A leverage ratio rule for capital adequacy

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Abstract

This paper studies the economic foundations for maximum leverage ratio capital adequacy rules. The paper makes three contributions to the literature. First, we show how to determine the maximum leverage ratio such that the probability of insolvency is less than some predetermined quantity. Two, we show that a leverage ratio rule controls for the same risks as does a Value-at-Risk (VaR) capital adequacy rule. Third, we argue that leverage ratio rules are better than VaR rules because they are more intuitive and easier to compare across firms.

Keywords: Leverage ratios Capital adequacy rules Value-at-risk Collateral requirements Haircuts

1. Introduction

Financial reforms following the 2007 credit crisis, including the newly proposed Basel III capital requirements (2010) and the recently enacted Dodd Frank Wall Street Reform and Consumer Protection Act, stress the important of capital adequacy rules. Leverage ratios have reappeared in the proposed Basel III capital standards, with no economic reasoning provided for the maximum leverage ratios (see (2010, p. 64)), except perhaps to be consistent with historical averages in non-crisis periods. In addition, the maximum leverage ratios are introduced to control for risks believed to be different from those captured by the existing Value-at-Risk (VaR) capital standards. Given these developments, the purpose of this paper is to revisit leverage ratio based capital rules and relate them to the existing VaR methods.

The existing economic literature studying capital regulations relating to bank behavior and business cycles is reviewed in the papers by Berger et al. (1995), Drumond (2009), and VanHoose (2007).

The contributions of our paper to this literature are threefold:
1. to provide an economic foundation for determining the maximum leverage ratio, using as a analogy both the standard collateral provisions used in over-the-counter (OTC) derivative markets and the common margin requirements used for exchange traded securities,
2. to show that a leverage ratio rule controls for the same risks as those controlled for using VaR based rules, and
3. to argue that leverage ratio rules are more intuitive and more easily comparable across firms.

The implication of these contributions, of course, is that leverage ratio rules should be the preferred method for the determination of capital adequacy, and not VaR based rules.

A related paper to ours is that of Blum (2008). Blum constructs an asymmetric information model where banks can report their VaR untruthfully. In this context, he argues that maximum leverage ratios provide an additional tool that regulators can use to induce banks to report their risks truthfully. Our paper takes a different perspective. We assume at the onset that truthful reporting is a non-issue due to regulatory monitoring. In this context, we study whether VaR versus maximum leverage ratio rules control for different risks. As discussed above, our answer is no. We show that they both VaR and maximum leverage ratios are equivalent tools for controlling insolvency risk.

An outline for this paper is as follows. Section 2 presents the model structure needed for the analysis. Section 3 reviews VaR
as used for capital adequacy. Sections 4 and 5 present the collateral and leverage ratio rules for capital adequacy, respectively. Section 6 proves the equivalence between these three different rules for capital adequacy, while Section 7 concludes.

2. Model structure

Consider an economy with an infinite horizon where the randomness is captured by a filtered probability space \((\Omega, F, (F_t)_{t=0}^\infty, P)\) with \(\Omega\) the state space, \(F\) the set of events, \((F_t)_{t=0}^\infty\) the information filtration, and \(P\) the statistical probability measure. On this time horizon, we consider the time interval \([t, t+\Delta]\) where \(\Delta > 0\) could be a day, week, month, or a year.

We consider a financial institution with the time \(t\) balance sheet as in Table 1.

The firm has assets, liabilities, and equity, where \(A_t, D_t,\) and \(E_t\) denote their time \(t\) market values, respectively. We assume that the values, considered as stochastic processes, are all \(F_t\) - measurable. There is the well-known accounting identity

\[
A_t = D_t + E_t, \tag{1}
\]

that is noted for subsequent use.

Standing at time \(t\) and projecting forward to time \(t + \Delta\), for risk management purposes, the firm’s shareholders, management, and government regulators are interested in the likelihood that the firm will become insolvent, where insolvency is defined to be the condition where the value of equity becomes non-positive, i.e., \(E_{t+\Delta} - D_{t+\Delta} \leq 0\).

