Credit risk management

- **Credit risk** refers to the risk of not being able to pay one’s debt.

- Managing a firm’s credit risk must start with its *capital structure*:
  - If a company does not have any liability, it has nothing to default on. The larger the liability (the higher the leverage), the more likely the firm can have difficulties meeting its liability obligations in the future.

- What matters is not just its current capital structure level, but also, probably more importantly, its *capital structure policy/behavior*.
  - The policy/behavior itself dictates how much the firm can take on debt for the same level of credit risk.
  - Banks differ from other industries less in the terms of their leverage levels, more in terms of how they control/alter their capital structure.

- Somewhat paradoxically, Miller & Modigliani won a Nobel prize by showing that capital structure does not matter, *under certain conditions*.
  - Traditional analysis focuses on static costs/benefits of debt.
  - I think of it from the perspective of (i) dynamic asset allocation and (ii) derivative pricing and dynamic hedging.
Commonly-cited costs and benefits of debt

- **Benefits of debt**
  - Tax benefits: Interest expense is tax deductible.
  - Adds external discipline to management

- **Costs of debt:**
  - Bankruptcy cost: legal, liquidation cost
  - Agency costs: Lenders have different objective/interest from owners, and can force owners to make suboptimal decisions.
  - Loss of future financing flexibility.

- **Conditions for Miller & Modigliani irrelevance:**
  - Investments are efficient (hence no need for outside discipline)
  - There is no tax, no information asymmetry, no financing capacity or liquidity constraint.

- **Issues with benefits/costs analysis:**
  - A lot of heuristics that are hard to quantify and aggregate/combine.
  - Quantifiable benefits/costs are similar across companies, implying similar debt/equity ratios.
A dynamic asset allocation perspective

Think how an investor makes an asset-allocation decision:  

$$w_t = \frac{1}{\gamma} \frac{\mu_t}{\nu_t}$$

- Investment to the risky asset is proportional to the expected excess return over the financing cost ($\mu_t$), and inversely proportional to the variance (risk).

- One can either hold partial cash as cushion ($w_t < 1$) when the investment is too risky for the return, or lever up multiple times ($w_t > 1$) when the investment is highly profitable or less risky.

- With fixed profitability (Sharpe ratio, $\mu_t/\sqrt{\nu_t}$), one should invest less to more risky projects — the underlying principle of the risk parity strategy.

- The optimal investment to a constant investment opportunity is to hold a constant leverage, which necessitates continuous rebalancing, i.e., constantly increasing/decreasing investment/financing.

- One can take more or less leverage depending on risk appetite ($\gamma$) ...

- Illiquidity of investments (difficulty to get in or out the investments) and financing constraints (difficulty to get refinancing) reduce one’s rebalancing/refinancing capability ... Key credit risk management concerns.
Leverage is an integral part of dynamic asset allocation

A firm is just like an investor, with the capital structure decision being fundamentally an investment decision.

- With largely similar Sharpe ratio across different businesses (through competition), leverage level is mainly dictated by the riskiness of business.
  - Risky business (such as tech) tends to hoard cash. Safe business (such as regulated utility) tends to use high leverage.
- Some business may want to take leverage, but cannot, due to lack of (cheap) financing channels.
- Refinancing is as important as financing, reinvesting is as important as investing, to maintain a constant leverage level.
- Banks are unique in
  - its capability in obtaining cheap financing at all times (deposits, and central bank windows)
  - its flexibility in investing in many different projects, securities...

⇒ best at maintaining a constant leverage level via frequent rebalancing.
When does credit risk arise?

- Default would never happen, no matter how large the leverage, if
  - Leverage is closely and *continuously* monitored and adjusted,
  - Market moves in *continuous* fashion (as assumed in classic dynamic asset allocation/asset pricing theories).

- Example: levered brokerage trading accounts
  - If daily movement averages about 1%, one can assume a maximum of daily movement of 5%. A leverage of 20 times does not lead to any default with daily marking to market.

