



# The Bank capital regulation (BCR) model

Hyejin Cho

## ► To cite this version:

Hyejin Cho. The Bank capital regulation (BCR) model. The International Conference on Economic and Financial Risks, Othmar M. Lehner, Sep 2014, oxford, United Kingdom. pp.168-190. hal-00958499v2

**HAL Id: hal-00958499**

**<https://hal.science/hal-00958499v2>**

Submitted on 23 Mar 2015

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

# The Bank Capital Regulation (BCR) Model

Hye-jin Cho<sup>†</sup>

<sup>†</sup>Department of Economics, University of Paris 1, Pantheon-Sorbonne, PARIS, FRANCE

**Abstract.** *The motivation of this article is to induce the bank capital management solution for banks and regulation bodies on commercial banks. The goal of the paper is intended to mitigate the risk of a banking area and also provide the right incentive for banks to support the real economy.*

**Keyword:** *Demand Deposit, On-balance-sheet risks and off-balance-sheet risks, Portfolio composition, Minimum equity capital regulation.*<sup>1</sup>

**JEL Classifications:** *C62; C63 ; D01 ; G10 ; G21*

## Part I Introduction

In Europe, after the Basel 1 (1988) accord, the banking supervision Accords in Basel, Switzerland, Basel 2 (1999) and Basel 3 (2010) have been evolved. The issuer, the Basel Committee on Banking Supervision (BCBS), advised about credit risk (1988.07) at the Basel 1 and amended about market risk (1996.01) with the Basel 1 Amendment. In the revised framework of the Basel 2, operational risk (2004.06) was introduced and enhanced at the Basel 3 (2010.12). In this overall perspective, these Basel Capital Rules have been enhanced up to the Basel 3. For example, the scope of operational risk is enlarged. This requires some reasonable motivation since banks face the situation to manage the cost to follow banking capital regulation rules. Of particular significance is that the government needs to regulate banks to prevent panic from the systemic banking crisis.

Much interest has been aroused in cascading failure of bank run prevention. For example, Friedman and Schwartz (1963) observe large costs imposed on the economy of United States caused by bank runs in the 1930s. Upon on much more recent data, in systemically important banking crises of the world from 1970 to 2007, the average net

---

<sup>1</sup> This work was achieved through the Laboratory of Excellence on Financial Regulation (Labex ReFi) supported by PRES heSam under the reference ANR-10-LABX-0095. It benefitted from a French government support managed by the National Research Agency (ANR) within the project Investissements d'Avenir Paris Nouveaux Mondes (invesments for the future Paris-New Worlds) under the reference ANR-11-IDEX-0006-02. My special thanks go to my supervisor Raphael Douady, my co-supervisor Duc Khuong Nguyen and Jean-Bernard Chatelain for a good comment in 8<sup>th</sup> Doctorissimes in the University of Paris1. Invaluable inspiration to figure out financial economic methodology on this article was furnished by Chris Shannon, Frank Riedel, Nobuhiro Kiyotaki and all participants at seminars in 2014 by the university of Paris1 (Panthéon Sorbonne), the 2014 International Conference on Economic and Financial Risks by the University of Poitier, Advanced in Stochastic Calculus by University of Bielefeld 2014, the 14<sup>th</sup> SAET conference by the Waseda university, the 14 FRAP conference by Oriel College, Oxford University and 2014 Extreme Events in France by the ESSEC. I wish also to record my affection to my family and JP.

recapitalization cost to the government was 6% of GDP (Gross Domestic product). Fiscal costs associated with crisis management were averaged 13% for GDP (16% of GDP if expense recoveries are ignored), and economic output losses were averaged about 20% of GDP during the first four years of the crisis. Otherwise, if the government decides to adopt the Basel capital regulation framework, the adoption cost will influence the economy of countries. Either households or banks, related parties to economy should pay for the Basel capital regulation as the preventive method in the banking business cycle. An OECD (The Organization for Economic Cooperation and Development) study released on 17 February 2011, estimated that the medium-term impact of the Basel III implementation on GDP growth would be in the range of 0.05% to 0.15% per year. Economic output would be mainly affected by increase in banks' lending spreads, as banks pass a rise in bank funding costs, due to higher capital requirements, to their customers. Therefore, the situation is that banks are struggling to manage the regulation cost and the government wants to defend about nationwide contagion of other banks.

## **Part II The macro-prudential approach to financial regulation covering on-balance-sheet and off-balance-sheet (OBS)**

Insofar as systemic risk is concerned, risks that firms, households and reserve banks and commercial banks face are highly linked to each other. Seen from this point of view, the banking industry and the monetary policy have particular relevance to systemic risk. Undoubtedly, it goes without saying that financial contagion problems through international banks should be measured in the manner of systemic risk management. With the macro-prudential approach, it is highly probable that systemic risk is explained by the static model of the general equilibrium. Because on-balance-sheet and off-balance-sheet (OBS) risks are structurally segmented annually or periodically by financial statements containing the balance sheet. Even though domino effects or contagions can be understood as movements having the future tendency to figure out solutions toward the future, scope of regulation should be articulated by categorization of on-balance-sheet and off-balance-sheet (OBS) risks in the static model. Thus the macro-prudential approach to financial regulation covering on-balance-sheet and off-balance-sheet (OBS) risks is intimately linked with the general equilibrium (GE) approach.

On-balance-sheet risks are presented in a fourfold manner and are divided into credit risk, market risk, liquidity risk and systemic risk. Assets of banks have credit risk and market risk. Credit risk is the risk that a borrower will default on any type of debt by failing to make required payments. Market risk is the risk of losses in positions arising from movements in market prices. In case of liquidity risk, there are two major situations. One is emergency capacity of banks. When an illiquidity event takes place, an affected bank typically must borrow funds at interest rates exceeding those paid by other institutions. Another is about the stability of the banking system in case of inducing a large number of depositors to seek withdrawals. I would say liquidity risk in regard of demand deposit is on-the-balance-sheet risks of banks. Credit, market and liquidity risk are portrayed in considerable individual details but systemic risk is negative externality or adverse spillover effect stemming from transaction in which they were not participants. Distinguished from credit risk containing sovereign risk (government risk), counterparty risk (unincorporated entities' risk exposed to financial risk, usually

referring to governments, national banks), systemic risk is the risk of collapse of an entire financial system or the entire market, as opposed to risk associated with any individual entity, group or component of a system. George G. Kaufman and Kenneth E. Scott (2003) define “systemic risk” in imprecise terms as below:

”Systemic risk refers to the risk or probability of breakdowns in an entire system, as opposed to breakdowns in individual parts or components, and is evidenced by co-movements (correlations) among most or all the parts.”

Darryll Hendricks (2009), who is a practitioner, suggests a more theoretical definition from sciences in which the term originated:

“A systemic risk is the risk of a phase transition from one equilibrium to another, much less optimal equilibrium, characterized by multiple self-reinforcing feedback mechanisms making it difficult to reverse.”

Banks engage in a number of activities that yield income, entail expenses and manage risks from on-balance-sheet risks to off-balance-sheet risks. Depending on bank characteristics, Banks extend loan commitments, security loans and trade derivative securities. Through extended loan commitments, the borrower has a guarantee of

**Table 2.1** Assets of U.S. commercial banks

Asset category	\$ Billions	%
Commercial and industrial loans	1,197.9	12.3
Consumer loans	847.4	9.0
Real estate loans	3,573.9	36.7
Interbank loans	364.6	3.6
Other loans	269.0	2.7
Total loans	6,252.8	64.3
Securities	2,017.7	20.7
Cash assets	247.1	2.5
Other assets	1,220.4	12.5
Total assets	9,738.0	100.0

(Source: Board of Governors of the Federal Reserve System, August 2008)

**Table 2.2** U.S. commercial bank liabilities and equity capital

Category	\$ Billions	%
Transactions deposits	579.1	6.0
Large time deposits	1,016.4	10.4
Savings and Small Time Deposits	4,171.6	42.8
Total deposits	5,767.1	59.2
Borrowings	1,744.8	17.9
Other liabilities	1,051.4	10.8
Total liabilities	8,563.3	87.9
Equity capital	1,174.7	12.1
Total liabilities and equity capital	9,738.0	100.0

(Source: Board of Governors of the Federal Reserve System, August 2008)

Figure II.1 Vanhooose 2008 - Asset/Liability of banks

credit at a given interest rate whenever desired during the specific period. The bank receives interest income on the portion of the credit line that the borrower draws upon, and the bank receives non-interest income on the unused portion. Whereas a loan commitment obligates a bank to bring a loan onto its balance sheet upon customers’ requests, securitization permits a bank to remove loans from a balance sheet. Trading derivative securities also proved to be significant source of revenues. This claim is supported by the survey of David Van Hoose (2010), by the end of 2008, United States banks held a notional amount of derivatives totally more than 190 trillion dollar, of which about 150 trillion dollar of derivatives’ exposure was comprised of interest rate contracts.

