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VALUATION OF DEPOSIT INSURANCE IN SOUTH AFRICA USING AN OPTION-BASED MODEL

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Abstract

Discussions on introducing a deposit insurance scheme in South Africa have been floating around since 2000, without any official proposal being published or brought to Parliament. Globally, countries have increasingly adopted deposit insurance schemes with the understanding that they provide a public benefit of increasing confidence in the financial system. It is likely that, South African banks and government have resisted introduction of any scheme owing to costing issues. This paper estimates the cost of deposit insurance premiums for seven large South African banks for the first time, annually over the period 2000 to 2009 using an option-based model. The premiums exhibit high volatility over time and across banks but yield an average value that is internationally comparable. The authors also propose a risk-weighted, multi-tier premium structure to encourage appropriate pricing for different categories of risk.

Keywords: South Africa, deposit insurance, option valuation

I. INTRODUCTION

Determining a "fair" premium rate for deposit insurance is particularly troublesome. There are two broad approaches to the pricing problem. The first, which is implemented by this paper, is based on the work by Merton [9, 15] and uses the relationship between deposit insurance and put options to value the premiums. The second is to use historical data of bank failures to determine an actuarial estimate of expected losses and set premiums accordingly [11, 21].

For South Africa, using the second approach is particularly difficult because there have been so few bank failures. Consider that since 1990, South Africa has experienced 13 bank failures [16] compared to the United States that has experienced close to 320 bank failures since 2000 [8]. The political, economic and regulatory framework of South Africa has also changed fundamentally since 1994, and we argue that it is unreasonable to assume that the riskiness of banks prior to this period is any indication of current risks. Additionally, the South African banking sector is very concentrated, with the "big-4 banks" holding approximately 85 per cent of the assets in the sector [13]. The small number of South African banks raises the question of how reliable any historical estimates would be. Therefore, the long observation periods which are required for historical actuarial estimates are not meaningful for determining a "fair" premium [11].

The approach in this paper is thus to value deposit insurance premiums using an option-based model based on Ronn and Verma [18] and Duan [5]. This method provides a theoretical basis to value the premium that the South African Reserve Bank (SARB) could charge for deposit insurance. Secondly, the method creates annual estimates of deposit insurance premiums for individual bank, which allows us to investigate the merits of a flat-rate versus risk-adjusted premium.

The research objectives of this paper are to first estimate deposit insurance rates for South African banks, across banks and over time, using a modified method from Duan [5]. Given these estimates, further questions are considered:

- What is the risk distribution among banks, and what would be the implication of a fixed rate premium on cross-subsidization?
- How variable is the calculated premium over time; and how frequently should premium rates be adjusted?
- How does a conservatively assumed, historical-based insurance premium rate compare with the option-based approach?
- Do the estimated premiums support any particular insurance structure for South Africa?

Based on a decade of data, we find that seven South African banks cluster into three risk categories, with the smaller banks (African Bank and Capitec Bank) appearing less risky than the "big-4 banks" (Standard Bank, Nedbank, ABSA Bank and First Rand), and one bank (Investec) consistently showing a higher risk level. A flat-rate premium would result in smaller banks cross-subsidizing the "big-4 banks" and would discourage competition. The estimated premiums also show a high level of volatility over time, which may simply reflect business cycle conditions. Based on these results, we propose

a 3-tier premium model that captures relative risk and produces internationally comparable premiums.

II. BACKGROUND

Confidence in banks and the banking system is essential to overcome the risk from the inherent maturity mismatch between banks' short-term liabilities (deposits) and their long-term assets (loans). Depositors' psychological fear that a bank may fail can cause a run on a bank, regardless of the underlying financial condition of the institution. However, if deposits at banks could be fully guaranteed, and the guarantee was credible, then depositors would view their deposits as essentially risk-free [15].

