trillion won.

¹¹ The delinquency ratio of Korean banks' household loans had been decreased from 2.4% at the end of 2000 to 1.2% in June 2002, but from the second half of 2002 it took a rising trend to 2.6% in the first half of 2003.

¹² The New Basel Capital Accord allows banks using Standardized Approach to compute the minimum capital requirements against retail credits, including consumer loans and very small business loans, with the 75% risk weight that is substantially smaller than 100% risk weights under the current rules. In fact, it is an empirical question to be analyzed whether the proposed level of 75% risk weight is enough to cover the risk of retail credit in the emerging market countries that are generally considered to have different

With respect to SME exposures in the Korean banking industry, there seems to not have been a regulatory reaction against its risk so far. The delinquency rates on SME loans have been increasing recently, partly due to continuing stagnant domestic demand since the second half of 2003. In fact, delinquency rates as a whole for SME loans increased from 2.69% in September 2003 to 2.98% in April 2004. For individual enterprises, such as small-business proprietors, loans increased from 2.89% to 3.10% during the same period. In comparing the delinquency rates for loans to large companies that decreased from 0.84% to 0.42%, these numbers suggest that the credit risk associated with SME loans is quite substantial, especially considering the large proportion of SME loans to total corporate loans. In response to the rising risk of SME loans, Korean banks appear to be taking a more prudent approach in their credit assessment of SMEs.

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However, on the government side, it seems that preventing a possible credit crunch in the SME sector is the only matter of concern for the Korean financial supervisory authority. When banks tighten credit controls over the SME sector, it may lead to credit rationing among SMEs, and could reduce economic growth. However, financial regulators have the role of supervising the activities of financial institutions, as well as, maintaining stability in the financial system to support economic growth. In regulating the banks, financial authorities are burdened with a fine balancing act between curtailing the activities of domestic banks as part of its regulatory mission and providing enough support so as to ensure the role of banks in the allocation of sufficient capital resources to the production industries. While the motives of regulators seem to be at odds, economic growth potential could be threatened if regulators are consumed by the role of supporting economic growth. For example, regulators overly concerned with ensuring an adequate supply of loans to SMEs to secure financial stability may loosen regulation on bank capital.

Even in the discussions and comments surrounding the New Basel Capital Accord, also known as Basel II, we could find similar concerns. After the first version of the New Accord was drafted, many economists and policy makers in various countries

risk profiles for consumer credits compared to advanced countries such as member countries of the Basel Committee.

pointed out the problem of calibrating credit risk for SMEs.¹³ They criticized that the risk-weight curve was too steep and too high, which induced too-high risk-weights for most of the SMEs. These criticisms shared a common belief that loans to SMEs differ from loans to large businesses since the relationship between the owner/manager of a SME and a bank is often very close and SMEs are more informationally opaque. That is, because lenders face fixed lending costs, lending to small firms is by definition more expensive in terms of per dollar lent. In fact, the concern is that capital charges, which are too large, could lead to credit rationing among SMEs, thereby possibly reducing economic growth.

As a response to these comments and concerns, the Basel Committee (BIS, 2003) introduced changes in the formula used to calibrate the risk-weights in order to reduce the risk-weight on SME exposures.¹⁴ The committee introduced an adjustment in the risk-weight formula under the IRB (internal ratings based) approach for corporate credit to firms with turnover between €5 and €50 million by, more precisely, changing the correlation formula with a term that reduces the value of the correlation proportionately to the size of the firm. Furthermore, banks that treat their SME exposures as a homogeneous portfolio (in the same way as they treat their retail exposures) are permitted to apply the retail IRB capital requirements to the portfolio with more favorable retail risk-weight formula as long as the exposure to the bank of any individual SME (with turnover between €1 and €5 million) is less than €1 million.¹⁵

These recent adjustments in the risk-weight formula for SME loans also allow Korean bank regulators to have some more leeway. Since the proportion of SME loans to total corporate exposure in the Korean banking industry is slightly less than 90%, and about 60% of SME loans can be treated as ‘retail exposures’ by banks. Thus, Korean regulators may be persuaded not be concerned about the occurrence of a serious SME credit tightening, when adopting the New Accord as a financial supervisory standard.

¹³ SMEs are defined by the Basel Committee as those with less than €50 million in annual turnover.

¹⁴ The committee first proposed the New Basel Capital Accord in December 2001, with revisions in July 2002 and April 2003. More revisions are likely before the final adoption of the accord. By year-end 2006, Basel II is expected to replace the original Basel Accord, which was implemented in 1992.

¹⁵ The Bank for International Settlements (BIS, 2001, p. 55) defines retail credit as “homogeneous portfolios comprising a large number of small, low value loans with either a consumer or business focus, and where the incremental risk of any single exposure is small”. These types of loans include loans to individuals such as credit cards and residential mortgages, and SME loans could also be included as long as the bank treats these facilities the same way it treats other retail credits.

3. Agenda for the Korean bank supervisors

The treatment of SME exposures is viewed as especially important in countries like Korea where SMEs comprise a significant component of the industrial sector and the banking industry's loan portfolio. Under the New Accord proposed by Basel Committee, lower capital requirements are allowed at up to 20% on exposures for SMEs compared to exposures to larger firms. Given the importance of SMEs in the Korean economy, treating credit risk differently on loans for SME and large businesses by applying different correlation terms proportional to the size of a firm as proposed by the New Accord seems to be somehow acceptable.

Credit correlation, which is also referred as default correlation, is an important factor used to determine the distribution of losses in a bank loan portfolio. In order to assess risk at the portfolio level, capturing the correlations between individual exposures is crucial. In most of the credit risk models, the correlation measures the degree of sensitivity of the probability of default to the systematic risk factors that represent the "state of the economy".¹⁶ The more individual bank loans tend to react simultaneously to systematic risk factors, the greater the risk of a portfolio will be.

Under the proposed New Accord, banks will be permitted to separately distinguish exposures to SMEs from large firms. For banks opting to use the standardized approach for SME exposures, a risk-weight for general corporate exposures would be applied, while continuing to use the 8% capital requirement (under the original Basel Capital Accord). However, for exposures to very small firms, banks would be able to apply the fixed retail credit risk-weight of 75% to calculate the minimum capital requirement: $K = EAD \times 0.75 \times 0.08$ where K is the capital requirement for SME exposures and EAD is the exposure at default of the SME credit.

If a bank chooses the advanced internal ratings based (A-IRB) approach for SME exposures, the bank must estimate PD and LGD, as well as EAD and consider the maturity factor.¹⁷ With these risk components, the minimum capital levels required against SME credit are calculated using the same formula used for general corporate exposures:

¹⁶ In the estimation of loan loss distribution, parameters such as the probabilities of default and their variance determine credit correlations. Therefore, a good calibration of these parameters is an important element in portfolio risk management.

¹⁷ The Basel Committee has made two sub-broad approaches of the IRB approach: a foundation and an advanced. Under the foundation approach, as a general rule, banks provide their own estimates of PD and rely on supervisory estimates for other risk components. Under the advanced approach, banks provide more of their own estimates of PD, LGD, EAD, and M, subject to meeting minimum standards. In both cases, banks must use the risk weight functions provided for the purpose of deriving capital requirements.

$$K = EAD \times LGD \times \Phi \left(\frac{\Phi^{-1}(PD) + \sqrt{\rho} \times \Phi^{-1}(C)}{\sqrt{1-\rho}} \right) \times \frac{1 + (M - 2.5) \times B(PD)}{1 - 1.5 \times B(PD)}$$

where $\Phi(\cdot)$ is the cumulative distribution function for the standard normal, C is the confidence level, ρ is the credit correlation, M is the maturity of exposure, and $B(PD)$ is the maturity adjustment term that is a function of PD.

Therefore, one can find that the required capital as a function of the probability of default can vary substantially depending on the correlation coefficient assumed. In particular, since the foundation approach sets the maturity at 2.5 years and assumes no maturity adjustment, the formula for minimum required capital could be simplified as

$$K = EAD \times LGD \times \Phi \left(\frac{\Phi^{-1}(PD) + \sqrt{\rho} \times \Phi^{-1}(C)}{\sqrt{1-\rho}} \right),$$

and it is also easy to find that if the correlation is zero, as in an extreme case, the capital requirement is just $K = EAD \times LGD \times PD$, and if the correlation is one, the extreme opposite, the capital requirement is $K = EAD \times LGD$.

