Implications Of The Risk-Based Capital Requirements Of Implicit Recourse In Asset Securitizations In The Banking Industry

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ABSTRACT

We consider implications of the risk-based capital requirements of implicit recourse in asset securitizations. These implications include issues in finance such as risk management and contracting between counterparties. The first part of our analysis deals with asset securitizations where originating institutions provide investors with implicit recourse. We show that the risk-based capital requirements associated with the new regulatory definition of implicit recourse may discourage some banks from offering implicit recourse in their asset securitizations. This suggests that the new regulatory definition of implicit recourse may be a workable compromise between supervisory regulators and originating institutions. We then consider a scenario where banks enter into reinsurance contracting with banks in other regions to mitigate some regional economic risks. These reinsurance contracts may enable banks to improve the performance of their balance sheet assets. Although we find weak correlation among equity returns for regional banks, future high correlation among bank portfolios could pose a problem to regulators because when a bank gets into financial distress this may spill over to other network banks. Widening yield spreads in asset securitizations might serve as an early warning signal of financial distress. Thus, regulators might devote more supervisory resources on originating institutions when their asset securitization yield spreads widen.

INTRODUCTION

In competing for depository funds within the banking industry and with mutual funds, banks provide implicit interest by providing their customers with check processing and other services. Banks may also pay explicit interest on time deposits or by sweeping out demand deposit funds into accounts that pay interest overnight. Historically banks have used deposits as the primarily source of funds for loans. Banks have also issued debt as well as equity. Advances in technology and regulatory changes have spurred asset securitizations as an alternative source of funds for bank loans. Banks securitize loans by employing a trust that receives the cash flows resulting from the pool of securitized loans. Investors then receive the cash flows from the executor of the trust.

Originating institutions may like to stand behind their asset securitizations to protect the low-cost source of funds just as manufacturers provide warranties for their products in order to achieve better prices. Originating institutions may provide buyers of their securitized assets with credit enhancement to protect them from credit losses. The credit enhancement may exceed the contractual obligations of the originating institutions. Consequently, originating institutions may retain significant credit risk. The retained risk of credit losses concerns regulators.[1]

[1] Implicit recourse is a supervisory concern because originating institutions may securitize assets without any explicit recourse in order to remove these assets from their balance sheets so that they will not have to allocate any risk-based capital to these assets. However, implicit recourse

We consider implications of the risk-based capital requirements of implicit recourse in asset securitizations in the banking industry. These implications include issues in finance such as risk management and contracting between counterparties. We perform our theoretical analysis by solving a bank manager's utility maximization problem.

We analyze asset securitizations where originating institutions provide investors with implicit recourse. We show that the risk-based capital requirements associated with the new regulatory definition of implicit recourse may discourage some originating institutions from offering implicit recourse in their asset securitizations. This suggests that the new regulatory definition of implicit recourse may be a workable compromise between supervisory regulators and institutions that originate asset securitizations.

We then analyze a scenario where banks securitize their assets without offering implicit recourse. The banks engage in reinsurance contracting with banks in other regions to mitigate some regional economic risks. Under such a contract, a bank purchases some amount of receivables from a bank in another region during a period of weak economic conditions in the home region in exchange for granting a similar right to the counterparty. This risk management arrangement enables banks to improve the performance of their balance sheets assets.

According to our limited data, we find weak correlation among equity returns for regional banks. The commingling of securities by network banks may not be a pressing regulatory concern now, but equity returns from regional banks might become highly correlated in the future due to existing incentives, for example, performance based stock options for managers. Bank managers may commingle bank securities in order to increase the returns on the banks' assets. When banks get into financial distress, they may not be able to securitize their assets easily. They may need to pay higher yield spreads, but higher yield spreads may cause banks to lose liquidity. Consequently, their asset securitizations funding may seize up. An implication of this is that regulators may use widening yield spreads in asset securitizations as an early warning signal of financial distress. Indeed, when this scenario occurs, regulators might devote more supervisory resources to such originating institutions.

Our work complements the work of Greenbaum and Thakor (1987) and Gorton and Pennacchi (1995). Greenbaum and Thakor argue that better quality assets will be sold to investors, and poor quality assets will be funded by deposits. Gorton and Pennacchi consider incentive-compatible sales of bank loans, where a bank offers buyers some implicit support against default. They argue that investors are willing to buy the bank's securities. We show that the new regulatory definition of implicit recourse in asset securitizations may discourage some originating institutions from offering implicit recourse in the asset securitizations. This suggests that the new regulatory definition of implicit recourse may achieve some desired effects. We then consider a scenario where asset securitizations may be used in risk management of balance sheet assets. By entering into reinsurance contracting with counterparties in other regions, banks may improve the performance of their balance sheet assets. Other related work to ours includes the work of Hiemstra, Jacques, and Kane (1998) and Cohen and Kane (2003) who argue that risk-based capital requirements are a tax on low-risk assets. They suggest that asset securitizations are a regulatory arbitrage loophole that is used to mitigate risk-based capital requirements. Johnson (1999) argues that asset securitization may lower the cost of providing consumer loans, and they may reduce the costs of borrowing by consumers.

We have organized the paper as follows. Section 2 provides some background information about asset securitizations. Section 3 provides our analysis of implications of the new regulatory definition of implicit recourse in asset securitizations. Section 4 concludes the paper.

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suggests that an originating institution may still be assuming some of the risk associated with their securitized assets (Board of Governors of the Federal Reserve System, 2002).

ASSET SECURITIZATIONS

Asset securitizations are a means of funding loans, managing balance sheet assets, generating fee income, and so forth. Asset securitization shares are sold to the public.[2] The shares represent ownership in a securitization trust. The trust receives cash flows from the asset servicer who collects the proceeds generated by the underlying assets, for instance, principal and interest payments resulting from bank loans. The trust then distributes the proceeds to the investors. When assets are sold without recourse by an originating institution, the originator may remove the securitized assets from its balance sheet to reduce risk-based capital requirements. Securitized assets include mortgage loans, automobile loans, credit card receivables, truck leases, trade receivables, student loans, and other assets with predictable cash flows. Asset securitization agreements tend to be for a period of one year to three years.

In the United States, we observe that large regional banks and money centers[3] take advantage of asset securitizations. Credit underwriting, collection procedures and other system capabilities are necessary for an originating institution to securitize its assets. Small banks may receive less benefit from asset securitizations because these capabilities may entail large fixed costs. Small banks may pool their asset securitizations to benefit from economies of scale. However, pooling asset securitizations reduces the incentive for originating institutions to provide investors with credit enhancement, because many originators share the benefits. Nevertheless, a small bank may still accomplish asset securitizations through a big correspondent bank that enjoys economies of scale. The bigger bank may charge the small bank a fee for facilitating its asset securitization. The bigger bank may also purchase the securities of the small bank at a discount. Such correspondent relationships are similar to a big bank facilitating check processing and credit card processing for a small bank.

Originating institutions, investors, and guarantors share the risk of credit losses in asset securitizations. Asset securitizations also involve other risks, such as reputation risk, liquidity risk, and the risk of capital adequacy during the life of the securitized assets.

