A Note on Bank Default Risk and Delivery Channel Strategy under Deposit Insurance Fund Protection

Shi Chen[1], Chuen-Ping Chang[2] & Kevin P. Keh[3]

[1] School of Economics, Southwestern University of Finance and Economics, Chengdu, China

[2] Department of Wealth and Taxation Management, Kaohsiung University of Applied Science, Kaohsiung City, Taiwan

[3] Department of International Business, Tamkang University, New Taipei City, Taiwan

Correspondence: Chuen-Ping Chang, Department of Wealth and Taxation Management, Kaohsiung University of Applied Science, No.58, Shenzhong Rd., Yanchao Dist., Kaohsiung City 824, Taiwan. E-mail: cpchang@cc.kuas.edu.tw

Received: August 7, 2014 Accepted: August 27, 2014 Online Published: September 5, 2014

doi:10.5430/ijfr.v5n4p114 URL: http://dx.doi.org/10.5430/ijfr.v5n4p114

Abstract

Increasing investment in human resource relative to information technology system in retail banking delivery channels increases the optimal bank interest margin and decreases the default risk in the bank's equity returns during a financial crisis. Raising the regulatory barrier inducing a wealth transfer from shareholders to the Federal Deposit Insurance Corporation reinforces both the effects above. Human resource investment with regulatory deposit insurance fund protection as such make the distressed bank more prudent to risk-taking, thereby contributing to the stability of the banking system.

Keywords: barrier option, FDIC, delivery channel choice

1. Introduction

The banking industry is experiencing a renewed focus on retail banking, a trend often attributed to the stability and profitability of retail activities (Hirtle and Stiroh, 2007). This note discusses one recent trend of the return to retail banking during a financial crisis and places it in the larger context of alternative delivery channels and bank regulation. Alternative delivery channels in retail banking can be motivated based on an argument about human resource investment relative to information technology investment in the spirit of Harangus (2009) and Kondo (2010) (Note 1). Parallel to an increased importance of the return to retail banking, there has been an ongoing discussion about the role of deposit insurance fund protection to influence bank behavior and make banks more robust against financial shocks, i.e., to strengthen the soundness and stability of banks in the usual parlance of the Federal Deposit Insurance Corporation (FDIC). Bank regulation in retail banking can be motivated based on the deposit insurance fund protection under the Federal Deposit Insurance Corporation Improvement Act (Episcopos, 2008).

In this note, the barrier options theory of corporate security valuation is applied to the contingent claims of a regulated bank to address the problem of early bank closure during a financial crisis (Episcopos, 2008). The FDIC as a regulator/insurer of the bank owns a down-and-in call (DIC) option on the bank assets which can be balanced against the expected coverage cost. We show that, as the bank increases its human resource management relative to its information technology investment, the optimal bank interest margin is increased, and the default risk in the bank's equity returns is reduced. Our findings are consistent with Harangus (2009): human capital may produce superior return performance and greater safety for the bank. In addition, the positive impact on the margin and the negative impact on the default risk are reinforced as the regulatory barrier increases. Our findings are supported by Episcopos (2008). In conclusion, human resource management and deposit insurance fund protection as such make the bank less prone to risk-taking in retail banking activities, thereby contributing to the banking stability.

2. The Model

Consider a single-period $(t \in [0,1])$ model of a banking firm. At $t=0$, the bank accepts D dollars of deposits. The bank provides depositors with a rate of return equal to the risk-free rate R_D. Equity capital K held by the bank is tied by regulation to be a fixed proportion q of the bank's deposits $K \geq qD$ where q is the required capital-to-deposits ratio. Loan demand is a function of the loan rate, $L(R_L)$ with the condition of $\partial L / \partial R_L < 0$. This condition implies that the bank exercises some monopoly power in its loan market (Mukuddem-Petersen et al., 2008). The bank holds liquid asset B that earns the security-market interest rate of R. When the capital requirement constraint is binding, the bank's balance-sheet constraint at $t = 0$ is

$$L + B = D + K = K(\frac{1}{q} + 1) \tag{1}$$

The bank's objective is to set R_L to maximize the market value of a barrier option function (Brockman and Turtle, 2003) defined in terms of profits, subject to Eq. (1). In this context, the market value of the bank's equity S can be written as (Note 2):