In relation to what I have previously said, the general equilibrium (GE) approach is useful to understand the overall mechanism of financial transaction and economic policy. The opposite mechanism of assets and liabilities on bank characteristic in the figure II.1, is different from usual balance sheets of firms. That is, banks regardless of

central banks or commercial banks have characteristic that loans are assets of banks and deposits are liabilities.

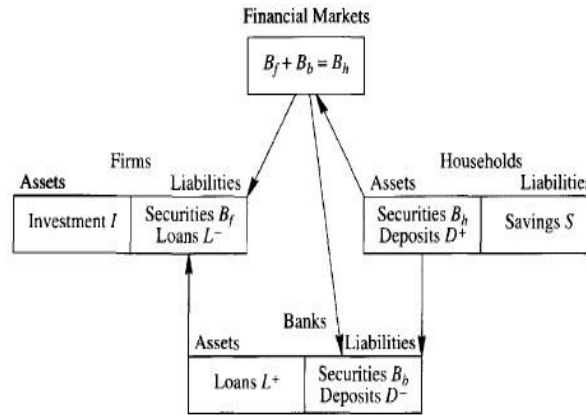


Figure II.2 Freixas-Rochet (1999)

All of these figures are emphasized by capital circulation of the Freixas-Rochet model (1999) in the figure II.2. In conjunction with the Freixas-Rochet model, the equilibrium is detected with the general equilibrium approach with direct relevance to circulation of securities and stability of deposits. In the paper, the general equilibrium approach is upgraded with an adroit mixture of the balance sheet concept evaluating the value of economic entities and the income statement concept considering the profit to support the existence of financial entities.

## Part III Model

### 1. Saving preference of Consumers

A microeconomic theory of banks had not been existed before the microeconomic foundation related to banks in the early 1970s. I would suggest add a banking sector at the Arrow general equilibrium model (1953) under the complete financial market assumption. The main purpose of the model has been to explore solutions about the problem of households, firms, banks and regulation bodies.

The two-period model ( $t=0,1,2$ ) with a unique physical good initially owned by consumers in the economy in which a continuum of ex-ante identical agents is each endowed with one unit of goods at the period  $t=0$ , and this good is to be consumed at each period of  $t=1$  and  $t=2$ . The consumer chooses her consumption profile  $(C_1, C_2)$  and the allocation of her savings  $S$  between bank deposits  $D_h$  and securities  $\sum_{s \in \Omega} P_s B_s^h$ , in a way that maximize her utility function  $\mu$  under her budget constraints:

$$\text{Max } \mu(C_1, C_2)$$

$$C_1 + \sum_{s \in \Omega} P_s B_s^h + D^h + S_h - \sum_{s \in \Omega} P_s B_s^h - D_h = W_1$$

$$C_2 = \Pi_f + \Pi_b + (1+r) \sum_{s \in \Omega} P_s B_s^h + (1+r_D) D^h + (1+r_h) S_h - (1+r) \sum_{s \in \Omega} P_s B_s^h - (1+r_D) D^h$$

Where  $W_1$  for her initial endowment of the consumption good,  $\Pi_f + \Pi_b$  for respectively profits of the firm and of the bank (distributed to the consumer-stockholder at  $t=2$ ).  $B^h$  denotes for securities,  $D^h$  for bank deposits.  $S_h$  denotes for savings.  $r$ ,  $r_D$ ,  $r_h$  are interest rates paid by securities, deposits and savings. For each future state of the world  $s$  ( $s \in \Omega$ ) one can determine the price  $P_s$  the contingent claim that pays one unit of accounts in state  $s$  and nothing otherwise.

The consumer has a well-defined set of desires ("preference"), which can be represented by a numerical utility function. In addition, we assume that the consumer chooses optimally, in the sense that they choose the option with the highest utility of those available to them. It implies that a consumer is solving an optimization problem. An optimization problem has three key components.

a. **Selected object** The consumer chooses her consumption profile  $(C_1, C_2)$  and allocation of her savings  $S_h$  between bank deposits  $D_h$  and securities  $B^h$ . If real assets  $S_h - \sum_{s \in \Omega} P_s B_s^h - D_h$  is non-negative, it implies real assets are sufficient to support the household economy.

b. **The objective function** The consumer maximizes her utility function  $\mu$ .  $\mu$  is assumed to be increasing and concave. Notice that preferences are contingent states and do not fit the standard Von Neumann-Morgenstern representation. Incompleteness of preference becomes apparent that decision makers cannot make a decision in the ambiguous situation. However, even though one individual or one factor doesn't decide, the regulator decides the policy with a foretaste of what is to come after annual closing accounts.

c. **Constraints**

**Cash-in-advance**  $0 < D_h \leq W_1$ , The paper will be based on the Cash-in-advance constraint. This approach that was introduced by Clower (1967) is the requirement that each consumer or firm must have sufficient available cash before they can buy goods.

**Price of security h under Uncertainty**  $\sum_{s \in \Omega} P_s B_s^h$  (resp.  $\sum_{s \in \Omega} P_s B_s^f$ ,  $\sum_{s \in \Omega} P_s B_s^b$ ) implies the price of securities by the absence of arbitrage opportunities. A bank issues (or buys) a security  $h$  (intepreted as a deposit or a loan) characterized by the array  $B_s^h$  ( $s \in \Omega$ ) (resp.  $B_s^f$ ,  $B_s^b$ ) of each payoff in all future states of world  $\omega$

**Interior Solution** The consumer's program  $(P_h)$  has an interior solution only when interest rates are equal:  $r = r_D$

**Preference of Savings** In the Arrow-Debreu model, money is redundant in the market. Households are indifferent about the composition of savings. In the paper, the household has preference to increase the budget to collect savings  $S_h$  and affected by risk levels of securities, deposits and real assets. Savings  $S_h$  is the sum of Securities  $\sum_{s \in \Omega} P_s B_s^h$ , Deposits  $D_h$  and Real Assets  $S_h - (\sum_{s \in \Omega} P_s B_s^h + D_h)$ .

#### d. Arguments

There are concerns about savings that are substituted into consumption by the household like Covas-Fujuta (2010). Diaz (2005) adds no capital requirement at basics to reduce consumption and increase savings by the household. Haslag (2001) assumed that return to money is positively related to the money growth rate that is a random variable, gross real returns to savings are random. His realized gross real return to savings indicates that the gross real return to savings is a weighted sum of capital and fiat money (which derives its value from government regulation or law, so called as 'fiat currency'). The weight is the share of agent's asset.

In the Waller model (2004), Savings are very passively selected by the household depending upon decisions at the previous period. Middle-aged agents have already earned their wage income, as the wage during period  $t$  was determined by the previous period's interest rates (a level of the capital stock). Also, they have already decided how much to consume and save (since savings are a fixed fraction of wage income), but they have not yet decided how to allocate their savings between capital and fiat currency. What these middle aged agents want at this point is just the highest possible interest rate between period  $t$  and  $t + 1$ , so that they can obtain the best possible return on their savings and can thus consume as much as possible during their period of old age. In the third period of life, retired agents consume their savings and exit the model.

Practically, Christensen-Meh-Moran (2011, Bank of Canada) mentioned, at the timing of events, households deposit savings at banks that use these funds as well as their own net worth to finance the entrepreneur's projects. In the investment frame, exiting (failing to return from the project) agents sell their capital for consumption goods and surviving agents buy this capital as part of their consumption-savings decision.