Originating institutions may provide investors with credit enhancement through contractual obligations that protect buyers of their securitized assets from incurring some level of credit losses. This type of credit enhancement constitutes contractual recourse. Examples include retained subordinated interest, excess spread accounts, cash collateral accounts, over collateralization, and asset repurchase obligations. Generally, the regulatory capital adequacy guidelines require an originating institution to hold risk-based capital against the outstanding amount of the securitized assets (OCC et al, 2002). The regulatory guidelines provide three exceptions to this general rule.

Under the low-level of credit loss exposure provision, the risk-based capital requirements for credit arrangements with recourse are limited to the maximum contractual loss exposure. For example, if an originating institution sells $100 worth of credit card loans, the risk-based capital requirement is 8 percent of $100 or $8. Suppose that the originating institution retains $4 of credit loss exposure. Under the low-exposure of credit loss provision, the required amount of capital to hold against this credit loss exposure is only $4.

Under the rating-based approach, the risk-based capital requirement for a residual interest or some other recourse is based on its relative risk of credit loss. The face amount is multiplied by a risk weight that ranges from 20 percent to 200 percent. A recognized rating agency, for instance, Fitch, Moody's, and Standard and Poor's, assigns the risk weights based on credit analysis that might include both market observations of comparable assets and stress testing.

For a residual interest that does not qualify for the rating-based approach, the risk-based capital is a dollar-for-dollar capital charge. The required amount of the risk-based capital is equal to the residual interest, even when

[2] In the United States, other methods of asset securitizations include issues under Rule 144A, which establishes new rules regarding the buying and reselling of restricted securities. Restricted securities are exempt from Securities and Exchange Commission (SEC) registration requirements and cannot be traded on the public markets. Rule 144A improves the liquidity and efficiency of the private placement market by giving more freedom to institutional investors to trade securities. Rule 144A is also intended to induce foreign companies to sell securities in the U.S. capital markets.

[3] Money centers are financial institutions which do not rely on deposits as the primary source of their funds. Citigroup Incorporated and JP Morgan/Chase/Bank One are examples of money centers.

this charge exceeds the normal 8 percent of the credit loss exposure. For example, suppose that an originating institution sells $100 in credit card loans and retains $9 in residual interest first loss exposure. Then the risk-based capital charge is $9.

Originating institutions may provide buyers of their securitized assets with implicit recourse. According to the Office of the Comptroller of Currency et al (2002), this type of credit enhancement is post-sale support to securitized assets beyond any contractual obligation. Originating institutions may provide investors with implicit recourse for a variety of reasons. They may provide buyers of their securitized assets with implicit recourse to prevent an early amortization event triggered by poor performance of their securitized assets.[4] They may provide investors with implicit recourse to protect their future access to the market for asset-backed securities.

Originating institutions may provide investors with implicit recourse in a variety of ways. They may exchange performing assets for nonperforming assets in a securitization trust or a special purpose entity. They may fund credit enhancement beyond contractual requirement. They may sell assets to a securitization trust or a special purpose entity at a discount from the price specified in the securitization document. They may purchase assets from a securitization trust or special purpose entity at an amount greater than the fair value.

As an example, we suppose that the securitization documents require a bank to transfer new receivables to a securitization trust at par value. Several months after the asset securitizations, we suppose that delinquencies and charge-offs on a pool of receivables in the trust have risen dramatically. A rating agency has placed the bank's securitized assets under observation for a possible downgrade. We suppose that the bank sells $100 worth of receivables to the trust at below par value to support the pool of receivables in the trust. The required risk-based capital is 8 percent of $100 or $8.

When an originating institution provides investors with implicit recourse in its asset securitizations, regulators may rule that the originating institution should never have removed the securitized assets from its balance sheet. The originating institution should have maintained risk-based capital for the securitized assets. Regulators may penalize the originating institution for not maintaining enough regulatory capital. Regulators may induce the originating institution to increase its risk-based capital, perhaps by issuing new equity under unfavorable circumstances.

Asset securitizations are a global phenomenon. The figures in the following tables support this point of view. These figures were taken from the Asset-Backed Securities Alert newsletter on global asset securitization activity.[5]

Table 1: U.S. asset-backed securities and volume of world asset-backed securities

Year-to-date breakdown of U.S. asset-backed securities	Percent	Year-to-date volume of asset-backed securities issuance ($billion)	2003	2002
Credit cards	13	U.S. Public	$427.7	$365.4
Sub-prime residential	19	U.S. 144A	60.9	36.3
Auto	16	U.S. Private	0.0	1.6
Home equity	27	Non-U.S.	174.2	117.3
Others	25	Total	662.9	523.7
Total	100			

[4] The merger between Bank One and First USA in 1997 helped to dilute the poorly performing credit card receivables of Bank One. Bank One merged First USA credit card loans with Bank One's credit card securitizations. This dilution helped to prevent an early amortization event that might have been triggered by 7 percent of nonperforming loans.

[5] http://www.abalert.com/Public/MarketPlace/MarketStatistics/index.cfm

In the following tables we present global asset securitizations through 30 September, 2003. Specifically, we present methods of asset securitizations, sources of collateral for asset securitizations, securitizing institutions, types of collateral for asset securitizations, and top managers of U.S. asset-backed securities.

Table 2: Methods of asset securitizations

How the securities were offered	9M-03 Issuance ($million)	No. of deals	Market share (percent)	9M-02 Issuance ($million)	No. of deals	Market share (percent)
U.S. Public	$583,990.3	966	70.7	$448,426.0	797	69.0
Non-U.S.	146,953.3	360	17.8	113,749.1	312	17.5
U.S. Rule 144A	95,602.3	358	11.6	85,001.0	361	13.1
U.S. Private	40.0	1	0.0	2,773.0	27	0.4
Total	826,585.9	1,685	100	649,949.1	1,497	100

Table 3: Sources of collateral for asset securitizations

Sources of collateral	9M-03 Issuance ($million)	No. of deals	Market share (percent)	9M-02 Issuance ($million)	No. of deals	Market share (percent)
United States	$658,476.0	1,324	79.7	$527,834.9	1,171	81.2
United Kingdom	63,586.0	116	7.7	43,307.4	82	6.7
Italy	23,108.0	36	2.8	14,707.6	25	2.3
Australia	19,303.8	63	2.3	13,946.7	54	2.1
Spain	15,963.2	18	1.9	6,624.8	14	1.0
Others	46,148.8	128	5.6	43,527.8	151	6.7
Total	826,585.9	1,685	100	649,949.1	1,497	100

THE ECONOMY

We consider a simple market economy that lasts for one period from date 0 to date 1. Aggregate or market risk is generated by two states of nature, one is a period of strong economic conditions and the other is a period of weak economic conditions. Since our model is static, we assume that market risk occurs at date 0.

The financial institutions include several banks and a central bank, which is the Federal Reserve in the United States. The banks are similar except for their capital structures, the amount of risk in their portfolios, and the quality of their credit underwriting. Agents in the economy include bank shareholders, bank managers, investors, borrowers who include consumers, and bank regulators.

Banks may securitize their loans by issuing securities in several tranches which differ in their seniority of claims.[6] For simplicity of modeling, we assume that banks issue securities in two tranches. The first tranche consists of low-risk securities and the second tranche consists of high-risk securities, which protect the low-risk securities by absorbing losses in front of them. The low-risk securities are sold to the public. The high-risk securities are funded by equity and debt, which includes bank deposits and long-term debt. The high-risk securities remain on a bank's balance sheet. We assume that a guarantor provides credit enhancement for an originating institution's securitized assets. This kind of credit enhancement mitigates moral hazard, thus enabling an originating institution to obtain a high credit rating for its asset securitizations.

