Identification and Management of Systemic Risks: Macro and Micro Evidence in Korea

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Abstract

This study attempts to empirically identify the external shocks causing a systemic crisis and their propagation mechanisms over financial system in Korea. The measured macro aggregate shock series are found to have played a crucial role in explaining systemic crises in the past. It is also found that macro aggregate disturbances, instead of idiosyncratic factors, could affect the behaviors of individual economic agents like firms and financial institutions in a great deal. From the corporate data analysis, the credit channel effect in the course of shock amplification and propagation seems rather weak in Korea. The comovement of asset portfolios and loan loss provisions across financial institutions together with their weak correlation of individual banks' portfolios over time implies the importance of paying attention to macro risk factors in managing systemic risks.

1. Introduction

The probability of experiencing systemic crises[1] is not negligible throughout the history. Due to the inherent nature of banking business, for example, liquidity crunch takes place once in a while for fundamentally reasonable grounds [Mitchell (1941), Gorton (1988), etc.], or comes randomly from just mob psychology or self-fulfilling prophecy [Kindleberger (1978), Diamond and Dybvig (1983), Farmer (1993), etc.]. Let alone their causes, one of the foremost reasons for paying much attention to systemic crises is the astronomical amounts of their ensuing costs from both macro and micro perspectives.[2] In order to keep these probable and costly incidents from recurring, policymakers and academics have made common efforts to devise managing systemic risks, of which the examples are central banking, deposit insurance, prudential regulation, etc. Despite these instruments in hand, we are not still able to make a full stop of systemic crises.

The issue of systemic crises becomes located at the center of financial regulation, especially in the emerging market economies (EME) countries like Korea

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[1] A systemic financial crisis refers to an incident of potentially severe disruptions of financial markets that, by impairing markets' ability to function effectively, can have large adverse effects on the real economy.

[2] Hoggarth, Reis and Saporta (2001) measured the costs of banking crises in terms of two categories: direct resolution costs and welfare costs. The direct resolution costs refer to the wealth redistribution from taxpayers to the stakeholders of intevened banks, which has micro economic implications. These costs are found to be larger in lower-income countries and those with higher degrees of banking intermediation. The cumulative output losses, a proxy for welfare costs, are estimated around 15 to 20 percent of annual GDP. The losses are much larger in the event of a twin banking and currency crisis than in the case of a banking crisis alone. Bordo, Eichengreen, Klingebiel and Martinez-Peria (2001) also reached a simliar size of measured depth of various crises in terms of cumulative output losses: 5.9 percent losses to currency crises, 6.2% losses to banking crises, and 18.6% losses to twin crises.

which has undergone a serious damage due to recent currency and/or financial crises. Compared with the intense interests and attention, however, empirical studies on systemic crisis and its management that policymakers could refer to are rare in such countries. That is, at least in Korea, key empirical discussions are almost lacking such as how a systemic crisis is defined quantitatively; how frequent, severe and durable it is; in what way it undermines the corporate and financial sectors, which in turn aggravates the overall situation further, etc. These curiosities motivate the current study.

The purpose of the paper (chapter) is to examine both macro and micro phenomena in the context of business fluctuations caused by external shocks. This attempt is based on the business cycle view that a systemic crisis responds to unfolding economic circumstances, so it is a natural outgrowth of the business cycle. Following a series of business cycle and financial economics literatures, the current study is to investigate, identify and measure the shocks that drive initial business flucutations in Korea. Then, it looks at how finance matters by scrutinizing amplification and propagation processes, focusing on lender-borrower relationship in the spirit of Bernanke, Gertler and Gilchrist (1999) and Kiyotaki and Moore (1997). Next, it discusses contagion mechanism via balance sheet of Korean financial institutions. To this end, it shows the similarity of asset portfolios of the financial institutions and their loan losses.

In short, this study asks how much the theories in the academic literature could explain the crises that Korea has experienced. Its agenda looks challenging and comprehensive due to the wide coverage of the issues that are not only academically but also practically debatable. Note, however, that it does not dare to provide a well organized, unifying and encompassing methodology. Rather, it is just intended to

ignite further empirical analyses, based on which an appropriate system of crisis management could be established.

This study provides some prominent observations in relation to policy implications: it is macro aggregate shocks that systemic crisis managers should pay considerable attention to. A unit disturbance that hits the aggregate quantity and price variables causes very large swings of business cycles in Korea. The measured shock series using the macro variables well explain the crisis events in the past history. In addition, both borrowing firms and lending financial institutions in Korea are more vulnerable to common shocks, which seem related to macro aggregate variables, than idiosyncratic ones. It means that the credit channel through firms' balance sheet [Bernanke and Gertler (1989), Kiyotaki and Moore (1997), etc.] is not effective enough to account for Korea's business fluctuations.

This article is organized as follows. The second section overviews the academic literature on the theories and empirical analyses about systemic risks and their channels to evolve into crises. It puts more emphasis on the financial market frictions that generate the relevance of firms' financial structure, which is the case where Modigliani-Miller theorem, one of the most well known academic achievements in financial economics, does not hold. The third section attempts to identify the macro aggregate shocks observed in the Korean time series data. The structural vector autoregression model is used with the long-run restriction studied by Blanchard and Quah (1989). The identified permanent and transitory shock series and their dynamic effects, not only qualitative but also quantitative, on the real quantity and financial price variables will be examined to witness the importance of the macro aggregate shocks in systemic risks. In section 4, the Credit Channel Model suggested by Bernanke, Gertler

and Gilchrist (1999) will be investigated in the Korean context. Taking into account both demand and supply side of credits, it tries to infer policy implications from the empirical analyses on the determinants of corporate borrowing costs for the purpose of confirming the effectiveness of balance sheet channel and on the comparison of the asset portfolios, including loan loss provisions, among financial institutions for the purpose of seeing their vulnerability to common shocks. Summarizing the questions posed and answers found, the last section makes concluding remarks with policy implications of this study.

2. Literature Survey on Systemic Crisis

2.1. Nature of Crisis: Sunspots or Business Cycles?

Ever since banks were instituted, bank runs in which depositors attempt to withdraw their funds simultaneously have threatened not only the individual banks but also the entire financial system. Inherently, the runs on fragile banks seem inevitable at a positive probability due to the very nature of banking business that they issue short-term liquid liabilities but invest in long-term illiquid assets. More problematic is a panic, or a systemic crisis, where solvent and sound banks are forced confronted with contagious runs triggered by either the depositors' misconception or rational expectation on the possibility of their financial distress.

Economic theories that account for the causes of systemic crises have been underpinned from the two different standpoints. The first view is that the crises are just random events, unrelated to economic fundamentals. According to this tradition, financial panics may stem from mob psychology in the sprit of Kindleberger (1978) or

self-fulfilling prophecies as in Diamond and Dybvig (1983) and Farmer (1993). Theoretically, there may exist multiple equilibria, of which one, or a bank run, occurs when every depositor believes that others try to unconditionally withdraw funds earlier than she does. On the other hand, if no body believes that unduly runs are about to occur except for only financially necessary withdrawals, no systemic crisis takes place. Among these two kinds of equilibria, this view says that the determinant could be economically irrelevant factors, or *sunspots*, that could affect the belief formation of depositors in a self-fulfilling manner. Then, the driving forces for systemic crises will be extraneous shocks to economy, thus being related to psychology.

The second view is that bank runs and the resulting crises are the natural results of business cycles. As an economy becomes sluggish, capital adequacy of banks deteriorates due to lower creditworthiness, and sometimes defaults, of their borrowers. Anticipating financial difficulties of trading banks, the depositors may attempt to withdraw funds prior to others, which will bring about a panic in the financial sector. In contrast to the view of random events, this school advocates that a systemic crisis is an essential part of business cycles that could be accounted for by economic fundamentals and institutions. Also, the driving forces for systemic crises could be ultimately aggregate disturbances, or exogenous shocks, that generate macroeconomic business cycles.

Conducting an empirical study as to which view better explains a systemic crisis, Gorton (1988) finds that banking panics are related to business cycles, rather than to extraneous random events. Particularly, during the National Banking Era (from the Civil War in 1864 to the Creation of the Federal Reserve System in 1914) the five worst recessions were accompanied by banking panics. Calomiris and Gorton (1991) also

argue that the data do not support the *sunspot* view.

2.2. Demand Side of Credit: Financial Acceleration

Once systemic crises have some relationship with business cycles, could the phenomena during the panic situations be reconciled with standard macroeconomic theory? The canonical real business cycle model and the textbook Keynesian model echo that conditions in financial and credit markets do not affect the real economy. Thus, Modigliani-Miller (1958) theorem of the indeterminacy and irrelevance of firms' financial structure in real economic outputs is a valid proposition in both the mainstream macroeconomic theories without frictions. However, these approaches that finance is just a shadow of real economy seem to have drawbacks, for they do not well explain huge swings of business cycles, which sometimes end up with catastrophes, without somehow amplification and propagation mechanisms of external shocks. The inability of the models to replicate the movements of real aggregate quantity variables during systemic crises asks for theorizing frictions in financial and credit markets so as to enhance the explanatory power to the business cycle fluctuations in the abnormal periods.

One of the theory that incorporates financial frictions to account for large business swings is called a Credit Channel Model. Along with the standard theories, this alternative view that gives a more central role to credit market conditions in the propagation of cyclical fluctuations has a long-standing tradition.[3] Fisher (1933), for example, cautiously argued that the severity of the Great Depression was attributable in

[3] The deteriorating credit market conditions include sharp increase in insolvent and bankrupt firms, rising real debt burdens, collapsing asset prices, bank failures, etc.

part to the heavy burden of debt and ensuing financial distress associated with the deflation of the early 1930s.[4]

Bernanke and Gertler (1989) developed this Fisher's idea of credit market frictions into a theoretic arena.[5] In order for frictions in credit markets to embed in the model, they introduced agency costs in the form of the "costly state verification" studied by Townsend (1979). In other words, assuming an asymmetry of information between borrowers and lenders and an existence of monitoring costs to verify the outcome of borrowers' investment projects, the model yields optimal financial arrangements entailing deadweight losses, or agency costs, relative to the first-best perfect-information equilibrium. A potential borrower with high net worth or collateralizable assets faces a small risk of bankruptcy and thus a small premium on external finance[6], whereas a borrower with less resource to invest is in an opposite position. In such an economy, an adverse shock lowering the cash flows and net worth

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[4] Fisher (1933) deduced the chains of over-indebtedness in the following nine links: "(1) *Debt liquidation* leads to *distress selling* and to (2) *Contraction of deposit currency*, as bank loans are paid off, and to a slowing down of velocity of circulation. This contraction of deposits and of their velocity, precipitated by distress selling, causes (3) *A fall in the level of prices*, in other words, a swelling of the dollar. Assuming, as above stated, that this fall of prices is not interfered with by reflation or otherwise, there must be (4) *A still greater fall in the net worths of business*, precipitating bankruptcies is and (5) *A like fall in profits*, which in a capitalistic, that is, a private-profit society, leads the concerns which are running at a loss to make (6) *A reduction in output, in trade and in employment* of labor. These losses, bankruptcies, and unemployment, lead to (7) *Pessimism and loss of confidence*, which in turn lead to (8) *Hoarding and slowing down still more the velocity of circulation*. The above eight changes cause (9) *Complicated disturbances in the rates of interest*, in particular, a fall in the nominal, or money, rates and a rise in the real, or commodity, rates of interest."