$$S = [VN(d_1) - Ze^{-\delta} N(d_2)] - [V(\frac{H}{V})^{2\eta} N(b_1) - Ze^{-\delta} (\frac{H}{V})^{2\eta-2} N(b_2)] \tag{2}$$

where

$$V = (1 + R_L)L \text{ with } dV = \mu V dt + \sigma V dW$$

$$Z = \frac{(1 + R_D)K}{q} + cL + F(c) - (1 + R)[K(\frac{1}{q} + 1) - L]$$

$$\delta = R - R_D$$

$$d_1 = \frac{1}{\sigma}(\ln \frac{V}{Z} + \delta + \frac{\sigma^2}{2}),\ d_2 = d_1 - \sigma$$

$$H = \alpha Z,\ \eta = \frac{\delta}{\sigma^2} + \frac{1}{2}$$

$$b_1 = \frac{1}{\sigma}(\ln \frac{H^2}{VZ} + \delta + \frac{\sigma^2}{2}),\ b_2 = b_1 - \sigma$$

In Eq. (2), V is the value of loan repayments at $t = 1$ with an instantaneous drift μ and instantaneous volatility σ. A standard Wiener process is W. V is then treated as an underlying asset in the down-and-out call (DOC) valuation. Z is defined as the net-obligation payments between the cost payments and the repayments from the liquid-asset investment at $t = 1$. The cost payments includes the payments to depositors $(1 + R_D)D$, the administrative cost of loans cL where c is the marginal cost, and the fixed cost $F(c)$. The fixed cost function is specified as a function of the marginal administrative cost with the condition of $\partial F / \partial c < 0$. A backward technology related to investment in human resource management can be identified as a higher c with a lower F, while an advanced technology related to investment in information technology management can be identified as a lower c with a higher F. δ is the compounded riskless rate of the strike price Z in the call option. H is the value of the bank's assets that triggers bankruptcy (this is the barrier on knock-out value of the bank). For tractability, it is assumed that the default barrier level H is proportional to the bank's net-obligation payments Z by a barrier-to-debt ratio α $(H = \alpha Z)$. $N(\cdot)$ is the standard normal cumulative distribution. The first term $[\cdot]$ on the right-hand side of Eq. (2) is recognized as the expected asset value and present value of the net-obligation payments using the standard call (SC) option view of the bank. The second term $[\cdot]$ is recognized as the value of a DIC option that is the different between a SC and a DOC option.

With information about Eq. (2), the default risk in the bank's equity returns, P_{def}, will then be given by the Brockman and Turtle (2003) formula for bankruptcy prediction:

$$P_{def} = N(g_1) + e^{g_2} N(g_3) \tag{3}$$

where

$$g_1 = \frac{1}{\sigma}(\ln\frac{\alpha Z}{V} - \delta + \frac{\sigma^2}{2}), \quad g_2 = \frac{1}{\sigma^2}(\delta - \frac{\sigma^2}{2})\ln\frac{\alpha Z}{V}, \quad g_3 = \frac{1}{\sigma}(\ln\frac{\alpha Z}{V} + \delta - \frac{\sigma^2}{2})$$

3. Solution and Results

Partially differentiating Eq. (2) with respect to R_L, the first-order condition is given by:

$$\frac{\partial S}{\partial R_L} = [\frac{\partial V}{\partial R_L}N(d_1) + V\frac{\partial N(d_1)}{\partial d_1}\frac{\partial d_1}{\partial R_L} - \frac{\partial Z}{\partial R_L}e^{-\delta}N(d_2) - Ze^{-\delta}\frac{\partial N(d_2)}{\partial d_2}\frac{\partial d_2}{\partial R_L}]$$

$$-[\frac{\partial V}{\partial R_L}(\frac{\alpha Z}{V})^{2\eta}N(b_1) + V(2\eta)(\frac{\alpha Z}{V})^{2\eta}(\frac{1}{Z}\frac{\partial Z}{\partial R_L} - \frac{1}{V}\frac{\partial V}{\partial R_L})N(b_1)$$

$$+V(\frac{\alpha Z}{V})^{2\eta}\frac{N(b_1)}{\partial b_1}\frac{\partial b_1}{\partial R_L} - \frac{\partial Z}{\partial R_L}e^{-\delta}(\frac{\alpha Z}{V})^{2\eta-2}N(b_1)$$

$$-Ze^{-\delta}(2\eta-2)(\frac{\alpha Z}{V})^{2\eta-2}(\frac{1}{Z}\frac{\partial Z}{\partial R_L} - \frac{1}{V}\frac{\partial V}{\partial R_L})N(b_2)$$

$$-Ze^{-\delta}(\frac{\alpha Z}{V})^{2\eta-2}\frac{\partial N(b_2)}{\partial b_2}\frac{\partial b_2}{\partial R_L}] = 0 \tag{4}$$