South African banks do not currently have an explicit deposit insurance system in place. Nevertheless, should banks become unable to meet their short term liabilities to depositors, depositors may believe that they will be reimbursed by the government instead—an implicit deposit insurance system. This is a reasonable assumption on the part of borrowers, based on the SARB's previous reimbursement of depositors of failed banks [16, 17]. The commercial banking industry in South Africa has assets representing about 120 per cent of GDP; with the "big-4 banks" accounting for almost 85 percent of these assets [13]. Are these banks too big to fail? An explicit deposit insurance scheme allows the "rules of the game" to be transparent.

It is also debatable whether the cost of insurance should be borne by the public or private sector. The goal of deposit insurance, unlike traditional insurance, is not to compensate the customer for losses; rather, it is to prevent the loss from occurring in the first place. Therefore, there are desirable positive externalities that result from the increased financial stability provided by a deposit insurance scheme. We therefore argue that the government may legitimately subsidise a deposit insurance scheme as it may be partially viewed as a public good.[1]

According to the 2005 Bank Supervision Annual Report, serious discussions about a deposit insurance scheme (DIS) started in 2000 as "there was a need to establish a DIS in SA". The report further states that "the Department is of the opinion that it should be possible to finalise a proposal, for submission to the Minister, during 2006". One of the major unresolved issues is the legal nature of the DIS. This affects how members contribute to the fund, and how the fund will pay out to members. Another issues is how the DIS would be funded – initially, and operationally.

Interestingly, since this report there has been no mention of a DIS in any of the Bank Supervision Annual Reports from 2006 to 2010. Furthermore, there is no public information on any of the analysis that has been completed. News reports over the last decade have mentioned a DIS every few years, but once again, there is no official documentation about the issue that has been released.

[1] Much has also been written about the traditional moral hazard problem with a deposit insurance scheme, where banks are incentivised to undertake riskier activities [14] and may even destabilize the financial system [22], but this is not relevant to the focus of this paper.

Correspondence with the SARB reveals that a lot of preliminary work has been done on proposals on how such a scheme could be funded, operated etc.; but all these proposals are with the National Treasury for consideration. These documents are currently still not publically available. The National Treasury has the final decisions as to the implementation of a deposit insurance scheme. The pricing model under consideration is being modelled by a private company and is not the structural option-based model used in this paper.

Why is the government willing to hold a large uninsured risk? What are the reasons that the analysis is not open for public debate and discussion? Or is government ignoring the issue, as it is preoccupied with other problems? What are the repercussions for South Africa?

International schemes for pricing deposit insurance exhibit a wide range of parameters concerning not only rates, but coverage limits, funding sources, and various administrative controls [23]. In the small sample of comparator countries and factors shown in Table 1, we observe that risk-adjusted schemes are common, and premiums often range in the 0.3 to 0.7 percent of deposits.

Table 1 Comparison of Deposit Insurance Premiums

Country	Annual Premium Cost, Percent of Deposit	Risk-adjusted	Funding (Public/Private)
Argentina	0.36-0.72	yes	private
Brazil	0.3	no	private
Finland	0.05-0.3	yes	joint
Greece	0.25-1.25	no	private
India	0.05	no	joint
Mexico	0.3-1.0	no	joint
Nigeria	0.9375	no	joint
Turkey	1.0-1.2	yes	joint
Uganda	0.2	no	joint
USA	0.0-0.27	yes	joint

Source: Demirguc and Sobaci [3]

In June 2009, 49% of countries worldwide (93 countries) had a deposit insurance system in place, and another 12% of countries were considering introducing a deposit insurance system [12]. South Africa is considered to be one of the countries considering introducing a deposit insurance scheme; yet, to date, no official public documents detailing any proposed deposit insurance scheme have been published.

In 2002, after the failures of Regal Bank and Saambou Bank, there was renewed interest and pressure for the introduction of a deposit insurance scheme. Government spent the next three years researching and discussing such a policy. However, the idea disappeared around 2004/2005, apparently due to strong opposition from the "big-4 banks". After the financial crisis of 2008, there was once again renewed public interest in financial stability and hence deposit insurance, but banks and the government have let the idea languish, which raises the question of "why."