[5] The Fisher's "creed" as to the propagation of debt deflation and their aftermath during the Great Depression is empirically and theoretically replicated by Bernanke (1983).

[6] External finance premium is defined as the difference between the cost of funds raised externally and the opportunity of funds internal to the firm [Bernanke, Gertler and Gilchrist (1999)].

of firms raises external finance premium, withdrawing on-going projects or at least reducing an investment in new projects. Declining investment lowers economic activities and cash flows in subsequent periods, amplifying and propagating the effects of the initial shocks. The key virtue of this model is that information asymmetry among borrowers and lenders make the Modigliani-Miller theorem inapplicable, opening up the possibility of an interaction between real and financial economies.[7]

Kiyotaki and Moore (1997) further developed the credit channel model of Bernanke and Gertler (1989) by introducing durable assets that are not only production factors but also serve as collateral for loans. To endogenize the dynamic interactions between asset prices and credit limits, they theoretically created powerful transmission mechanism by which the effects of shocks persist, amplify and spread out. Suppose that a firm is credit constrained and borrowed heavily against the value of its landholdings. When an adverse temporary shock on its productivity occurs, this credit-constrained firm becomes forced to cut back on its investment expenditure. The firm will earn less revenue, its net worth will fall, and it will further reduce investment due to even higher credit constraints. Then, the knock-on effect of a current temporary shock will persist far in the future. Furthermore, the lower cash flows of land investment in response to the shock reduce the price of land, which causes the firm's net worth to drop considerably. As a result, the firm has to make yet deeper cuts in its investment in land. This intertemporal multiplier process goes on for a long while.

[7] The Credit Channel Model with financial market imperfections in the sense of asymmetric information is analyzed from a different angle by Greenwald and Stiglitz (1993). Unlike Beranke and Gertler (1989) who put more emphasis on lenders' risk hedging behaviors against firms' delinquencies, Greenwald and Stiglitz focused on firms' perceptions of the risks of changes in their own net worth position which can have potentially large effects on their willingness to produce.

The innovating component by Kiyotaki and Moore (1997) is that persistence and amplification reinforce each other.[8] With the explicit consideration of inelastically supplied assets like land, they can distinguish a dynamic multiplier from a static one. The static multiplier performs like the effect argued by Bernanke and Gertler (1989) within a period. The productivity shock reduces the net worth of the constrained firms, which forces them to cut back the demand for land directly and indirectly via the land price drop in the period. However, not only the land price drop in the period of the shock occurred but also subsequent drops afterwards due to the persistence of the credit shrinkage trigger the dynamic multiplier. Therefore, on top of the curtailment in investment due to the direct net worth reduction vis-à-vis an adverse shock, the cumulative impact on asset prices can be significant.[9]

The theories related to the Credit Channel Model are best summarized in

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[8] The two-way feedback between borrowing limits and the price of assets in the context of the relevance of financial structure of firms and business cycles was discussed earlier in Shleifer and Vishny (1992). They argue that, when a financially distressed firm needs to sell assets, its industry peers that are natural purchasers are likely to be experiencing problems themselves, leading to asset sales at prices below the value in best use. The resulting fall in asset prices exacerbates the firm's financial distress by lowering the debt capacity of all firms in the industry. This is an advanced argument relative to Bernanke and Gertler (1989) in the sense that Shleifer and Vishny explicitly considered the price of tradable assets, but its incorporation has limited implication for static effects, ignoring more powerful dynamic multiplier process and the crucial interplay between amplification and persistence.

[9] In order to understand the Credit Channel Model by Bernanke and Gertler (1989), Kiyotaki and Moore (1997) used the analogy of a well-known predator-prey model where the debts of the credit-constrained firms are predators and their landholdings are prey. Namely, a rise in these firms' landholdings means that they have more net worth with which to borrow: the prey feed the predators. A high level of debt erodes the firms' available funds and curtails their investment in land: the predators kill off the prey. Kiyotaki and Moore's model, however, is richer in that it has, in addition to the debts and landholdings, a third variable, the price of land, which is forward-looking and causes the economy to react much more to a shock.

Bernanke, Gertler and Gilchrist (1999), which is specifically known as a financial accelerator model. They developed a full-fledged dynamic general equilibrium model that synthesizes the various literatures mentioning the importance of credit market frictions.[10] Their framework incorporates endogenous developments in credit markets that propagate and amplify shocks to macroeconomy through the inverse linkage between external finance premium and the net worth of potential borrowers.[11] This inverse relationship arises because, when borrowers are short of funds to finance projects, lenders ask for enough compensation for taking excessive risks, or high agency costs. To the extent that borrowers' net worth is procyclical, the external finance premium will be countercyclical, widening the business cycle swings.

Empirical researches related to the credit channel model and macroeconomic effects of financial regulation have been put forth in much financial economics and policy literature. Among others, Benito and Whitley (2003) developed empirical models that relate implicit interest rates paid by firms to the measures of their financial health using both aggregate and individual company data in the United Kingdom. They concluded that both aggregate and disaggregate approaches confirm a significant influence on interest rates from changes in the financial health of companies.

2.3. Supply Side of Credits: Bank Lending Channel

Even if Bernanke, Gertler and Gilchrist (1999) demonstrated a general equilibrium approach to explain business cycle phenomena through credit market

[10] For more comprehensive general equilibrium model of the Credit Channel Model including banking sector, financial regulator, assets with secondary markets, etc., refer to Tsomocos (2003).

[11] Net worth of borrowers is defined as the borrowers' liquid assets plus collateral value of illiquid assets less outstanding obligations [Bernanke, Gertler and Gilchrist (1999)].

frictions, their model emphasized the balance sheet channel, or the demand side of credits because it lacks explicit introduction of financial institutions. As Hall (2001) argued, a bank lending channel, or the supply side of funds, is equally important along with the borrowers' balance sheet channel. For some reasons, like subject to a monetary tightening, banks may face difficulties in raising external funds to fund lending such as decline in deposits. If banks cannot adjust their balance sheets by reducing holdings of short-term assets, this might restrict their ability to extend new loans. Under these circumstances, while highly creditworthy borrowers may be able to substitute other forms of finance for bank lending like bonds, less creditworthy borrowers such as small firms and individuals may be unable to switch from banks to alternative finance sources. These institutional constraints will be associated with a rise in external finance premium and/or a tightening in non-price conditions such as covenants or collateral requirements.

In addition to monetary policy shocks, non-monetary shocks such as changes in financial health of the banking sector and prudential regulations may shift supply curve of loans. For instance, loan losses or a price fall in securities held in asset portfolios might reduce bank capital. Changes in prudential regulation such as introducing strengthened capital adequacy requirements might enable banks less easily to advance external finance. Also, banks' risk appetites and their desire for liquidity on their own balance sheet may occasionally change so that their willingness to lend to borrowers falls.[12]

This bank lending channel may be potentially significant if increases in interest

[12] Credit supply shortages due to monetary shocks, capital adequacy shocks and preference shocks are often called credit crunch, capital crunch and market credit crunch, respectively [Hall (2001)].

rates lead to a reduction in the supply of bank loans and if the loans are imperfect substitutes for other forms of finance. Thus, a credit or capital crunch is more likely to matter in less developed economies where a substantial proportion of loans is intermediated by small and/or poorly capitalized banks. As the crunch takes place very infrequently, the potential for substantial spillovers from the financial instability to real economy, as seen in Asian crises in 1997 and earlier Latin American lending crisis in the 1980s, reminds of policymakers and regulatory authorities in the emerging market economies (EME) the need for the health of banking system.

The macroeconomic implications of financial regulation like capital adequacy requirements for banks as a shock propagation mechanism have attracted growing attention to financial architects whose aim is to maintain a fair amount of balance between financial stability and economic efficiency. Blum and Hellwig (1995), for example, studied the relationship between the US credit crunch in early 1990s and the 1988 Basle agreement. They were concerned as to whether a rigid link between bank equity capital and bank lending may act as an automatic amplifier for macroeconomic fluctuations, inducing banks to lend more when times are good and to lend less when times are bad, thus reinforcing any underlying shocks. They found that, under regular conditions, a shift from a regime of non-binding capital adequacy requirements to a regime of binding capital adequacy requirements may induce a discontinuous increase in the sensitivity of equilibrium output and price with respect to a demand disturbance.

The procycality of financial regulation is now at the heart of the “Basle II” which is supposed to replace the current formula-based bank capital adequacy requirements by the end of 2006. One of the core objectives of the Basel II is to link capital requirements more closely to risks. Accordingly, in a downturn when risks are

more likely materialize, required capital requirements tend to increase. Then, economic capital requirements and output growth will move in an opposite direction. If the required capital amounts increase, however, banks should reduce their loans and the subsequent credit squeeze would exacerbate the downturn. These procyclical features embedded in the Basle II might amplify business cycle fluctuations and result in credit crunches when coupled with huge adverse shocks in an economy. Therefore, policymakers and academics should take into account the effects of the structural changes in financial regulation.

In the following two sections, this study attempts to empirically assess the fragility of Korea's financial and corporate sectors from the viewpoint of systemic risks. After identifying the external shocks that trigger business fluctuations with a certain assumption, it traces the propagation and amplification paths suggested by the credit channel model and contagious factors among financial institutions whose asset portfolios are alike in and across the financial industries in section 4. Hence, this paper tries to evaluate the applicability of the business cycle view to Korea so as to draw policy inferences regarding the systemic risk management.

3. Quantitative Identification of Systemic Crisis in Korea

3.1. Measurement of External Shocks and their Responses

What is the nature of shocks that drive business fluctuations as well as economic growth? Are there purely financial shocks that do not originate from the real side of an economy but do affect the dynamics of real resource allocations? These are some of the list of the most fundamental questions that macroeconomists have tried to answer

to but yet convincingly explained despite the studies for more than two centuries. Many economists have considered technology innovations, monetary policy, oil price movement, government expenditures, tax increases, financial regulation, etc., as candidates for the factors causing unexpected economic shifts. For example, Hansen and Prescott (1993) claimed technology shocks and Blanchard (1993) and Hall (1993) took consumption shocks that caused the 1990 recession in the US. These shocks are, however, not the ultimate external sources of economic fluctuations, for they are all dependent upon past history and/or future expectations.[13]

Notwithstanding the importance of the causes of business cycles in the context of policy implications, this study does not focus on the nature of shocks, but on the measurement of the shocks occurred in the economy no matter what they are. On the one hand, this research preference stems from the otherwise grandiose work scope that would make it extremely difficult and challenging. On the other, the viewpoint of policymakers, rather than of academics of intellectual curiosity, is considered that empirical findings are to be applied for policy responses to economic disturbances. In this vein, the section asks how the permanent and transitory shocks have looked like in Korea. For example, this study seeks to find out, at least in hindsight, how sizable those shocks were during the currency crisis in the late 1997 and the following financial crises, if any, relative to the overall measure of aggregate risks. Being answered to the size of the shocks and their dynamic effects, policymakers could guess an incoming path of shock evolutions and take more appropriate and timely actions once they are likely to cause a systemic crisis.

[13] See Cochrane (1995) for the detailed discussions on shocks.

