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A counter cyclical adjustment on the economic capital measurement of listed commercial banks

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Abstract

With the implementation of the "Basel III", banks need more capital to cover risks. The changing rules of capital will be different from the previous. Taking Morgan as an example, a top-down method is used to calculate its economic capital. Then, by comparing with the reported economic capital, the result shows Morgan has considered pro-cyclicality and made a great counter cyclical adjustment. In order to provide regulatory authority a reasonable method to know well the risk of commercial banks, the top-down economic capital measure model is counter cyclical modified.

Key words: Economic capital; Top-down method; Pro-cyclicality; Counter cyclical adjustment

JEL classification: C6, G2

1 INTRODUCTION

"Basel III" , the new global regulatory framework requires banks to have higher quality and larger quantity of capital, which greatly increase the banks operating cost, as well as restrict the high-risk behavior in banks. Capital management is always an important composition of the management in banks. Many literatures about the current capital management mainly focus on capital allocation, where the optimal could realize the highest benefit cost, but these capital allocation methods are built on series of assumptions (Zanjani ,2010; Erel et al., 2013; Peng et al., 2013). However, subject to regulatory constraints, the banks can not keep the optimal capital ratio. Unfortunately, due to the fact that the banks cannot keep the optimal capital ratio with the constraints of regulation, literatures on optimal capital under the constraint of bank supervision are proposed (Miles et al., 2013; Repullo and Suarez, 2013). With the implementation of the "Basel

III", how to minimize capital will be valued by the bank managers.

Bank's capital is defined as the present value of assets minus the present value of liabilities. Capital is negatively correlated with risk, while being the opposite with the bank's credit quality. Economic capital is such a concept corresponding to risks arising from the course of business. Economic capital management is a cutting-edge and popular capital management mode in commercial banks. Economic capital can be applied in daily management of commercial bank, such as asset allocation and loan pricing. The key to economic capital management is how to measure economic capital. Generally, there are two perspectives in economic capital calculation: bottom-up and top-down. Internal Ratings-Based approach of BaselⅢ suggests bottom-up approach, which calculates economic capital according to amount of various types of risk, including credit risk, operational risk and market risk. However, Schroeck（2002）has introduced a top-down approach for deriving economic capital, this approach calculating economic capital based on listed banks' market data and credit ratings. The economic capital amount in the top-down perspective is similar with the amount reported by bank at the time.

With the development of finance, the Basel committee is gradually realizing that economic capital measurement have strong pro-cyclicality. Some measures such as estimating default rate based on long-term data and using loss given default in a recession have been used to remit pro-cyclicality. This suggests that the economic capital of commercial banks will be great after adjustment in better period while less during weak economy. But the effect of the counter cyclical adjustment can not be measured. The economic capital calculated by using Schroeck's model was close to the economic capital reported by the bank before "Basel II" and "Basel III", consequently, we assume that the economic capital calculated by using Schroeck's model can reflect the risk of banks. This paper adopts top-down approach to measure economic capital before adjustment, inspects the degree of cycle smoothing in the economic capital measurement, makes counter cyclical adjustment for the economic capital model and finally uses the model to calculate the economic capital next year.

2 Model

The top-down approach is based on the theory of option pricing, which regard default as an event that the asset value is less than certain default point which is usually related to the structure

of debt in bank. As following formula shows,

$$PD_t = P(V_t < C_t) \tag{1}$$

Here, PD_t means probability of default at time t, C_t represent default point at time t.

Suppose the asset of bank follows the geometric Brownian motion,

$$\frac{dV_t}{V_t} = \mu dt + \sigma dW(t) \tag{2}$$

Here, μ means average return on asset value, σ is the volatility ratio of asset, $dW(t)$ is standard Brownian motion, the mean of which is 0 and the variance is dt ,it is also known as wiener process. Then the value of bank asset is,

$$V_t = V_0 \, \mathrm{e}^{(\mu - \frac{\sigma^2}{2})t + \sigma W(t)} \tag{3}$$

Together with (1) and (3) yields,

$$\begin{aligned} PD_t &= P(V_0 \, \mathrm{e}^{(\mu - \frac{\sigma^2}{2})t + \sigma W(t)} < C_t) \\ &= P((\mu - \frac{\sigma^2}{2})t + \sigma W(t) < \ln \frac{C_t}{V_0}) \end{aligned} \tag{4}$$

Because of $W(t) = \varepsilon\sqrt{t}$ ， $\varepsilon \sim N(0,1)$,formula (4) can be translated to the following formula,

$$PD_t = P(\varepsilon < \frac{\ln \frac{C_t}{V_0} - (\mu - \frac{\sigma^2}{2})t}{\sigma\sqrt{t}}) = \Phi\left(\frac{\ln \frac{C_t}{V_0} - (\mu - \frac{\sigma^2}{2})t}{\sigma\sqrt{t}}\right) \tag{5}$$

Commercial banks have their own credit ratings. A reduction in credit ratings will affect their competitiveness, reduce public confidence and is not conducive to the development of business. Therefore, we can get the corresponding probability of default according to credit rating. This probability of default is a base line and a target which commercial bank need maintain to guarantee public confidence, recorded as PD_{d} .