- Credit risk arises when
  - One cannot *rebalance* as desired, due to inability to unload risky investments (or make new investments), or inability to refinance.
    - Security investments tend to be much more liquid than business investments
  - The business experiences unexpected large negative shocks (*jumps*).
    - Default (and loss) can happen if there is a chance of a very large move (say 20% or even higher) even if the average move size is 1%.
    - The no-default leverage level is dictated by the maximum jump size.
Traditional credit risk metrics

**Traditional metrics**
- Balance sheet measure: Debt ratio
- Income statement measure: Interest coverage ratio

**Both are useful metrics**
- Higher leverage (debt ratio) increases the chance of default in the presence of large shocks or inability to rebalance.
- High profitability can/should accommodate a higher leverage (interest expense)

**Limitations:**
- Traditional theory provides no guidance on how to combine the two (and other) metrics — Atlman’s Z-score, empirical based, additive combination
- Cross-sectional comparison needs to adjust for riskiness of investment
- Static metrics have no role for rebalancing behaviors/capabilities.
The Merton (1974) model: Set up

The starting point of modern finance (in my view)

- Assumptions:
  - The company has a zero-coupon bond with principal $D$ and expiring at $T$. Company defaults if and only if its asset value at time $T$, $A_T$, is less than the debt principal.
  - Asset values follow a simple continuous process (GBM):
    $$\frac{dA_t}{A_t} = \mu dt + \sigma_A dW_t.$$  

- Comments:
  - The company does not have the flexibility of adjusting leverage, refinancing, or adjusting investments/business characteristics.
  - The model captures two key elements of default risk: leverage and business risk, in a very simple and intuitive way.
  - The model is extremely stylized, but with careful, smart implementation, it can also be made very useful.
  - The starting point of credit ratings by Moody’s (KMV), Bloomberg, ...
The Merton (1974) model: Pricing

- Under Merton (1974), equity is a European call option on the asset: At debt maturity $T$, the equity holders receive $\max(0, A_T - D)$.
- The call-option (equity) value satisfies the Black-Merton-Scholes formula:
  \[ E_t = A_t N(d + \sigma_A \sqrt{T - t}) - DN(d), \]
  where
  \[ d = \frac{\mathbb{E}_t(\ln A_T/D)}{\text{Std}_t(\ln A_T/D)} = \frac{\ln(A_t/D) + r(T - t) - \frac{1}{2}\sigma^2_A(T - t)}{\sigma_A \sqrt{T - t}}. \]
  
- In the option pricing literature, $d$ is referred to as the standardized \textit{moneyness} of the option.
- In the credit literature, $d$ is often referred to as the \textit{distance-to-default}, a critical input for many credit rating agencies.
- The numerator measures the expected financial leverage of the firm at the debt expiration, and the denominator measures the uncertainty (standard deviation) of this leverage.
The key contribution of the model is the *distance to default* measure, which combines two features of a firm (leverage and business risk) to create a standardized capital structure measure comparable across firms with different business risk profiles.

- The debt maturity (the option maturity) controls the relative contribution of the leverage and the business risk.

Many academic studies debate on whether the credit spread implied by the model matches market values, and call the mismatch a “puzzle.”

Industry practices are more practical and use the distance to default to differentiate the credit qualities of different firms:

- One can always regress credit spread on leverage and risk, but Merton provides an intuitive, structural way of combining these two firm characteristics into one standardized variable that becomes much more comparable across firms than each variable alone.

- The intuitive concept of risk adjustment has been embedded into bank regulations in the name of “risk weighted asset” (RWA).
Despite its stylized nature, a well-thought-out implementation of the Merton model can generate very useful credit risk comparisons across different firms.

Think creatively to map realistic capital structures to the stylized model:

1. **Definition of \( D \) (debt principal):**
   - KMV, Bloomberg: Short-term debt + Half of long-term debt.
   - Bai&Wu: Total debt
   - Banks: The role of deposits in debt definition?

2. **Debt maturity**
   - KMV: One year, for the purpose of short-term default prediction
   - Bai&Wu: 10 years, to give more weight to business volatility

3. **Average return on asset:** Use historical average RoA v. riskfree rate
   - Integrate debt ratio, coverage ratio, and business ...

4. **Estimation method:**
   - Historical approach: Convert equity to asset value, estimate historical volatility of asset value.
   - Convert market cap and historical equity return volatility directly to asset value and asset volatility