3.2. VAR with the Long-run Restriction

To look at the interaction between real and financial economy, this study considers a vector autoregression (VAR) model consisting of the variables from both sectors. Based on the premises that (i) there are multiple orthogonal shocks in the economy, and (ii) the shocks may be either transitory or permanent, the VAR answers to the following question: how and how much do the identified permanent and transitory shocks affect the cyclical variations in financial variables along with those in real aggregate ones?

There have been extensive studies about the nature of a permanent shock in the context of real business cycles theory, which is often identified as a shock from the supply side like the one affecting the balanced growth path. For example, a technological innovation to enhance labor productivity could have long-lasting favorable effects on the aggregate output level. In contrast, a transitory shock is believed somehow related to the demand side of an economy.

Let us run a two-variable VAR with the long-run restriction: the permanent shock affect the level of a real aggregate variable like the GDP growth rate in the long-run, but not that of a financial variable such as default premium. In contrast, the transitory shock does not affect either the level of the real aggregate variable nor that of the default premium. In a formal expression, the bivariate regression described above is constructed as follows:

(3.1) bivariate regression : $$\begin{bmatrix} \Delta y_t \\ f_t \end{bmatrix} = \begin{bmatrix} \phi_1 \\ \phi_2 \end{bmatrix} + A(L) \begin{bmatrix} \Delta y_{t-1} \\ f_{t-1} \end{bmatrix} + u_t ,$$

(3.2) long-run restriction : $$u_t = \Gamma_0 \varepsilon_t \quad , \quad \left[(I - A(1))^{-1} \Gamma_0 \right]_{1,2} = 0 \quad \text{and}$$

$$Var(\varepsilon_t) = \Sigma_\varepsilon \quad ,$$

where Γ_0 is a (2×2) long-run restriction matrix, ε_t is a vector of the permanent and transitory disturbances, $(\varepsilon_t^P, \varepsilon_t^T)'$, and Σ_ε is a diagonal matrix. y_t and f_t stand for the GDP growth rate and default premium from the financial sector, respectively. The long-run restriction of (2.1.2) is methodologically the same as that of Blanchard and Quah (1989) and shares a similar flavor with the multivariate VAR by King, Plosser, Stock and Watson (1991) and Rotemberg and Woodford (1996).

A methodological ground for this bivariate VAR is to exactly identify the time series of both the permanent and transitory shocks. In the equation (3.2), once the variance of the shocks, Σ_ε, is normalized as an identity matrix, the condition of $\left[(I - A(1))^{-1}\Gamma_0\right]_{1,2} = 0$ with the estimated variance of residuals, u_t, yields the numbers of Γ_0 because the four unknown elements of Γ_0 are resolved with four independent equations.[14] Then, the exact identification of the structural model enables us to quantitatively measure the shocks occurred as shown in the following subsection.

An economic motivation for the VAR with the GDP growth rate and default premium is to examine the credit channel dynamics trigged by the shocks. As aforementioned in section 2, the role of financial markets is non-trivial at least in the amplification and propagation of external shocks, though they are seldom believe to generate the shocks themselves. The credit channel model like Bernanke, Gertler and

[14] Three equations come from the regression and the remaining one equation comes from the long-run restriction. The multivariate VAR as in King, Plosser, Stock and Watson (1991) and Rotemberg and Woodford (1996) with the long-run restriction of the same kind this paper, however, assumed identifies the permanent shock only. The transitory shocks could not be identified without further assumptions on the nature of the shocks.

Gilchrist (1999), among others, takes into account external finance premium which is related to borrowing conditions depending on the financial health in the corporate sector. Indeed, the default premium, usually defined as a difference between the corporate bond yield and risk-free bond yield, captures a favor of the external finance premium. Thus, the simultaneous effects of the real output and bond market premium could reveal some clues on the role of finance.[15]

The data used in the regression are as follows: the time period of consideration is between 1987 to 2003 at a quarterly frequency due to availability of the bond yields data set. As for the output, seasonally adjusted real GDP growth rate (relative to previous quarter) is used. The default premium is measured as the difference between yields of the investment grade corporate bond in the over-the-count (OTC) market and of the first type National Housing Bond (NHB). Obviously, this is a poor measure for the default premium since the maturity of the two bonds is not identical, three and five years, respectively, and NHB is not at all a benchmark risk-free rate. Despite the unsatisfactory characteristics of this measurement, the premium could hardly be improved.[16]

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[15] The empirical work is not pursued to scrutinize the direct implications of the Credit Channel Model because it does not contain any information on the corporate finance structure. These implications will be assessed with micro firm-level data in section 4. Here the purpose of this job is to examine the dynamic interaction between the real side of an economy and the credit markets in the context of macro aggregate risks.

[16] In Korea, the Government Treasury Bond (GTB) yield data are available only after 1995 and they did not reflect on market supply and demand until the outbreak of financial crisis due to the feature of compulsory underwriting practices by banks. That is to say, the appreciated price of the then GTB over the market price was treated as a quasi-tax. Thus, GTB had not functioned as a benchmark risk-free bond nor reflected on the market conditions.

3.3. Results

3.3.1. Dynamic Responses to External Shocks

The impulse response functions shown in Figure 3-1 and 3-2 summarize the dynamic effects of the permanent and transitory shocks on the GDP growth rate and default premium in Korea. They represent percentage deviations from the steady state values due to 1% shocks in a period and no shocks afterwards. As assumed by the long-run restriction, the GDP growth rate increases permanently in response to the permanent shock and the default premium will return to the steady state level eventually due to the same shock in Figure 3-1. In contrast, the permanent effects of both the variables vis-à-vis the transitory shock phase out as seen in Figure 3-2.

[Figure 3-1 and 3-2 Here]

There are some noticeable features of the impulse response results. Firstly and foremost importantly, the default premium due to favorable shocks, either permanent or transitory, declines initially for a while. In response to a 1% unexpectedly good permanent signal, the premium declines by 0.2% away from the steady state for two quarters after the shock. This means that the corporate bond yield relative to the risk-free bond one decreases by 0.2% more. It is interpreted that such a good economic condition due to the positive shock makes the corporate default probability lower. The measured response of the default premium vis-à-vis a good temporary shock looks similar only with the difference of magnitude and persistence. This result is consistent to the argument made by the credit channel model. According to Bernanke, Getler and Gilchrist (1999), during the downturn of business activities the frictions on the borrowing conditions straitjacket the amounts of firms' credit available. For example, lower values of collateral and increasing likelihood of bankruptcy render

firms to be able to borrow less and/or to pay more interests in recessions. Thus, the impulse response results reconfirm that the story by the credit channel model survives in Korea.

Secondly and as expected, the GDP growth rate increases due to both the permanent and transitory shocks. In particular, the response of the real aggregate quantity is quite brisk to the permanent shock in the sense that a unit increase in the permanently positive shock drives the GDP growth rate upward by twice. This magnitude of the response in Korea is much greater than that in the US, which means that Korea is much more responsive to permanent aggregate shocks. In contrast, the response of the GDP growth rate due to the temporary shock is quite modest.

Thirdly and summarizing the first and second points, the effects of the permanent shock on the real aggregate quantities are greater, whereas the financial price variables due the transitory shock are much more resilient. This observation implies that a small disturbance in leading the GDP level change permanently makes the level of bond yields lower quite uniformly, regardless of the level of default risks. In addition, it also implies that the one in leading the GDP level to change only temporarily drives much larger swings in the differences of borrowers' capability to mobilize external finances via the varying fluctuations in corporate bankruptcy rate and collateral values of their fixed assets and securities held.

3.3.2. Identified Shock Series

Figure 3-3 displays the identified time series of the permanent and transitory shocks

from the third quarter of 1988 to the fourth quarter of 2003.[17] By the assumption, they are normalized with mean zero and standard deviation one, so that the series swing around zero. One of the most interesting features is observed around the 1997 currency crisis and ensuing financial crisis in the following years. Over the entire sample periods, the measured permanent and transitory shocks are the largest in the first quarter of 1998 and the forth quarter of 1997, respectively. Furthermore, the size of the shocks is by far larger than that in all other periods. The transitory shock in the last quarter of 1997 is measured to be - 5.19%, which means a huge temporary hit rarely occurring in the statistical sense took place. Also the permanent shock in the next quarter is - 3.6%, which could hardly occur as well.

[Figure 3-3 Here]

Regarding the crisis, a next relevant question is why the transitory shock preceded the permanent shock. One of the answers refers to earlier reaction of price variables in the financial markets than real aggregate quantities to the outbreak of unanticipated disturbances,[18] for the former contains forward looking expectations influenced by the disturbances while the latter reflects on backward looking performances of economic activities. Since the currency crisis broke out in the late November, the growth rate of GDP during the fourth quarter partly captured the performances after the crisis. That is to say, the October and November activities cancel out the contraction after crisis. However, the default premium measured in this study is the difference of the bond yields at the end of quarter. Thus, the bond prices

[17] The lags used in the regression of (3.1) is six. Therefore, the first six observations of the shocks are not measured.

[18] Of course, there exist a number of endogeous factors that caused the 1997 crisis [Claessens (2003)] but this empirical model assumes shocks to be exogeously given.

captured the full story of the crisis and the future expectations as of the end of 1997. This data description partly accounts for the huge negative transitory shock preceded by the ensuing permanent shock.

Figure 3-3 also demonstrates the Daewoo moratorium in the third quarter of 1999. Contrary to the economists' and policymakers' consensus that the insolvency of the Daewoo group, a second largest business conglomerate in Korea, might and, some may argue that it did, lead a crisis, the measured shocks in that quarter are negligible. As for this observation, there could be several interpretations. One is that the time series of the bond yields were severely distorted at that time. As a matter of fact, the Bond Stabilization Fund had been run to respond to massive fund withdrawals from the Investment Trusts and to control the interest rate swings in the corporate bond markets from the August of 1999 to the February of 2000. More importantly, the aggregate performances in 1999 were extremely good partly because of an unprecedented deep trough in 1998 and the subsequent rebounds in 1999 and also partly because of the high foreign demands due to world economic booms in 1999.

Figure 3-3 also shows the depth of the liquidity crisis of credit card industry in the second quarter of 2003. The economic slowdown since 2002 led the GDP growth rate sluggish around the early 2003. Additionally, the liquidity and solvency problem of the SK group ignited by auditing embellishments and frauds hit the corporate bond markets hard, especially around the liabilities issued by the highly levered credit card companies which had advanced enormous amounts of credits to millions of delinquent consumers. This event seems to be very serious statistically. The size of the permanent shock in the second quarter of 2003 was actually the largest since the first quarter of 1998 and fourth ranked over the entire time span from 1988 to 2003.

However, the bond market crash in terms of price was not so problematic, despite the shrunk trading volume. In fact, the regulatory actions such as intervention in the bond markets through credit ratings, funding and coordination among stakeholders alleviated the widespread contagion of the problem. Thus, the permanent shock that is more or less related to real economy seems to have played greater roles in the overall performances than the transitory shock that reflects presumably more on financial economy.

Table 3-4 and 3-5 show the histograms of the permanent and transitory shocks measured, respectively, which is overlapped with the standardized normal distribution with mean zero and standard deviation one. As seen in the figures, both shocks are more concentrated around the mean than the normal distribution. In the case of the permanent shock, the histogram of Figure 3-4 is quite balanced with one negative outlier at the time of the crisis. The histogram of Figure 3-4 displays more favorable events with also a far outreaching and improbable transitory shock.