III. METHODOLOGY

In Merton's [15] seminal paper, he showed that value of deposit insurance to a bank could be described as a put option on the assets of the bank, with a strike price equal to the value of the bank's deposits. Using the Black-Scholes formula, it is then possible to calculate the value of this option, and thus the fair price that should be charged for insuring the deposits. This model is presented below.

A. THEORY OF DEPOSIT INSURANCE AS A PUT OPTION

A bank has a total asset value of V_0 at time 0, consisting of equity and debt. Suppose the bank's debt consists of deposits (B_1) and all other debt (B_2), then the value of the bank's total debt is $B = B_1 + B_2$. Deposits as a proportion of total debt is then B_1/B. Assuming that all debt is issued at the risk-free rate of interest, at time $T > 0$ the bank's total debt will be Be^{rT}. Suppose that T is the length of time until the bank's next audit, at which time a decision is made on closure: if the bank is unable to pay back its debt at the time of audit, it would be forced to close and repay its debt by selling off its assets. If the further assumption is made that all debt is of equal seniority, then the payoffs to the various stakeholders at time T are as follows:

(i) Should $V_T > Be^{rT}$, then the bank's liability to debt-holders would be Be^{rT} and depositors would be entitled to receive B_1e^{rT} of this amount. The value of the bank to equity-holders would be $V_T - Be^{rT}$.

(ii) If instead $V_T < Be^{rT}$, then the bank would be unable to meet its liabilities and debt-holders would receive a maximum amount of V_T; incurring a loss equal to $Be^{rT} - V_T$. Depositors would be entitled to receive $(V_TB_1)/B$, the proportion of the salvageable asset value owed to them. The value of the bank to equity-holders in this case would be 0.

The payoff to depositors is therefore $\min\{B_1e^{rT}, (V_TB_1)/B\}$ and the payoff to equity-holders is $\max\{V_T - Be^{rT}, 0\}$.

Ronn and Verma [18] argue that the value of a firm's assets is different depending on whether its deposits are insured or not. They argue that there is an "accretion value on account of the insurance", so that the value of the firm's assets after insurance (V) is larger than the value of the firm's assets before insurance (V')—i.e. that $V > V'$. This accretion value is however diminished by the effect of competition (C). Let P_V be the accretion value as a result of insurance, then $V = V' + P_V - C$. Ronn and Verma [18] point out that if the fair price for deposit insurance is charged, then no accretion occurs and $V = V'$, so there is no distortion due to the introduction of deposit insurance.

The bank now enters into an insurance contract. The terms of this contract are that if the bank is unable to repay the depositor's portion of its total debt, B_1, then the insurer would pay this debt obligation; and in exchange obtain the bank's assets. In this case, payoff (ii) becomes:

(ii) If instead $V_T < Be^{rT}$, then the bank would be unable to meet its liabilities and debt-holders would receive a maximum amount of V_T; incurring a loss equal to $Be^{rT} - V_T$. Without the insurance contract, depositors would be entitled to

receive $(V_T B_1)/B$, incurring a loss equal to $B_1 e^{rT} - (V_T B_1)/B$. However because the deposits are insured, the insurer would pay out the full amount that is owed to depositors and incur a loss of $B_1 e^{rT} - (V_T B_1)/B$. The value of the bank to equity-holders in this case would be 0, as before.

The payoff to depositors is therefore $B_1 e^{rT}$, the payoff to equity-holders is $\max\{V_T - Be^{rT}, 0\}$, and the payoff to the insurer is $-\max\{0, B_1 e^{rT} - (V_T B_1)/B\}$.