However, in reality, even though the agent has a house, they need to spend expenditure for renting, maintenance and extension of houses. Savings and real asset portion are large enough to make the loan from banks. It is hard to explain price fluctuation of houses and savings on the economy by depending upon the interest rate of capital stock and deposit, or perfect substitution of consumption. For households, the preference of savings is the matter about existence of household economy making future benefits and directly affecting to the welfare of any individual.

House-price appreciation by the model of Goodhart-Kashrap-Tsomocos (2012) is impressive. Reducing deposit defaults induces more savings circulated by the bank and less self-insurance and by the end, the reduction in self-insurance reduces the number of houses for sale in a good state, which means that house-price appreciation in the boom is higher than otherwise. Most of all, the market incompleteness with deadweight costs of default distorts the housing market. Wealthy agents endowed with houses make their saving decisions accounting for the possibility that deposits will not be fully repaid. When default penalties for banks are low, then households internalize risks putting less wealth into the banking system and hold more in the form of houses. This choice increases the supply of houses that is available in boom, which lowers house prices and raise welfare for agents entering the housing market at that time. To insure that house price reduction in the bad state of the world, households P and F are also presumed to have lower wealth. Likewise, the non-bank is endowed with lower capital in period 1 as well as in the bad state of the world. This model describes the house bubble phenomenon interestingly.

In the model of Lucas (1995), to support the incompleteness of markets, he pointed out savings that the young split their savings between bank deposits, which promise a fixed nominal return, and a bank equity, which yields an uncertain real dividend. In addition, because a constant fraction of initial wealth is saved, there is no distortion due to fixed nominal interest payments on deposits. Hence regardless of deposits, the bank equity is related to the real effect of monetary policy.

In the paper, at the framework of securities, deposits and real assets with savings, firstly, the relation between savings and real assets (especially houses) can be much more attached. Secondly, deposits included in the total saving amount which are escaped from the one-sided thinking that deposits are equal to savings and can be perfectly substituted to consumption. Thirdly, Securities at uncertainty are affecting to the investment portfolio of households. These dynamics are explained by the following academical detail.

Households choose  $(C_1, C_2, S_1, S_2, R_1)$  taking prices  $(W_1, W_2)$  as given. Formally, if we consider the 4-factor model containing banks, because banks have the special financial structure having deposits as liabilities and loans as assets, we need to have the different mindset from generally accepted accounting principles about debit and credit accounts. The general equilibrium (GE) diagram is similar with the balance sheet. Distinguishably, the money flow in the paper starts at the bank transaction which is “deposits and borrowings” as liabilities and “claims to corporate” as assets.

Then, deposits of household are the amount to be accumulated in banks. Conveniently, riskier investments than deposits for household are categorized as securities.

Savings are moving in the real household economy by capital circulation of securities, deposits and real assets. In addition, the welfare of each household is moving from dynamics of accumulated savings. In the overlapping generation model, wealth is always given and manages the household economy easily by each generation. In reality, one who didn't get a house as a legacy, she should spend quite a long time to have a house or rent a house. Attention about fundamental wealth related to non-working capital of a household economy should be emphasized. If the consumer spends his income entirely, the total amount  $W_1$  may be spent totally and can be bounded. In this manner, the household always has their fundamental welfare to manage the household economy and consumption can be naturally deduced from the framework of household economy. That is,  $W_1$  is the budget constraint and the market information is incomplete so we cannot deduce the real variable of consumption in reality.  $W_1$  and incompleted market information are not enough to deduce the real variable of consumption. In terms of the working capital, we are not so surprised to know that capital has various liquidities. For example, a household wants to spend money on a daily basis but should reduce the amount of money by spending it to have fundamental living basis like houses. In the paper, the financial budget constraint is bounded within the  $W_1$  except for  $S_1$  because  $S_1$  is the summation of securities, deposits and real assets. These are vital factors to operate household economy related to financial markets. The working capital concept at the household economy is evoked within the general equilibrium in the paper. In the perspective that the industrial characteristics of banks mainly operated by capital, it makes sense to us that consideration about the household economy should be balanced with the working capital concept of banks.



Then, why we need to define return  $R_1$  in this model? Simply, we think of three variables of  $W$  for endowment,  $S$  for savings and  $C$  for consumption. We assume that the concept of the golden-rule saving rate in *Chapter 1 of Barro and Sala-i-Martin*,  $n$  denotes for the constant exogenous population growth rate, and  $d$  is for the constant exogenous rate of depreciation of capital. We know the house saving rate is 5% (usually 2-11%, *OECD, Economic Outlook n.91, June 2012*). The amount of savings in the economy should grow as population grows. To support this insured saving amount caused by population growth, the return should be enough to make profits to cover the insurance expense in the economy with the general equilibrium (GE) perspective. Then, we can assume the worst scenario like a bank-run case. Even though the fix amount of saving deposits is secured, the loss amount induced from total savings by the end - insured savings will go to the consumption part. In this overall perspective of an equilibrium, insuring savings of households seems plausible to support the economy of households, yet it requires further understanding about the profitable dynamic mechanism to operate the economic cycle. I would say the original form is mainly based on the BCR general equilibrium model diagram presenting as the balance-sheet format as it can be because on-balance-sheet factors are reflected by two regards - the money flow perspective (profit) and the economic status perspective (net present value).

Original form (savings containing real assets)

Max  $\mu(C_1, C_2)$

$$C_1 + \sum_{s \in \Omega} P_s B_s^h + D^h + S_h - \sum_{s \in \Omega} P_s B_s^h - D_h = W_1$$

$$C_2 = \Pi_f + \Pi_b + (1+r) \sum_{s \in \Omega} P_s B_s^h + (1+r_D) D^h + (1+r_h) S_h - (1+r) \sum_{s \in \Omega} P_s B_s^h - (1+r_D) D^h$$

Simplified form for calculation (savings containing real assets)

Max  $\mu(C_1, C_2)$

$$C_1 = W_1 - S_1$$

$$C_2 = R_1 + W_2 - (1+r) S_1 - S_2$$

We have the first order condition of consumption at period 1 and 2 as below.

$$\frac{\partial \mathcal{L}}{\partial C_1} = \mu'(C_1, C_2) - \lambda = 0$$

$$\frac{\partial \mathcal{L}}{\partial C_2} = \mu'(C_1, C_2) - \lambda = 0$$

We know the Lagrange multiplier is 0 as  $\lambda = 0$ , by the  $\frac{\partial \mathcal{L}}{\partial S_1}$ , the first order condition of savings at period 1 and by the  $\frac{\partial \mathcal{L}}{\partial R_1}$ , the first order condition of return from initial investment. In addition, we get  $\lambda(1+r_1) = 0$  by the  $\frac{\partial \mathcal{L}}{\partial S_1}$ , the first order condition of savings at period 1.

Therefore, what is get from checking the first order condition of household problem is that households consume today or tomorrow regardless of a banking money flow and it is not affected by the return of initial savings.  $\mu'(C_1, C_2) = 0$  denotes as time indifference about consumption preference. Households operate the household economy related to banks regardless of consumption for today or tomorrow. We conclude

consumption choice is not affected by return of initial savings  $r_1$  at the frame of banking money flow related to household.

The house expense portion in deposits held with MFIs (Monetary Financial Institutions) is the asset that can induce the future benefit and considered as priority to invest for a long time. For example, among loans to households of MFIs (5231 billion euros), loans for house purchase are 74%, 3858.1 billion euros in 2013. Note that we focus on the money transaction started from the bank balance sheet, in the concept of savings, House fee is deduced from  $S_h - \sum_{s \in \Omega} P_s B_s^h - D_h$  Where  $h$  is the period of household.

If we suppose the house fee is not contained in savings as below.