[6] This is analogous to a grocer who finds that instead of selling whole chicken, the grocer can earn more revenue by selling chicken in parts (breasts, thighs, wings) which have different appeal to different customers.

Table 4: Securitizing institutions

Who securitized the assets	9M-03 Issuance ($million)	No. of deals	Market share (percent)	9M-02 Issuance ($million)	No. of deals	Market share (percent)
Mortgage bank	$263,534.5	565	31.9	$176,221.9	421	27.1
Bank	192,749.8	353	23.3	142,316.9	310	21.9
Finance company (diversified)	72,995.5	143	8.8	60,427.0	139	9.3
Commercial mortgage lender	71,688.7	130	8.7	59,995.1	117	9.2
Investment firm	54,205.6	188	6.6	58,803.1	189	9.0
Finance company (captive)	41,789.2	45	5.1	55,717.8	55	8.6
Securities firm	36,167.1	88	4.4	19,230.5	80	3.0
Credit-card bank	24,649.3	47	3.0	19,207.4	35	3.0
Sallie Mae	22,884.2	21	2.8	8,174.6	6	1.3
Government entity	9,461.6	16	1.1	7,406.3	14	1.1
Auto lender (independent)	8,716.6	22	1.1	8,370.0	16	1.3
Leasing company	6,698.1	18	0.8	8,525.9	26	1.3
Others	21,045.7	49	2.5	25,552.7	89	3.9
Total	826,585.9	1,685	100	649,949.1	1,497	100

Table 5: Types of collateral for asset securitizations

Types of receivables that backed the issues	9M-03 Issuance ($million)	No. of deals	Market share (percent)	9M-02 Issuance ($million)	No. of deals	Market share (percent)
Residential mortgages	$226,826.7	482	27.4	$149,588.6	369	23.0
Home-equity loans	100,411.2	161	12.1	75,165.1	138	11.6
Non-U.S. mortgages	93,165.2	137	11.3	43,819.3	91	6.7
Commercial mortgages	71,688.7	130	8.7	59,995.1	117	9.2
Subprime mortgages	70,207.8	151	8.5	54,145.9	123	8.3
Credit cards	58,763.2	103	7.1	57,923.7	95	8.9
Corporate bonds	42,855.6	181	5.2	47,139.5	176	7.3
Student loans	32,145.3	37	3.9	18,232.5	28	2.8
Auto loans (subprime)	16,076.7	31	1.9	21,796.1	35	3.4
Equipment leases	10,415.9	26	1.3	12,294.2	40	1.9
Others	60,414.4	210	7.3	59,251.0	240	9.1
Total	826,585.9	1,685	100	649,949.1	1,497	100

We present the top managers of U.S. asset-backed securities in the first half of 2003. The ranking is done by the dollar amount of the total assets managed.

Table 6: Top managers of U.S. asset-backed securities

Managers of U.S. asset-backed securities in the first half of 2003	Issuance ($million)	No. of deals	Managers of U.S. asset-backed securities in the first half of 2003	Issuance ($million)	No. of deals
1. Citigroup	$88,810.8	110	2. JP Morgan Chase	$83,257.0	79
3. Deutsche Bank	72,572.3	82	4. Bank One	67,740.8	80
5. Credit Suisse First Boston	66,365.1	79	6. Bank of America	65,847.5	88
7. Lehman Brothers	65,667.0	97	8. Morgan Stanley	55,291.2	67
9. Merrill Lynch	55,022.8	65	10. UBS	30,730.0	35
11. Barclays Capital	29,882.4	36	12. Bears Stearns	27,492.0	41
13. RBS Greenwich Capital	26,442.7	49	14. Wachovia	23,892.4	39
15. ABN Amro	17,654.6	13	16. GMAC RFC Sec.	15,996.2	25
17. Countrywide Securities	11,047.6	27	18. RBC Dain Rauscher	9,599.2	8
19. Goldman Sachs	9,278.5	16	20. William Capital Group	8,878.6	10

We assume that bank shareholders are risk-neutral. Bank managers receive a large proportion of their compensation through executive stock options, which help to align the interests of bank managers with those of bank shareholders (Hall and Liebman 1998, Meulbroek 2001). This compensation scheme helps to mitigate moral hazard problems. For instance, managers of financially distressed institutions may attempt to gamble their way out of financial difficulty because managers hold mostly the upside potential, but not the deep downside exposure of the portfolios of their institutions. Managers may also put less effort in managing a firm because they have little stake in the firm.

A bank manager maximizes the manager's utility of expected returns and variance. The bank manager's utility function is similar to the one used in derivation of the Capital Asset Pricing Model (CAPM). A portfolio's expected return is a measure of the reward for holding the portfolio, so it has a positive effect on an agent's utility. On the other hand, a portfolio's variance is a measure of uncertainty of the portfolio's expected return, so it has a negative effect on a risk-averse agent's utility.[7] We may ignore a bank manager's base salary in the analysis because the manager makes financial decisions at the margin.

Implicit Recourse in Asset Securitizations

We analyze implications of the risk-based capital requirements of implicit recourse which originating institutions may provide buyers of their securitized assets. There are several types of implicit recourse, but we shall focus on two cases. The other cases may be analyzed along similar lines. First, an originating institution may sell assets to a securitization trust or a special purpose entity at a discount from the price specified in the securitization document. Second, an originating institution may purchase assets from a securitization trust or a special purpose entity at an amount greater than their fair value. These forms of credit enhancement make originating institutions assume significant risk of credit losses.

If there is not enough regulatory capital, a bank may be required to issue equity under unfavorable circumstances. This may depress the bank's share price. Consequently, the bank may not want to have the regulatory capital constraint binding on its residual portfolio when it originates asset securitizations. One way to achieve this mathematically is to modify the constraint for high-risk securities by adding an exogenous amount to it.[8]

[7] To be precise, we assume that one unit currency may be exchanged for one unit of consumption in utility maximization by a bank manager.
[8] The chief financial officer selects the proximity to the regulatory capital constraint using the behavior of other financial institutions. This is because the chief financial officer does not want to attract undue regulatory oversight. This is analogous to a motorist who may feel comfortable going five miles above the posted speed limit when everyone else is doing so, but may be reluctant to do so, when everyone else is traveling at or below the posted speed limit.

We assume that a bank provides buyers of its low-risk securities with implicit recourse. Investors in the low-risk securities receive their cash flows. Bank creditors receive interest payments and principal amounts of their invested funds. The bank has total capital w, and has aggregate debt d, which includes deposits and long-term debt. The bank's aggregate debt is strictly less than its total amount of capital. That is, the bank has a positive amount of equity in its capital structure. Bank creditors receive d(1+r) at the end of the period, where r is the interest rate. Our analysis of a bank manager's utility maximization focuses on residual cash flows, which belong to the bank's shareholders.

A bank manager solves the following utility maximization problem.