A sufficient condition for an optimum is that $\partial^2 S / \partial R_L^2 < 0$. Next, we consider the effect on the bank's default risk evaluated at the optimal loan rate (and thus at the optimal bank interest margin) from changes in alternative delivery channels. Differentiation of Eq. (3) with respect to c yields:

$$\frac{dP_{def}}{dc} = \frac{\partial P_{def}}{\partial c} + \frac{\partial P_{def}}{\partial R_L}\frac{\partial R_L}{\partial c} \tag{5}$$

where

$$\frac{\partial R_L}{\partial c} = -\frac{\partial^2 S}{\partial R_L \partial c} / \frac{\partial^2 S}{\partial R_L^2}$$

Both the terms in Eq. (5) are indeterminate perhaps due to the added complexity of barrier options in our model. However, we can use a numerical analysis to speak of tendencies of Eq. (5). Unless otherwise indicated, the parameters are $R = 3.5\%$, $R_D = 2.5\%$, $D = 340$, $q = 9.0\%$, and $\sigma = 0.4$. Let $(R_L\%, L)$ change from (4.5, 350) to (5.0, 336) due to the condition of $\partial L / \partial R_L < 0$. Let (c, F) change from (0.010, 9) to (0.015, 4) due to the condition of $\partial F / \partial c < 0$. The specification of capital adequacy requirement, $q = K / D = 9.0\%$, is consistent with the Basel. The assumption of $\alpha = 0.5$ is consistent with the empirical evidence of Brockman and Turtle (2003) (Note 3).

Table 1. Values of SC, DIC, and DOC

(c, F)	$(R_L\%, L)$ (4.5, 350)	(4.6, 349)	(4.7, 347)	(4.8, 344)	(4.9, 340)	(5.0, 335)	(5.1, 329)
	SC						
(0.010, 9)	71.5736	71.6365	71.5300	71.2526	70.8026	70.1783	69.3784
(0.011, 8)	71.8985	71.9626	71.8581	71.5833	71.1365	70.5162	69.7209
(0.012, 7)	72.2246	72.2900	72.1875	71.9152	71.4717	70.8554	70.0648
(0.013, 6)	72.5520	72.6187	72.5181	72.2484	71.8082	71.1959	70.4101
(0.014, 5)	72.8806	72.9486	72.8499	72.5829	72.1460	71.5378	70.7569
(0.015, 4)	73.2105	73.2797	73.1830	72.9187	72.4852	71.8811	71.1050
	DIC						
(0.010, 9)	0.0562	0.0554	0.0544	0.0530	0.0514	0.0496	0.0475
(0.011, 8)	0.0551	0.0543	0.0532	0.0519	0.0503	0.0485	0.0464
(0.012, 7)	0.0540	0.0532	0.0522	0.0508	0.0493	0.0474	0.0454
(0.013, 6)	0.0529	0.0521	0.0511	0.0498	0.0482	0.0464	0.0444
(0.014, 5)	0.0518	0.0511	0.0500	0.0487	0.0472	0.0454	0.0434
(0.015, 4)	0.0508	0.0500	0.0490	0.0477	0.0462	0.0444	0.0424
	DOC = SC − DIC						
(0.010, 9)	71.5173	71.5810	71.4757	71.1996	70.7512	70.1287	69.3309
(0.011, 8)	71.8434	71.9083	71.8049	71.5314	71.0861	70.4677	69.6745
(0.012, 7)	72.1706	72.2368	72.1353	71.8644	71.4224	70.8079	70.0194
(0.013, 6)	72.4991	72.5666	72.4670	72.1986	71.7600	71.1495	70.3658
(0.014, 5)	72.8288	72.8975	72.7999	72.5342	72.0989	71.4924	70.7135
(0.015, 4)	73.1597	73.2297	73.1340	72.8710	72.4390	71.8367	71.0626

Notes: Parameter values, unless stated otherwise: $R = 3.5\%$, $R_D = 2.5\%$, $D = 340$, $q = 9.0\%$, $\sigma = 0.4$, and $\alpha = 0.5$. Shaded areas in the last panel of the DOC valuation represent an approximate equity value with a corresponding optimal loan rate at various delivery channel choices.