[Figure 3-4 and 3-5 Here]

4. Vulnerability of the Korean Economy to External Shocks

4.1. Two Contagion Paths

Suppose that external shocks be occurred as measured in the previous section. Then we could ask ourselves how the shocks propagate over time and in what fashion. This section tries to answer to these questions by looking at the microeconomic financial conditions of corporate firms and financial institutions in Korea.

As argued in section 2, we could imagine two channels of propagation and

amplification of shocks into a crisis. The first one is through the financial statements of borrowers. Once a shock causes a shift in real aggregate quantities such as GDP drops, the consequences on the corporate balance sheets are about to exacerbate the corporate creditworthiness by way of lowing profitability. Also, the asset price decline would lead the collateral value, which in turn constrains the borrowing conditions and terms. If these credit channel effects begin to activate, the real economy would otherwise hurt more seriously and persistently. This financial acceleration is the story mentioned by Kiyotaki and Moore (1997) and Bernanke, Gertler and Gilchrist (1999). The following subsection attempts to find out the determinants of corporate funding rates by considering macro and micro variables together.

The second channel of propagation, amplification and contagion of shocks is through asset portfolios of financial institutions. Banking crises generally stem from the assets side of banks' balance sheets – from a protracted deterioration in asset quality. For example, banks' asset holdings are very similar across banks and one of the highly concentrated assets become sour like the bonds issued by the credit card companies in 2003. Since most of the banks hold considerable amounts of their bonds relative to their capital position, the credit card companies problem triggered banks' capital inadequacy. In order to avoid regulatory punishments like the prompt corrective action, banks should reduce the amount of loanable funds and withdraw investments early. The supply side response to a shock from the lenders' point of view exaggerates the depth of credit crunch, potentially ending up with a systemic crisis. This episode let us put more emphasis on the financial health of banks and assimilation of their asset portfolios. This channel is reviewed with relevant statistics in subsection 4.3.

4.2. Capital Gearing and External Finance Premium

This subsection tests the effect of the credit channel in shock propagation and amplification suggested by Bernanke and Gertler (1989), Kiyotaki and Moore (1997), Bernanke, Gertler, Gilchrist (1999), etc. The hypothesis posed here is whether a capital structure of a firm, or capital gearing measured by the ratio of debts to equities, affects the corporate borrowing rates. The importance of capital gearing has been argued in many credit channel model literatures in the context that deterioration (improvement) in borrowers' net worth increases (decreases) the cost of finance.

In the following regression analysis using firm level data set, we consider many controls for the firms like profitability, liquidity, size of firms, credit ratings, and macroeconomic conditions in order to incorporate fixed effects and year effects. For instance, profitability of a firm's certain projects executed in the specific year may affect borrowing rates regardless of its debt-to-equity ratio. In the similar reasoning the firm's borrowing condition depends on its liquidity level and other macroeconomic performances like a GDP growth rate and monetary policy measured by call rates. Because of asymmetric accessibility of bond markets, the size of firms, either large companies or small and medium sized enterprises (SMEs) could also determine the borrowing terms.

Before running regressions, we briefly overview the relationship between the borrowing interest rates and other explanatory variables under study. Figure 4-1 demonstrates the relationship between capital gearing and borrowing rate. At first glance, nice positive correlation is observed except for the periods around the 1997 crisis. Figure 4-2 displays inverse relationship between interest coverage ratio and borrowing rate. Figure 4-3 and 4-4 show the relationship between the GDP growth

rate and borrowing rates by the large companies and SMEs, which is also negatively correlated. Finally, Figure 4-5 provides the hierarchy of borrowing rates by credit ratings: the poorer a credit rating, the higher the corresponding borrowing rate. In sum, all of the figures conform to a conventional wisdom.

[Figure 4-1 to 4-5 Here]

With this information on the basic statistics, let us run the following unbalanced panel regression over the periods between 1991 and 2003:

$$(4.1) \quad log(ABR_t^i) = \alpha_0 + \alpha_1 log(CG_{t-1}^i) + \alpha_2 log(ICR_t^i) + \alpha_3 log(CFT_t^i) + \alpha_4 Size_t^i + \alpha_5 log(CR_t^i) + \alpha_6 log(RGDP_t) + \alpha_7 log(CALL_t) + \xi_t^i .$$

Here, the dependent variable, ABR_t^i, is the average borrowing rate of a firm *i* in period *t*. The explanatory variables consist of firm *i* 's capital gearing (or debt-to-equity ratio) at the end of previous period, CG_{t-1}^i; interest coverage ratio (or operating profits divided by interest expenses), ICR_t^i; ratio of annual cash flows relative to turnovers, CFT_t^i; size dummy, $Size_t^i$; credit rating, CR_t^i; and two macro variables such as annual real GDP growth rate, $RGDP_t^i$, and one-day call rate averaged out over period *t*, $CALL_t^i$. The companies of interest are the externally audited ones that have issued bonds or commercial papers so as to get credit ratings.[19]

The results over the entire sample are summarized in Table 4-1. Without

[19] The data used in this subsection is described in the Appendix A.

controlling other variables, the capital gearing is positively and significantly correlated to borrowing rates in the column (1). Even if profitability relative to debt burdens, or interest coverage ratio, and liquidity relative to business activities, or cash flows to turnover, are additionally considered, the positive correlation between capital gearing and borrowing rates, or the negative correlation between borrowers' net worth and borrowing rates, survives in the column (2) and (3). Also, higher profitability and liquidity reduce the borrowing interest rates, other things being equal. All of these results in Korea are consistent to the prediction by the credit channel model.

If we control other factors that could presumably affect the interest rates, the results become different. The columns of (4), (5) and (6) in Table 4-1 show the relative insignificance of the capital gearing in determining the borrowers' funding costs, while all other control variables are reasonably significant. For example, the firm size does affect the borrowing costs in favor of large companies and higher credit rated companies spend less in mobilizing external finances. The aggregate factors like overall GDP growth rate and call rate, a proxy for monetary policies, also significantly affect the firms' unit interest costs. The capital gearing, however, becomes insignificant, especially in the columns of (5) and (6). From Table 4-1 we could also infer the fact that the aggregate factors are dominant over idiosyncratic and firm-specific financial structure and business performances in determining the interest costs. This implies that, at least in Korea, macro factors, rather than the credit cannel, could be more important in accounting for corporate risks, hence reaching a conclusion that credit channel effect is rather minor in systemic risks and that macroeconomic shocks attract more attention. This result is consistent to Hall (2001) that pointed out less importance of the balance sheet channel effects in underdeveloped or developing

countries than in the developed countries.

[Table 4-1 Here]

Table 4-2 and 4-3 shows the results of bifurcated sampling into two groups: large companies and SMEs. There are many observations that differentiate the SMEs from large companies. One of the differences between the two groups is that the capital gearing affects the borrowing costs by firm size in an unidentical way, while the effects are not at all significant in both cases. While the large companies are less subject to financial health in borrowing, the SMEs look more or less desperate in making their financial structure sound so as to reduce external financing costs. The second difference is the effectiveness of credit ratings. As for the large companies, a good credit rating is crucial because they borrow much from capital markets. To the contrary, the SMEs' major funding sources are financial institutions, rather than bond markets. Thus, official credit ratings become relatively secondary components for borrowing decisions. Third, as seen in Table 4-2 and 4-3, both the real GDP growth rate and call rate have significantly positive relationship with the firms' borrowing costs. Among macro variables, however, the SMEs are more severely affected by monetary policies, while the large companies by the real shocks leading changes in the GDP growth rate. According to the regression with all explanatory variables (column (6) of Table 4-2 and 4-3), the elasticity of the borrowing interest rates of the large companies with respect to the real GDP growth rate is 0.12, while it is 0.04 for the SMEs. The elasticity with respect to the call rate for the SMEs (0.31) is greater than that for the large companies (0.14). These estimates are quite plausible, recalled that the SMEs' liabilities are concentrated in short maturity claims so that the borrowing costs are more in tandem with short-term nominal interest rates. Also, the high explanatory power of

real GDP for the large firms' borrowing costs is easily reconciled with the relatively large contributing share of their outputs to GDP.[20]

[Table 4-2 and 4-3 Here]

4.3. Risk Contagion through Balance Sheet of Financial Institutions

A bank collapse multiplies the harmful effects of an initial shock, as credit squeezes and costly liquidation of investment projects cause drops in real output and collapses in asset prices. It is even more harmful that a certain bank's risks are contagious over other financial institutions, which means a systemic crisis. Massive and simultaneous distresses of many financial institutions originate from the interrelated asset positions among these institutions. Since financial institutions face liquidity needs due to uncertain withdrawals by their customers, the credit lines among financial institutions allow them to cope with liquidity shocks and to save the cost of maintaining reserves. However, as Freixas, Parigi and Rochet (1999) argued, the interbank market exposes the system to a coordination failure even if all banks are solvent.[21]

There are roughly three sources of contagion in the balance sheets of financial institutions: payment systems, interbank market, and derivatives. In order to understand entire picture of payment systems, we might need overall fund flow charts

[20] That is, the high correlation between the large firms' borrowing costs and real GDP growth rate has a reverse causality relationship.

[21] Freixas, Parigi and Rochet (1999) model inter-regional financial connections for the premise that depositors face uncertainty about the location where they need to consume. The financial connections arise, in contrast, in Allen and Gale as a form of insurance: when liquidity preference shocks are imperfectly correlated across regions, cross holdings of deposits by banks redistribute the liquidity in the economy. Then, these links expose the system to the possibility that a small liquidity shock in one location spread to the rest of the economy.

that summarize the issuers and underwriters of claims by financial sectors and institutions. This is not only a huge but also infeasible task outside financial regulatory authorities. Thus, this study tries to do a shortcut analysis by examining the portfolios of Korean financial institutions, putting more emphasis on the commercial banks. More specifically, we will investigate the balance sheets of the banks and figure out their assimilation and vulnerability to common shocks. This approach shares the spirit of de Bandt and Hartmann (1998) and Kaufman (1994) in that pure panic contagion is rare; far more common is contagion through perceived correlations in the asset returns of financial institutions. Next, the derivative trading and outstanding balance of the financial institutions that are recently becoming increasingly important in credit and market risk management will be taken into account from the viewpoint of systemic risk management.

4.3.1. Assimilation of Banks' Balance Sheets

In order to check whether systemic risks in the type of contagion of financial distress among banks, the asset portfolios are scrutinized across banks and over time. Figure 4-6 and 4-7 demonstrate the movement of the asset holdings by the four major Korean commercial banks: Kookmin Bank, Shinhan Bank, Woori Bank and Hana Bank. One of the most striking facts is that asset portfolios are quite different over time, but similar among the banks at a given time. This means that banks may be subject to common risk factors or at least keep track of the same trends in the strategically similar manner. In addition, the assimilation of the banks' balance sheets becomes strengthened due to a recent trend of financial conglomeration [Hahm and Hong (2003)]. With these observations combined, Korea's banking sector now seems exposed, in the *ex ante*

sense, to systemic risks in ever greater deal than in the past.

[Figure 4-6 and 4-7 Here]

The common credit risks among Korean banks can be reconfirmed in the pattern of the loan loss provisions and loan write-offs. In principle loan loss provisions should relate future expected losses on loans, but in practice accounting conventions are set in a backward rather than forward-looking manner. Particularly, specific provisions can only be made once the debts are impaired. Also general provisions that should cover losses which have not yet been identified do cover the losses that currently lie latent in the book. That is to say, the provisions reflect actual, rather than expected losses. These practices render us to read the loan loss provisions as the proxy for actual losses occurred for whatever reasons.