The New Accord proposed various formulas to calculate the correlation for corporate exposures, and made a firm size adjustment (i.e. $0.04 \times (1 - (S - 5)/45)$) for exposures to SME obligors:¹⁸

$$\text{Correlation for exposures to large firms} = 0.12 \times \left(\frac{1 - e^{-50 \times PD}}{1 - e^{-50}} \right) + 0.24 \times \left(1 - \frac{1 - e^{-50 \times PD}}{1 - e^{-50}} \right),$$

and

Correlation for SME exposures

$$= 0.12 \times \left(\frac{1 - e^{-50 \times PD}}{1 - e^{-50}} \right) + 0.24 \times \left(1 - \frac{1 - e^{-50 \times PD}}{1 - e^{-50}} \right) - 0.04 \times \left(1 - \frac{(S - 5)}{45} \right).$$

¹⁸ S is expressed as total annual turnover in millions of euros with values of S falling in the range of equal to or less than €50 million or greater than or equal to €5 million. Reported turnover of less than €5 million will be treated as if they were equivalent to €5 million for the purpose of the firm-size adjustment for SME obligors. Subject to national discretion, supervisors may allow banks, as a failsafe, to substitute total assets of the consolidated group for total turnover in calculating the SME threshold and the firm-size adjustment. However, total assets should be used only when total sales are not a meaningful indicator of

The small business exposures also can be treated as retail exposures when taking the IRB approach. For retail exposures other than residential mortgage exposures and qualifying revolving retail exposures, lower ranges in credit correlation are allowed under the New Accord compared to corporate exposures:¹⁹

$$\text{Correlation for retail exposures} = 0.02 \times \left(\frac{1 - e^{-35 \times PD}}{1 - e^{-35}} \right) + 0.17 \times \left(1 - \frac{1 - e^{-35 \times PD}}{1 - e^{-35}} \right).$$

Therefore, considering that the required capital calculated using formulas under the IRB approach increases with the correlation, banks can reduce the capital requirement for SME exposures by treating them as retail exposures.

Since the Basel Committee's new proposal allows banks to apply a more favorable retail risk-weight formula to very small businesses as shown above and Korean financial regulators may adopt the New Accord with quite minor modifications subject to national discretion, Korean banks that provide corporate credit mainly to SMEs will be able to benefit substantially by adopting the New Capital Adequacy Accord.

However, it is not proven to be rational for bank regulators of emerging market countries to loosen their grip and allow banks to treat more than half of their corporate credit portfolio as retail exposures. Since small firms are considered to be more sensitive to downturns in macroeconomic conditions than larger firms, the probability of default among risky small businesses tends to increase in a recessionary period. Therefore, handling small firms as retail exposures using a more favorable risk-weight formula has two implications for regulators. First, regulators should assume that the degree of increase in the credit correlation of a bank's SME portfolio in respect to the size of the borrowing firm is greater than what is assumed under the firm-size adjustment term. Second, regulators should also assume that the degree of decrease in the correlation of SME portfolio in respect to the PDs is greater than what is assumed

firm size. (BIS, 2003)

¹⁹ The credit correlation formula for the retail exposures indicates that the New Accord assumes that the correlation for retail exposures cannot be smaller than 0.02 and larger than 0.17, that is, should be in the range of [0.02, 0.17]. It can be also noticed that the correlation for the corporate exposures is assumed to be in the range of [0.12, 0.24] and, for the SME exposures, [0.08, 0.24]. In January 2004, the Basel Committee on Banking Supervision modified the risk weight functions and related formulas to move to a 'unexpected-loss-only' risk weighting construct by decomposing the original risk weight functions in to 'expected loss' and 'unexpected loss'. As a result, the correlation coefficients for the retail exposures were changed from 0.02 to 0.17 in the original formula to 0.03 to 0.16.

by the correlation formula for the corporate exposures.²⁰ However, if these assumed positive relationships between obligor's size and correlation, as well as, the negative relationship between PDs and correlation are not verified, adopting the New Accord without any consideration of a country's specific risk profile in the SME sector could be problematic in the sense that the mandatory capital requirement may not be sufficient to cover the economic capital for SME portfolios.

In addition, the problem of the systemic risk adds a new dimension that needs to be resolved by financial regulators in adopting the special treatment of SME exposures. Under the new regulation on capital, banks would be allowed to establish their own credit risk management system to find levels of risk characteristics, which is calculated by the system as the most reasonable for their own portfolio, such as the probability of default (PD), the loss given default (LGD), exposure at default (EAD), and default correlation. However, even though each bank maintains capital above the level that is equivalent to the economic capital of its portfolio, it may not be enough when considering that the increasing credit risk of a bank's portfolio can easily spread to other banks. Therefore, in setting out the credit correlation formula for SME exposures, the financial regulatory authority has to examine not only the correlation of the individual bank's SME portfolio, respectively, but also the default correlation for SME portfolios in aggregate for the whole banking industry.

In the following chapter, we analyze the credit correlations of Korean SMEs to provide direction for modifying the risk-weight formula that the Financial Supervisory Services may need to determine the level of national discretion, when it adopts the New Accord as the major regulatory framework for bank capital.

²⁰ The assumption of an inverse relationship between PD and correlation assumed in the correlation formula for the corporate exposure is already quite controversial. Most academic studies find a direct relationship such that firms with higher quality and thus lower default probability tend to have less systematic risk and therefore lower correlations, whereas firms with lower quality and thus higher default probability are more subject to market shocks and therefore have higher correlations. See Allen and Saunders (2003) for a discussion.

IV. Empirical Analysis

1. The model

The multi-factor credit risk model

Most of the credit risk models assume that the variance of PDs and correlations are driven by one or several risk factors. Here, the “risk factors” represent various sources that change in the obligor’s financial situation, which then influences the credit worthiness of obligors, and as a consequence, the asset value of portfolio (business cycle, for example). Though we used the multi-factor model to compute the asset correlation in this paper, a brief introduction of the one-factor model may be better suited for illustrative purposes (Gordy, 2000; Dietsch and Petey, 2004). In the one-factor model, each obligor i ’s state (that is, the credit indicator for the obligor i) is driven by an unobserved latent random variable U_i , which is defined as a linear function of a single systematic factor Z and a specific idiosyncratic factor ε_i :

$$U_i = \beta_i Z + \sqrt{1 - \beta_i^2} \varepsilon_i$$

where Z and ε_i are i.i.d. random variables following the standard normal distribution and $E[Z\varepsilon_i] = 0$. The systematic factor represents the state of the economy and measures the effect of the business cycle on the default rate. Hence, the weight β_i assigned to the systematic risk factor measures the sensitivity of obligor i to evolving general economic conditions. Since these sensitivities are identical for all obligors in the same portfolio ($\beta_i = \beta, \forall i$), the correlation between latent variables for the two obligors i and j in the same portfolio can be written as:

$$\text{Corr}[U_i, U_j] = \text{Cov}[U_i, U_j] = E[U_i U_j] - E[U_i]E[U_j] = \beta^2$$

As β increases, all obligors tend to be more correlated, while as β decreases, idiosyncratic risk prevails. Therefore, the degree of correlation between loan values is determined by the sensitivity of the latent variables to the systematic factor and the squared sensitivity β^2 is the asset correlation ρ .

In the multi-factor model, it is assumed that the variances and correlations of obligors’ credit indicators are determined by two or more risk factors. Analogous to the

definitions of the one-factor model, one can decompose the unobserved latent random variable U_i deriving obligor i 's credit indicator into K systematic risk factors and the idiosyncratic risk factor as in (1)

$$U_i = \sum_{k=1}^K \beta_{ik} Z_k + \sigma_i \varepsilon_i \quad (1)$$

where $\sigma_i = \sqrt{1 - \sum_{k=1}^K \beta_{ik}^2}$, Z_k is the k th systematic risk factor ($k = 1, \dots, K$) and β_{ik}

measures the obligor i 's sensitivity to the systemic factor Z_k . Here, we also assume that Z_k and ε_i are i.i.d. standard normal random variables and $E[Z_k \varepsilon_i] = 0$. In the multi-factor model, it is generally assumed that the sensitivity of one obligor to a certain systematic factor is identical to that of another obligor in the same portfolio or group ($\beta_{ik} = \beta_k, \forall i, k$). Under these assumptions, it can be easily shown that the correlation between credit indicators of the two obligors i and j in the same portfolio is calculated as the squared sum of sensitivity parameters β_k :

$$\text{Corr}[U_i, U_j] = \text{Cov}[U_i, U_j] = \sum_{k=1}^K \beta_k^2 = \rho \quad (2)$$

where ρ is now the degree of correlation between credit indicators of two obligors in the same portfolio.