B. Value of Insurance

The effect of entering into this insurance contract, from the bank's point of view, is that it is now entitled to receive an additional cash flow equal to $\max\{0, B_1 e^{rT} - (V_T B_1)/B\}$ at time T. In other words, at time T the insurance contract is worth $I_T = \max\{0, B_1 e^{rT} - (V_T B_1)/B\}$. This is identical to the payoff profile of an European put option with a strike price of $B_1 e^{rT}$ and a stock price of $(V_T B_1)/B$; effectively giving the bank the right, but not the obligation to sell the pro-rated assets due to depositors for a price of $B_1 e^{rT}$. Using the Black-Scholes formula, we can then calculate the value of I_0 as

$$I_0 = B_1 \Phi\ y + \sigma\ \overline{T}\ - V_0 \frac{B_1}{B} \Phi\ y\ , \tag{1}$$

where $\Phi(.)$ is the cumulative standard normal distribution, σ is the instantaneous standard deviation of the rate of return on the bank's assets, V_0 is the unobserved post-insurance value of the bank's assets, and $y = [\ln(B/V_0) - (\sigma^2 T)/2]/(\sigma\sqrt{T})$. Therefore d, the value of insurance per rand of deposits, is

$$d = \frac{I_0}{B_1} = \Phi\ y + \sigma\ \overline{T}\ - \frac{V_0}{B} \Phi(y). \tag{2}$$

C. Empirical Application of the Model

The post-insurance value of the bank's assets, V, is unobservable *ex ante*; and hence the instantaneous standard deviation of return on the bank's assets, σ_V, is also unobservable. Ronn and Verma [18] estimate these variables by using the relationship between the volatility of assets and the volatility of equity. If we describe the equity (E) of a bank as a call option on the assets (V) of the bank, with a strike price equal to the total the debt (D), then using the Black-Scholes formula:

$$E_0 = V_0 \Phi\ x\ - B\Phi\ x - \sigma_V\ \overline{T}\ , \tag{3}$$

where

$$x \equiv \frac{\ln\ \frac{V_0}{B}\ + \frac{1}{2}\sigma_V^2 T}{\sigma_V\ \overline{T}}.$$

Duan [5, 6] however, points out that the shortcoming in the Ronn and Verma [18] method is that they incorrectly treat the equity volatility as constant. Under the theoretical model of Merton [15], equity volatility is stochastic. Duan shows that it is possible to estimate theoretically correct values for V and σ_V using the maximum

likelihood estimates from a sample of a bank's equity values. The log-likelihood function for a sample of unobserved V_t is

$$L_V\ V_t, t = 1, \dots, n, \mu, \sigma\ = -\frac{n-1}{2}\ln\ 2\pi\sigma^2\ -\ \sum_{t=2}^{n}\ln V_t - \frac{1}{2\sigma^2}\ \sum_{t=2}^{n}\ \ln\ \frac{V_t}{V_{t-1}}\ -\mu\ ^2. \qquad (4)$$

Equation (4) defines an element-by-element transformation from a sample of unobserved V_t to a sample of observed sample of equity values, E_t. Using the results derived in Duan [5, 6], the log-likelihood function for the sample of equity values is therefore

$$L\ E_t, t = 1, \dots, n, \mu, \sigma\ = -\frac{n-1}{2}\ln\ 2\pi\sigma^2\ -\ \sum_{t=2}^{n}\ln\ V_t(\sigma)\Phi(d_t)$$

$$-\frac{1}{2\sigma^2}\ \sum_{t=2}^{n}\ \ln\ \frac{V_t(\sigma)}{V_{t-1}(\sigma)}\ -\mu\ ^2 \qquad (5)$$

where $\hat{V}_t(\sigma)$ is a solution to (3) for any σ, and $\hat{d}_t$ corresponds to d_t with $\hat{V}_t(\sigma)$ in place of V_t. The log-likelihood function in (5) can then be optimized to compute the maximum likelihood estimates for μ̂ and σ̂ [5, 6]. These values can then be substituted into (2) to solve for d.