What are the shocks that push the banks to raise the provisions? Figure 4-8 and 4-9 displaying the loan loss provisions and loan write-offs relative to total assets in the four major commercial banks partly answer to the question. These graphs imply that the variation in provisions across banks is lower than that over time. This seems to suggest that over time the major banks in Korea would hit from the common shocks than from idiosyncratic shocks.[22] Therefore, policymakers and financial regulators should pay more attention to aggregate shocks and their influences on bank capital adequacy in order to prevent and manage systemic risks.[23] [24]

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[22] The similar observation is found in the UK banks by Pain (2003).

[23] Davis (1993) measured the determinants of the loan loss provisions. He found that a sustained 1 % fall in the GDP growth raises the long-run rate of provisioning by 14%; a 1% rise in the level of the bankruptcy rate raises provisioning by 1.7%; a 1% rise in corporate capital gearing (= gross debt/capital stock) raises provisioning by 0.73% and a 1%p rise in real rates from an initial level of 4% raises provisioning by 8%.

[from Figure 4-8 to 4-11 Here]

4.3.2. Risk Exposure to Derivative Holdings

Financial innovations have brought about a host of techniques with which financial institutions can manage various risks, but also provided tools that could drive them to take excessive risks. One of the most significant devices for hedging and taking risks is derivative securities such as forward, future, option, swap, etc., so that monitoring the derivative positions of financial institutions should be a key task for systemic crisis management as well.

In Korea, the origin of derivatives went back to the 1980s when exchange rate forwards began to be traded for the purpose of hedging exchange risks due to the heavy volume of imports and exports. Recently, the derivatives become one of the major sources of non-interest revenues among financial institutions, especially banks and security companies. Table 4-4 and 4-5 show the derivatives trading by types and financial sectors in 2003. Since most of derivatives trading is assumed by security houses that deal with short-term contingent claims, the trading volume is astronomical, but the outstanding balance as of the end of 2003 is relatively smaller, albeit not at all negligible in view of total assets. For instance, banks held KRW 979 trillion, which is about 90% of their total assets (see Table 4-7). Because of the huge long balances by foreign branches rather than domestic commercial banks, the risks are more concentrated in foreign banks. However, the short-fall risks in the domestic banking

[24] Gonzalez-Hermosillo (1999) stressed the importance of the aggregate risks: banks do not fail because they have a large portion of troubled loans, but they fail because of their earlier investment decision whose outcomes may be also influenced by changed economic conditions – a high level of non-performing loans are the result of those same fundamental causes.

industry are quite worrisome. According to Table 4-8, the credit risk exposure by the domestic banks reaches to 13%, while the US counterpart is only 6%. Why do financial institutions get fierce to trade derivative securities? As for the answer, Table 4-9 provides a clue that it could contribute to profits considerably. But, recalling that financial incidents always start with excessive risk taking behaviors in order to exploit seemingly arbitrage opportunities and that derivatives are related to market aggregate risks to which Korean financial system is especially vulnerable, Korea's financial regulatory authorities should thoroughly examine the risk exposure to derivative holdings of the banks and security companies from the viewpoint of systemic risk management.

5. Summary and Conclusion

This study is designed to provide policymakers and financial regulatory authorities with empirical references to systemic risk management. To this end, it tries to answer to the following questions. First, how and how much do macro aggregate shocks affect both the real and financial economies in Korea? Second, how do we identify the shocks to the extent that could have quantitative implications to policymakers? Third, does Korean firms' financial structure matter in the course of propagation and amplification of external shocks into a crisis? Fourth, how vulnerable are Korean financial institutions to contagious systemic risks through their asset portfolios?

To these questions, this study answers as follows. First, macro aggregate shocks do matter in the sense that they could multiply disturbances and have quite persistent effects on the real economy. Especially, the permanent shock that affects the

level of real aggregate quantities, for instance, the one shifting labor productivity, disturbs the real side of an economy a lot, while it brings about temporary disorder in the financial side. In contrast, the influences of transitory shock seem limited to the financial markets.

Second, the size of the identified shocks with the long-run restriction could well explain the depth of the 1997-98 financial crisis. The identification also enables us to compare the shocks occurred over the time periods of interest. This explanation is particularly well understood in the *ex post* sense, but the *ex ante* application of the methodology for policy references asks for additional researches.

Third, capital gearing seems positively related to firms' borrowing costs. However, after considering other factors that could presumably affect the costs of external finance, we could find only a weak correlation between the firms' financial structure and borrowing costs. Rather, macro variables like real GDP growth rate and short-term nominal interest rates better explain the variations in unit corporate borrowing costs. This result could be interpreted that, on average, the Korean firms are more vulnerable to macro aggregate risk factors rather than idiosyncratic risks.

Fourth, the asset portfolios of the Korean financial institutions have moved together in a similar fashion over time. And the assimilation of their asset portfolios has been strengthened. These imply that the Korean financial institutions are also subject more to common risk factors than idiosyncratic risks like the non-financial firms.

All of the aforementioned results are uniformly stressing the importance of macro aggregate risks in managing a systemic crisis. In this context, it recommends to policymakers and financial regulatory authorities that they should call more attention to unveiling the characteristics of macro risk factors, of which the quantity is measured

here but the nature remains unanswered.

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Appendix A. Corporate Data used in Section 4

The corporate data set used in the analysis is based on the National Information & Credit Evaluation, Inc. (NICE). Out of the externally audited companies from 1991 to 2003, we select the companies that have credit ratings and the number of employees in order to measure the fixed effect of credit ratings and firm size effect. In Korea, the classification for the small and medium sized enterprises (SMEs) follows the amount of paid-in capital less than KRW 80 million or the number of employees less than 300. In order to exclude the contamination of the results, the firms whose liabilities exceed their assets are not captured in the sample. The number of sample firms that satisfy the existence of data is 7,051, which counts the same firm in different years separately.

The variables are constructed in the following way:

(1) Average Borrowing rate) = Interest Expense / Total borrowing;
(2) Total Borrowing = Short-term Borrowings + Current Portion of Long-term Liabilities + Bonds + Long-term Borrowings + Long-term Trade Payables + Long-term Payable-Lease;
(3) Debt-equity Ratio = Total Liabilities / Total Stockholders' Equity;
(4) Interest Coverage Ratio = Operating Income / Interest Expense; and,
(5) Cash Flows from Operating Activities = Net Income + Depreciation + Amortization of Intangible Assets/Deferred Charges + Provision for Liabilities + Other Expenses without Cash Outflows + Other Revenues without Cash Inflows.

Credit ratings by year are constructed in the following manner: when a new credit rating is issued for bond issuance on a certain date, we take the credit rating of the firm to the very first date of the year. Thus, a credit rating in a particular year used in the analysis is

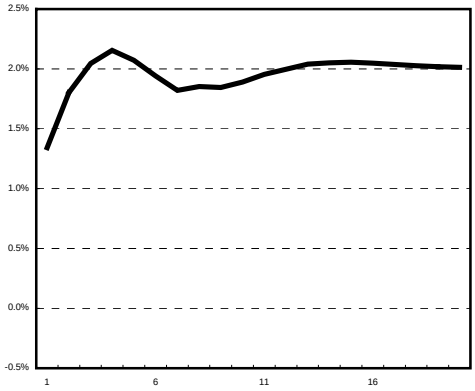
the one during the year. If no new credit rating is given in a particular year, the pre-existing credit rating is counted as valid. When long-term bond ratings are not available, credit ratings for short-term commercial papers are used with comparison table between bonds and commercial papers.

The remaining macro variables are real GDP growth rates and call rates. It is very simple and standard to use real GDP growth rates. As for the call rates, we use the average of monthly call rates for one-day maturity without collateral. The average of monthly time series is used on the premise that corporate borrowings occur uniformly for a given year.

Figure 3-1. Impulse Response Functions due to 1% Permanent Shock:

VAR with Lag 6

a. GDP Growth



b. Default Premium

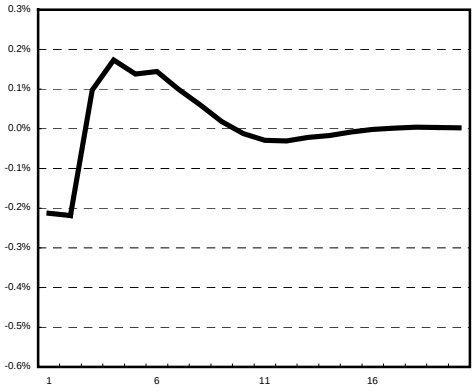
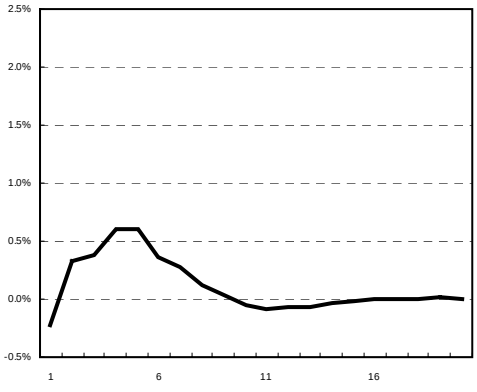


Figure 3-2. Impulse Response Functions due to 1% Transitory Shock:

VAR with Lag 6

a. GDP Growth



b. Default Premium

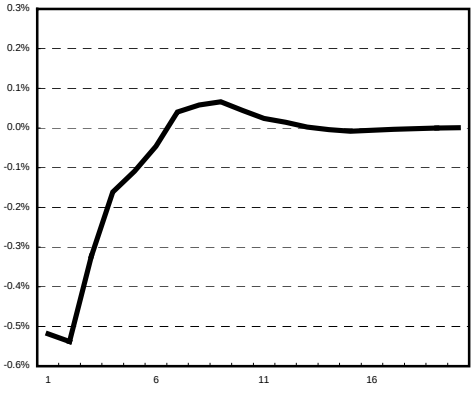


Figure 3-3. Identified Shock Series from 1988:3 to 2003:4

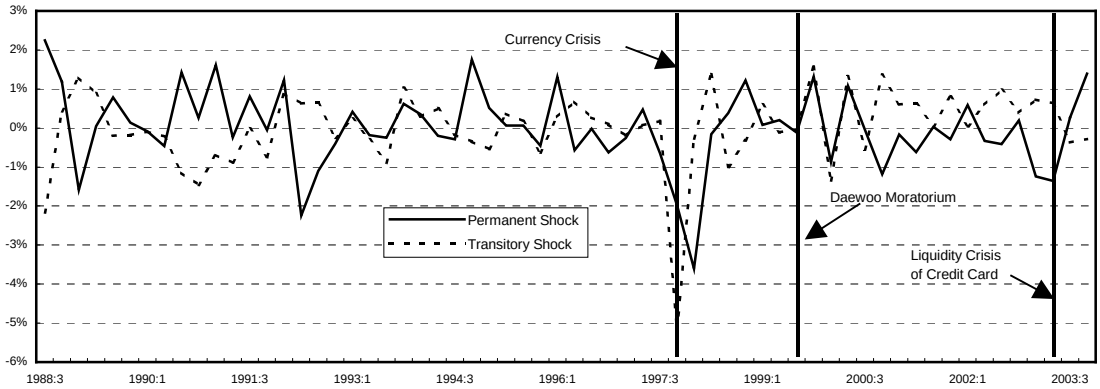


Figure 3-4. Histogram of the Permanent Shocks

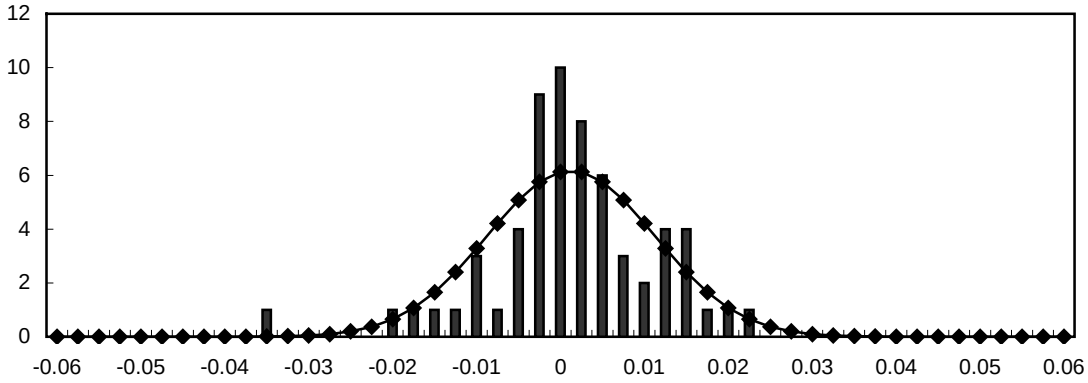


Figure 3-5. Histogram of the Transitory Shocks

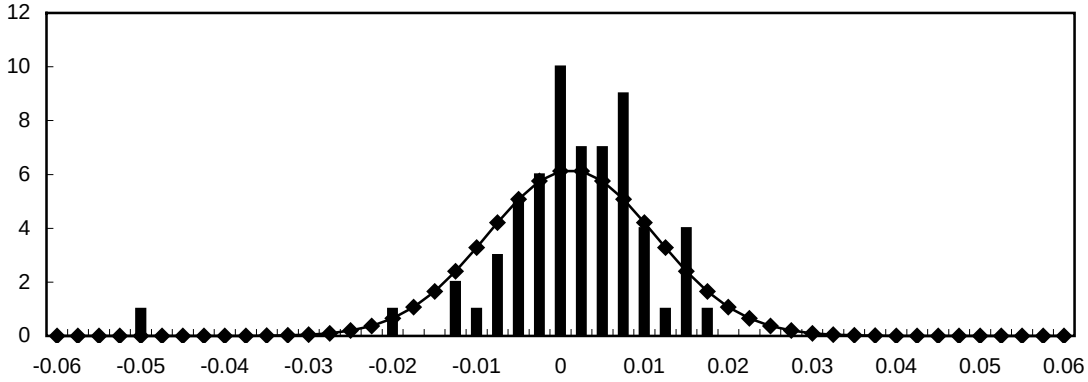


Table 4-1. Determinants of Average Borrowing Rate: the Entire Sample

$$log(ABR_t^i) = \alpha_0 + \alpha_1 log(CG_{t-1}^i) + \alpha_2 log(ICR_t^i) + \alpha_3 log(CFT_t^i) + \alpha_4 Size_t^i + \alpha_5 log(CR_t^i) + \alpha_6 log(RGDP_t) + \alpha_7 log(CALL_t) + \xi_t^i$$

	(1)	(2)	(3)	(4)	(5)	(6)
Log(CG_{t-1})	0.09295***	0.06851***	0.06343***	0.2209**	0.00995	0.0036
	(0.01093)	(0.00857)	(0.00928)	(0.00934)	(0.00985)	(0.01057)
Log(ICR_t)		-0.05508***	-0.0506***		-0.03252***	-0.02897***
		(0.00750)	(0.00946)		(0.00804)	(0.00993)
Log(CFT_t)			-0.04843***			-0.04184***
			(0.01001)			(0.01039)
Size Dummy				-0.03012*	-0.04515***	-0.04396**
				(0.01631)	(0.01696)	(0.01786)
Log(CR_t)				-0.23542***	-0.20772	-0.21347***
				(0.02941)	(0.03304)	(0.03570)
log($RGDP_t$)				0.10134***	0.10237***	0.1009***
				(0.02091)	(0.02168)	(0.02273)
log($Call_t$)				0.18556***	0.16964***	0.17364***
				(0.01801)	(0.01905)	(0.02017)
No, of Observations	5611	5131	4800	5159	4739	4466
Adjusted R^2	0.0245	0.0332	0.0392	0.0601	0.0645	0.0707

Note: ABR = Average Borrowing rate

CG = Capital gearing or Debt-to-equity ratio

ICR = Interest coverage ratio

CFT = Cash flow / Turnovers

Size Dummy = 0 for SME, 1 for Large Company

CR = Credit rating

RGDP = Annualized real GDP

Call = Annualized average Call interest rate

Table 4-2. Determinants of Average Borrowing Rate: Large Companies

$$log(ABR_t^i) = \alpha_0 + \alpha_1 log(CG_{t-1}^i) + \alpha_2 log(ICR_t^i) + \alpha_3 log(CFT_t^i) + \alpha_4 log(CR_t^i) + \alpha_5 log(RGDP_t) + \alpha_6 log(CALL_t) + \xi_t^i$$

	(1)	(2)	(3)	(4)	(5)	(6)
$log(CG_{t-1})$	0.07699***	0.04062***	0.02984**	0.01123	-0.00869	-0.02080
	(0.01180)	(0.01331)	(0.01426)	(0.01423)	(0.01522)	(0.01606)
$log(ICR_t)$		-0.06547***	-0.04535***		-0.02893**	-0.00470
		(0.01046)	(0.01296)		(0.01170)	(0.01415)
$log(CFT_t)$			-0.08023***			-0.08741***
			(0.01350)			(0.01432)
$log(CR_t)$				-0.31971***	-0.31618***	-0.32677***
				(0.04215)	(0.04752)	(0.04998)
$log(RGDP_t)$				0.11487***	0.11892***	0.12194***
				(0.02690)	(0.02811)	(0.02917)
$log(Call_t)$				0.12633***	0.12723***	0.13761***
				(0.02428)	(0.02645)	(0.02757)
No, of Observations	2973	2760	2602	2714	2528	2407
Adjusted R^2	0.0138	0.0252	0.0363	0.0421	0.0472	0.0619

Note: ABR = Average Borrowing rate

CG = Capital gearing or Debt-to-equity ratio

ICR = Interest coverage ratio

CFT = Cash flow / Turnovers

CR = Credit rating

RGDP = Annualized real GDP

Call = Annualized average Call interest rate

Table 4-3. Determinants of Average Borrowing Rate: SMEs

$$log(ABR_t^i) = \alpha_0 + \alpha_1 log(CG_{t-1}^i) + \alpha_2 log(ICR_t^i) + \alpha_3 log(CFT_t^i) + \alpha_4 log(CR_t^i) + \alpha_5 log(RGDP_t) + \alpha_6 log(CALL_t) + \xi_t^i$$

	(1)	(2)	(3)	(4)	(5)	(6)
$log(CG_{t-1})$	0.09172***	0.06938***	0.07429***	0.01988*	0.01193	0.01474
	(0.01049)	(0.01117)	(0.01223)	(0.01201)	(0.01238)	(0.01346)
$log(ICR_t)$		-0.06048***	-0.08645***		-0.05552***	-0.08012***
		(0.01055)	(0.01347)		(0.01068)	(0.01330)
$log(CFT_t)$			-0.00786***			0.01637
			(0.01443)			(0.01424)
$log(CR_t)$				-0.10334***	-0.03187	-0.04288
				(0.04000)	(0.04436)	(0.04927)
$log(RGDP_t)$				0.06739**	0.05004	0.04248
				(0.03264)	(0.03347)	(0.03527)
$log(Call_t)$				0.33130***	0.30477***	0.31042***
				(0.02723)	(0.02822)	(0.03002)
No, of Observations	2411	2174	2012	2241	2033	1889
Adjusted R^2	0.0303	0.0454	0.0552	0.0911	0.1004	0.1095