We further divide the systemic factors into K^M macroeconomic factors and K^P portfolio-specific factors. Since a portfolio-specific factor, by definition, affects only a single portfolio, the credit indicator for an obligor i in portfolio l can be written as:

$$U_i = \sum_{k=1}^{K^M} \beta_{ik}^M Z_k^M + \beta_i^P Z_l^P + \sigma_l \varepsilon_i \quad (3)$$

where

$$\sigma_l = \sqrt{1 - \sum_{k=1}^{K^M} (\beta_{ik}^M)^2 + (\beta_i^P)^2}.$$

Computation of correlation

The multi-factor model presented above shares its structure with the basic one-factor model framework of Merton (1974). Following Merton's model, the obligor's state or financial position at the end of the planning horizon also depends on the

location of the latent variable relative to a “threshold” value, which defines default in the multi-factor model. That is, an obligor defaults if the credit indicator falls below the default threshold. Since the latent variable is assumed to be a standard normal random variable, we can set the default threshold level for portfolio l such that the probability of default for an obligor i in the portfolio l , p_l is equivalent to the probability of the latent variable being smaller than the threshold value: $p_l = \Pr(U_i^l < \alpha_l) = \Phi(\alpha_l)$, where $\Phi(\cdot)$ is the cumulative distribution function for standard normal. Thus, the cut-off value α_l is simply calculated as $\alpha_l = \Phi^{-1}(p_l)$.

From the discussions above, we can construct the conditional probability of default with the realization of the factors in the latent variable:

$$p_l(\tilde{Z}) = \Pr(U_i^l < \alpha_l | \tilde{Z}) = \Pr\left(\sum_{k=1}^{K^M} \beta_{lk}^M Z_k^M + \beta_l^P Z_l^P + \sigma_l \varepsilon_i < \alpha_l | \tilde{Z}\right)$$

$$= \Pr\left(\varepsilon_i < \frac{\left(\alpha_l - \sum_{k=1}^{K^M} \beta_{lk}^M Z_k^M - \beta_l^P Z_l^P\right)}{\sigma_l}\right) = \Phi(\tilde{\alpha}_l)$$

where $\tilde{\alpha}_l = \frac{\alpha_l - \sum_{k=1}^{K^M} \beta_{lk}^M Z_k^M - \beta_l^P Z_l^P}{\sigma_l}$.

Applying an inverse transformation and making the change in the variable gives:

$$\Phi^{-1}(p_l) = \hat{\alpha}_l + \sum_{k=1}^{K^M} \hat{\beta}_{lk}^M Z_k^M + \hat{\beta}_l^P Z_l^P \quad (4)$$

where $\hat{\alpha}_l = (\alpha_l / \sigma_l)$, $\hat{\beta}_{lk}^M = -(\beta_{lk}^M / \sigma_l)$, and $\hat{\beta}_l^P = -(\beta_l^P / \sigma_l)$.

By regressing the inverse normal of the conditional probabilities to the macroeconomic factors, we can estimate the parameter vector $(\hat{\alpha} \quad \hat{\beta}_{11}^M \quad \dots \quad \hat{\beta}_{1K^M}^M)$

from the regression:

$$\Phi^{-1}(p_{it}) = \hat{\alpha}_i + \sum_{k=1}^{K^M} \hat{\beta}_{lk}^M Z_{kt}^M + \xi_{it} \quad (5)$$

On the other hand, the residual volatility gives the sensitivity of the inverse normal to the portfolio-specific factor:

$$\hat{\beta}_i^P = \sqrt{\sigma_{\hat{\alpha}_i}^2 - \sum_{k=1}^{K^M} (\hat{\beta}_{lk}^M)^2} \quad (6)$$

where $\sigma_{\hat{\alpha}_i}^2 = \frac{1}{T} \sum_{t=1}^T (\Phi^{-1}(p_{it}) - \bar{\Phi}^{-1}(p_i))^2$ and $\bar{\Phi}^{-1}(p_i) = \frac{1}{T} \sum_{t=1}^T \Phi^{-1}(p_{it})$. Note that

$$\sigma_i^2 = 1 - \sum_{k=1}^{K^M} (\beta_{lk}^M)^2 + (\beta_i^P)^2 = 1 - (\sigma_i^2 \sigma_{\hat{\alpha}_i}^2) \quad \text{and} \quad \sigma_i^2 = (1/1 + \sigma_{\hat{\alpha}_i}^2).$$

Finally, we can obtain a set of parameter estimates by substituting back to get:

$$\alpha_i = (\hat{\alpha}_i \cdot \sigma_i), \quad \beta_{lk}^M = -(\hat{\beta}_{lk}^M \cdot \sigma_i), \quad \beta_i^P = -(\hat{\beta}_i^P \cdot \sigma_i) \quad (7)$$

We can calculate an estimate of the correlation using the relationship in (2).

2. Estimation

Data and construction of portfolios

The data consists of information taken from the balance sheets and income statements of Korean SMEs compiled by D&B Korea. This database provides financial and non-financial information on companies in three categories; (1) companies listed on the Korean Stock Exchange (KSE) and KOSDAQ, (2) externally audited companies²¹, and other companies. The database includes all listed and externally audited companies and some other companies for which periodic acquisition of required information are possible.

For the purpose of this study, an SME is defined as a company that either does not

²¹ The law on the external auditing of incorporated companies in Korea requires that an incorporated company with asset larger than 7 billion KRW should have various financial documents such as balance sheet examined by external auditor(s).

exceed total capital of 8 billion won or 300 employees. We construct the SME portfolio according to the industrial classification (SIC) or asset size. In doing so, a delicate balancing effort between two criteria was required. First, the portfolios were designed with companies that had similar industrial characteristics or asset size of economic interest. The second criterion was insuring that these portfolios had a sufficient size of obligors and credit to reduce small sample concerns.

The SMEs in the database were rearranged in seven groups according to industrial categories. There are three portfolios for the manufacturing sector (Portfolios A, B, C), one for construction (Portfolio D), one for wholesale and retail sales (Portfolio E), one for real estate related services (Portfolio F), and one for other services (Portfolio G)²². With respect to asset size, an economically meaningful criterion for constructing the portfolios was less obvious. Hence, we chose size categories that were sufficiently different to ensure that we captured important aspects in terms of size differential, however careful attention was given to make the portfolios large enough to provide meaningful empirical results. We allocated all companies into five groups according to asset size so that each of the portfolios 1, 2, and 3 include 25% of the sample, while each of the portfolios 4 and 5 include 12.5% of SMEs in the sample²³. <Table 4> and <Table 5> summarize the financial characteristics of the SME portfolios classified by industrial category and asset size, respectively.

// <Table 4> and <Table 5> here //

We also construct portfolios based on both industrial category and asset size. The challenge here was to create portfolios, in which the number of obligors and the amount of total credit are more or less uniformly distributed across both criteria. However, given the extremely uneven distribution of companies across industry and asset size, achieving this task proved impossible. Thus, for the bivariate analysis, we combined two smaller portfolios (Portfolios 1 and 2) together so that the previous five categories based on asset size are collapsed into four categories, which generated 28 industry-asset size SME portfolios.

Macroeconomic factors

To extract macroeconomic factors assumed to dictate the latent variable in (3), and consequently, to systemically drive the default probabilities of each portfolio, eight

²² Further details on the constructing portfolios of SMEs can be found in Appendix 2.

²³ The threshold values dividing portfolios are different across fiscal years covered by the sample.

macroeconomic variables are considered: KOSPI stock index (KOSPI), industrial production (IP), wholesale and retail index (SALE), unemployment rate (UNEMP), GDP, yield on three-month CD (CD), yield on three-year corporate bond with A- grade (CBOND), and terms of trade (TOT).

To do so, annual data for the variables from 1992 to 2003 was obtained from the Bank of Korea's statistical database and Korea National Statistical Office. First, subtracting the sample mean and dividing by the sample standard deviation, we obtain a time series of standardized factor returns for the macroeconomic factors. Next, we obtain a set of independent factors such as the linear combination of the correlated macroeconomic factors through principal component analysis. The use of principal components reduces the number of factors used in the estimation of the model. <Figure 3> shows the proportion of variance that each of the principal components explain and the cumulative contributions. The first four principal components explain about 96% of the co-movements of all eight macroeconomic factors. Hence, we keep the first four principal components for the analysis to follow and treat the last four principal components as capturing co-movements among macroeconomic variables due to non-systematic noise.