Simplified form for calculation (savings without real assets)

Max  $\mu(C_1, C_2) = 0$

$C_1 + \sum_{1 \in \Omega} P_1 B_1^h + D_1 = W_1$

$R_1 + C_2 + (1+r) \sum_{1 \in \Omega} P_1 B_1^h + (1+r_1)D^1 - (1+r) - \sum_{2 \in \Omega} P_2 B_2^h - D_2 = W_2$

Also,  $C_1 = (W_1 - S_1) + (S_1 - \sum_{1 \in \Omega} P_1 B_1^h + D_1)$

The first-order condition

$$\frac{\partial \mathcal{L}}{\partial C_1} = \mu'(C_1, C_2) - \lambda = 0$$

$$\frac{\partial \mathcal{L}}{\partial C_2} = \mu'(C_1, C_2) - \lambda = 0$$

$$\frac{\partial \mathcal{L}}{\partial D_1} \lambda = 0$$

$$\frac{\partial \mathcal{L}}{\partial D_1} - \lambda (1+r_1) = 0$$

$$\frac{\partial \mathcal{L}}{\partial D_2} \lambda = 0 \quad \mu'(C_1, C_2) = 0$$

$$\frac{\partial \mathcal{L}}{\partial \sum_{1 \in \Omega} P_1 B_1^h} - \lambda (1+r_1) = 0$$

$$\frac{\partial \mathcal{L}}{\partial \sum_{1 \in \Omega} P_1 B_1^h} \lambda = 0$$

$$\frac{\partial \mathcal{L}}{\partial r_1} = \lambda (\sum_{1 \in \Omega} P_1 B_1^h + D_1) = 0$$

In conclusion,  $\mu'(C_1, C_2) = 0$  (time indifference about consumption preference) is the same condition regardless of real assets whether it is contained in savings or not.

Consumption choice is not affected by the interest rate  $r_1$  for initial savings (same condition regardless of real assets whether is contained in savings or not) and summation of securities and deposits  $\sum_{1 \in \Omega} P_1 B_1^h + D_1$ . Evidently, this condition appears in this banking model when we ignore real assets which is most stable in the household economy and can be interpreted as the big portion expense and the intangible asset producing future benefits. Therefore, with the condition that real assets are contained in savings, we can explain the house economy affected by the proportion of securities and deposits.

First intention to choose the general equilibrium model in the paper is to offer understandable method to the academic field and professional field. In the practice, the reserve bank has many methods and even they want more methods together in the weighted way. As I can do, I am intending to use real variables than random variables and a lot of Lagrange methods which is very general way to use the general equilibrium. The saving composition matter is more specifically supported by the following empirical data.

The deposit amount traded is different depending upon factor composition of economic models. For example, the European Central Bank announces the Euro areas' deposit amounts for the 4th quarter in 2013 in the Euro areas. Gross saving amount of households is 2521.3 billion euros (growth rate: 2.4). Deposits by non-financial corporations are 1870.7 billion euros. (growth rate: 6.7). Deposits by Insurance corporations and pension funds (financial intermediaries) are 653.2 billion euros. (growth rate: -5.3). Deposits by other financial intermediaries are 1854.1 billion euros (growth rate -3.1). Deposits by government are 440.8 billion euros (growth rate: -1.8). Deposits by non-euro area residents are 2522.9 billion euros (growth rate: -11.2). Therefore, without consideration about deposits by non-financial corporations (1870.7), the comparison between deposits by household (2521.3) and deposits by financial intermediaries (653.2+1854.1=2507.3) is naive explanation.

Loans for house purchase is 3858.1 billion euros. (growth rate: 0.7). It is Long-term liability affecting the existence of household economy. In addition, the total (7341.7) of deposits by insurance corporations, pension funds (653.2, -5.3), other financial intermediaries (1854.1, -3.1), non-financial corporations (1870.7), government (440.8), non-euro area residents (2522.9) are. Also, total (7752.2) of deposits by household (2521.3, 2.4) and Loans for house purchase (3858.1, 0.7) and other loans (796.7, -1.6), consumer credit (576.1, -3.0) are.

Loans for house purchase (3858.1, 0.7) other loans (796.7, -1.6) consumer credit (576.1, -3.0)	(billion euros, growth rate) insurance corporations and pension funds (653.2, -5.3) other financial intermediaries (1854.1, -3.1) non-financial corporations are (1870.7, 6.7) government (440.8, -1.8) non-euro area residents (2522.9, -11.2)
total 7341.7	total 7752.2

Empirical balance when the capital of a household economy is concerned

Ref: European Central Bank, the 4th quarter in 2013

Savings  $S_h$  are the sum of Securities  $\sum_{s \in \Omega} P_s B_s^h$ , Deposits  $D_h$ , Real assets  $S_h - \sum_{s \in \Omega} P_s B_s^h - D_h$ . Households try to control the balance of assets and liabilities because in the situation of uncertainty, to maintain enough Deposits  $D_h$  for the economic existence of households, households need to invest on securities as of  $\sum_{s \in \Omega} P_s B_s^h$  posed on uncertainty conditions. Mainly, real assets imply the budget for houses which can afford to manage the residence and invested real assets. For example, if the household has an apartment and there is the redundancy after spending the investment on securities and deposits, it can be the maintenance fee for house decoration or big furniture purchases.

The importance of portion for houses is considerable. Otherwise, if real assets are negative, hence, savings of households are less than the amount of securities and deposits. Even though, the amount of operation in the household is enough with securities and deposits. In the conservatism on the house budget, we can consider the effect on housing. In the paper, Houses of households is considered as future economic assets that support each member of households to make productions.

Through the general equilibrium approach, the link from the bank problem to the household problem is naturally connected. Also, the following technical finding by usage of same accounts at the household problem induces direction of regulation on banks like

the portfolio analysis and initial GDP consideration. The following are technical findings with saving preference.

Suppose that  $\exists s \in \{G, B\}$ ,  $G=Good$ ,  $B=Bad$ . In the case 1, risk aversion is a  $s$  below. (resp. risk-taking case)

$$\Omega = \{G, B\}, C_1 + \sum_{s \in \Omega} P_s B_{s=B}^h + D^h + S_h - \sum_{s \in \Omega} P_s B_{s=G}^h - D^h = W_1$$

In this case, portfolio analysis should be detected by regulation because the situation can be changed depending on the status.

In the case 2, incompleteness preference can be considered.

$\Omega = \{G, B, \text{no choice}\}$ , no choice can be selected by the choquet expectation  $CEv(\mu(x)) = \min_{\Pi \in \text{core}(v)} E_{\Pi}(\mu(x))$  where  $\text{core}(v) = \{\Delta S : \Pi(A) \geq v(A) \text{ for all } A \subseteq S\}$   
 $C_1 + 0 + D^h + S_h - 0 - D^h = W_1$  and  $D^h$  offset, hence  $C_1 + \frac{C_2}{1+rh} = W$

Initial GDP is caused by partition of initial endowment that is combination of consumption set. Hence, regulation direction is originated from initial GDP in this case.

## 2. *Borrowing composition of Firms - Additional session is in the Part IV.6*

The firm chooses its investment level  $I$  and its financing (through Real Assets  $\sum_{s \in \Omega} P_s B_s^h + D_h$ , Liabilities to banks  $\sum_{s \in \Omega} P_s B_s^h + D_h - L_{fr}$  (Or Liabilities to central banks  $L_{fr}$ ) in a way that maximizes its profit:

$$\text{Max } \Pi_f(P_f)$$

$$\Pi_f = f(I) + r_f (\sum_{s \in \Omega} P_s B_s^h + D_h) - r_L^{\text{bank}} (D_h + \sum_{s \in \Omega} P_s B_s^h - L_{fr}) - r_L^{\text{fr}} L_{fr}$$

$$I = S_h = D_h + \sum_{s \in \Omega} P_s B_s^h$$

Where  $f$  denotes the production function of the representative firm.  $r_f$  is the premium of firm's real assets.  $r_L^{\text{bank}}$ ,  $r_L^{\text{fr}}$  are interest rates on bank loans and federal reserve bank loan.  $D_h$  denotes for bank deposits.  $B_h$  denotes for securities. Especially  $B_{fr}$  denotes for securities of federal reserve banks.  $L_{fr}$  are loans claimed by the firm to the federal reserve bank. For each future state of the world  $s$  ( $s \in \omega$ ), one can determine the price  $P_s$  of the contingent claim that pays one unit of accounts in a state  $s$  and nothing otherwise.  $I$  is the investment level and  $S_h$  denotes for savings.