Problem 1 A bank manager chooses the dollar amount w - (x + y) of assets to securitize, where the dollar amount y is used to facilitate implicit recourse, to maximize the manager's expected utility

$$\kappa[(qH + (1-q)L)R(x) + Q(y) - C(x) - d(1+r)] - A\sigma(x,y)^2 \quad (1)$$

$$\text{Subject to } x + y \geq kw + a \quad (2)$$

$$x + y \leq w. \quad (3)$$

The bank manager's expected utility as defined in (1) is a function of the bank portfolio's expected return and the associated variance. The parameter A in the utility function is a measure of the manager's degree of risk aversion, which is zero for a risk-neutral bank manager. The bank manager is more risk averse for higher values of the parameter A, so variance has a larger negative effect on the manager's utility. The bank gets a high proportion, H, of its receivables during strong economic conditions which occur with probability q, and gets a low proportion, L, of its receivables during weak economic conditions which occur with probability 1-q, where $q \in (0,1)$. The bank manager gets a proportion, $\kappa \in (0,1)$, of the bank's residual expected return. The function Q(y) is decreasing with respect to y, and the standard deviation $\sigma(x,y)$ is increasing with respect to y. This is because the dollar amount used to facilitate implicit recourse depresses the bank's receivables, thus increasing the bank's exposure to credit loss. The cost of asset securitization, which includes the cost of underwriting the bank's loans, is defined by the function C(x). Constraint (2) describes a limit on the amount of low-risk securities which the bank securitizes with implicit recourse. The parameter k in (2) denotes the fraction of high-risk securities in the bank's total amount of assets. The parameter a in (2) is to prevent the regulatory capital requirement constraint from being binding. The parameters in constraint (2) satisfy the condition $kw + a \leq w$. Constraint (3) is a limit on the dollar amount of the bank's securitized loans.

In the following proposition we show that the risk-based capital requirements associated with implicit recourse may discourage some banks from offering implicit recourse in their asset securitizations. This suggests that the new regulatory definition of implicit recourse may be a workable compromise between originating institutions and regulators. We also show that asset securitizations may reduce the cost of funding capital.

Proposition 1 The amount of assets a bank securitizes is influenced by the risk-based capital requirements of implicit recourse that the bank may provide buyers of its securitized assets. When the regulatory capital requirements overweigh the benefits of offering implicit recourse, a bank may not offer implicit recourse in its asset securitizations. Also assets taken off the balance sheet reduce the regulatory capital requirement, thus decreasing the cost of funding capital.

A proof of Proposition 1 is provided in the appendix.

Risk Management by Reinsurance Contracting

We consider a scenario where banks manage credit risk of their balance sheet assets by entering into reinsurance contracting with banks in other regions.[9] If asset securitization buyers perceive that an originating institution will not be providing implicit recourse, they may demand a higher premium when the underlying cash flows become riskier. Since the securitized assets are likely to be correlated (depending on the reinsurance contracting the originating institutions do) with the prospects of the originating institution, an increase in the yield spread may serve as an early warning signal of financial distress. The commingling of securities by network banks may raise some regulatory concerns, because financial distress affecting one network bank may spill over to other network banks.

We first describe the economic geography of the United States.[10] The West Coast economy has most of everything. It has manufacturing, high technology industries, farming, airplane manufacturing, and the entertainment industries. The West Coast also trades with Asia. The Midwest economy has much manufacturing and farming. For instance, the automobile industry has its headquarters in Detroit, Michigan. The Gulf of Mexico states, such as Louisiana and Texas, have oil refining. They also trade heavily with South America and the Middle East, due, in part, to the proximity to the ports of Houston and New Orleans. The East Coast economy has most of everything. It has manufacturing, financial services, high technology, media and advertising. The East Coast also trades heavily with Europe.

Macroeconomic shocks to the United States economy may produce different regional economic dynamics. In the 1980s when the U.S. dollar appreciated against Asian currencies, the West Coast experienced a recession. Due to an increase in the oil price in the 1970s and early 1990s, the Gulf of Mexico states experienced recessions. The 1997-1998 Asian crisis had a disproportionate impact on firms that exported to Asia or whose products competed with imports from Asia. Regional shocks generally produce regional economic dynamics.

Asset diversification by investing in the portfolios of banks in other regions is fraught with moral hazard. This is because banks may not monitor their loans effectively due to monitoring costs, and because the benefits of monitoring are shared by other banks. Banks may achieve some degree of asset diversification by establishing branches in other regions. This may be costly due administrative costs in running regional branches. The costs might also arise from insufficient knowledge about the local conditions.

Banks may mitigate credit risks by entering into reinsurance contracting. These contracts deal with balance sheet assets. Under such a contract, a bank purchases some receivables from a bank in another region during a period of weak economic conditions in the home region in exchange for granting a similar right to the counterparty. Counterparties are supposed to maintain a certain quality in credit underwriting. Verification of credit underwriting is done ex post when contracts are settled, and this makes enforcement of the contracts feasible.

We assume that there are several regions in the economy. A bank enters into reinsurance contracting with banks in other regions to mitigate credit risk. In region i this bank gets a high proportion, H_i, of its receivables during strong economic conditions which occur with probability q_i, and gets a low proportion, L_i, of its receivables during weak economic conditions which occur with probability $1-q_i$, where $q_i \in (0,1)$. The probabilities q_i depend on regional economic characteristics and on national economic conditions, thus these events may be correlated.

For simplicity, we assume that there are only two levels of credit underwriting, high quality underwriting and low quality underwriting. If a bank performs high quality credit underwriting, the bank may purchase receivables from a bank in another region when economic conditions are weak in its home region. If a bank

[9] Some of the risky assets in the high risk-risk tranche might be sold off to hedge funds. For instance, the bank might engage in a leveraged total return swap with a hedge fund. We speculate that some hedge fund managers may desire high risk assets to outperform their peers in order to garner more assets under their management. High risk assets will also increase the expected return of their portfolios and hence the expected compensation of hedge fund managers who receive 20% of the upside returns of the portfolio under management. Due to complexity of this issue, we do not model it in this paper, but leave it to future research.

[10] Asset securitizations are a global phenomenon. This suggests that our reinsurance contracting may be extended to include banks in other countries. Such contracting may be subject to exchange rate risk and legal issues such as enforcement and settlement of contracts. For ease of modeling, we only consider reinsurance contracting within the U.S. even though parties would benefit from international diversification, too.

performs low quality credit underwriting, the bank is not permitted to purchase receivables from a bank in another region at a favorable agreed upon price. The counterparties agree on these stipulated conditions. Since inspection of credit underwriting is done ex post, banks do have incentives to perform high quality credit underwriting when they enter into reinsurance contracting.

We assume that banks securitize their low-risk assets without implicit recourse. Our aim is to consider risk management of balance sheet assets. A bank has total amount of capital w and aggregate debt d, which satisfies $d < w$. Bank creditors receive $d(1+r)$ at the end of the period, where r is the interest rate.

A bank manager solves the following utility maximization problem.