// <Figure 3> here //

<Figure 4> plots the factor loadings for the remaining four principal components. For example, the first principal component, which explains 43% of the co-movements of the macro variables, has a positive weight (loading) on CD, CBOND, UNEMP, GDP and TOT, and a negative weight on KOSPI, IP and SALES.

// <Figure 4> here //

Definition of default event

The D&B Korea database does not assign a credit rating to almost all of the SMEs unless they are listed on the KSE or KOSDAQ markets. Therefore, it is impossible to compile a time series based on credit ratings for each obligor or credit measures based on historic records of default rates, which is regarded as elemental in most credit risk models.

Instead, we define a default event when a firm cannot cover its interest payments with operating profits three years in a row, that is:

$$y_{it}^l = \begin{cases} 1 & \text{when } \bigcap_{r=0}^2 (\text{IPCR}_{it-r}^l < 1) \\ 0 & \text{otherwise} \end{cases}$$

where y_{it}^l is the default indicator for obligor i in portfolio l at time t and IPCR_{it}^l is the interest payment coverage ratio for obligor i in portfolio l at time t defined as the ratio of earnings before interest and tax (EBIT) to interest payment. We can calculate the default rate for portfolio l at time t , p_{it} as:

$$p_{it} = \frac{1}{I_l} \sum_{i=1}^{I_l} y_{it}^l \quad (7)$$

where I_l is the number of obligors belonging to portfolio l .

There are at least two reasons, theoretical and practical, for choosing IPCR as the default indicator rather than a traditional measure such as historically observed default probabilities of each portfolio. First of all, IPCR would be a reasonable substitute for observations on actual defaults in the absence of an extensive and reliable set of records on the default history of SMEs. Analyzing the default behavior of Korean firms with D&B Korea's database, Kang *et. al.* (2000) show that an IPCR of less than 1 for three successive years is an excellent predictor for 'actual' default in the near future.

Second, since we are more interested in accessing the degree of credit correlation for SME portfolios existing in the economy rather than SME portfolios an individual financial institution is exposed to, it would be better to take IPCR as a measure of creditworthiness. Due to the lack of an extensive and reliable network of credit rating systems and accumulation of credit history on individual borrowers, financial institutions in Korea have almost always depended on the value of a collateral in making loan decisions, especially for SMEs. Though the practice of risk management in Korean financial institutions, particularly banks, has improved significantly since the foreign exchange crisis in 1997, it is still too early to declare that the Korean financial industry has equipped itself with a properly working risk management system. The system does not seem to work appropriately mainly due to the lack of sufficient data to feed into already installed risk management models. It seems to be now a well-established proposition that it would take at least one more business cycle to accumulate an adequate amount of information to evaluate the performance of the current risk management system.

We obtain a time series of default probabilities for each portfolio using (7) annually from 1992 to 2003. The summary statistics of default probabilities for each portfolio are reported in <Table 6>, <Table 7> and <Table 8>. Portfolio F (real estate) exhibits the highest average and volatility followed by Portfolio G (services). On the other hand, the manufacturing sector represented by portfolio A, B, and C shows a low and stable default pattern. In terms of asset size, the most conspicuous pattern is the positive correlation between asset size and average default rate; that is, larger firms measured by asset size tend to fail more frequently than smaller ones. Considering the correlation structure among portfolios in <Table 7>, firms in the lower half tail of size distribution (Portfolio 1, 2) show a different default pattern from the ones in the upper half tail (Portfolio 3, 4, 5).

// <Table 6>, <Table 7>, and <Table 8> here //

Estimation of parameters

Equipped with a time series based on default rates for each portfolio and standardized factors obtained from a principal component analysis of correlated macroeconomic factors (variables), we can estimate the regression model in (5). The results are reported in <Table 9>, <Table 10> and <Table 11>.

// <Table 9>, <Table 10>, and <Table 11> here //

Based on the estimates from the regression and the relationships given in (6) and (7), we can calculate a set of estimates for the parameters of final interest. See <Table 12>, <Table 13> and <Table 14> for the results.

// <Table 12>, <Table 13>, and <Table 14> here //

It is pretty straightforward work to obtain the proportion of variances in the inverse normal values of default rates contributed by systemic factors and portfolio specific factors. The larger the contribution of systemic factors, the bigger the portion of correlation explained by systemic co-movement of macroeconomic variables. Both systemic and portfolio specific factors constitute the correlation of default probabilities of obligors belonging to the same portfolio. See <Table 15> and <Table 16> for the results.

// <Table 15> and <Table 16> here //

3. Interpretation and policy implications

The first and second columns of <Table 15> present the proportion of variance attributable to systemic and portfolio specific factors for the 7 portfolios based on the industrial characteristics of obligors and 5 portfolios based on the obligor firms' asset size. From the first 7 portfolios classified by industry, we could find that the portfolios of SME exposures in the real estate related service industry and other service industries (portfolio F and G) have credit risks that are not sensitive to macroeconomic factors. In contrast, the credit risks of SME exposures in the construction industry (portfolio D) and wholesale & retail sales industry (portfolio E) are highly susceptible to systematic risk factors.

For portfolios classified by size of the obligor SMEs, our analysis shows that the portfolios of larger SMEs tend to have risk characteristics that are less dependent on systematic elements. This result seems inconsistent with the general theory on portfolio diversification, since as a firm grows larger and takes on more assets, its risk and return characteristics should more closely resemble the overall asset market and be less dependent on idiosyncratic elements of individual business lines.²⁴

The third column of <Table 15> presents the credit correlation for the same 12 portfolios of Korean SMEs constructed according to the obligor firm's industrial characteristics and asset size. The estimated correlation values for the first 7 portfolios indicate that the differences between the portfolios based on industrial characteristics are very large. In particular, the SME portfolio in the construction industry (portfolio D) has the highest credit correlation value, 5.46%, and the SME portfolio in the real estate related service industry has the second highest value, 0.92%. Portfolio A, representing the SMEs in the medium-tech manufacturing industry, has the lowest correlation value; however, even the estimated correlation values for each portfolio in the manufacturing sector represented by portfolio A, B, and C are quite different from each other. These differing values suggest that the financial supervisory authority needs to take into consideration the industrial composition of the banks' SME exposures when it adopts the New Accord and proposed special treatment of SME exposures using the risk-weight formulas. In other words, regulation on a higher level of capital may be required

²⁴ The general theory of portfolio diversification suggests that, as the number of different securities within a portfolio increases, the portfolio becomes more diversified, and the idiosyncratic element of the portfolio's return becomes less important (Lopez, 2004). An analogous view could be taken with respect

for banks whose SME portfolios are concentrated with firms from the construction or service industry.

For the following 5 portfolios based on asset size, we found a greater difference between the estimated correlation values. The portfolio with the smallest SMEs (portfolio 1) has the highest credit correlation value, 14.24%, and the portfolio with the largest SMEs (portfolio 5) has the lowest correlation value, 0.64%. In addition to the large differences in correlation values between the portfolios based on firm size, we found that the default correlation values for portfolio decreases as the asset size of the obligor firms increase. As already mentioned above regarding the proportion of variance contributed by systemic and portfolio specific factors, this result seems also inconsistent to the general theory on portfolio diversification. This also indicates that the positive relationship between the obligor's size and credit correlations assumed using the risk-weight formula proposed by the Basel Committee cannot be supported in Korea. However, considering that <Table 7> shows a positive relationship between SME size and average probability of default of the respective portfolio, our results can be supporting evidence for the negative relationship between probability of default and credit correlation.

Results of the bivariate analysis using the constructed portfolios based on both industrial characteristics and asset size, presented in <Table 16> also shows evidence arguing against the existence of a positive relationship between the obligor's size and credit correlation. Even though the proportional relationship is not clear in some industry categories, the estimated credit correlation values of the smaller SME portfolios are consistently greater than those of the larger SMEs in all respective industry categories.

to a firm's asset size as above.

V. Conclusion

In this paper, we examined the current issues regarding capital regulation in Korea, while placing emphasis on the importance of identifying the risk profile of bank lending portfolios for financial regulators to design a sound capital requirement scheme. After considering the directions of the newly proposed amendments to the financial laws, we came to a tentative conclusion that Korea will most likely continue to maintain separation between banking, insurance, and securities for the foreseeable future. Hence, rather than focusing on capital requirement issues under a consolidated financial structure, our analysis focused on other important issues related to risk-based capital (RBC), as well as, on the regulatory capital requirement framework that is about to change with the adoption of the New Capital Adequacy Accord.