Note: ABR = Average Borrowing rate

CG = Capital gearing or Debt-to-equity ratio

ICR = Interest coverage ratio

CFT = Cash flow / Turnovers

CR = Credit rating

RGDP = Annualized real GDP

Call = Annualized average Call interest rate

Figure 4-1. Capital Gearing and Borrowing Rate

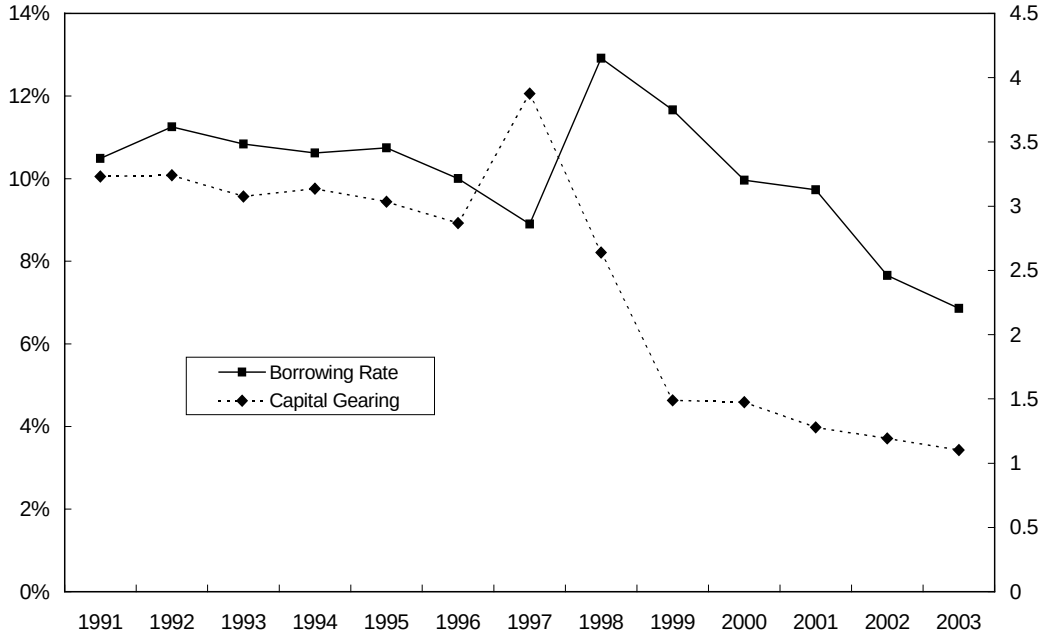


Figure 4-2. Interest Coverage Ratio and Borrowing Rate

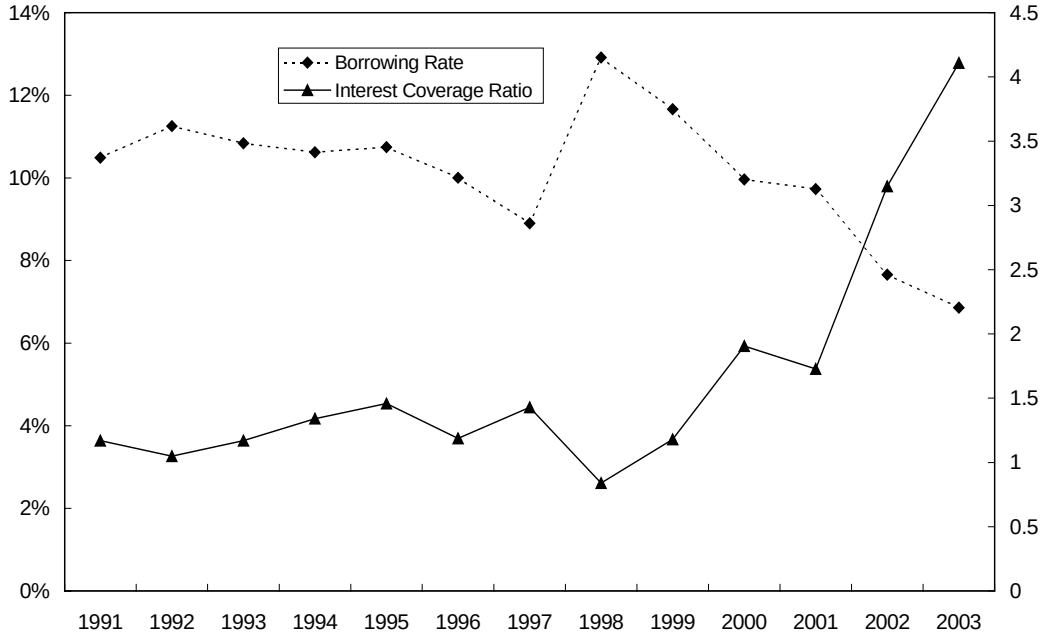


Figure 4-3. GDP Growth Rate and Borrowing Rate by Firm Size

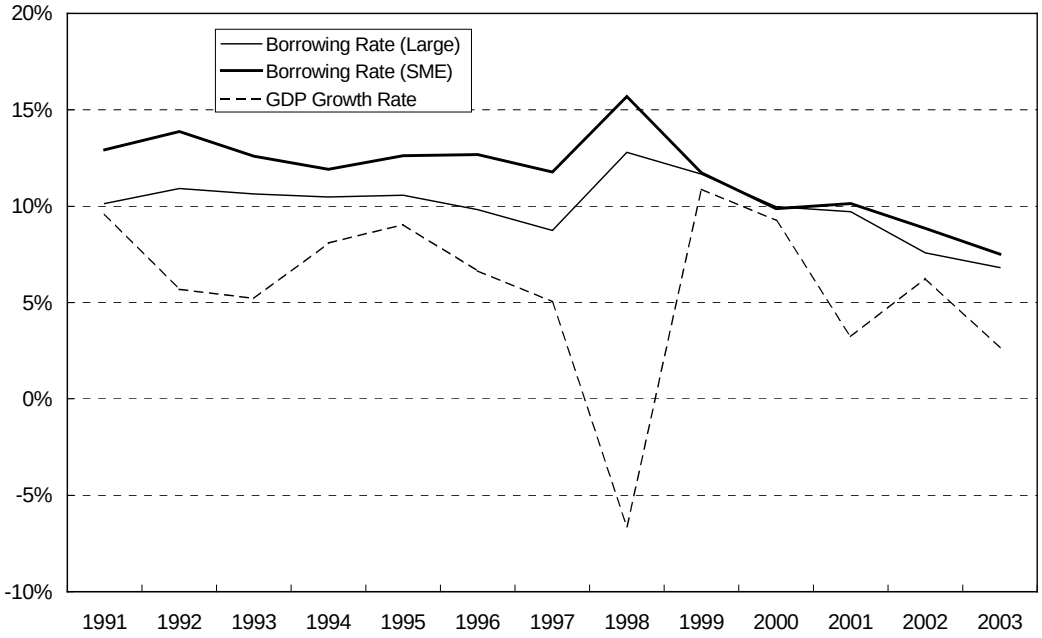


Figure 4-4. Call Rate and Borrowing Rate by Firm Size

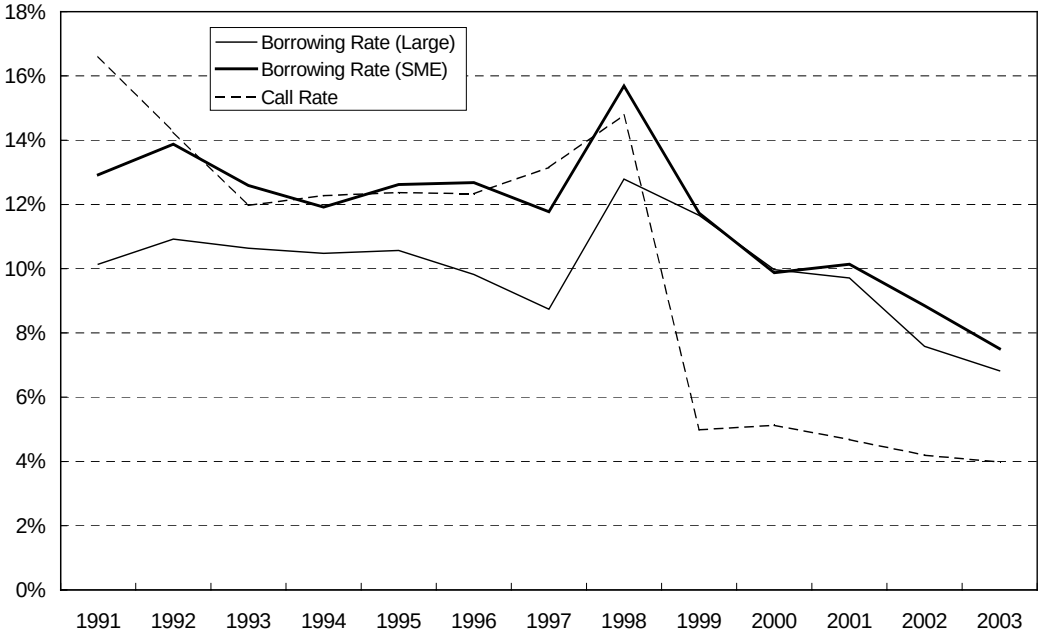


Figure 4-5. Borrowing Rate by Credit Rating

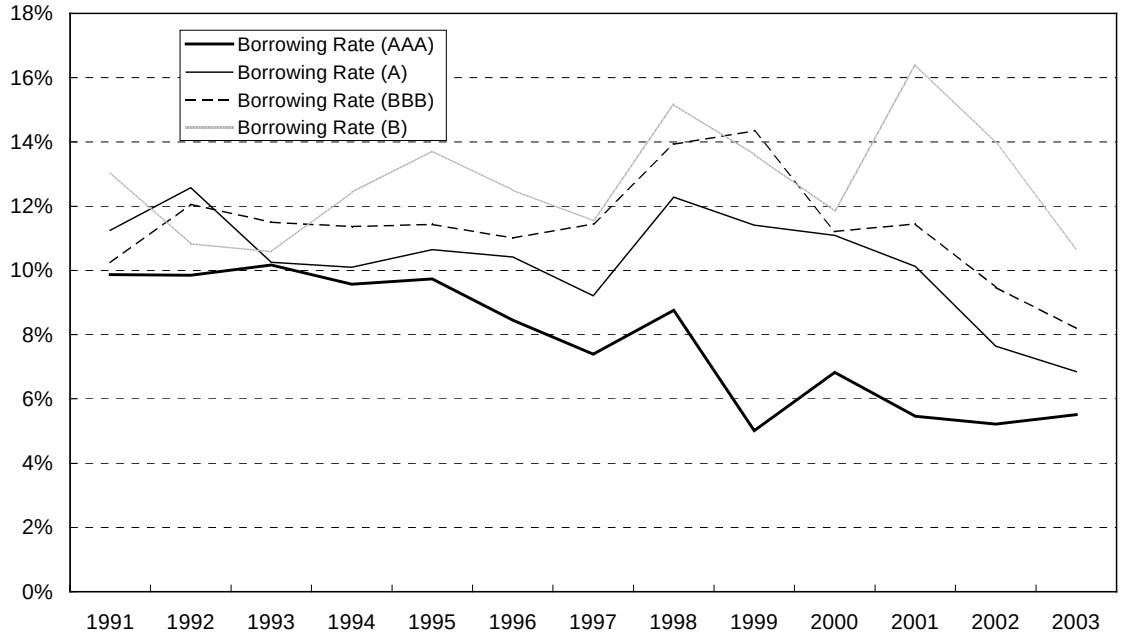


Figure 4-6. Ratio of Securities to Assets by the Major Commercial Banks

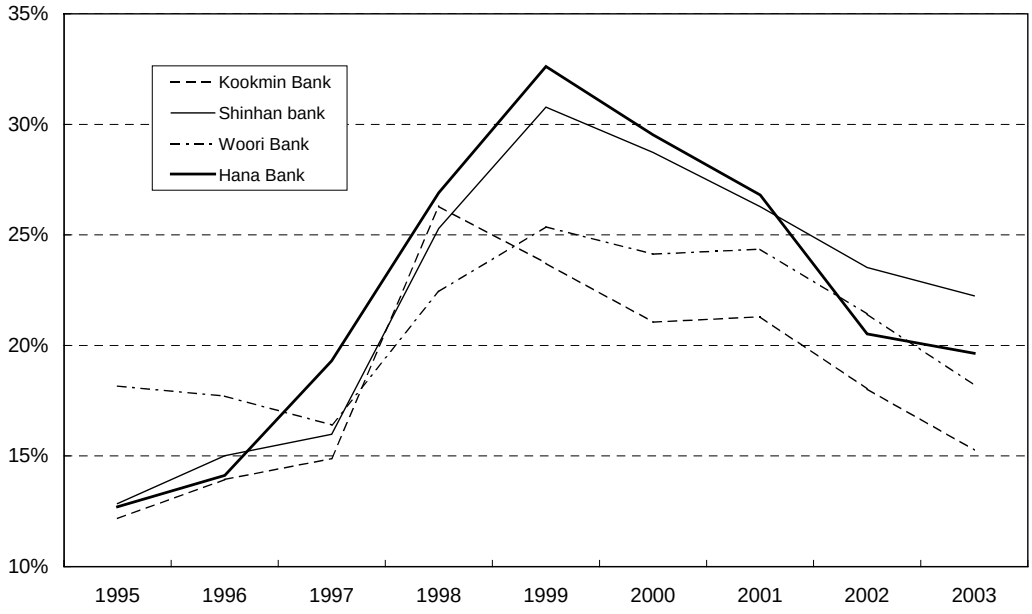


Figure 4-7. Ratio of Loans to Assets by the Major Commercial Banks

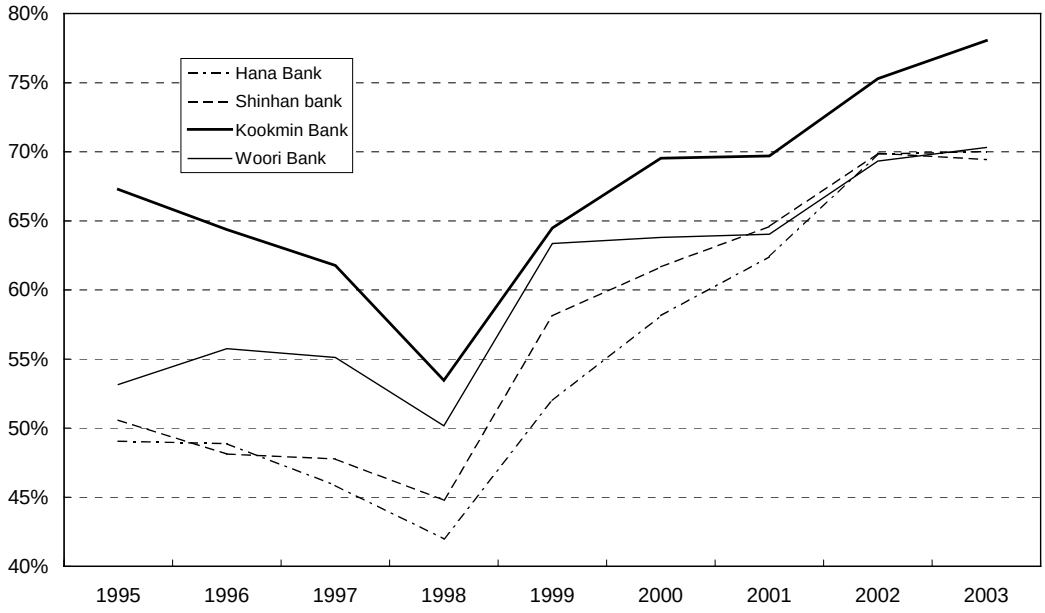


Figure 4-8. Loan Loss Provisions of the Major Commercial Banks

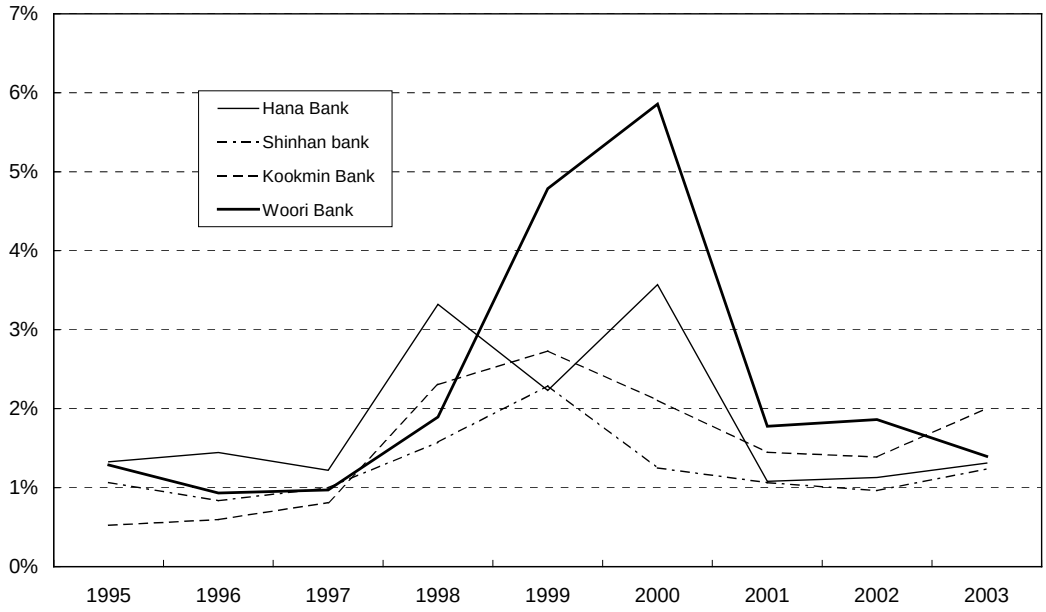


Figure 4-9. Loan Write-offs of the Major Commercial Banks

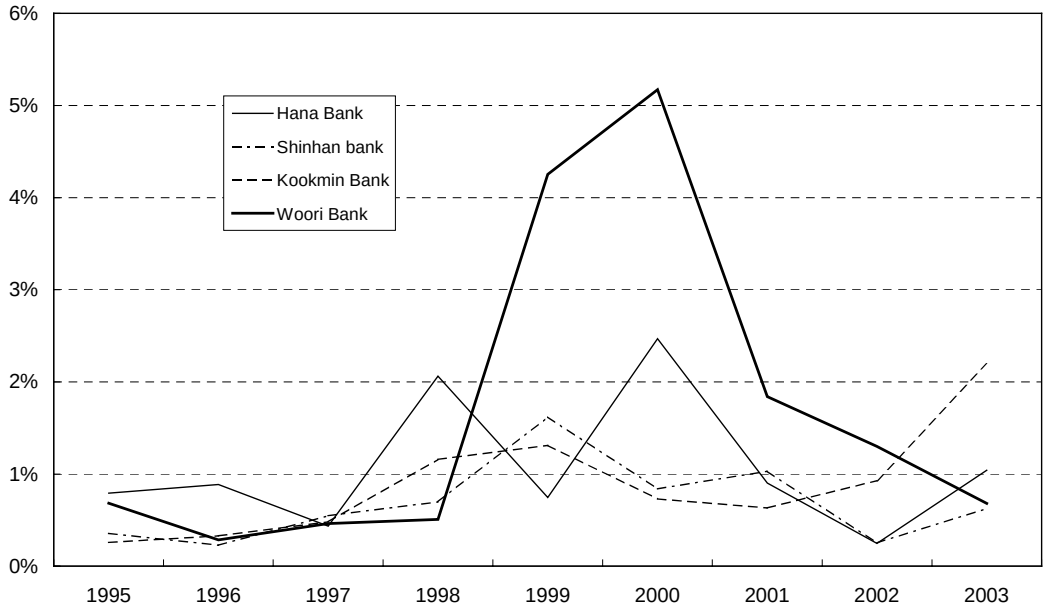


Figure 4-10. Net Increase in Loan Loss Provisions of the Major Commercial Banks

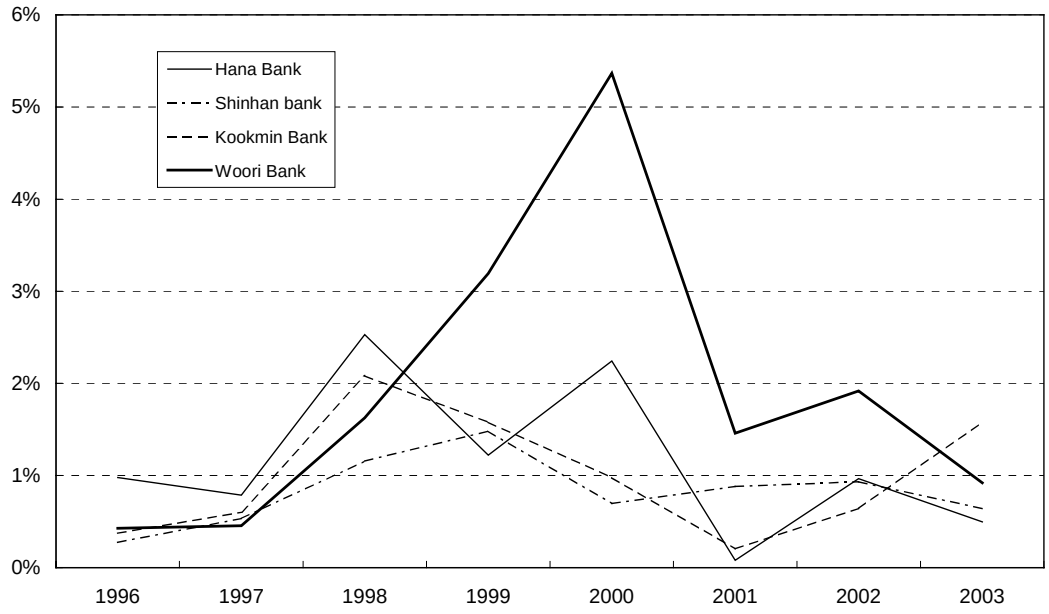


Table 4-4. Derivatives Trading by Types

(unit: trillion won, %)

	Trading Amount				Outstanding Balance			
	Stock	Interest Rate	Exchange Rate	Total	Stock	Interest Rate	Exchange Rate	Total
Forward	0.3	30	1,583	1,613 (7.5)	0.0	4	344	348 (34.1)
Future	1,314	1,803	120	3,237 (15.0)	2	16	2	20 (2.0)
Swap	0.1	240	113	353 (1.6)	0.1	389	166	555 (54.3)
Option	16,244	29	72	16,345 (75.9)	25	35	39	99 (9.6)
Total	17,588	2,102	1,888	21,548 (100)	27	444	552	1,022 (100)

Table 4-5. Derivatives Trading by Financial Sectors

(unit: trillion won, %)

	Trading Amount		Outstanding Balance	
Bank	2,941	(13.6)	979	(95.7)
Security	17,405	(80.8)	15	(1.5)