Explaining cross-sectional variation of CDS on U.S. firms

<table>
<thead>
<tr>
<th>Statistics</th>
<th>Cross-sectional $R^2$</th>
<th>$R^2$ differences</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>BLR</td>
<td>MCDS</td>
</tr>
<tr>
<td>A. In-sample performance from full-sample estimation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>0.49</td>
<td>0.65</td>
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<tr>
<td>Std</td>
<td>0.10</td>
<td>0.08</td>
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<tr>
<td>Minimum</td>
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<td>0.50</td>
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<td>Maximum</td>
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<td>0.78</td>
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<td>t-stats</td>
<td>14.75</td>
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<tr>
<td>B. Out-of-sample performance from half-sample estimation</td>
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<td></td>
</tr>
<tr>
<td>Mean</td>
<td>0.25</td>
<td>0.64</td>
</tr>
<tr>
<td>Std</td>
<td>0.96</td>
<td>0.09</td>
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<tr>
<td>Minimum</td>
<td>-13.24</td>
<td>0.26</td>
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<tr>
<td>Maximum</td>
<td>0.67</td>
<td>0.80</td>
</tr>
<tr>
<td>t-stats</td>
<td>4.79</td>
<td>31.75</td>
</tr>
</tbody>
</table>

BLR—bivariate regression on leverage and volatility
MCDS—Merton model CDS valuation
WCDS—Combines MCDS with a long list of additional characteristics
Example: Comparing credit risk of major U.S. banks

1. **Bloomberg credit model:** The key driver is a one-year *distance to default* (DD) measure computed based on a variant of the Merton (1974) model,

   \[ DD = \ln\left(\frac{A}{D}\right) + \mu_A - \frac{1}{2}\sigma_A^2 \]

   - Bloomberg sets the debt principal \( D \) to short-term debt (ST) plus half of long-term debt (LT).
   - Under the barrier option assumption, asset value \( A \) equals \( A = D + E \), where the equity value \( E \) is set to the market capitalization.
   - The mean \( \mu_A \) and volatility \( \sigma_A \) of the asset return are computed based on the mean and volatility of the stock return \( \mu_E, \sigma_E \):
     \[ \mu_A = E\mu_E/A \text{ and } \sigma_A = E\sigma_A/A. \]

2. **Book value of equity to asset value** (BE/A), as another leverage measure.

3. **Return on asset** (RoA), defined as net income over total asset, as a profitability measure.
Replicating Bloomberg results

All data are downloaded from Bloomberg terminal:

<table>
<thead>
<tr>
<th>Ticker</th>
<th>E</th>
<th>ST</th>
<th>LT</th>
<th>D</th>
<th>A</th>
<th>D/E</th>
<th>$\sigma_E$</th>
<th>$\sigma_A$</th>
<th>$\mu_E$</th>
<th>$\mu_A$</th>
<th>DD</th>
<th>$\frac{BE}{A}$</th>
<th>RoA</th>
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</thead>
<tbody>
<tr>
<td>JPM</td>
<td>143</td>
<td>354</td>
<td>323</td>
<td>515</td>
<td>658</td>
<td>3.6</td>
<td>37.8</td>
<td>8.2</td>
<td>10.63</td>
<td>2.31</td>
<td>3.22</td>
<td>26.7</td>
<td>0.84</td>
</tr>
<tr>
<td>GS</td>
<td>58</td>
<td>335</td>
<td>188</td>
<td>429</td>
<td>487</td>
<td>7.4</td>
<td>35.8</td>
<td>4.3</td>
<td>2.33</td>
<td>0.28</td>
<td>3.02</td>
<td>14.4</td>
<td>0.88</td>
</tr>
<tr>
<td>MS</td>
<td>37</td>
<td>323</td>
<td>166</td>
<td>406</td>
<td>443</td>
<td>10.9</td>
<td>53.9</td>
<td>4.5</td>
<td>-11.85</td>
<td>-1.00</td>
<td>1.70</td>
<td>10.7</td>
<td>0.48</td>
</tr>
<tr>
<td>BAC</td>
<td>75</td>
<td>311</td>
<td>372</td>
<td>497</td>
<td>572</td>
<td>6.7</td>
<td>54.3</td>
<td>7.1</td>
<td>-35.61</td>
<td>-4.65</td>
<td>1.28</td>
<td>37.0</td>
<td>0.00</td>
</tr>
<tr>
<td>C</td>
<td>92</td>
<td>436</td>
<td>324</td>
<td>598</td>
<td>690</td>
<td>6.5</td>
<td>49.3</td>
<td>6.6</td>
<td>0.18</td>
<td>0.02</td>
<td>2.15</td>
<td>25.8</td>
<td>0.59</td>
</tr>
</tbody>
</table>

- DD and RoA rank MS as the 4th. BE/A ranks MS as the distant 5th.
- MS has the largest leverage.
## Three measures and normalized scores