In carrying out our study, we take into consideration the following facts of the Korean banking industry. First, most of the bank asset portfolios consist of household and SME credit. Second, the recently implemented regulatory measures to curb the expansion of household credit have been by and large successful in maintaining the soundness of the banks' portfolios for that sector. Accordingly, priority of this paper has been placed on analyzing the risk characteristics of SME exposures, along with the capital requirement as a way to cope with risks of SME obligors.

Using large samples of Korean SMEs with a multi-factor risk model that extends the framework of Merton (1974), therefore, this paper draws an important policy implication on the relationships between the obligor SME's size and credit correlation. Note that the recently proposed formulas for the risk-weight by the Basel Committee allows for favorable lending treatment of small businesses under the assumptions of positive relationships between obligor's size and correlation, as well as, the negative relationship between PDs and correlation. Accordingly, if the assumptions turn out to be incompatible with empirical evidence provided by Korean experience, the regulatory capital requirement set by the New Accord may not be sufficient to cover the economic capital for SME portfolios.

The results of our analysis, first of all, show that the correlation of SME exposures decreases as the asset size of the obligor firms increases. This indicates that the positive relationship between obligor's size and credit correlations assumed in the risk-weight formula proposed by the Basel Committee cannot be supported in Korea. In this light, Korean financial regulators should be careful in adopting the New Accord, especially when treating small business exposures as retail exposures. However, in contrast to our second concern, our analysis found a negative relationship between the probability of

default and credit correlation assumed under the risk-weight formula proposed by the Basel Committee.

Our results also suggest that the financial supervisory authority needs to place emphasis on the industrial composition of SME exposures when it adopts the New Accord and proposed special treatment of SME exposures. The differences between the estimated correlation values for portfolios based on industrial characteristics were quite large. In particular, regulators may require banks to have a higher level of capital for SME portfolios that are concentrated with firms from the construction or service industry.

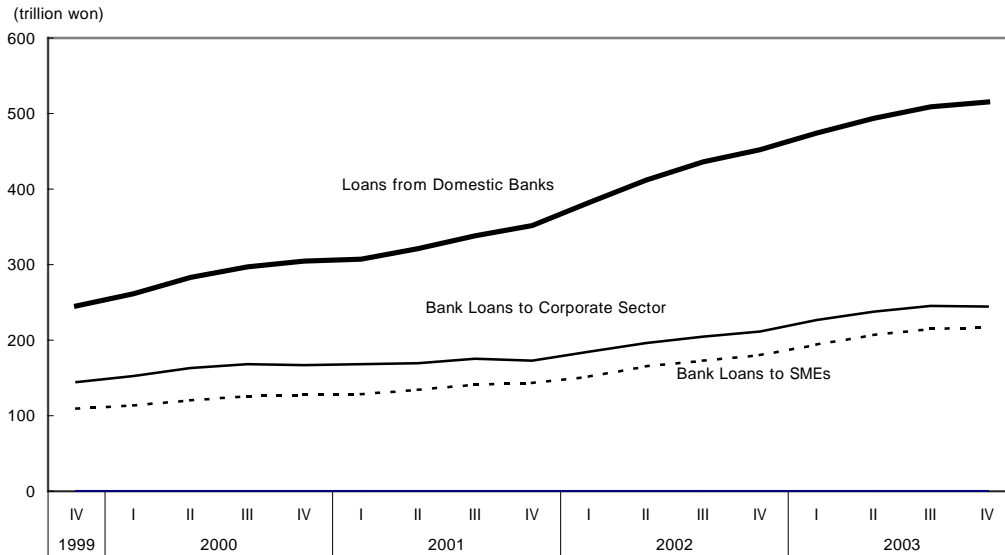
It may be too early to evaluate the capital requirement framework for SME exposures in the New Accord and suggest detailed directions of its application to the Korean financial regulatory system, since more revisions are likely before the final draft. To cover all the bases, it is also worthwhile to mention the limitations of our analysis. First, the observation period might be too short to cover at least an entire business cycle. This could bring about a selection bias in the measurement of PDs, giving way to the possibility of a misleading low PDs volatility. The only solution that addresses this would be to accumulate new data through time. Second, the estimated correlations were computed based on a very large sample of Korean SMEs that maybe quasi-exhaustive. This could lead to an underestimation of the credit correlation, since the size of the individual bank's SME portfolios can be far smaller than the data we used, and consequently, a bank may observe a higher correlation in its book. Thus, the results of the empirical analysis in this paper should be interpreted with some caveats in mind.

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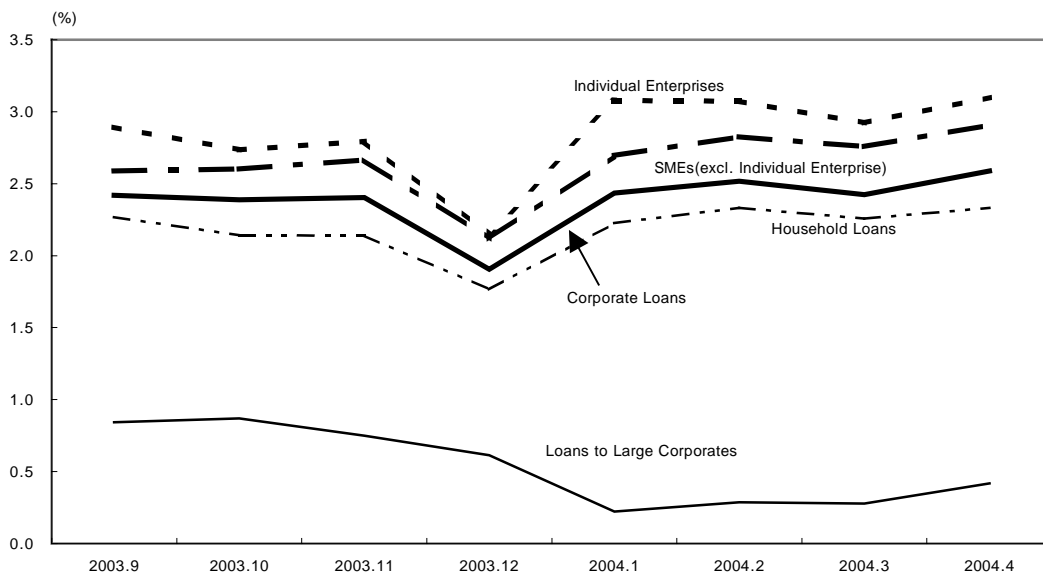
<Figure 1> Loans outstanding of Korean domestic banks by sectors



Note: Numbers are of the deposit money banks in Korea.

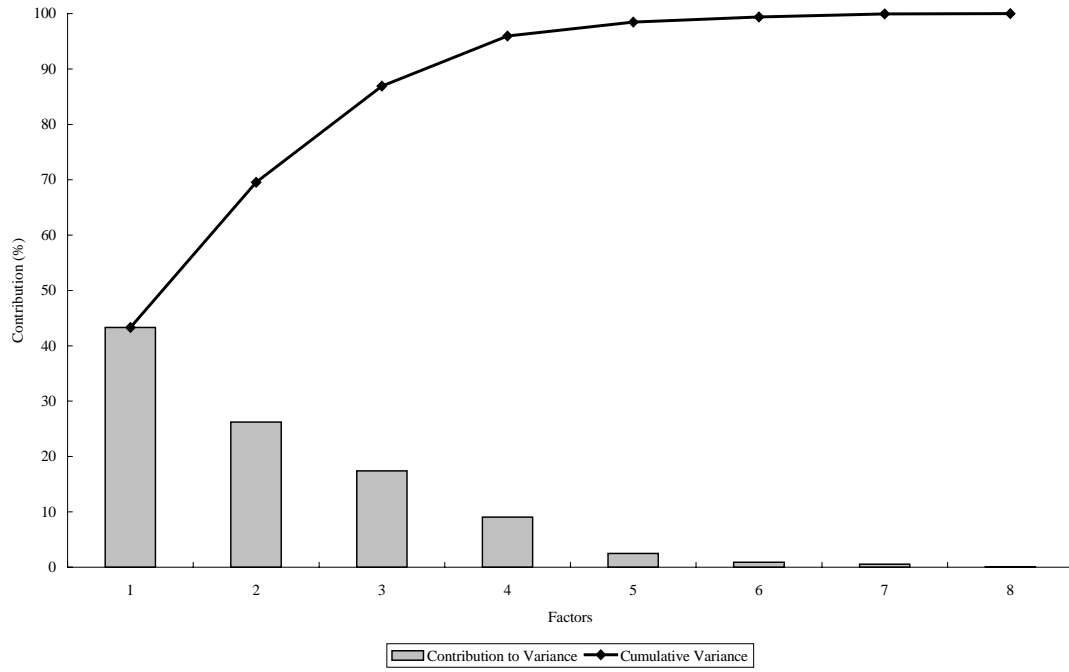
Source: The Bank of Korea. Financial Supervisory Services.