Insurance	54	(0.3)	20	(1.9)
Trust*	647	(3.0)	7	(0.7)
Others**	501	(2.3)	1	(0.2)
Total	21,548	(100.0)	1,022	(100.0)

* Trust = Bank Trust + Investment Trust

** Others= Credit Card + Future + Merchant Bank

Table 4-6. Derivatives Trading in the Exchange and Over-the-Counter(OTC)

(unit: trillion won, %)

		Stock	Interest Rate	Exchange Rate	Others	Total
Trading Amount	Exchange	17,540 (90.1)	1,804 (9.3)	119 (0.6)	2 (0.01)	19,465 (100.0)
	OTC	17 (0.8)	298 (14.3)	1,767 (84.9)	- -	2,083 (100.0)
Outstanding Balance	Exchange	10 (34.4)	17 (57.7)	2 (7.9)	- -	30 (100.0)
	OTC	16 (1.6)	426 (43.0)	550 (55.4)	- -	992 (100.0)

* Source: Financial Supervisory Service

Table 4-7. Ratio of Derivatives Outstanding Balance to Total Assets

(unit: trillion won, %)

	Bank			Security	Insurance	Total	Commercial Bank in the US
		Domestic Bank	Foreign Branch				
Total Assets	1,089	1,000	89	56	221	1,366	5,902
Nominal Balance of Derivatives	979	380	598	15	20	1,013	70,005
Ratio	0.90	0.38	6.72	0.27	0.09	0.74	11.86

* Source: Financial Supervisory Service, Office of the Comptroller of the Currency

Table 4-8. Credit Risk Exposure by Financial Sectors

(unit: trillion won)

	Bank			Security	Insurance	Total	US Commercial Bank
		Domestic Bank	Foreign Branch				
Adjusted Capital (A)	81	76	6	5	25	111	-
Credit Conversion (B)	25	10	15	0.4	2	27	-
Credit Risk Exposure (A/B)	0.31	0.13	2.52	0.07	0.06	0.24	0.06

* Source: Financial Supervisory Service, Office of the Comptroller of the Currency

* add on: (nominal balance × conversion rate by commodity and maturity)

Table 4-9. Profits from Derivatives Trading

(unit: 100 million won)

	Bank			Security	Insurance	Total
		Domestic Bank	Foreign Branch			
Profits from Derivatives Trading (A)	5,260	1,430	3,830	2,340	45	7,645
Operating Profits (B)	38,130	32,200	5,930	12,560	39,170	89,860
Ratio (A/B)	13.8	4.4	64.6	18.6	0.1	8.5

* Source: Financial Supervisory Service