Problem 2 A bank manager chooses the dollar amount $w - (x + y_2 + \ldots + y_n)$ of assets to securitize, where the dollar amounts $y = (y_2, \ldots, y_n)$ are used to facilitate reinsurance of balance sheet assets, to maximize the manager's expected utility

$$\kappa[(q_1H_1 + (1-q_1)L_1)R(x) + \Sigma_{2\leq i \leq n}\,(q_1q_iH_1 + (1-q_1)(1-q_i)L_1)R(y_i) + (1-q_1)q_iH_iQ_i(y_i) - q_1(1-q_i)H_1R(c_i)) - C_1(x) - d(1+r)] - A\sigma_1(x,y)^2 \quad (4)$$

$$\text{Subject to } y_2 \leq m_2 \ldots y_n \leq m_n \quad (5)$$

$$x + y_2 + \ldots + y_n \geq kw \quad (6)$$

$$x + y_2 + \ldots + y_n \leq w. \quad (7)$$

The bank manager's expected utility as defined in (4) is a function of the bank portfolio's expected rate of return and the associated variance. The bank manager gets a proportion, $\kappa \in (0,1)$, of the expected returns which the bank's shareholders get from their investment. The constant A in the utility function captures the manager's degree of risk aversion, which is zero for a risk-neutral manager. We define $C_1(x)$ to be the cost of asset securitization, which includes the cost of underwriting the bank's loans. When the yield spread becomes wider the securitized assets become riskier, then this is reflected by an increase in the cost function $C_1(x)$. If the regional economies are in the good state of nature or are in the bad state of nature, the banks do get the receivables from their loans. If the economy in region 1 is in the bad state of nature and the economy in region i is in the good state of nature, the bank in region 1 gets the amount of receivables $H_iQ_i(y_i)$ from bank i. If the conditions are reversed, the bank in region i gets the amount of receivables $H_1R(c_i)$ from bank 1, which explains the negative sign in the term $q_1(1-q_i)H_1R(c_i)$ in the utility function. The bank knows the fraction of its high-risk securities, which we denote by k. The optimal dollar amount of capital, $c_i \in [0, m_i]$, which is chosen by the manager of a bank in another region to fulfill a reinsurance contract is exogenous to this bank manager's utility maximization problem. The constraints in (5) describe individual limits on the dollar amount of high-risk securities used in reinsurance contracting. These constraints protect counterparty banks from over insuring a bank. For simplicity, the limits on the dollar amounts are exogenous. The slack $m_i - c_i$, which is not used in the reinsurance contracts, is absorbed in the bank's choice variable x. Constraint (6) describes a limit on the dollar amount of the high-risk securities, where k denotes the fraction of high-risk securities. Constraint (7) describes a limit on the dollar amount of the bank's total securities.

The simplest case of Problem 2 occurs when there are two regions in the economy, for example, the East Coast and the West Coast of the United States. The number of counterparty banks may be larger than two, because a large bank on the East Coast may not find a counterparty bank on the West Coast which is large enough to contract with. So it may enter into reinsurance contracts with at least two banks on the West Coast.

The feasible region defined by the constraints is a compact set. There exists a solution to Problem 2 because the objective function is continuous on a compact set. That is, the objective function attains maximum and

minimum values. The maximum value will either be on the boundary of the feasible region or on the interior of the feasible region. An interior solution must satisfy the Kuhn-Tucker conditions.

There are several factors that may contribute to the choice of a solution. These factors include the cost of asset securitizations, where a large fixed cost may overwhelm the benefits of asset securitizations.

The following proposition describes the optimal allocations in a bank's asset securitization. The reinsurance contracts may enable a risk-averse bank manager to reduce the variance of the bank's portfolio, thus increasing the manager's utility.

Proposition 2 If the cost of asset securitization is low enough, a bank manager will sell all low-risk securities to investors. The manager will choose the amount of securities to keep on the bank's balance sheet and the amount to sell to banks in other regions so as to maximize the manager's expected utility.

A proof of Proposition 2 is presented in the appendix.

CONCLUSION

We perform a theoretical analysis of implications of the risk-based capital requirements of implicit recourse in asset securitizations. We show that the risk-based capital requirements associated with implicit recourse may discourage some banks from providing buyers of their securitized assets with implicit recourse. We then consider a scenario where some banks engage in reinsurance contracting with banks in other regions to mitigate high default rates in their loans. These reinsurance contracts may enable banks to improve the performance of their balance sheet assets. We find weak correlation among equity returns for regional banks. The commingling of securities by network banks might not be a pressing regulatory concern now, but equity returns for regional banks might become highly correlated in the future due to existing incentives. We suggest that widening yield spreads on asset securitizations might function as an early warning signal of financial distress. Regulators might devote more supervisory resources on such originating institutions when this scenario occurs.

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Appendix

Example 1 Asset securitization with implicit recourse:

We provide a simple numerical example of implicit recourse in asset securitization. A bank manager chooses the dollar amount w - (x + y) of assets to securitize, where the dollar amount y is used to facilitate implicit recourse, to maximize the manager's expected utility

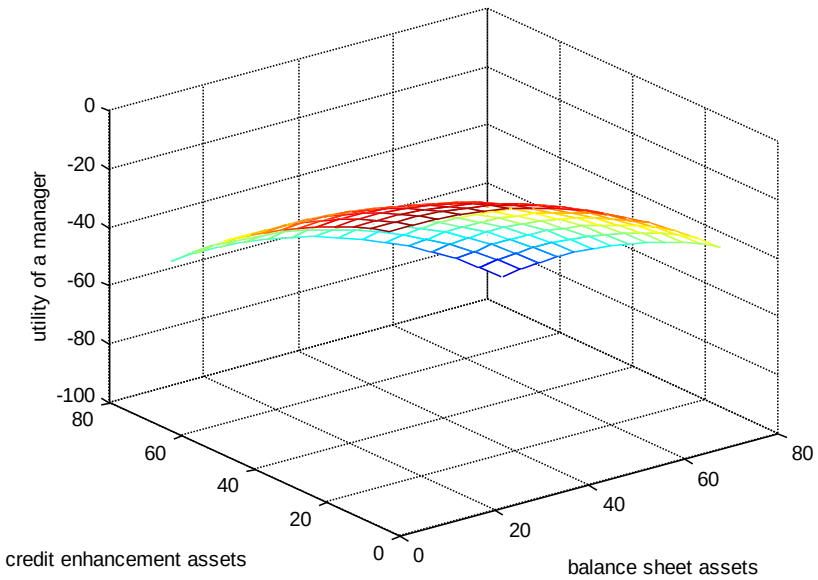
$$\kappa[(qH + (1-q)L)R(x) + Q(y) - C(x) - d(1+r)] - A\sigma(x,y)^2 \quad (8)$$

$$\text{Subject to } kw + a \leq x + y \leq w \quad (9)$$

We assume the functional forms $R(x) = (1 + b_1)x$ and $Q(y) = -b_2y$, where b_1 and b_2 are rates of return on investment. We assume a convex cost function of the form $C(x) = cx^2$, which is a reasonable assumption in the economics literature. The bank allocates the dollars amounts between the two regions in the following proportions: $w_1 = x/(x + y)$ and $w_2 = y/(x + y)$. Then the standard deviation corresponding to the asset securitization is given by the formula $\sigma(x,y)^2 = \sigma_1^2 + 0.05y^2$.

In figure 1 below we show that some amount of credit enhancement may be beneficial to the asset securitizing institution. However, when amount of assets allocated to facilitate credit enhancement exceeds a certain amount then this may not be beneficial to the securitizing institution.