**Interior Solution**  $P_f$  has an interior solution only when:  $r_f = r_L^{\text{bank}} = r_L^{\text{fr}}$

The Modigliani-Miller (MM) theorem projects a theme of a theorem on capital structure. The basic theorem states that, under a certain market price process (the classical random walk) and an efficient market, in the absence of taxes, bankruptcy costs, agency costs and asymmetric information, the value of a firm is unaffected by how that firm is financed. Firms are indifferent about the composition of borrowings. Given the proposition II of the Modigliani-Miller (MM) theorem, a higher debt-to-equity ratio

leads to a higher required return on equity because of the higher risk involved for equity-holders in a company with debt.  $r_E = r_0 + \frac{D}{E} (r_0 - r_D)$  where  $r_E$  is the required rate of return on equity or cost of equity,  $r_0$  is the company unlevered cost of capital (ie. Assume no leverage,  $r_D$  is the required rate of return on borrowings or cost of debt and  $\frac{D}{E}$  is the debt-to-equity ratio under two assumptions: (1) no transaction costs exist. (2) individuals and corporations borrow at the same rates. However, on the surface, given same ratios of  $\frac{D}{E}$ , two different sized banks are distortly interpreted. Even though this proposition is induced in the absence of the bankruptcy costs, merges of banks like “too big to fail”, so called “the size game among big banks, are considerable. Thus it is certainly worth inquiring D+E behind it’s apparent dynamics of  $\frac{D}{E}$ .

The BCR model provides a key with which to unlock riddles of firms’ borrowing compositions. The borrowing composition of firms imparted dynamics with the preference to maintain Real Assets  $\sum_{s \in \Omega} P_s B_s^h + D_h$ . Regardless of equilibrium, firms prefer to loan from central banks (so called as bonds) than commercial banks. Among the  $D_h$  and  $\sum_{s \in \Omega} P_s B_s^h$ , Firms prefer to have  $D_h$  because of financial stability and preference about certainty. The model reflects the tendency of banks toward the big size with Real Assets. In the economic existence respect of banks, banks have responsibility to operate the dynamics of the debt-to-equity ratio  $\frac{D}{E}$  and maintain the economic entity of Real Assets D+E in the economy of countries.

Given the firm’s problem, we have ambiguity about change of firms because of investments or loan status. Precise explanation about the relation with commercial banks and central banks should be offered. In the general equilibrium (GE), firms choose labor cost and manage the capital for production or business process but labor effect is hard to be clarified with certain connection of commercial banks and federal banks. Hence, the transaction like loan movements (i.e. liabilities to banks, liabilities to central banks, investments) can be selected to explain in this paper. Additionally, Investments is regarded as Real assets to support existence of business entities. It implies firms want to acquire investment budget to maintain real assets that can be requisite for existence of firms. Therefore, by having borrowing preference to have much more stability between liabilities to banks and central banks (so called as bonds), firms pursue to obtain stability to acquire the investment up to the stability of Investments which can be equal to Real Assets. Thus, we can explain dynamics of investments and loans with the firm’s property.

There are many arguments to explain the ambiguity of firms with informational asymmetry, shock absorbed by effective capitals, securities, technical shocks, and interest rates on loans and borrowing constraints.

Boyd-Chang-Smith (2004) points out two informational asymmetry problems of firms: The moral hazard problem arises because any borrower’s project choice is not observable. Also, the costly state verification (CSV) problem arises because, for either type of projects, the return of investments cannot be freely observed by any agent other than the project owner.

In the Nelson-Pinter (2012) model, at the production function of cobb-douglas standard form, there is a shock variable to the quality of physical capitals. When we face the unanticipated exogenous declines in the productive capacity of physical capitals, available “Effective capitals” for use in the production is diminished. This intends to

consider the effect on banks since banks hold claims on physical capitals directly on their balance sheets, this will be loss for banks, which must be absorbed or passed on to outside creditors.

In the Dewatripont-tirole (2012) model, he argues that securities are characterized not only by income rights but also by control rights. Optimal corporate choices are the time-inconsistency. Investors in control of corporate choices must face an incentive that differs from firm-value maximization. So a banking manager has no financial resources to cover an investment cost and turns to investors for financing. The capital structure - that is, the allocation among investors of contingent cash-flow and control rights - is designed at this financial stage.

Covas Fujita (2010) mentioned that the technology shock is distributed as standard normal distribution. Labor and capital rental markets are assumed to be competitive.

Diaz (2005) thinks that since interest rates on loans are greater or equal than the discount rate, firms prefer to use internal sources (i.e. cash flows) rather than external financing. In addition, he induces that capital depreciation is paid out of firm's cash flow and net investment is entirely financed with debting. In the model of Nuno-Thomas (2013), they assumed that the firm can only borrow from banks located on the same island.

In the static model of general equilibrium (GE), if we know the GDP endowment as the exogenous factor, we can calculate more at the firm's problem. Indeed, the analysis about GDP like Consumption to GDP, Government Expenditure to GDP, Fixed Capital Formation to GDP, Export to GDP, Net Export to GDP, Money to GDP except for inflation rate and nominal interest rate are used with the general equilibrium (GE) approach.

The effort to figure out ambiguity of firms and overall perspective analysis display a coherent structural and compositional understanding. Then, how we can measure the firm's productivity relating to the banking area in general equilibrium (GE)? The classical viewpoint that there are three basic factors of production, (land, labor and capital) at the production function. Total-factor productivity (TFP) is different from the traditional calculation measured by inputs of labor and capital. The TFP calculation is measured as a Solow residual affecting in total output and not caused by inputs. The equation  $Y = A \times K^\alpha \times L^\beta$  in Cobb-Douglas form represents total output (Y) as a function of total-factor productivity (A), capital input (K), labor input (L), and the two inputs' respective shares of output ( $\alpha$  and  $\beta$  are the capital input share of contribution for K and L respectively). The problem is that units of A do not admit a simple economic interpretation. We have two ways to calculate TFP (Chen, 2011). Firstly, we obtain the TFP measurement by estimating a production function. Secondly, we establish a model to find the determinant of TFP and uncover whether financial factors exert any effects on TFP. Materials and energy are secondary factors because they are from land, labor and capital.

It can be puzzled whether duplicated or missed amounts are existed in the general equilibrium (GE). The equity portion as capitals is in the liabilities of firms and the wage portion as expense is in the eliminated account of firms. With this production function measure, we are talking about the exact asset amount of firms that is the part of equity at the same time. Let's go back to the definition of the production function. Factors of production are inputs to the production process. Finished goods are the

output and the relationship of input and output is the production function. The important point is that we cannot exaggerate too much about money. Indeed, the classical viewpoint is that money is not contained in capital because it is not directly produce any good so it is hard to be related to consumptions of goods at the problem of household.

In the paper, firstly, we are focusing on “capital” including the “financial capital.” Financial capital is raised to operate and expand a business and it is net worth (assets minus liabilities) including money borrowed from others. Originally, “Capital” means goods that can help produce other goods in the future, the result of investment. Considering a labor is not realistic because the number of employees at the firm is hard to be considered at the banking problem. Already we consider equity (asset-liability) is the result after considering labor cost. Redundant firm size variable can evoke the biased information if we pursue obtain the general equilibrium (GE) in this model. It's true that wage is the large portion of input at the firm and should be considered distinguishably. However, for the special industry like banking, we need to clarify needed variables to figure out the problem in the academic field for future and in the realistic world for present.

If we contain banks and federal banks in the banking model, we add the real asset variable. It implies the capital concept is naturally inducing the working capital concept. Adding the shock variable to the quality of physical capital (Nelson-Pinter 2012, Gertler-Karadi 2011, Gertler-Kiyotaki 2010) is hard to be measured and needed to be predicted with a lot of unexpected uncertain situation.

Also, the conservative business cycle is deduced. If we assume that multiplier  $\mu$  exists,  $\mu(D_h+B_h)>D_h+B_h-L^{fr}>L^{fr}$ . This assumption exactly reflects the preference of safer capital type like real assets > a government bond (lower interest rate on a bond than a loan) > a loan.

### 3. Demand Deposit of Bank

**Scope of Bank** Domestically chartered commercial banks, country branches and agencies of foreign banks, Edge Act corporation.