<table>
<thead>
<tr>
<th>Ticker</th>
<th>Raw estimates</th>
<th>Normalized scores</th>
<th>Average Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$DD$</td>
<td>$BE$</td>
<td>$RoA$</td>
</tr>
<tr>
<td>JPM</td>
<td>3.22</td>
<td>7.76</td>
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<tr>
<td>GS</td>
<td>3.02</td>
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<tr>
<td>MS</td>
<td>1.70</td>
<td>5.90</td>
<td>0.48</td>
</tr>
<tr>
<td>BAC</td>
<td>1.28</td>
<td>9.94</td>
<td>0.00</td>
</tr>
<tr>
<td>C</td>
<td>2.15</td>
<td>9.48</td>
<td>0.59</td>
</tr>
</tbody>
</table>

- Each measure is normalized to one for MS.
- The last column (AS) computes a weighted average score, with the weights being 0.5 on $DD$, 0.4 on $BE/A$, and 0.1 on $RoA$.
- The weight is the same as before, and MS ranks the last.
Our proposed methodology revisions

1. Include deposits into the debt principal ($D$).

2. $BE/A$ and $RoA$ are not adjusted for the different riskiness of the asset for different firms. Replace them with risk-adjusted measures:
   - Use $T1C/RWA$ (tier-1-capital/risk-adjusted asset) as risk-adjusted leverage and
   - Use $OI/RWA$ (12-month trading operating income/risk-adjusted asset) as risk-adjusted profitability.

<table>
<thead>
<tr>
<th>Ticker</th>
<th>Revised $D$</th>
<th>$T1C$</th>
<th>$OI$</th>
<th>RWA</th>
</tr>
</thead>
<tbody>
<tr>
<td>JPM</td>
<td>1079068</td>
<td>150384</td>
<td>30177</td>
<td>1224390</td>
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<tr>
<td>GS</td>
<td>134283</td>
<td>71233</td>
<td>6169</td>
<td>444290</td>
</tr>
<tr>
<td>MS</td>
<td>158662</td>
<td>52880</td>
<td>6037</td>
<td>329560</td>
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<tr>
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<tr>
<td>C</td>
<td>832578</td>
<td>126193</td>
<td>14899</td>
<td>977629</td>
</tr>
</tbody>
</table>
The revised three measures and normalized scores

<table>
<thead>
<tr>
<th>Ticker</th>
<th>Raw estimates</th>
<th>Normalized scores</th>
<th>Average Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$DD$</td>
<td>$BE/A$</td>
<td>$RoA$</td>
</tr>
<tr>
<td>JPM</td>
<td>3.31</td>
<td>12.28</td>
<td>2.46</td>
</tr>
<tr>
<td>GS</td>
<td>3.29</td>
<td>16.03</td>
<td>1.39</td>
</tr>
<tr>
<td>MS</td>
<td>1.91</td>
<td>16.05</td>
<td>1.83</td>
</tr>
<tr>
<td>BAC</td>
<td>0.64</td>
<td>12.40</td>
<td>0.30</td>
</tr>
<tr>
<td>C</td>
<td>2.12</td>
<td>12.91</td>
<td>1.52</td>
</tr>
</tbody>
</table>

- The debt revision does not alter the ranking of DD.
- The risk adjustment is important as it transforms MS from the worst (in raw leverage) to the best (in risk-adjusted leverage).
- The weighted average ranks MS as the third.
- The issue with MS is that it has a larger raw leverage, but invests in less risky projects.
Beyond Merton: Limitations and extensions

- The key characteristics of a great model is that it makes bold/dramatic simplifying assumptions to arrive at deep insights that make economic sense.
- One key objective of “structural” credit modeling is to see through the millions of details in a firm and show how different firm characteristics combine to determine credit risk.
  - The Merton model says that the key credit determinants are financial leverage and business risk and their contributions do not come in additively, but one serves as the scale of the other.
- Given the highly stylized nature, the model can of course be extended in several dimensions:
  1. Asset value dynamics
  2. Capital structure specifications
  3. Default triggering mechanisms
  4. Firm operation, investment, and refinancing decisions
Beyond Merton: Asset value dynamics

Everybody talks about jumps and stochastic volatility. The question is not the process itself, but how these features show up in firm characteristics and in the transformation.

- Jumps and stochastic volatility changes the return distribution. $1 - N(d)$ captures the default probability under Merton. The normal transformation can be switched to a non-normal transformation, but such variations only generate marginal effects: The transformation won’t change the cross-sectional ranking of credit risk across firms.