IV. DATA

Daily market capitalization data were collected from Thompson Reuters Datastream [2]. Monthly data on bank liabilities were collected from the DI900 and BA900 databases on the SARB [19, 20] website. Most of the banks that were examined were part of a larger holding company whose operations did not only include commercial banking. Similar to Ronn and Verma [18], we assumed that the capital structure of the bank is similar to that of its holding company because market capitalization data are generally only available for the banking group. For most banking groups the large majority of assets are those of the bank.

Deposit insurance valuation is performed on seven banks. The choice of banks was restricted to those listed on the Johannesburg Stock Exchange (JSE): ABSA Group Limited, African Bank Investments Limited, Capitec Bank Holdings Limited, Firstrand Limited, Investec, Nedbank Limited and Standard Bank Group.

Data for the ten-year period from 2000 to 2009 was collected per bank. Market capitalization and liability data were combined to produce daily equity and debt values for the period—a total of 2,556 observations per bank. The total debt series was updated monthly, owing to its availability. We use the GAUSS code provided by Duan [5, 6] to estimate the maximum likelihood estimates for μ̂ and σ̂.

The continuous daily returns on bank assets are calculated as ln[V̂t(σ)/V̂t-1(σ)]; from this the daily standard deviation can be calculated and annualized based on the number of trading days—between 248 and 262.

V. RESULTS

Based on the above methodology, the estimated insurance premiums, per million rand, are reported in Table 2. Complete results for all banks, including estimates of μ, σ and their standard deviations can be provided on request.

Table 2 Estimates for Deposit Insurance Premiums per Million Rand of Deposits

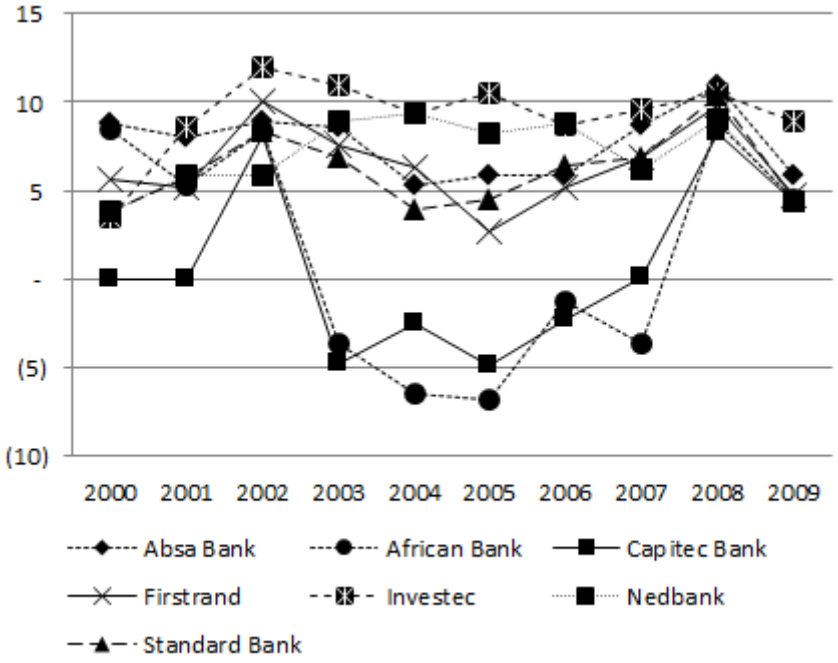
	Absa Bank	African Bank	Capitec Bank	Firstrand	Investec	Nedbank	Standard Bank	Weighted Average[a]
2000	6 491	5 023	N/A	293	32	45	46	1,955
2001	3,022	197	N/A	171	5,468	355	325	1,437
2002	7,159	4,494	3,388	22,796	157,231	357	4,243	19,025
2003	5,245	0	0	1,935	54,737	7,346	935	7,008
2004	198	0	0	574	12,493	12,136	50	3,732
2005	353	0	0	15	36,219	3,637	88	3,072
2006	371	0	0	173	5,759	6,648	629	1,999
2007	5,992	0	1	1,015	15,208	494	940	3,002
2008	56,039	6,528	3,888	17,867	37,567	8,836	33,412	31,375
2009	338	93	81	118	7, 582	84	92	645
Avg.	8,520	1,633	735	4,495	33,229	3,993	4,076	7,325

a Weighted by liabilities.