The bank chooses its supply of loans to firms  $D_h+B_{fr}+L_{fr}$ , its demand for deposits  $D_h$ , and the borrowing  $B_{fr}-L_{fr}$  in a way that maximized its profit:

$$\begin{aligned} & \text{Max } \Pi_b(P_b) \\ & \Pi_b = r_L^{\text{Bank}}(D_h + \sum_{s \in \Omega} P_s B_s^h - L_{fr}) - r_{Lfr}(\sum_{s \in \Omega} P_s B_s^{fr} - L_{fr}) - r^D D^h \end{aligned}$$

where  $r_L^{\text{Bank}}$ ,  $r_{Lfr}$  are interest rates on bank loans and federal reserve bank loan.  $D_h$  denotes for bank deposits.  $r_D$  is the interest rate paid by deposits.  $B_s^h$  denotes for securities. Especially  $B_s^{fr}$  denotes for securities of federal reserve banks.  $L_{fr}$  are loans claimed by the firm to the federal reserve bank.

The bank maximizes the profit by choosing its supply of loans  $L^+$ , its demand for deposits  $D^-$  and the issuance  $\sum_{s \in \Omega} P_s B_s^b$ .

$$\begin{aligned} & \text{Max } \Pi_b(P_b) \\ & \Pi_b = r_L L^+ + r \sum_{s \in \Omega} P_s B_s^b - r^D D^- L^+ = \sum_{s \in \Omega} P_s B_s^b + D^- \end{aligned}$$

The part of banks' problem provides a context which capital circulation within banks is required by other main factors of economy. The problem of banks is presented without equities of banks in fairly balanced debits and credits of banks. This main issue has been to handle the demand deposit in the banking area and it related to the money supply closely. In the data of Board of Governors of the Federal Reserve System, demand deposit and money stock data have been collected from Demand Deposit, Currency and Related items (J.3, Semi monthly) in 1960 to Money Stock Measures in 2012.

Under the fractional reserve banking, deposit is important indicator for economy because of money multiplier effect. In the formula of  $\text{moneysupply} = \text{currency} + \text{deposits}$ , demand deposit which has highest liquidity among deposits on the balance sheet of banks is directly related to the M1 of central banks. Diamond and Dybvig model (1983) explains why bank runs occur at an undesirable equilibrium and why banks issue demand deposits that are more liquid than their assets by providing better risk sharing among people who need to consume at different random times. The key to describe the rationality both for the existence of banks and for their vulnerability to runs is the illiquidity of assets, especially by the demand deposit. His conclusion on the bank runs as better indicator of economic distress than money supply is too quick because there is the duplicated section of deposits and money supply. A bank run is the sudden withdrawal of deposits of just one bank and money supply contains the currency section.

In case of bank runs, the government of country should prepare the recovery solution for economy. Regularly, given information about money supply, the government can figure out about both moving of currency and deposits. Krugman (2006) points this out that deposits are usually considered part of the narrowly defined money supply, as they can be used, via checks and drafts, and a means of payment for goods and services and to settle debts. The money supply of a country is usually held to consist of currency plus demand deposits. In most countries, demand deposits account for a majority of the money supply. To explain the correlation between deposit (demand deposit) and money supply, bank runs can be interpreted as the sudden constraint of deposit and money supply. We research on indicators of economic crisis so economic crisis is not the indicator to analyze the status of economy.

Gorton and Pennacchi (1990) assume that the uniqueness of demand deposits roles as a desirable medium of exchange so the existence of demand for privately produced riskless trading securities induces issuing demand deposits by banks. Actually, under the fractional reserve banking, a bank deposit is not a bailment that implies physical possession of personal property. It moves safely upon the banking revenue process.

Firstly, the property of customer was deposited. In turn, the customer receives an asset called the deposit account. Finally, the deposit account is the liability of the bank on its balance sheet. On the balance sheet of Liabilities of all commercial banks in the United States (2014.01), 70% is the deposit account. The circulation of deposits is important in economy. David Vanhoose (2010) categories the deposit into three sections like transaction deposit, large-denomination time deposit, saving deposits and small-denomination time deposits, at the United States commercial bank liability and equity capital. Transaction deposit contains non-interest-bearing demand deposits. Transaction deposit is 6% among total liabilities and equity capital of bank balance sheet.

Dewatripont-Tirole (2012) points out that deposit insurance is the prevention of banks runs following the Diamond-Dybvig (1983).



In the model of Boyd-Chang-Smith (2004), even though project return is safe because of a large number of borrowers, he assumes possibility for banks to fail.

Regardless of a single borrower and aggregate of borrower, potential bankers can suggest needless to operate the bank.

In the model of Covas-Fujita (2010), the bank can raise funds through either deposits or equity so holding equity involves the equity issuance cost.

Diaz model (2005) also tries to select the considerable sources. For example, firms only source of financing is bank lending the bank can claim the full amount of firm's cash flow. The equity of banks moves under upper limit of dividend (under the hypothesis that the bank can turn equity into dividend with restriction) because of balance sheet constraint.

Goodhart-Kashrap-Tsomocos (2012) mentioned shadow banking. The securitized loans, called mortgage backed securities (MBS) can be sold to the non-bank and the non-bank will finance the purchase with a repo loan from the bank (that will have the MBS as collateral)

#### 4. Federal Reserve Banks and general equilibrium (GE)

The Federal Reserve Bank chooses its investment level  $I$  and its financing (through real assets  $D_h + \sum_{s \in \Omega} P_s B_s^h$ , Liabilities to bank  $D_h + \sum_{s \in \Omega} P_s B_s^h - L_{fr}$  (or Liabilities to central bank  $L_{fr}$ ) in a way that maximizes its profit:

$$\text{Max } \Pi_b(P_b)$$

$$\Pi_f = f(I) + r_f(D_h + \sum_{s \in \Omega} P_s B_s^h) - r_L^{\text{Bank}}(D_h + \sum_{s \in \Omega} P_s B_s^h - L_{fr}) - r_L^{\text{fr}} L_{fr}$$

$$I = S_h$$

Where  $f$  denotes the production function of the representative firm.  $r_f$  is the premium of firm's real assets.  $r_L^{\text{Bank}}$ ,  $r_L^{\text{fr}}$  are interest rates on bank loans and federal reserve bank loan.  $D_h$  denotes for bank deposits.  $B^h$  denotes for securities. Especially  $B^{\text{fr}}$  denotes for securities of federalreserve banks.  $L_{fr}$  are loans claimed by the firm to the federal reserve bank. For each future state of the world  $s$  ( $s \in \Omega$ ), one can determine the price  $P_s$  of the contingent claim that pays one unit of account in state  $s$  and nothing otherwise.  $I$  is the investment level and  $S_h$  denotes for savings.

Interior Solution  $P_f$  has an interior solution only when:  $r_f = r_L^{\text{Bank}} = r_L^{\text{fr}}$

#### 5. General Equilibrium (GE)

General equilibrium (GE) is characterized by a vector of interest rates ( $r, r_D, r_h, r_f, r_L^{\text{Bank}}, r_L^{\text{fr}}$ ) and three vectors of demand and supply levels ( $C_1, C_2, \sum_{s \in \Omega} P_s B_s^h, D^h$ ) for the consumer,  $(I, \sum_{s \in \Omega} P_s B_s^h, D^h, L_{fr})$  for the firm,  $(L_{fr}, \sum_{s \in \Omega} P_s B_s^h, D_h, \sum_{s \in \Omega} P_s B_s^{\text{fr}})$  for the bank and  $(D_h, \sum_{s \in \Omega} P_s B_s^h, L_{fr})$  for federal reserve banks.

Each agent behaves optimally. (i.e., his or her decisions solve  $P_h, P_f$  or  $P_b$  respectively.