According to target probability of default, we get default point recorded as C_T through solving formula (5).

$$C_T = V_0 e^{N^{-1}(PD_{\mathrm{d}})\sigma\sqrt{T} + (\mu - \frac{\sigma^2}{2})T} \tag{6}$$

C_T means the maximum amount of debt that commercial bank can pay so as to maintain the

target probability of default at time t, if the amount of debt is greater than the C_T ,the probability of default will higher than target level, meanwhile, the bank will have a credit downgrade.

At this time, the economic capital of commercial bank is equivalent to the gap between asset value and default point as following formula shows,

$$EC = V_0 - C_T \tag{7}$$

3 The measurement of economic capital

Taking JP Morgan as example owing to few banks has reported their economic capital. Selecting asset-liability data and stock data published by JP Morgan, then calculating the economic capital of Morgan, and making a comparison with the reported economic capital.

First of all, the asset value and asset volatility have been calculated according to Black-Scholes formula as follows,

$$\begin{aligned} E &= VN(d_1) - e^{-r} DP' N(d_2) \\ \sigma_E &= \frac{VN(d_1)}{E}\sigma_V \end{aligned} \tag{8}$$

Here, E means stockholders' equity of Morgan, σ_E is volatility of stock return, which select the fluctuation of weekly stock returns, V is asset value, σ_V is volatility of asset value, initial default point $DP' = A_0 - \frac{1}{2}L$, A_0 , L represents asset and long-term debt, respectively. $N(d_1)$ is accumulation standard normal distribution function, $d_2 = d_1 - \sigma_V\sqrt{T}$,r is risk-free interest rate equal to annual average value of daily treasure long-term rate.

We get asset value and asset volatility by MATLAB, shown in the table below.

Table 1 Asset value and asset volatility of Morgan from 2010 to 2012 (in millions)

	E	A_0	L	DP'	σ_E	r	V_0	σ_V
2010	165365	2031989	289165	1887407	0.296235692	0.039694	1979320	0.0247
2011	176106	2117605	270653	1982279	0.338230691	0.03880	2082935	0.0286
2012	183573	2265792	256775	2137405	0.302152458	0.035192	2247071	0.0247

By formula (7), we get the default point, here μ is the sum of return on asset and risk-free interest rate.

Table 2 Economic capital of Morgan (in millions)

	Credit rating	PD_d	$N^{-1}(PD_d)$	μ	C_T	EC	EC as report(EC_r)	Difference $EC_r - EC$	$\frac{\text{difference}}{EC}$
2010	A+	0.0005	-3.29053	0.048552	1915648	63671.99	78400	14728	0.231311
2011	A	0.0007	-3.19465	0.048003	1995654	87280.82	78100	-9180.819	-0.10519
2012	A	0.0007	-3.19465	0.044979	2174245	72825.73	86000	13174.3	0.180902

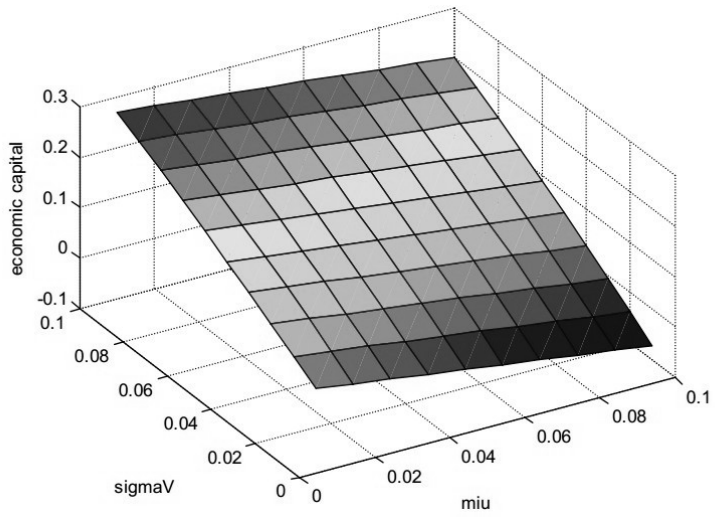
Table 2 shows that the differences between economic capital calculated by top-down approach (EC) and those reported (EC_r) are more than 10%. The top-down model is sensitive to the change in the stock market. From Morgan's stock data, we also found the stock price was on the rise in 2010 and 2012 while the EC is less than EC_r, whereas the stock price declined in 2011, the EC is more than EC_r. So, we can infer that Morgan has considered pro-cyclicality and made a great counter cyclical adjustment in the post-crisis era.