We attempt to identify the knock-out value, i.e., the difference between SC and DOC equity valuation. The findings in the case of $\alpha = 0.5$ are summarized in Table 1. The equity value in the SC valuation observed from the first panel is consistently larger that the equity value in the DOC valuation observed from the third panel, implying that the knock-out value is existent observed from the second panel.

Table 2. Responsiveness of optimal bank interest margin and default risk to delivery channel choices at various levels of regulatory barrier

(c, F), $\Delta(c, F)$	α $(R_L\%)$ 0.50 (4.6)	0.55 (4.6)	0.60 (4.6)	0.65 (4.6)	0.70 (4.7)
	DOC (DIC)				
(0.010, 9)	71.5810 (0.0554)	71.3061 (0.3303)	70.2302 (1.4062)	67.0470 (4.5894)	59.5992 (11.9308)
(0.011, 8)	71.9083 (0.0543)	71.6383 (0.3243)	70.5794 (1.3832)	67.4410 (4.5217)	60.0873 (11.7708)
(0.012, 7)	72.2368 (0.0532)	71.9717 (0.3184)	70.9296 (1.3604)	67.8353 (4.4547)	60.5751 (11.6124)
(0.013, 6)	72.5666 (0.0521)	72.3061 (0.3126)	71.2807 (1.3380)	68.2302 (4.3885)	61.0625 (11.4556)
(0.014, 5)	72.8975 (0.0511)	72.6418 (0.3068)	71.6328 (1.3158)	68.6255 (4.3231)	61.5495 (11.3004)
(0.015, 4)	73.2297 (0.0500)	72.9786 (0.3012)	71.9857 (1.2940)	69.0212 (4.2585)	62.0362 (11.1468)
	$\partial R_L / \partial c$				

0.010→0.011	0.7385	0.7220	0.6776	0.5882	1.0136
0.011→0.012	0.7459	0.7294	0.6852	0.5959	1.0238
0.012→0.013	0.7534	0.7370	0.6929	0.6038	1.0344
0.013→0.014	0.7609	0.7447	0.7007	0.6117	1.0452
0.014→0.015	0.7686	0.7524	0.7086	0.6198	1.0564
	P_{def}				
(0.010, 9)	0.0657	0.1083	0.1638	0.2314	0.3079
(0.011, 8)	0.0650	0.1073	0.1624	0.2296	0.3056
(0.012, 7)	0.0643	0.1062	0.1610	0.2278	0.3034
(0.013, 6)	0.0636	0.1052	0.1596	0.2260	0.3012
(0.014, 5)	0.0630	0.1042	0.1582	0.2242	0.2990
(0.015, 4)	0.0623	0.1032	0.1568	0.2224	0.2968
	dP_{def} / dc				
0.010→0.011	-0.6959	-1.0401	-1.4280	-1.8320	-2.2480
0.011→0.012	-0.6912	-1.0344	-1.4216	-1.8256	-2.2422
0.012→0.013	-0.6866	-1.0286	-1.4152	-1.8191	-2.2363
0.013→0.014	-0.6819	-1.0228	-1.4087	-1.8125	-2.2304
0.014→0.015	-0.6773	-1.0170	-1.4022	-1.8060	-2.2245

Notes: Parameter values, unless stated otherwise: $R = 3.5\%$, $R_D = 2.5\%$, $D = 340$, $q = 9.0\%$, and $\sigma = 0.4$. α (R_L%) represents an optimal loan rate at a constant level of α. DOC, DIC, and P_{def} are approximate values associated with a corresponding optimal loan rate. The conditions of $\partial^2 S / \partial R_L^2 < 0$ in $\partial R_L / \partial c$ at various levels of α are confirmed.