Since we are concerned with internal risk management (before bankruptcy proceedings are executed), we consider the possibility that over the time interval \([t, t+\Delta]\), the value of the liabilities can exceed the value of the assets, i.e., the equity can have a strictly negative value \(E_{t+\Delta} < 0\). In this case, bankruptcy proceedings would eventually be instituted, and the equity’s limited liability would be invoked. The value of the equity would become zero, and the losses to the equity holders would be transferred to the liability holders.

To analyze capital adequacy rules, including value-at-risk, we study the time \(t\) conditional probability distribution of the change in the firm’s equity value over \([t, t+\Delta]\), \(\Delta E_t = E_{t+\Delta} - E_t\), denoted \(P(\cdot)\).

3. Value-at-Risk (VaR)

This section reviews the use of Value-at-Risk (VaR) for capital adequacy. This is the standard approach used by financial institutions and regulators, based on the Basel II capital standards (2004). We first give the definition of VaR in our notation.

3.1. VaR definition

Definition. value-at-risk

\[
\text{VaR}_x = \inf\{K \geq 0 | P_t(\Delta E_t \leq -K) \leq x\}. \tag{2}
\]

value-at-risk is that loss in equity value, a dollar quantity, that is exceeded with probability less than or equal to \(x\). The minus sign on \(K\) guarantees that VaR is a non-negative number. As such, VaR satisfies the following condition:

\[
P_t(\Delta E_t \leq -\text{VaR}_x) \leq x. \tag{3}
\]

The probability that the loss in equity value is less than the VaR is less than or equal to \(x\).

Note that the conditional probability distribution \(P_t(\cdot)\), and therefore VaR, depend on the current market values of \(A_t, D_t, E_t\) and their future evolutions. Changing the firm’s time \(t\) balance sheet will, therefore, change the firm’s VaR.

Conceptually, VaR is used to determine capital adequacy in the following way.

3.2. The VaR rule

Assuming that the firm’s equity is solvent at time \(t\), i.e., \(E_t > 0\), one monitors \(E_t\).

If \(E_t \geq \text{VaR}_x\), then there is sufficient capital.

If \(E_t < \text{VaR}_x\), then capital is insufficient.

If insufficient capital, the firm’s assets and liabilities need to be restructured.

In the case of insufficient capital as determined by the VaR rule, the firm’s balance sheet needs to be restructured. Of course, many choices are possible. For example:

1. the firm can sell risky assets \(A_t\) and reduce the outstanding liabilities \(D_t\), or
2. the firm can obtain additional capital \(E_t\) and purchase new assets \(A_t\), or
3. the firm can sell risky assets \(A_t\) to buy less risky assets \(A_t\) without changing either the value of debt \(D_t\) or equity \(E_t\).

These financial restructurings, if correctly implemented, reduce the firm’s VaR.

The connection between the VaR rule for capital adequacy and the probability of insolvency is provided in the following theorem.

3.3. The theorem

Theorem 1 (the VaR rule). Under the VaR rule for capital adequacy, \(P_t(E_{t+\Delta} \leq 0) \leq x\).

Proof. We have \(x \geq P_t(\Delta E_t \leq -\text{VaR}_x) = P_t(E_t + \Delta E_t \leq E_t - \text{VaR}_x) = P_t(E_{t+\Delta} \leq E_t - \text{VaR}_x).\) Since under the rule \(E_t - \text{VaR}_x \geq 0\), \(P_t(E_{t+\Delta} \leq 0) \leq P_t(E_{t+\Delta} \leq E_t - \text{VaR}_x).\) This completes the proof. \(\square\)

This theorem shows that if the VaR rule is followed, then the firm’s probability of insolvency over the time interval \([t, t+\Delta]\) is less than or equal to \(x\).

It is well known that using VaR as the sole capital adequacy rule has some problems. The two most commonly discussed are that VaR ignores the magnitude of changes in the firm’s equity beyond the \(x\) quantile, and it may penalize diversification (see Jarrow (2007)). Alternative risk measures that avoid these failings, including conditional VaR, have been discussed in the literature (see Bluhm et al. (2003)). This paper is not concerned with the failings of VaR and better risk measures. Rather, this paper is only concerned with the relation between VaR and leverage ratio rules for capital adequacy.

4. A collateral rule

This section proposes a new collateral rule for capital adequacy. The rule applies at time \(t\) when the firm’s equity is solvent, i.e., \(E_t > 0\).
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