4 Modification

We modify the top-down model according to its intrinsic properties.

4.1 The top-down model's intrinsic properties

While PD_d is equal to 0.007, there is a certain relationship among μ(miu), σ_V(sigmaV) and economic capital in the top-down model, as shown below.



Picture 1 the relationship between miu, sigmaV and economic capital

When the average return μ is 0.045, the relationship between asset volatility σ_V and economic capital is similar to a straight line with the slope equal to 2.57, thus the economic capital is sensitive to the volatility of asset. Especially for Morgan, it has a large asset scale, even a small change of asset volatility will cause a great change in the amount of economic capital. So we choose the asset volatility as the modified object.

4.2 Modification of the asset volatility

From the table 2, the sign of the difference is opposite to the change of share price. Then we modify the model on the basis of bank stock yield.

As we know, the risk of the bank was influenced by self factors, but also influenced by the whole market. According to capital asset pricing model (CAPM), we calculate the Morgan's expected return. The expected return can reflect the change of the market, so does the economic capital calculated by using this parameter.

From 2010 to 2012, the beta coefficients of the CAPM are 1.212, 1.374, 1.3675, those are calculated based on daily return rate of Morgan and NYSE. Since annual returns of NYSE are 0.0834, -0.073, 0.102, we get the returns of Morgan are 0.092671247,-0.114934697, 0.126625882.

Now suppose

$$\sigma_V{}' = \begin{cases} (1+\alpha_l R)\sigma_V \\ \sigma_V \exp(\alpha_e R) \end{cases} \tag{9}$$

By minimizing the residual sum of square of economic capital in three years, we get the correction factor:

$$\begin{cases} \alpha_l = 0.62 \\ \alpha_e = 0.622 \end{cases}$$

Table 3 Economic capital after correction (in millions)

	linear correction	$\frac{\text{difference}}{EC_r}$	Index correction	$\frac{\text{difference}}{EC_r}$
2010	72628.99	-7.36%	72921.27	-6.99%
2011	74271.82	-4.90%	74686.61	-4.37%
2012	86140.66	0.16%	86722.05	0.84%

4.3 Calculate the economic capital in 2013

It is worth mentioning that the correction factor is different while using other banks' data. Since Morgan's annual report 2013 has not published its economic capital, we use this modified model to measure it. First, we can calculate annual σ_E according to the stock data of Morgan in 2013. In addition, the commercial bank's average return on asset value is equal to ROA plus risk-free rate, here the value of μ is 0.03278. The credit rating of Morgan is A, so its PD_{d} is equal to 0.007. The economic capital in 2013 after modification is shown below.

Table 4 estimation results (in millions)

method	μ	σ_E	PD_{d}	$N^{-1}(PD_{\mathrm{d}})$	V	σ_V	C_T	$EC = V - C_T$
Linear estimation	0.03278	0.192	0.007	-3.19465	2383324.7	0.0164	2322038.8	61285.9
exponent estimation							2321073.6	62251.1

When using linear modification, the economic capital needs to achieve 61.3 billion in the case of the target probability of default is 0.007. Within range of the error correction the maximum of which is 7.36%, the economic capital may reach 65.8 billion. While the exponent estimation result shows the economic capital needs to achieve 62.25 billion. Within range of the error correction the maximum of which is 6.99%, the economic capital may reach 66.6 billion.

5 Conclusion

After the financial crisis, the top-down approach has its limitations in a certain sense. After the modification above, drawing the macro factors into the top-down approach can better meet the demand of financial regulation.

This paper proposes a method which adopts public and transparent data for regulatory authority to know well the risk of commercial banks in the post-crisis era. The authority can monitor the capital adequacy through contrasting the economic capital calculated by the top-down approach with economic capital estimated by Internal Ratings-Based approach. This method is conducive to the implement of regulatory authority's measures as well. For example, according to the economic situation, the regulatory authorities can request commercial banks

to increase their economic capital in order to strengthen the counter cycle regulation.

In addition, calculation of the correction factor is not limited to a single bank, so that regulatory authorities can utilize their own information to supervise all the listed banks.

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