<Figure 2> Delinquency rates on the loans of Korean banks by sectors

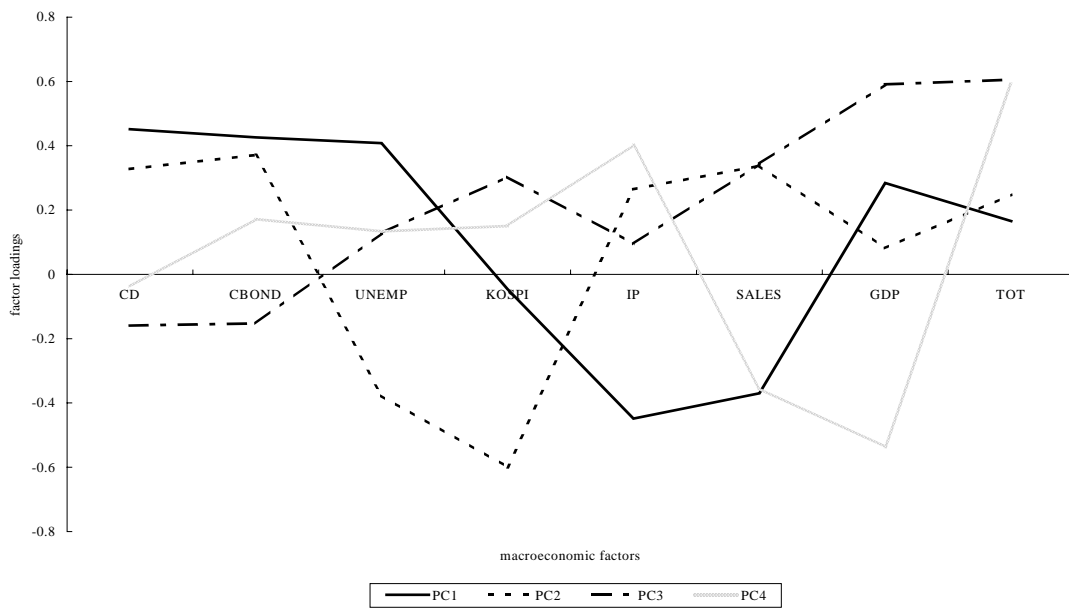


Source: Financial Supervisory Services.

<Figure 3> Proportion of Variance Explained by Principle Components



<Figure 4> Factor Loadings for the First Four Principle Components



<Table 1> BIS Capital Adequacy Ratio of Korean Banks

(%)

	Banks with national operation	Banks with provincial operation
2001	10.80	10.74
2002	10.46	11.26
2003	10.40	11.13

<Table 2> Changes in outstanding Loans of Korean banks

(Billion KRW)

End of	1998	1999	2000	2001	2002	2003
Total loans	-61	48,981	59,361	47,158	100,336	63,174
Corporate Loans	-1,971	23,328	22,588	5,794	38,693	33,155
to Large Businesses	1,111	3,008	4,484	-9,814	1,681	-3,633
to SMBs	-3,081	20,320	18,104	15,608	37,012	36,788
Household Loans	1,910	25,653	36,772	41,736	61,797	29,599

Note: Numbers are of the deposit money banks in Korea.

Source: The Bank of Korea. Financial Supervisory Services.

<Table 3> Delinquency rates on the corporate loans of Korean banks by sectors

(%)

End of	2001	2002	Sep. 2003	2003	Apr. 2004
Total Corporate loans	1.9	1.8	2.4	1.9	2.6
To Large Businesses	1.8	1.1	0.8	0.6	0.4
To SMBs	1.9	2.0	2.7	2.1	3.0
(Individual Enterprises)	2.0	2.1	2.9	2.2	3.1

Source: Financial Supervisory Services.

<Table 4> Portfolios of SMEs by Industrial Categories

(Million KRW)

Portfolio	Number of Companies	Current Asset	Total Asset	Current Debt	Total Debt	Capital Stock
A	2034	11841	25284	10204	14002	3670
B	2834	10556	20123	9227	13414	3171
C	1831	10637	22546	9504	13343	2664
D	982	23163	33943	17026	29511	4290
E	1784	9933	17495	10458	22169	2879
F	305	36038	98927	23882	66305	21978
G	1287	8329	23834	8141	15462	4311

Note: All numbers are averages for companies in each portfolio based on balance sheet of year 2003.

Data: D&B Korea

<Table 5> Portfolios of SMEs by Asset Size

(Million KRW)

Portfolio	Upper Bound	Current Asset	Total Asset	Current Debt	Total Debt	Capital Stock
1	3672	950	1539	769	1053	452
2	10594	3951	7224	3677	5086	1546
3	22950	8399	15585	7762	10484	2480
4	58978	18832	36067	16824	23975	5212
5	-	65106	161531	57448	124799	24520

Note: 1) All numbers are averages for companies in each category based on balance sheet of year 2003.

2) Upper bound indicates the largest total asset for each portfolio.

Data: D&B Korea

<Table 6> Correlation Matrix for Default Probabilities: Industrial Categories

	A	B	C	D	E	F	G
A	1	-0.5201	0.4589	-0.0216	0.0769	0.5871	-0.1431
B		1	0.1125	0.2408	0.6374	-0.6033	0.7656
C			1	0.5657	0.5865	0.4986	0.1805
D				1	0.2029	0.2912	-0.0393
E					1	0.0702	0.4516
F						1	-0.6494
G							1
Average	0.0307	0.0259	0.0429	0.0502	0.0317	0.1474	0.0634
S.D.	0.0033	0.0136	0.0113	0.0210	0.0083	0.0373	0.0201

<Table 7> Correlation Matrix for Default Probabilities: Asset Size

	1	2	3	4	5
1	1	0.8626	-0.0028	-0.2041	-0.7174
2		1	-0.0033	-0.1997	-0.6658
3			1	0.7854	0.1182
4				1	0.5135
5					1
Average	0.0157	0.0221	0.0520	0.0714	0.0908
S.D.	0.0120	0.0138	0.0091	0.0134	0.0126

<Table 8> Correlation Matrix for Default Probabilities: Industrial Categories and Asset size