Figure 1: A plot of a manager's utility function. The parameters are: w = 100$, d = 25$, H = 98%, L = 96%, q = 0.60, b_1 = 12%, b_2 = 0.012, c = 0.005/$1, r = 8% and A = 1.25/1$ where 1.25 is the level of the manager's risk aversion.



Example 2 Reinsurance contracting between two banks:

We provide a simple numerical example of a refinancing contract between two banks in two different regions in the United States, for example, the East Coast and the West Coast. A bank manager chooses the dollar amount w - (x + y) of assets to securitize, where the dollar amount y is used to facilitate reinsurance of balance sheet assets, to maximize the manager's expected utility

$$\kappa[(q_1H_1 + (1-q_1)L_1)R(x) + (q_1q_2H_1 + (1-q_1)(1-q_2)L_1)R(y) + (1-q_1)q_2H_2Q_2(y) -$$

$$q_1(1-q_2)H_1R(c_2)) - C(x) - d(1+r)] - A\sigma(x,y)^2 \quad (10)$$

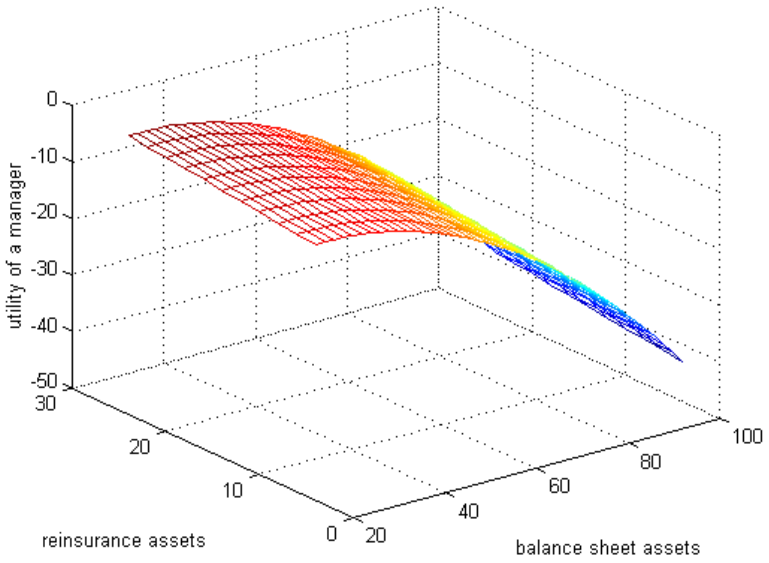
$$\text{Subject to } y \leq m \quad (11)$$

$$kw \leq x + y \leq w. \quad (12)$$

We assume the functional forms $R(x) = (1 + b_1)x$ and $R(y) = (1 + b_2)y$, which are dollar returns, where b_1 and b_2 are the corresponding rates of return in the two regions. We assume a convex cost function of the form $C(x) = cx^2$, the parameter c is chosen to capture the cost and also to harmonize the units which are in dollars. The bank allocates the dollars amounts between the two regions in the following proportions: $w_1 = x/(x + y)$ and $w_2 = y/(x + y)$. The standard deviation corresponding to the asset securitization is given by the formula $\sigma(x,y)^2 = w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\rho_{12}\sigma_1\sigma_2$, where the correlation coefficient between these investment returns is given by $\rho_{12} = Cov(x,y)/(\sigma_1\sigma_2)$.

In figure 2 below we show that some reinsurance contracting is beneficial for the given parameter values. The optimal solution is a corner solution where a bank uses the maximum amount of assets to facilitate reinsurance. We also see that bank securitizes a positive amount of its low risk assets.

Figure 2: A plot of a manager's utility function. The parameters are: w = 100$, d = 25$, k = 0.30, m = 0.25, H_1 = 98%, L_1 = 96%, H_2 = 98%, L_2 = 95%, q_1 =0.75, q_2 = 0.65, cov(x,y) = 0.25, b_1 = 12%, b_2 = 13%, c = 0.025/1$, r = 8%, κ = 25% and A = 1.25/1$ where 1.25 is the level of the manager's risk aversion.



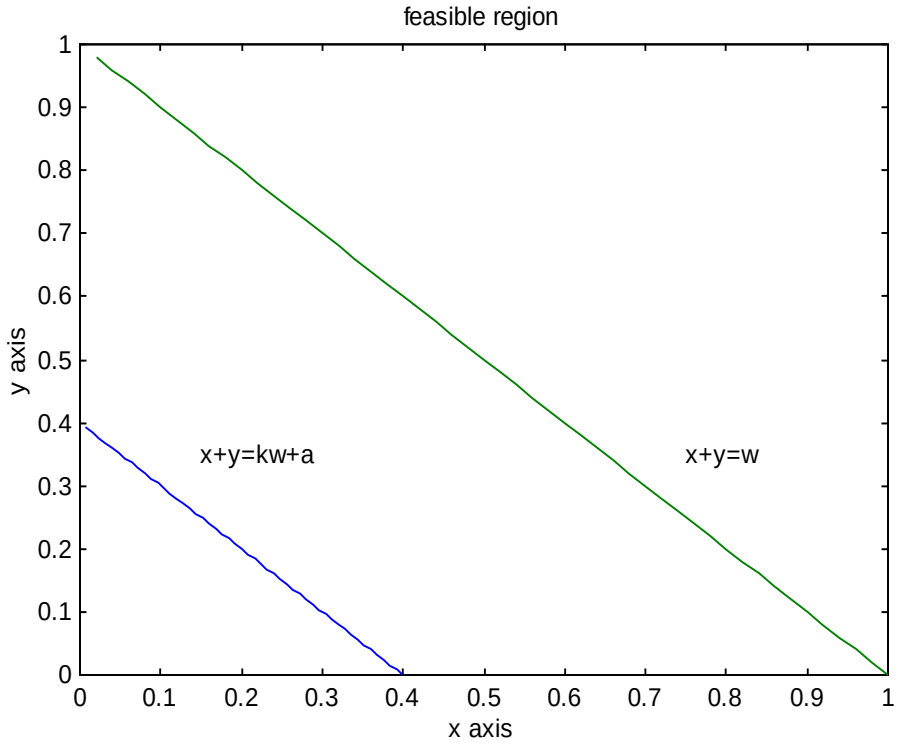
Proof of Proposition 1

The feasible region, which is described in figure 3 below, is a compact set, that is, a closed and bounded set. Thus, the continuous objective function will obtain maximum and minimum values in the feasible region. We know the maximum will either be on the boundary or on the interior of the feasible region. The interior point must satisfy the Kuhn-Tucker conditions. The second order conditions hold for an interior optimum.

There are several factors that may contribute to the choice a solution. These factors include the cost of asset securitizations, where a large fixed cost may overwhelm the benefits of asset securitizations, and the risk-based capital requirements of implicit recourse.

Any point on the line $x + y = kw + a$ implies that the bank securitizes as much of its low-risk securities as possible. The boundary point $(x,y) = (0,0.4)$ is not a solution because the amount y is used to facilitate credit enhancement. This may decrease expected return on the bank's portfolio and may increase variance. The boundary point $(x,y) = (0.4,0)$ is a possible solution because it may be value maximizing. The amount y is used to facilitate credit enhancement. This may decrease expected return on the bank's portfolio and increase variance. Any point on the line $x + y = w$ says that the bank does not securitize its low-risk assets. The boundary point $(x,y) = (1,0)$ is a possible solution. This type of solution may be caused by a large fixed cost that overwhelms the benefits of asset securitization. This kind of solution may be implemented by a small bank.