In the first panel of Table 2, it is shown interesting that, as the regulatory barrier increases, the bank's DOC equity value is reduced, but the FDIC's claim value (DIC) is increased. The result is understood because the DOC is less likely to come into effect and the DIC is less likely to vanish, as the regulatory barrier increases. Thus, a transfer of wealth from the bank's equity holders to the FDIC takes place. Next, as the bank increases its human capital relative to its information technology investment in delivery channels, the bank's DOC equity value is increased and the FDIC's claim value is decreased. A result observed from the second panel is that an increase in the human capital relative to the information technology investment has a positive effect on the optimal bank interest margin. Intuitively, as the bank decides to increase its human capital investment in delivery channels, it must now provide a return to a larger administrative cost base. One way the bank may attempt to augment its total returns is by shifting its financial investments to the liquid assets from its loan portfolio. If loan demand is relatively rate-elastic, a less loan portfolio is possible at an increased margin. In addition, as the regulatory barrier increases, the positive impact at an optimal margin is increased as well. This explains that an increase in the regulatory barrier reduces the bank's incentives to increase loan risk.

The observations in the third panel demonstrate that the default risk is increased as the regulatory barrier increases, but is reduced as the human capital increases. The former can be interpreted as increasing the implicit deposit insurance cost burden (and hence the net-obligation payments) resulting in increasing bankruptcy probability. The latter can be interpreted as human resource contribution in banking. The result observed from the last panel is that an increasing in the human capital investment decreases the default risk. This negative effect is increased as the regulatory barrier increases. Human capital investment and regulatory barrier as such make the bank less prone to loan risk-taking and less bankruptcy probability, thereby contributing to the stability of banking system. Our findings are largely supported by Harangus (2009) in bank risk management and Episcopos (2008) in bank regulation.

4. Conclusion

The paper proposes a barrier option framework for bank interest margin determination and bankruptcy prediction when the choices of human capital investment relative to information technology investment in delivery channels and the regulatory barrier are taken into account. Increasing the regulatory barrier induces a transfer of wealth from the bank to the FDIC, implying better protection of the insurance fund. In addition, an increase in the human capital relative to information technology investment in delivery channels is positively related to bank interest margin, but negatively to bankruptcy probability. In conclusion, it is shown that human capital investment and regulatory barrier as such contribute retail banking stability. One issue that has not been addressed is that the impact of different types of human resource management related to employee perceptions of human resource policies and work practices on bank performance is heterogeneous. Is it the case that the results of this paper also apply to the heterogeneous case? Such concerns are beyond the scope of this paper, and so are not addressed here. What this paper does demonstrate, however, is the important role played by human resource investment in affecting bank performance and regulation effectiveness of the banking system.

References

Brockman, P., & Turtle, H.J. (2003). A barrier option framework for corporate security valuation. *Journal of Financial Economics*, *67*, 511-529. http://dx.doi.org/10.1016/S0304-405X(02)00260-X

Cotugno, M., & Stefanelli, V. (2011). Bank size, functional distance and loss given default rate of bank loans. *International Journal of Financial Research*, *2*, 31-44. http://dx.doi.org/10.5430/ijfr.v2n1p31

Episcopos, A. (2008). Bank capital regulation in a barrier option framework. *Journal of Banking and Finance*, *32*, 1677-1686. http://dx.doi.org/10.1016/j.jbankfin.2007.11.018

Harangus, D. (2009). The importance of human capital in banking. Tibiscus University of Timisoara. Research paper.

Hirtle, B.J., & Stiroh, K.J. (2007). The return to retail and the performance of US banks. *Journal of Banking and Finance*, *31*, 1101-1133. http://dx.doi.org/10.1016/j.jbankfin.2006.10.004

Kondo, K. (2010). Do ATMs influence bank profitability in Japan? *Applied Economics Letters*, *17*, 297-303. http://dx.doi.org/10.1080/13504850701720379

Mukuddem-Petersen, J., Petersen, M.A., Schoeman, I.M., & Tau, B.A. (2008). Dynamic modelling of bank profits. *Applied Financial Economics Letters*, *4*, 157-161. http://dx.doi.org/10.1080/17446540701630056

Notes

Note 1. It is well-recognized that retail banking technology choices of human resource management relative to information technology system management are related to relationship lending issues that we are silent on. See, for example, Cotugno and Stefanelli (2011) for relationship lending focusing on the benefits for banks.

Note 2. We follow Brockman and Turtle (2003) and simply our discussion by assuming a zero rebate upon failure.

Note 3. Brockman and Turtle (2003) present that the average barrier estimates by years (1989-1998) are from 0.5900 in 1993 to 0.8395 in 1990. In our numerical exercises, the various barrier levels are assumed to be from $\alpha = 0.5$ to $\alpha = 0.7$, consistent with the findings of Brockman and Turtle (2003).