	A2	A3	A4	A5	B2	B3	B4	B5	C2	C3	C4	C5	D2	D3	D4	D5	E2	E3	E4	E5	F2	F3	F4	F5	G2	G3	G4	G5
A2	1.000	-0.706	-0.725	-0.851	0.788	0.188	0.231	-0.230	0.752	-0.253	-0.434	-0.657	0.540	0.530	0.627	0.156	0.855	-0.216	-0.426	-0.636	0.410	-0.562	-0.309	0.209	0.862	-0.301	-0.563	-0.688
A3		1.000	0.636	0.575	-0.660	-0.134	-0.084	-0.164	-0.606	0.546	0.461	0.560	-0.366	-0.299	-0.271	0.017	-0.772	0.100	0.333	0.307	-0.325	0.290	0.365	-0.383	-0.538	0.449	0.633	0.620
A4			1.000	0.664	-0.674	-0.095	-0.154	0.302	-0.493	0.287	0.708	0.634	-0.421	-0.516	-0.686	-0.331	-0.656	0.306	0.716	0.744	-0.285	0.457	0.305	-0.065	-0.693	0.187	0.583	0.833
A5				1.000	-0.890	-0.560	-0.433	0.380	-0.803	-0.024	0.264	0.665	-0.539	-0.569	-0.595	-0.046	-0.877	-0.090	0.424	0.755	-0.297	0.695	0.336	-0.102	-0.880	-0.038	0.420	0.690
B2					1.000	0.608	0.612	-0.139	0.864	-0.062	-0.354	-0.705	0.451	0.390	0.507	-0.119	0.942	0.224	-0.297	-0.718	0.127	-0.591	-0.502	0.148	0.929	0.006	-0.300	-0.644
B3						1.000	0.522	-0.107	0.486	0.520	0.209	-0.358	0.019	0.103	0.125	-0.472	0.414	0.535	0.106	-0.449	-0.455	-0.507	-0.366	0.196	0.477	0.333	0.217	-0.090
B4							1.000	-0.132	0.360	0.060	-0.258	-0.538	-0.085	-0.241	-0.047	-0.443	0.431	0.330	-0.215	-0.450	-0.184	-0.500	-0.605	-0.232	0.559	0.354	0.193	-0.078
B5								1.000	0.023	-0.249	0.234	0.203	-0.317	-0.264	-0.251	-0.258	-0.063	0.157	0.515	0.595	-0.189	0.492	0.171	0.418	-0.185	-0.275	0.050	0.294
C2									1.000	0.053	0.012	-0.403	0.688	0.647	0.659	0.134	0.907	0.406	-0.002	-0.433	0.234	-0.244	-0.142	0.061	0.824	0.094	-0.395	-0.583
C3										1.000	0.694	0.444	0.083	0.266	0.260	0.097	-0.227	0.564	0.445	-0.061	-0.378	0.093	0.411	-0.379	-0.053	0.758	0.575	0.418
C4											1.000	0.734	0.092	0.170	-0.048	0.073	-0.323	0.639	0.818	0.538	-0.169	0.517	0.656	-0.189	-0.383	0.507	0.431	0.584
C5												1.000	-0.003	0.039	-0.133	0.342	-0.618	0.356	0.702	0.708	0.011	0.839	0.836	-0.376	-0.700	0.397	0.450	0.643
D2													1.000	0.866	0.720	0.699	0.561	0.197	-0.076	-0.365	0.663	0.006	0.282	-0.329	0.385	0.193	-0.343	-0.507
D3														1.000	0.904	0.759	0.480	0.158	-0.110	-0.355	0.488	0.023	0.451	-0.230	0.412	0.246	-0.426	-0.530
D4															1.000	0.681	0.522	0.056	-0.224	-0.512	0.313	-0.082	0.284	-0.221	0.606	0.222	-0.387	-0.567
D5																1.000	-0.011	-0.130	-0.178	-0.092	0.623	0.342	0.666	-0.542	-0.064	0.246	-0.276	-0.249
E2																	1.000	0.191	-0.248	-0.550	0.322	-0.445	-0.380	0.199	0.898	-0.127	-0.497	-0.724
E3																		1.000	0.608	0.225	-0.267	0.343	0.182	-0.308	0.096	0.691	0.288	0.190
E4																			1.000	0.649	-0.280	0.625	0.460	0.070	-0.331	0.202	0.519	0.621
E5																				1.000	-0.167	0.821	0.461	0.021	-0.686	-0.028	0.116	0.569
F2																					1.000	-0.023	0.323	-0.236	0.101	-0.122	-0.323	-0.330
F3																						1.000	0.681	-0.273	-0.576	0.201	0.106	0.395
F4																							1.000	-0.366	-0.447	0.365	0.179	0.364
F5																								1.000	0.152	-0.797	-0.227	-0.201
G2																									1.000	-0.043	-0.388	-0.671
G3																										1.000	0.420	0.294
G4																											1.000	0.807
G5																												1.000

<Table 9> Regression for Multi-factor Merton Model: Industrial Categories

	A	B	C	D	E	F	G
α	-1.8725	-1.9740	-1.7298	-1.6816	-1.8676	-1.0617	-1.5461
PC1	0.0089	0.0169	0.0397	0.0126	0.0318	0.0063	0.0376
PC 2	0.0179	-0.0293	0.0022	-0.0158	0.0051	0.0104	-0.0208
PC 3	0.0138	-0.0413	-0.0119	-0.1605	-0.0017	0.0055	0.0289
PC 4	0.0081	0.0320	0.0009	0.0331	0.0565	0.0391	0.0001
\bar{R}^2	0.9627	0.6333	0.2134	0.3385	0.1395	0.2464	0.5018

<Table 10> Regression for Multi-factor Merton Model: Asset Size

	1	2	3	4	5
α	-2.3486	-2.0708	-1.6312	-1.4722	-1.3401
PC 1	0.0219	0.0352	0.0259	0.0276	0.0041
PC 2	-0.0373	0.0036	-0.0044	0.0110	0.0005
PC 3	-0.2058	-0.1385	0.0066	0.0327	0.0206
PC 4	0.2883	0.0597	-0.0271	-0.0013	-0.0074
\bar{R}^2	0.5954	0.5507	0.4021	0.4471	0.1057

<Table 11> Regression for Multi-factor Merton Model: Industrial Categories /Asset Size

Portfolio	α	PC 1	PC 2	PC 3	PC 4	\bar{R}^2
A2	-2.2874	0.0141	0.0013	-0.1276	0.1167	0.3780
A3	-1.8417	0.0048	0.0158	0.0278	-0.0158	0.2534
A4	-1.6553	0.0267	0.0603	0.1003	-0.0254	0.7490
A5	-1.6562	-0.0243	0.0357	0.1114	-0.0795	0.3240
B2	-2.3983	0.0305	-0.0834	-0.1841	0.1100	0.4984
B3	-1.8345	0.0406	-0.0110	0.0074	-0.0708	0.3173
B4	-1.6614	0.0074	-0.0128	0.0169	0.0634	0.2005
B5	-1.7340	-0.0159	-0.0003	0.0480	0.0272	0.4448
C2	-2.1864	0.0387	0.0297	-0.1533	0.1530	0.4719
C3	-1.6864	0.0359	-0.0078	0.0055	-0.0621	0.5622
C4	-1.4880	0.0478	0.0352	0.0430	-0.0495	0.5854
C5	-1.3867	0.0312	0.0166	0.0657	-0.0539	0.1947
D2	-2.0606	0.0372	0.0321	-0.2791	0.2430	0.4684
D3	-1.7367	0.0178	-0.0085	-0.1696	0.0356	0.6001
D4	-1.4514	0.0013	-0.0618	-0.2202	0.0375	0.4330
D5	-1.5019	-0.0118	-0.0080	-0.1230	0.0180	0.6455
E2	-2.3542	0.0276	-0.0001	-0.1572	0.2042	0.5810
E3	-1.7143	0.0544	-0.0007	0.0211	0.0404	0.4130
E4	-1.3736	0.0473	0.0234	0.0672	0.0071	0.5047
E5	-1.2546	0.0064	0.0499	0.0944	0.0192	0.4273
F2	-1.7648	0.0272	-0.0033	-0.2148	0.5941	0.3552
F3	-1.0175	0.0082	0.0258	0.0439	0.0528	0.0776
F4	-0.9812	0.0149	0.0023	0.0117	-0.0229	0.0334
F5	-1.0067	-0.0335	-0.0017	0.0504	-0.0267	0.1391
G2	-1.9848	0.0336	-0.0618	-0.1803	0.1825	0.4639
G3	-1.6041	0.0573	-0.0518	-0.0061	-0.0068	0.2660
G4	-1.4994	0.0309	-0.0269	0.0781	-0.0419	0.5740
G5	-0.8663	0.0261	0.0056	0.1303	-0.0777	0.7195

<Table 12> Parameter Estimates: Industrial Categories

	A	B	C	D	E	F	G
α_l	-1.8704	-1.9455	-1.7176	-1.6698	-1.8544	-1.0542	-1.5352
β_{l1}^M	-0.0089	-0.0167	-0.0395	-0.0125	-0.0316	-0.0062	-0.0373
β_{l2}^M	-0.0179	0.0289	-0.0022	0.0157	-0.0051	-0.0104	0.0207
β_{l3}^M	-0.0138	0.0407	0.0119	0.1594	0.0017	-0.0055	-0.0287
β_{l4}^M	-0.0081	-0.0315	-0.0009	-0.0328	-0.0561	-0.0388	-0.0001
β_l^P	-0.0401	-0.1580	-0.1111	-0.1665	-0.0931	-0.1660	-0.1568
σ_l	0.9989	0.9855	0.9930	0.9734	0.9935	0.9855	0.9865

<Table 13> Parameter Estimates: Asset Size

	1	2	3	4	5
α_l	-1.9446	-1.9518	-1.6193	-1.4615	-1.3303
β_{l1}^M	-0.0182	-0.0331	-0.0257	-0.0274	-0.0041
β_{l2}^M	0.0309	-0.0034	0.0044	-0.0109	-0.0005
β_{l3}^M	0.1704	0.1305	-0.0065	-0.0325	-0.0205
β_{l4}^M	-0.2387	-0.0563	0.0269	0.0013	0.0074
β_l^P	-0.2348	-0.1812	-0.0761	-0.0880	-0.0771
σ_l	0.8280	0.9425	0.9927	0.9903	0.9935