Figure 3: The feasible region is enclosed by the following lines: $x + y = kw + a$, $x = 0$, $x + y = w$ and $y = 0$. The parameters are $w = 1$, k is 30 percent of w and a is 8 percent of kw.



The Kuhn-Tucker conditions associated with Problem 1 are as follows:

$$\kappa[(qH + (1-q)L)R_x - C_x] - 2A\sigma\sigma_x + \lambda_1 - \lambda_2 \leq 0 \quad (13)$$

$$x(\kappa[(qH + (1-q)L)R_x - C_x] - 2A\sigma\sigma_x + \lambda_1 - \lambda_2) = 0 \quad (14)$$

$$\kappa Q_y - 2A\sigma\sigma_y + \lambda_1 - \lambda_2 \leq 0 \quad (15)$$

$$y(\kappa Q_y - 2A\sigma\sigma_y + \lambda_1 - \lambda_2) = 0 \quad (16)$$

$$x + y - kw \geq 0 \quad (17)$$

$$\lambda_1(x + y - kw) = 0 \quad (18)$$

$$w - x - y \geq 0 \quad (19)$$

$$\lambda_2(w - x - y) = 0 \quad (20)$$

$$x, y, \lambda_1, \lambda_2 \geq 0. \quad (21)$$

The Lagrange multipliers both cannot be positive simultaneously. If the Lagrange multiplier λ_2 is positive, then the inequality (19) is an equality, which implies that the bank does not securitize its low-risk securities. This solution could be due to the cost of asset securitization exceeding the internal capital hurdle rate. If the Lagrange multiplier λ_1 is positive, then the inequality (17) is an equality, which implies that the bank securitizes all of its low-risk loans. However, the bank must meet the risk-based capital requirements of implicit recourse. If we get an interior solution, then both Lagrange multipliers are zero. An interior solution implies that the bank securitizes only a part of its low-risk securities.

Proof of Proposition 2

We prove the proposition by backward induction. At the first stage of the backward induction, we define the choice variables as follows: $z = x + y_2 + \ldots + y_{n-1}$, and $t = y_n$. This transformation reduces a multidimensional problem to a simpler two-dimensional problem. The bank manager chooses the amounts z and t to maximize the expected utility

$$\kappa[(q_1H_1 + (1-q_1)L_1)R(x) + \Sigma_{2\leq i \leq n}\,(q_1q_iH_1 + (1-q_1)(1-q_i)L_1)R(y_i) + (1-q_1)q_iH_iQ_i(y_i) - q_1(1-q_i)H_1R(c_i)) - C_1(x) - d(1+r)] - A\sigma_1(z,t)^2 \quad (22)$$

$$\text{subject to } t \leq m_n \quad (23)$$

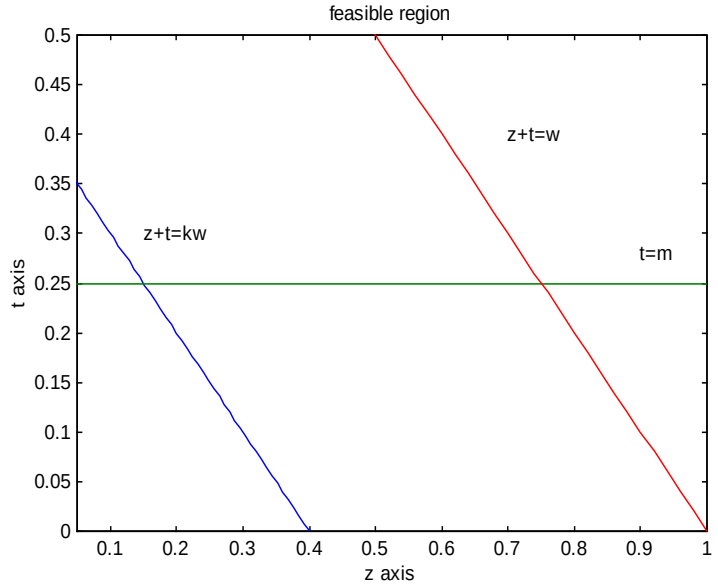
$$z + t \geq kw. \quad (24)$$

The associated feasible region, which is described in figure 4 below, is a compact set. Thus, we are assured of the existence of a solution to the problem defined by (22) - (24), because the objective function is a continuous function. That is, the objective function attains maximum and minimum values. The maximum value will either be on the boundary or on the interior of the feasible region. An interior point must satisfy the associated Kuhn-Tucker conditions. An interior optimum must satisfy the second order conditions.

There are several factors that may contribute to the choice of a solution. These factors include the cost of asset securitizations, where a large fixed cost may overwhelm the benefits of asset securitizations.

Any point on the line z + t = kw suggests that the bank securitizes all its low-risk assets. The boundary point given by (z,t) = (0.15,0.25) is a possible solution because the bank is able to securitize its low-risk assets and reduce variance. The amount y is used to facilitate reinsurance. This may improve the performance of balance sheet assets. The point (x,y) = (0.4,0) is a possible solution. This kind of solution might be implemented by a risk-neutral bank manager who cares about increasing expected returns but does not care about variance reduction through reinsurance contracting. Any point on the line z+t = w suggests that the bank does not securitize its assets at all. A solution of this type may be caused by a large fixed cost that overwhelms the benefits of asset securitization. In particular, the point (z,t) = (0.75,0.25) is a possible solution. This kind of solution might be implemented by a small bank.

Figure 4: The feasible region is enclosed by the following lines: z + t = kw, t = m, z + t = w and t = 0, where m = m_n. The parameters are m = 0.25, w = 1 and k is 30 percent of w.



The Kuhn-Tucker conditions associated with the problem defined by (22) - (24) are as follows:

$$\kappa[(q_1H_1 + (1-q_1)L_1)R_z + \Sigma_{2\leq i\leq n-1}\,(q_1q_iH_1 + (1-q_1)(1-q_i)L_1)R_z + (1-q_1)q_iH_iQ_{iz} - C_{1z}] - 2A\sigma_1\sigma_{1z} + \lambda_2 - \lambda_3 \leq 0 \quad (25)$$

$$z(\kappa[(q_1H_1 + (1-q_1)L_1)R_z + \Sigma_{2\leq i\leq n-1}\,(q_1q_iH_1 + (1-q_1)(1-q_i)L_1)R_z + (1-q_1)q_iH_iQ_{iz} - C_{1z}] - 2A\sigma_1\sigma_{1z} + \lambda_2 - \lambda_3) = 0 \quad (26)$$

$$\kappa(q_1q_nH_1 + (1-q_1)(1-q_n)L_1)R_z + (1-q_1)q_nH_nQ_{nz} - 2A\sigma_1\sigma_{1t} - \lambda_1 + \lambda_2 - \lambda_3 \leq 0 \quad (27)$$

$$t(\kappa(q_1q_nH_1 + (1-q_1)(1-q_n)L_1)R_z + (1-q_1)q_nH_nQ_{nz} - 2A\sigma_1\sigma_{1t} - \lambda_1 + \lambda_2 - \lambda_3) = 0 \quad (28)$$

$$m - t \geq 0 \quad (29)$$

$$\lambda_1(m - t) = 0 \quad (30)$$

$$z + t - kw \geq 0 \quad (31)$$

$$\lambda_2(z + t - kw) = 0 \quad (32)$$

$$w - z - t \geq 0 \tag{33}$$

$$\lambda_3(w - z - t) = 0 \tag{34}$$

$$z, t, \lambda_1, \lambda_2, \lambda_3 \geq 0. \tag{35}$$

The amount t is positive because not all the securities are the low-risk type, and the contingency claim contracting does not allow a bank to off load all of its high-risk securities to a counterparty bank. This condition is described by constraint (29). If A is positive, then the amount z is positive because this will decrease variance, thus increasing the bank manager's utility.