Each market clearing

$I = S$  (Good market)

$D_h(\text{Firm}) - D_h(\text{Firm}) + D_h(\text{Household}) - D_h(\text{Household}) + D_h(\text{Bank}) - D_h(\text{Bank})$

(Deposit market)

$L_{fr}(\text{Firm}) - L_{fr}(\text{Firm}) - L_{fr}(\text{Bank}) + L_{fr}(\text{Firm}) + L_{fr}(\text{FR:Federal Reserve Banks}) - L_{fr}$

(FR) (Credit Market)

$$B_s^h(\text{Firm}) - B_s^h(\text{Firm}) + B_s^h(\text{Household}) - B_s^h(\text{Household}) + B_s^{\text{fr}}(\text{Bank}) - B_s^{\text{fr}}(\text{Bank}) + B_s^{\text{fr}}(\text{FR}) - B_s^{\text{fr}}(\text{FB}) (\text{Financial market})$$

It is clear in this model that the only possible equilibrium is such that all interest rates are equal:  $r = r_L = r_D$

### Each Market Clearing

$I=S$  (Good Market)

$D_{\text{Firm}} - D_{\text{Firm}} + D_{\text{Household}} - D_{\text{Household}} + D_{\text{Bank}} - D_{\text{Bank}}$  (Deposit market)

$L_{\text{Firm}} - L_{\text{Firm}} + L_{\text{Bank}} + L_{\text{FR}} - L_{\text{FR}}$  (Credit Market)

$B_{\text{Firm}} - B_{\text{Firm}} + B_{\text{Household}} - B_{\text{Household}} + B_{\text{Bank}} - B_{\text{Bank}} + B_{\text{FR}} - B_{\text{FR}}$  (Financial Market)

Firms		Households	
Assets	Liabilities	Assets	Liabilities
Real Asset $D_h + B_h$ (=Investment I)	Liabilities to banks $D_h + B_h - L_{fr}$ Liabilities to central bank $L_{fr}$	Securities $B_h$ Deposits $D_h$ Real Asset $S_h - (B_h + D_h)$	Savings $S_h$
Banks: domestically chartered commercial banks, country branches and agencies of foreign banks, Edge Act corporation		Federal Reserve Banks	
Assets	Liabilities	Assets	Liabilities
Claims to corporate $D_h + B_h - L_{fr}$	Deposits $D_h$ Borrowing $B_{fr} - L_{fr}$	Claims to corporate $L_{fr}$ Currency $C_r$ Borrowing to banks $B_{fr} - L_{fr}$	Securities $B_{fr}$

(result) Arrow (1953)

If firms and households have unrestricted access to perfect financial markets, then at the competitive equilibrium, banks make zero profit and the size and composition of balance sheet (banks) have no impact on other economic agents.

(result) Cho (2014)

If some accumulated variables are not negative, for example, the components Investment I, Savings  $S_h$ ,  $L_{fr}$  are not negative, there is the equilibrium in the economy and the existence of each factors like firms, Households, Banks, Federal Reserve Banks is fulfilled. The size of banks is affecting on each agent because equity capitals depend on previous deposits (*additional explanation in Part IV, 7*). Depending the change of bank size influencing on total deposits  $D_h$ , the liability of firms is affected by liabilities to banks  $D_h + \sum_{s \in \Omega} P_s B_s^{\text{fr}} - L_{fr}$ , deposits of household  $D_h$  and real assets of households and firms. This is supported by the following the process of equity capital multiplication.

## Part IV Effects of Equity Capital Regulation

### *6. Additional explanation about the borrowing composition of firm's problem – The portfolio composition effected by the minimum equity capital regulation.*

In the model of Kahane (1977), the minimum capital requirement causes an unintended result: it worsened, rather than improved the intermediary's condition and increases its probability of ruin. He checks this calculation with the ruin constraint and given standard deviation of rate of return at the portfolio composition of liability, stock and bonds.

In this paper, with the portfolio of risky portfolio and stable portfolio, explanation will be easier to be understood why minimum equity regulation induces for banks to operate riskier portfolio. In addition, it intends to reduce pro-cyclicality (to the financial shocks) and promote the countercyclical buffer.

If we assume that the bank manages a risky portfolio with an expected rate of return of 17% and a standard deviation of 27%. The expected rate of return on equity is 7% and even though, there is pressure to raise the required equity every period, liability is same every period. The bank tries to meet the bank capital condition regulated by financial intermediaries so the bank should operate much more risky portfolio comparing to the previous period as following.

Effects of increasing the equity at the portfolio composition

Period	Required Equity, Liability	Portfolio composition (risky portfolio, stable portfolio)
1	12 (12%), 88(88%)	(-61.6%, 161.6%)
2	13 (13%), 88(87.12%)	(-61 %, 161 %)
3	14 (14%), 88(86.72%)	(-60.4 %, 160.4 %)

To calculate the portfolio composition, we calculate the expected value (Mean).

$$\text{Mean } 0.12(12/100) \times 0.07 + 0.88 \times 0 = 0.0084$$

$$0.1287(13/101) \times 0.07 + 0.8712 \times 0 = 0.0090$$

$$0.1372(14/102) \times 0.07 + 0.8672 \times 0 = 0.0096$$

Suppose that the bank decides to invest in the portfolio having a proportion Y of the total investment budget so that the overall portfolio will have an expected rate of return as above.

We know an expected rate of return of a risky portfolio  $R_p$  is 17% and an expected rate of return of a stable portfolio is 7%. Hence, we get the risky portfolio proportion Y.

$R_f + (R_p - R_f) \times Y$	Proportion Y
$0.07 + 0.1 \times Y = 0.0084$	-0.616
$0.07 + 0.1 \times Y = 0.0090$	-0.61
$0.07 + 0.1 \times Y = 0.0096$	-0.604

Thus, in order to obtain a mean return of 0.84%, 0.90%, 0.96%, the bank must invest -61.6%, -61%, -60.4 of total funds in the risky portfolio and 161.6%, 161%, 160.4% in stable portfolio.

Standard deviation that implies the probability, to get mean of returns, is also increasing.

Standard Deviation

$$0.12 \times 0.27 = 0.0324$$

$$0.13 \times 0.27 = 0.0351$$

$$0.14 \times 0.27 = 0.0378$$

## 7. Previous deposit affects optimized equity capital

n	Deposits	Borrowings	OptimizedEquityCapital
n = 0	$D_0 = 1$	-	-
n = 1	$D_1 = (1 - \beta - K)$	$B_1 = (1 - \beta)$	$OEC_1 = K$
n = 2	$D_2 = (1 - \beta - K)^2$	$B_2 = (1 - \beta)(1 - \beta - K)$	$OEC_2 = K(1 - \beta - K)$
n = 3	$D_3 = (1 - \beta - K)^3$	$B_3 = (1 - \beta)(1 - \beta - K)^2$	$OEC_3 = K(1 - \beta - K)^2$
...	...	...	...
n = k	$D_k = (1 - \beta - K)^k$	$B_k = (1 - \beta)(1 - \beta - K)^{k-1}$	$OEC_k = K(1 - \beta - K)^{k-1}$
...	...	...	...
n $\rightarrow \infty$	$D_\infty = 0$ total deposits	$B_\infty = 0$ total borrowings	$OEC_\infty = 0$ total optimized equity capital
	$D = \frac{1}{K + \beta}$	$B = \frac{1 - \beta}{K + \beta}$	$\frac{K}{K + \beta}$

[ $\beta$  = restriction of borrowing] Then, Borrowings can be executed between Deposit 1 and Restriction  $\beta$

[Balance sheet equality constraint]  $D_n = B_n - OEC_n$

Hart and Jaffee (1974) analyzed the properties of the feasible and efficient set with the assumption that the initial equity capital is zero (i.e.  $K=0$ ). However, it is possible that the intermediary's equity is zero in the substantial degree of leverage (high liabilities to equity ratios  $\frac{EquityCapital}{Dh+Bfr+Lfr}$ ). Then, we should assume that the equity is negligible.

In the paper as the same as KAHANE (1977), we assume the equity is positive ( $K > 0$ ) so that the opportunity set does not pas through the origin (i.e. the vector of Deposit D, Borrowing B, Optimized Equity Capital = 0 give an infeasible solution).