- The effects of sudden drops (jumps) in asset value can be translated into sudden drops in stock price, which can show up vividly in deep-out-of-money (DOOM) put options (Carr & Wu, Review of Financial Studies, 2011, “A Simple Robust Link Between American Puts and Credit Protection”).
  - Deep out of money put options are essentially credit insurance contracts.
Beyond Merton: Capital structure specification

Virtually all firms have debt of multiple maturities, including coupon/interest expense payments in the middle.

- Even if one uses the Merton model, how to implement the model remains an issue. For example, KMV uses short-term liability + half of long-term liability to proxy the debt principal $D$ in Merton model. Why?

- Given the same amount of total debt, which types of firms have higher credit risk at different horizons? Firms with more short-term or more long-term debt?

- These questions cannot be appropriately addressed theoretically without making the right assumption on the default triggering mechanism, which may also depend on the (flexibility) of the refinancing decision.

  - Do firms only default at debt payment period or can they default at any time? Can debt holders force bankruptcy preemptively?
  - When one debt matures, should/will the firm pay off the debt with its current earnings (by paying less dividend), its asset (via liquidation), or refinancing (via equity or debt)?
Beyond Merton: Debt payment decisions

- If the firm plans to payoff its obligation using earnings, it better has enough earnings to cover the payment — *Interest coverage ratio* relies on this idea.

- If the firm plans to liquidate asset to cover its debt payment, its asset must have a significant component that can be liquidated easily — *liquidity ratios* are useful indicators.
  
  Investment firms can reduce their investment size fairly easily and they indeed do so frequently according to market conditions; but it can be costly for a manufacturing firm to do so.

- If the firm plans to refinance its expiring debt, market credit conditions can become an important concern. Also, all variables that are considered by debt investors (profitability, existing leverage, liquidity, size, past performance, etc) become naturally important in determining the refinancing cost (and possibility). This reflects the *self-reinforcing* aspect of credit risk.
Triggering mechanism: A barrier option approach

- Merton assumes that default can only be triggered at the debt expiry.
- An alternative is to assume that the firm can default any time before the debt maturity when the firm’s asset value falls below a certain threshold $B$.
  \[ \Rightarrow \text{Equity becomes a call option on the asset value with a knock-out barrier.} \]
- The generic down-and-out call option formula is a bit complicated. Let $C(S, K, T)$ denote the vanilla call option value at spot $S$, strike $K$, and expiry $T$, the down-and-out call value is (assuming $B \leq D$),
  \[ DOC_t(A, D, B, T) = C_t(A, D, T) - (A/B)^{2\alpha} C(B^2/A, D, T), \quad \alpha = \frac{1}{2} - \frac{r}{\sigma^2}. \]
- Assume zero rates ($r = 0$) and set the barrier to the debt principal $B = D$, the down-and-out call option (the equity value) is always worth its intrinsic,
  \[ DOC_t(A, D, D, T) = \max(0, A - D) \]
- Bharath and Shumway (2008)’s “naive” Merton alternative assumes $E = A - D$ and can be justified under this barrier assumption.
- Leland (1994) and Leland and Toft (1996) consider more complex setups with barriers. KMV claims to use/consider a barrier approach.
Multiple debts: A two-debt example

- Merton assumes that the firm has one zero-coupon bond expiring at $T$.
- Now let’s consider the case of two zero-coupon bonds of principals $D_1$ and $D_2$ expiring at $T_1$ and $T_2$, respectively ($T_1 < T_2$).
  - At $T_2$, the default condition is the same as in Merton: The firm defaults if at that time $A_{T_2} < D_2$, and equity is the residual claimer.
  - At $T_1$, the default condition is often assumed to be $A_{T_1} < D_1 + E_{T_1}(D_2)$.
  - Although the firm only needs to pay $D_1$ at $T_1$, it is unlikely the firm can roll-over its debt and maintain its firm size and debt structure if the firm’s value is less than its debt value.
- The equity can be regarded as a compound option (Geske, 1974, 1977).
- The two-debt example can be solved semi-analytically, but it is probably more practical to build a binomial tree, with which one can match the actual debt payment schedules and consider additional conditions.
  - In practice, the conditions can be stricter, say a fraction ($\delta$) of its asset value must be higher than the debt value.
  - More research is needed on how to model the firm-level liquidity effect (how easy it is to liquidate its asset) and market-level credit crunch (how easy it is to obtain refinancing).
Free of default via flexible leverage rebalancing