We focus only on a corner solution where a securitizing institution uses the maximum amount of assets to facilitate reinsurance as illustrated by figure 2 above. We denote the optimal value of t by b_n.

At the second stage of the backward induction, we define the choice variables as follows: $z = x + y_2 + \ldots + y_{n-2}$, and $t = y_{n-1}$. The bank manager chooses the amounts z and t to maximize the expected utility

$$\kappa[(q_1H_1 + (1-q_1)L_1)R(x) + \Sigma_{2\leq i\leq n-1}(q_1q_iH_1 + (1-q_1)(1-q_i)L_1)R(y_i) + (1-q_1)q_iH_iQ_i(y_i) - q_1(1-q_i)H_1R(c_i)) - C_1(x) - d(1+r)] - A\sigma_1(z,t)^2 + \kappa[(q_1q_nH_1 + (1-q_1)(1-q_n)L_1)R(b_n) + (1-q_1)q_nH_nQ_n(b_n) - q_1(1-q_n)H_1R(c_n)] \tag{36}$$

$$\text{subject to } t \leq m_{n-1} \tag{37}$$

$$z + t \geq kw - b_n. \tag{38}$$

Analyzing the Kuhn-Tucker conditions associated with the problem defined by (36) - (38), yields optimal values for z and t. We denote the optimal value of t by b_{n-1}.

At the j th stage of the backward induction, we define the choice variables as follows: $z = x + y_2 + \ldots + y_{n-j}$, and $t = y_{n+1-j}$. The bank manager chooses the amounts z and t to maximize the expected utility

$$\kappa[(q_1H_1 + (1-q_1)L_1)R(x) + \Sigma_{2\leq i\leq n+1-j}(q_1q_iH_i + (1-q_1)(1-q_i)L_i)R(y_i) + (1-q_1)q_iH_iQ_i(y_i) - q_1(1-q_i)H_iR_i(c_i)) - C_1(x) - d(1+r)] - A\sigma_1(z,t)^2 + \kappa\Sigma_{n+2-j\leq i\leq n}[(q_1q_iH_1 + (1-q_1)(1-q_i)L_1)R(b_i) + (1-q_1)q_iH_iQ_i(b_i) - q_1(1-q_i)H_1R(c_i)] \tag{39}$$

$$\text{subject to } t \leq m_{n+1-j} \tag{40}$$

$$z + t \geq kw - b_{n+2-j} - \ldots - b_n. \tag{41}$$

The optimal values $b_{n+2-j}, \ldots, b_n$ were obtained in the preceding stages of the backward induction. Analyzing the Kuhn-Tucker conditions associated with the problem defined by (39) - (41) yields optimal values for z and t. We denote the optimal value of t by b_{n+1-j}.

We continue the backward induction process until we reach the last stage. We define the choice variables as follows: $z = x$ and $t = y_2$. The bank manager chooses the amounts z and t to maximize the expected utility

$$\kappa[(q_1H_1 + (1-q_1)L_1)R(z) + (q_1q_2H_1 + (1-q_1)(1-q_2)L_1)R(z) + (1-q_1)q_2H_2Q_2(t) - q_1(1-q_2)H_1R(c_2) - C_1(z) - d(1+r)] - A\sigma_1(z,t)^2 + \kappa\Sigma_{3\leq i\leq n}[(q_1q_iH_1 + (1-q_1)(1-q_i)L_1)R(y_i) + (1-q_1)q_iH_iQ_i(b_i) - q_1(1-q_i)H_1R(c_i)] \tag{42}$$

$$\text{subject to } t \leq m_2 \tag{43}$$

$$z + t \geq kw - b_3 - b_4 - \ldots - b_{n-1} - b_n. \tag{44}$$

Analyzing the Kuhn-Tucker conditions associated with the problem defined by (42) - (44) yields optimal values for z and t. We denote the optimal value of by z by a and the optimal value of t by b_2. Thus, we have determined a solution to Problem 2 given by x = a and y = (b_2, …, b_n). This concludes our proof of Proposition 2.

Graphs and Charts

We focus on the top-five bank holding companies in the United States, because they dominate asset securitizations. We measure the size of a company by dollar value of the total assets it holds.

Figure 5: Top five bank holding companies as of 31 December, 2002

	Bank holding company	Assets ($million)
C	Citigroup Inc.	$1097190
JPM	J.P. Morgan Chase & Company	758800
BAC	Bank of America	660458
WFC	Wells Fargo and Company	349259
WB	Wachovia Corporation	341839

Figure 6: Share prices for the top five bank holding companies

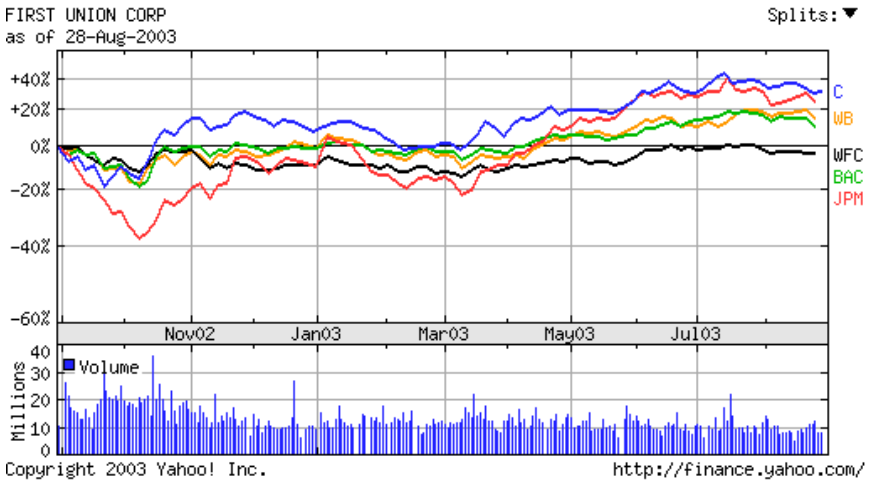


Figure 7: Linear correlation between monthly stock returns for the top-five bank holding companies

January 1998 to August 2003	C	JPM	BAC	WFC	WB
C	1				
JPM	0.460591	1			
BAC	0.510639	0.640448	1		
WFC	0.270952	0.347255	0.50265	1	
WB	0.377348	0.542602	0.801757	0.647738	1

The linear correlation among returns on equity is weak for the top-five bank holding companies. This suggests that there may be more risks than regional economic risks which banks cannot so easily hedge with each other.