Then theoretical superior limit for deposits is defined by the following:

$$\text{Deposits} = \sum_{n=0}^{\infty} (1-K-\beta) = \frac{1}{K+\beta}$$

Theoretically, superior limit for the equity capital by the firm is defined by the following:

$$\text{OptimizedEquityCapital} = K \times \text{Deposit} = \frac{K}{K+\beta}$$

And the theoretical superior limit for total borrowings in banks is defined by the following:

$$\text{Borrowings} = (1-\beta) \times \text{Deposits} = \frac{1-\beta}{K+\beta}$$

The process described above by the geometric series can be represented, where Borrowings at stage k are a function of deposits at the precedent stage:

Optimized Equity Capital at stage k is a function of the deposits at the precedent stage:  
 $\text{OEC}_k = K \times D_{k-1}$

Hence, if the optimized equity capital depends on the initial deposit and assume the terminal condition of bank is liquidation of bank deposits.

(result) Hence, Optimized Equity Capital depends on the previous deposit. In addition, deposit insurance cost also increases because deposit insurance depends on the number of household.

Deposits at stage k are the difference between additional borrowings and optimized equity capital relative to the same stage:  $D_k = B_k - \text{OEC}_k$

In the model of Gorton-Winton (1995), bank size is given. In the theorem of Modigliani-Miller, the size and composition of banks' balance sheets have no impact on other agents. However, as population grows, insured deposits will increase. Then, the bank size should grow so bank size growth concern should be measured.

#### 8. *K index for the indicator of risk taking*

Define the equity capital ratio with respect to total liabilities and equity capital,  $\frac{\text{EquityCapital}}{Dh+Bfrr-Lfrr}$ ,  $K \in (0,1)$ , the borrowing (from federal banks) ratio  $\frac{Bfrr-Lfrr}{Dh+Bfrr-Lfrr}$ ,  $\beta \in (0,1)$ . Suppose the demand for funds is unlimited, by summing up two quantities, the theoretical equity capital multiplier is defined as:

$$k = \frac{\text{Deposits} + \text{OptimizedEquityCapital}}{\text{Borrowings} + \text{OptimizedEquityCapital}} = \frac{1+K}{K+\beta}$$

where the equity capital ratio with respect to total liabilities and equity capital,  $\frac{\text{EquityCapital}}{Dh+Bfrr+Lfrr}$

k is the index to decline to increase the risk at the portfolio of commercial banks. The deposit is fixed at total 1 and borrowings have the constraint cannot be negative value beyond the minimum borrowings  $\beta$ . For example, if deposit=1, the minimum of required equity = 10%, borrowings = 0.3.

$$\frac{1+0.1}{0.3+0.1} = \frac{1.1}{0.4} = 2.75$$

If the minimum of required equity is raised from 10% to 15%, k index was as below:

$$\frac{1+0.15}{0.3+0.15} = \frac{1.15}{0.45} = 2.55$$

To increase the k index, the bank should increase the deposit beyond the initial deposit level (1 in this simulation) or allocate the borrowing portfolio.

## 9. Conclusion

The minimum capital requirement is a necessary condition for banking sector stability to raise the quality, consistency and transparency of the capital base. However, it has friction with the portfolio management. By using effects of increasing the equity at the portfolio composition, reducing pro-cyclicality (to the financial shocks) and promoting the countercyclical buffer are pursued.

In the Basel 3 system, the risk coverage framework intends to capture all material risks by using counterparty credit risk formula weighted on the external rating of the counter party. Exposure measures contain on-balance sheet, repurchase agreements and securities finance, derivatives and off-balance sheet (OBS) items. In the paper, rather than enlarging the risk contagion, related factors and risk affection scope are detected without overstatement by using the general equilibrium (GE) model and deposit affection to the optimized equity capital. Deposits are in the large portion at the household, firm and banks. To explain risk coverage, by proving correlation of optimized equity capital upon the previous deposit level, the paper aims to ensure that banking-sector- capital requirements take account of the macro-financial environment in which each substantial economic entity operates.

Basel 3 introduced a minimum leverage ratio. The leverage ratio was calculated by dividing Tier1 capital by the bank's average total consolidated assets. In the paper, k index is suggested as the indicator of risk taking. Within the liability, three major fractions like deposits, borrowings and optimized equity capital are considered as the complementary of minimum capital requirement. Assets of commercial banks are mainly consisted with loans and securities. Because the optimized equity capital grows and deposits is restricted by change. Borrowings that are the difference between asset and deposit+equity capital should be checked whether borrowings cover the optimized equity by k index or not.

The combination of portfolio composition test, deposit-equity optimization and k index enables bounding the bank capital regulation problems.

## 10. Reference

- Boyd, J., Chang, C. and Smith, B. (2004). Deposit insurance and bank regulation in a monetary economy: a general equilibrium exposition. *Economic Theory*, 24(4), pp.741-767.
- Bullard, J. and Waller, C. (2004). Central Bank Design in General Equilibrium. *Journal of Money, Credit, and Banking*, 36(1), pp.95-113.
- Christensen, I., Meh, C. and Moran, K. (n.d.). Bank Leverage Regulation and Macroeconomic Dynamic. *SSRN Journal*.
- Covas, F., Fujita, S. (2010). *Procyclicality Of Capital Requirements In a General Equilibrium Model of Liquidity Dependence*, International Journal of Central Banking. P.143, P.161.
- Dewatripont, M. and Tirole, J. (2012). Macroeconomic Shocks and Banking Regulation. *Journal of Money, Credit and Banking*, 44, pp.237-254.
- Diamond, D. and Dybvig, P. (1983). Bank Runs, Deposit Insurance, and Liquidity. *Journal of Political Economy*, 91(3), p.401.
- Diaz, R. A. (2005) *General Equilibrium Implications Of The Capital Adequacy Regulation For Banks*. P.12, P.15, P.26.
- European Central Bank. 2.5 Deposits held with MFIs. retrieved from <http://sdw.ecb.europa.eu/reports.do?node=100000145>.
- Freixas, X. (1997). *Microeconomics of banking*. Cambridge, Mass.: MIT Press.
- Goodhart, C., Kashyap, A., Tsomocos, D. and Vardoulakis, A. (n.d.). Financial Regulation in General Equilibrium. *SSRN Journal*.
- Gorton, G. and Pennacchi, G. (1990). Financial Intermediaries and Liquidity Creation. *The Journal of Finance*, 45(1), pp.49-71.
- Haslag, J. H. (2001) *On Fed Watching And Central Bank Transparency In An Overlapping Generations Model*. Federal Reserve Bank Of Dallas. P.5.
- Jenter, D. (2003) *MIT Sloan Lecture Notes, Finance Theory II*.
- Kahane, Y. (1977). Capital adequacy and the regulation of financial intermediaries. *Journal of Banking & Finance*, 1(2), pp.207-218.
- Kaufman, G. G, Scott, K. E (2003) *What Is Systemic Risk, and Do Bank Regulators Retard or Contribute to it?*. the Independent Review, P.171. Hendricks, D. (2009) Defining Systemic Risk, Briefing Paper No1. the Pew Financial Reform Project.
- Kemmerer, D., Friedman, M. and Schwartz, A. (1964). A Monetary History of the United States, 1867-1960. *The American Historical Review*, 70(1), p.195.
- Kim, J. (2011). *Milestones About Financial Risk and Basel 3*. Korea Reserve Bank, Seoul. South Korea. retrieved from <http://public.bokeducation.or.kr/ecostudy/fridayView.do?btNo=4553>.
- Krugman, P. and Wells, R. (2006). *Economics*. New York: Worth Publishers.
- Lucas, D. (1995). Comment on Financial Intermediation and Monetary Policy in a General Equilibrium Banking Model. *Journal of Money, Credit and Banking*, 27(4), p.1316.
- Modigliani, F., Miller, M. (1958) *The Cost of Capital, Corporation Finance and the Theory of Investment*. American Economic Review. P.261-297.
- Nelson, B., Pinter, G. (2012) *Macroprudential Capital Regulation In General Equilibrium*. P.14.
- Nuno, G., Thomas, C. (2013) *Bank Leverage Cycles*. P.7. H6. *Money Stock Measures*. retrieved from <http://www.federalreserve.gov/releases/h6/>.
- Slovik, P., Cournède, B. (2011) *Macroeconomic Impact of Basel III*. OECD Economic Department Working Papers. OECD publishing.
- Thaler, R. H. (1997) Irving Fisher: *The modern Behavioral Economist*. American Economic Review.
- VanHoose, D. (2010). *The industrial organization of banking*. Berlin: Springer.