<Table 14> Parameter Estimates: Industrial Categories /Asset Size

Portfolio	α_i	β_{i1}^M	β_{i2}^M	β_{i3}^M	β_{i4}^M	β_i^P	σ_i
A2	-2.1028	-0.0129	-0.0012	0.1173	-0.1073	-0.2208	0.9193
A3	-1.8283	-0.0044	-0.0145	-0.0256	0.0145	-0.0714	0.9927
A4	-1.6028	-0.0245	-0.0554	-0.0922	0.0234	-0.1224	0.9683
A5	-1.5306	0.0224	-0.0328	-0.1024	0.0731	-0.2278	0.9242
B2	-2.0893	-0.0266	0.0726	0.1604	-0.0958	-0.2671	0.8712
B3	-1.7802	-0.0354	0.0096	-0.0064	0.0617	-0.1341	0.9704
B4	-1.6301	-0.0065	0.0111	-0.0148	-0.0553	-0.1055	0.9812
B5	-1.7162	0.0138	0.0003	-0.0418	-0.0237	-0.0732	0.9897
C2	-1.9519	-0.0345	-0.0265	0.1369	-0.1366	-0.2376	0.8927
C3	-1.6644	-0.0320	0.0069	-0.0049	0.0554	-0.0797	0.9870
C4	-1.4511	-0.0427	-0.0315	-0.0384	0.0442	-0.1184	0.9752
C5	-1.3057	-0.0279	-0.0148	-0.0587	0.0481	-0.2065	0.9416
D2	-1.5406	-0.0278	-0.0240	0.2087	-0.1817	-0.3328	0.7476
D3	-1.6227	-0.0133	0.0064	0.1268	-0.0266	-0.1493	0.9343
D4	-1.2976	-0.0010	0.0462	0.1646	-0.0280	-0.1903	0.8941
D5	-1.4296	0.0088	0.0059	0.0920	-0.0135	-0.1397	0.9518
E2	-2.1100	-0.0248	0.0001	0.1409	-0.1831	-0.1975	0.8963
E3	-1.6657	-0.0487	0.0006	-0.0189	-0.0362	-0.1393	0.9717
E4	-1.3335	-0.0424	-0.0209	-0.0602	-0.0063	-0.1353	0.9708
E5	-1.2038	-0.0057	-0.0447	-0.0846	-0.0172	-0.1562	0.9595
F2	-0.9250	-0.0143	0.0017	0.1126	-0.3114	-0.3736	0.5241
F3	-0.9407	-0.0043	-0.0135	-0.0230	-0.0277	-0.1447	0.9245
F4	-0.9430	-0.0078	-0.0012	-0.0061	0.0120	-0.1043	0.9611
F5	-0.9523	0.0175	0.0009	-0.0264	0.0140	-0.1204	0.9460
G2	-1.8893	-0.0286	0.0526	0.1534	-0.1553	-0.2749	0.9519
G3	-1.5709	-0.0487	0.0441	0.0052	0.0058	-0.2052	0.9793
G4	-1.4385	-0.0263	0.0229	-0.0665	0.0357	-0.1072	0.9594
G5	-0.8550	-0.0222	-0.0048	-0.1108	0.0662	-0.1158	0.9870

<Table 15> Systemic and Portfolio Specific Risks

Portfolio	Systemic factors	Portfolio specific factors	Correlation
A	28.9229	71.0771	0.2264
B	13.0969	86.9031	2.8710
C	12.1366	87.8634	1.4037
D	49.2466	50.7534	5.4603
E	32.4715	67.5285	1.2848
F	5.7457	94.2543	2.9246
G	9.6943	90.3057	2.7236
1	98.8605	1.1395	14.2427
2	86.0280	13.9720	5.4152
3	98.2879	1.7121	0.7229
4	97.1565	2.8435	0.9679
5	94.5877	5.4123	0.6438

<Table 16> Systemic and Portfolio Specific Risks: Industrial Categories /Asset Size

Portfolio	Systemic factors	Portfolio specific factors	Correlation
A2	34.2731	65.7269	7.4201
A3	17.6467	82.3533	0.6198
A4	45.9257	54.0743	2.7701
A5	25.1248	74.8752	6.9320
B2	36.4287	63.5713	11.2223
B3	22.4120	77.5880	2.3164
B4	23.5901	76.4099	1.4576
B5	31.7744	68.2256	0.7864
C2	41.0379	58.9621	9.5761
C3	39.6180	60.3820	1.0518
C4	30.8163	69.1837	2.0248
C5	13.6711	86.3289	4.9397
D2	41.2917	58.7083	18.8672
D3	43.2845	56.7155	3.9280
D4	45.3334	54.6666	6.6240
D5	30.9651	69.0349	2.8285
E2	58.0538	41.9462	9.2984
E3	17.2415	82.7585	2.3432
E4	24.3742	75.6258	2.4195
E5	27.9975	72.0025	3.3872
F2	44.0457	55.9543	24.9417
F3	6.6777	93.3223	2.2426
F4	2.1946	97.8054	1.1127
F5	7.6717	92.3283	1.5693
G2	40.3932	59.6068	12.6825
G3	9.4135	90.5865	4.6499
G4	37.5350	62.4650	1.8393
G5	56.1418	43.8582	3.0600

Appendix 1: Initial Capital Requirement

(Billion KRW)

	Area of operation	Initial capital
Bank	National bank	100
	Provincial bank	25
Insurance	Life insurance	30
	life	20
	annuity	20
	Non-life insurance	30
	fire	10
	marine	15
	auto	30
	guarantee	30
	reinsurance	30
	Third insurance	30
	casualty	10
	disease	10
Security Company	Underwriting, dealing, brokerage	50
	Dealing, brokerage	20
	Brokerage	3
	ECN	15

Appendix 2: Description of Portfolio Construction by Industrial Categories

Portfolio	Weight	SIC		
A	12.79%	D-1	D09	Manufacture of Coke, Refined Petroleum Products and Nuclear Fuel
			D10	Manufacture of Chemicals and Chemical Products
			D11	Manufacture of Rubber and Plastic Products
			D12	Manufacture of Other Non-metallic Mineral Products
			D13	Manufacture of Basic Metals
			D14	Manufacture of Fabricated Metal Products, Except Machinery and Furniture
			D23	Recycling
B	13.92%	D-2	D15	Manufacture of Other Machinery and Equipment
			D16	Manufacture of Computers and Office Machinery
			D17	Manufacture of Electrical Machinery and Apparatuses n.e.c.
			D18	Manufacture of Electronic Components, Radio, Television and Communication Equipment and Apparatuses
			D19	Manufacture of Medical, Precision and Optical Instruments, Watches and Clocks
			D20	Manufacture of Motor Vehicles, Trailers and Semi-trailers
			D21	Manufacture of Other Transport Equipment
C	9.93%	D-3	D01	Manufacture of Food Products and Beverages
			D02	Manufacture of Tobacco Products
			D03	Manufacture of Textiles, Except Sewn Wearing apparel
			D04	Manufacture of Sewn Wearing Apparel and Fur Articles
			D05	Tanning and Dressing of Leather , Manufacture of Luggage and Footwear
			D06	Manufacture of Wood and of Products of Wood and Cork, Except Furniture; Manufacture of Articles of Straw and Plaiting Materials
			D07	Manufacture of Pulp, Paper and Paper Products
			D08	Publishing, Printing and Reproduction of Recorded Media
			D22	Manufacture of Furniture; Manufacturing of Articles n.e.c.
D	9.97%	F	CONSTRUCTION	
E	16.68%	G	WHOLESALE AND RETAIL TRADE	
F	14.84%	L	REAL ESTATE AND RENTING AND LEASING	
G	11.25%	M	BUSINESS ACTIVITIES	
		N	PUBLIC ADMINISTRATION AND DEFENCE ; COMPULSORY SOCIAL SECURITY	
		O	EDUCATION	
		P	HEALTH AND SOCIAL WORK	
		Q	RECREATIONAL, CULTURAL AND SPORTING ACTIVITIES	
		R	OTHER COMMUNITY, REPAIR AND PERSONAL SERVICE ACTIVITIES	
		S	PRIVATE HOUSEHOLDS WITH EMPLOYED PERSONS	
		I	TRANSPORT	
		J	POST AND TELECOMMUNICATIONS	