The large variation in deposit insurance premiums coupled with the tight confidence bounds, implying a small margin of error, raises the question as to whether the method of Duan is inappropriate for determining an actual premium rate as opposed to simply defining risk levels, as some have argued [18]. Clearly it is impractical to change premiums so dramatically from year to year, although any risk-based scheme must allow for periodic changes in the premium.

To better identify two notable characteristics of the data, we plot ln(*premium*) in Figure 1. The logarithm function rescales the premiums so that the trends are more pronounced. First, we note that the some fairly consistent behavior among the relative bank premiums: the two smaller banks tend to be significantly below the other banks; and Investec tends to be the highest.

Figure 1 Variation of ln(*premium*) over Time



Secondly, there seems to be some cyclical behavior, or at least common annual movement for all of the banks, which might be more apparent in Table 2. This is logical, as the premiums reflect JSE valuation, which is subject to common trends for the banking sector.

To investigate how closely the series for each bank move together, we calculated the correlations between the banks. The results showed that the deposit insurance premiums of banks are highly correlated, with an average correlation of 0.81. This can be explained by arguing that banks belong to the same industry and are largely exposed to the same risks. Nevertheless, the variation among banks is still disturbing and requires further examination.

VI. CONCLUSIONS

Option-based valuation models provide a "first jab" at what deposit insurance premiums could look like for South African banks. We conclude by discussing several issues that are of relevant to any pricing policy and then propose a hypothetical historical pricing example.

A. THE VALUE OF MARKET-BASED RISK ASSESSMENT

Our model, which utilizes market information as an input, has the advantage of distinguishing theoretically consistent estimates of bank risk. We believe that substantially different categories of bank risk merit different treatment in terms of insurance premiums, as is common internationally (Table 1). Recognizing that the market is also subject to the machinations of short-term investor sentiment, we would propose using long-term average premiums, which would tend to smooth out cyclical risk.

The first implication of our result is to allow for bank specific premiums. If we assume that the value of deposit insurance is an indicator of the riskiness of a bank, then the argument is that insurance is worth more to a risky bank than a cautious bank. However, given the volatility of our estimates, we would prefer to argue for categories of risk—possible three for South African banks (see section D).

Secondly, the fluctuation of average premiums over time provides an assessment of banking sector risk, which may be cyclical or have some secular trend. We argue that this is beneficial for estimating insurance premiums. For now, we prefer to average out long-term variations on the assumption that it smoothes out cyclical market risk.

The underlying issue is that the model is very sensitive to estimates of asset volatility—a result of the Black-Scholes model. The effect is that during periods of uncertainty in the stock market, the model can produce very volatile movements in the calculated deposit insurance premiums.

B. Flat vs. Risk-Adjusted Premiums

The results suggest that the two small banks (African Bank and Capitec Bank) have similar risk profiles, the "big-4 banks" have similar profiles, and Investec stands out as a consistently higher risk. This presents a case for a multi-tiered deposit insurance premium. There are two main issues: the volatility of the calculated premium and cross-subsidisation.

The calculated annual premiums vary in relation to the perceived market risk as observed in the stock market. Such fluctuation creates an additional variable cost to be passed on to the depositor, which is not desirable. Rather, a premium representing the average over a business cycle might be used. In our case, the average option-based premium over the period 2000 to 2009 is R7,325 per million or 0.007325 percent of deposits—at the higher end of international standards.

If we were to introduce a flat-rate premium, it might seem logical to introduce it at a rate that is the average of the "big-4 bank's" risk premium, because they hold about 85% of the assets in the banking industry. However, because the smaller banks are less risky, they would be subsidizing the "big-4 banks". Such cross-subsidisation toward riskier, larger banks increases barriers to entry to the banking sector and reduces competition, which is not desirable.

In our view, a 3-tier rate structure would provide a competitive advantage to more cautious (lower-premium) banks, which may not be bad, even if it would be resisted by higher-risk banks. This would still leave open the issue of a periodic revision of risk to allow for a change in risk categories. Some rule could be established for a shift in premium if a bank maintains a lower risk level for a certain number of years.

C. Costs

Who should bear the financial burden of financing a deposit insurance scheme? If there is an implicit deposit insurance scheme, it becomes a fiscal problem, and the government has to foot the bill using tax payers' money. An explicit deposit insurance

scheme, even if only a partial deposit insurance scheme, has the benefit of more clearly defining the private and public risk exposure.

We would also argue that deposit insurance creates positive externalities for the government/SARB in terms of increased stability of the financial sector. This may warrant a government subsidy, as this insurance provides a legitimate social benefit. The exact level of subsidy might be quantified within a cost-benefit analysis, but we explore some hypothetical situation below.

It is our assumption that the costs of deposit insurance would ultimately be passes on to the depositor in the form of higher bank fees or lower deposit rates. Our view is that there is a low likelihood of the banks absorbing the cost out of profits, although banking customers could be reaching their cost limit.

D. Hypothetical Historical Example

For comparison purposes, on a purely hypothetical basis, we assume that one of the "big-4 banks" fails once every 20 years and loses assets sufficient to cause a loss of half of its deposits. For example, let us use Absa bank, which had deposits in 2009 of R350.8 billion that represented 53 percent of its total liabilities. Let us simplify the calculation by assuming that there is no inflation or cost of debt or administrative costs; so we divide this loss equally among all banks' depositors over 20 years. This requires an annual contribution of R8.77 billion to the insurance fund. We assume that all 7 banks have the same ratio of deposits to total liabilities, which implies total customer deposits of R1,350 billion, based on total banking sector liabilities. Depositors would have to pay a premium of 0.0065 rand per rand insured in order to cover the annual insurance contribution of R8.77 billion. This premium rate, R6,500 rand per million (0.65 percent) is not substantially different than the weighted average option-based premium of R7,325 per million (Table 2). The high premium reflects the concentrated nature of the South Africa banking system—one large banking failure might be equivalent to 10 smaller bank failures.

E. Proposal

We think that a fully private deposit insurance scheme based on a the weighted average insurance premium for the 7 banks for the 2000-09 period would be costly at R7,325 per million rand of deposits or 0.7325 percent.

We see two possible modifications. In the first instance, the government provides a flat 50 percent subsidy, substantially cutting down the incremental cost to the depositor to 0.34 percent, but still creating a cross-subsidization problem. This size subsidy is large and fundamentally assumes that the public benefits of this insurance are equal to the private benefits. This level would put South African deposit insurance on a very comparable level to other comparator countries (Table 1).

In the second modification, a 3-tier premium structure is implemented on top of the 50 percent government subsidy. For this simplified analysis, we calculate a "low" premium as the annual liability-weighted average premium for African Bank and Capitec; the "average" premium as the average premium of the "big-4"; and a "high" premium as the

average premium for Investec (Table 3). This 3-tier approach is intended to assign an appropriate price to different ordinal levels of bank risk, and minimize cross-subsidization. Although the "high" premium level may be excessive in this case, it serves as an example and could easily be readjusted with modest subsidies from the other categories.

Table 3 Possible 3-Tier Premium Scale

Premium level	Average Annual Premium Without Subsidy, Cost per Million Rand
"Low"	1 619
"Average"	7 651
"High"	27 744
Mean	7 325

Source: Calculation by authors, based on liability-weighted average

In conclusion, the authors believe in the public benefits of deposit insurance, and we have presented a strategy for calculating insurance premiums according to an option-based model, using a multi-tier premium scale, and including government participation. Such an approach may be the most promising course of action for South African deposit insurance.

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