- Merton and Geske assume that default only occur at debt payment times.
  - These companies have a passive debt structure that will only be updated upon debt expiry.
- Financial firms, including banks and investment firms, can be much more active in rebalancing their financial leverage (Adrian and Shin (2010)).
- Think of the simplest example of trading on margin.
  - Trading on margin is essentially levered investment. The asset is the amount of the investment, which can be several times higher than the equity (the amount of margin one puts at the exchange).
  - One rarely observes default on margin trading, despite high leverage.
  - The key is that it has a barrier feature at which point the creditor (exchange) can force close the position if no new capital is injected. The barrier is set at a level that the creditor rarely loses money at the forced closure.
  - The debt can be thought of as short-term credit.
- If asset follows *diffusion* dynamics and the firm can flexibly (and optimally) adjust the financial leverage, the firm in principal never needs to default.
Constant proportional portfolio insurance (CPPI)

This may be a side topic, but it is somewhat useful in terms of how we think of credit risk, especially for financial firms.

- CPPI allows an investor to limit downside risk while retaining some upside potential by maintaining an exposure to risky assets equal to a constant multiple $m > 1$ of the cushion. In diffusion models with continuous trading, this strategy has no downside risk.

- CPPI is a self-financing strategy, with the goal to guarantee a fixed amount $N$ of capital at maturity $T$.

- Let $B_t$ denote the present value of the guaranteed amount $N$ and $V_t$ denote the total portfolio value. The strategy at any date $t$ can be described as,

  - If $V_t > B_t$, the risky asset exposure (amount of money invested into the risky asset) is given by $mC_t = m(V_t - B_t)$, where $C_t$ is the “cushion” and $m > 1$ is a constant multiplier.

  - If $V_t \leq B_t$, the entire portfolio is invested into the zero-coupon.

- If one can guarantee a fixed amount at expiration, one never needs to default.
Diffusion risk does not cause default, jumps do

- Under the Merton model, the diffusion nature of the dynamics dictates that the default event is completely predictable before it happens.

- We show via the CPPI strategy that one can always avoid the predictable event if one is allowed to scale the risky investment continuously and freely.

- Hence, the true risk under the Merton model is not from the diffusion dynamics, but from **structural constraints** — the firm cannot do anything to get out its debt or its investments once in.

- However, when the asset value can jump down unexpectedly by a large amount, even frequent rebalancing cannot guarantee default free.

- Thus, in practice, one should worry about large downside jumps (via strategic positioning, scenario analysis), while working actively to avoid difficulties caused by diffusion movements (via active rebalancing).
  - The strategic positioning is analogous to static hedging. The active rebalancing is analogous to dynamic hedging.
Two types of defaults

Fundamentally, there are two types of defaults that ask for different types of responses and have different levels of market impacts.

1. **Structural defaults**: Defaults due to structural constraints.
   - Both creditors and debtors can see default coming, but they are structurally constrained to do anything about it.
   - The Merton (1974) model is one such case: The diffusion behavior dictates that default event is predictable, yet creditors are not allowed to force close the debt early to avoid loss of principal.
   - The barrier option alternative assumption allows the creditor to get out early as soon as the asset value hits a boundary. Under certain assumptions, the creditor never loses its principal.
   - The CPPI example is inspirational in the sense that the financial managers can drastically reduce their chance of default (to zero) under diffusion dynamics if they can actively rebalance their portfolio — All firms have some capacity to do so, more for financial firms (such as investment banks) and investment firms.

To avoid defaults caused by structural constraints, financial managers should strive to keep credit channels open, maintain a flexible capital structure that can be readily updated/adjusted based on market conditions.
Two types of defaults

Fundamentally, there are two types of defaults that ask for different types of responses and have different levels of market impacts.

1. **Defaults induced by structural constraints**
2. **Default induced by exogenous sudden, large, market shocks:**

   - It is difficult to neutralize such shocks via dynamic hedging, which works better for diffusions or jumps of fixed/known sizes than for jumps of random sizes.
   - One can in principle take option positions to hedge jumps of different sizes — The strong aggregate demand for such insurance-like option contracts often pushes the option price to very high levels.
   - Worse yet, large negative shocks often generate chain reactions, or “self-exciting behavior.” One large negative shock tends to increase the chance of having more large negative shocks to follow, either sequentially for one firm or one market (destabilizing spiral), or cross-sectionally across different firms or markets (contagion).

*World-wide crash-o-phobia* (Foresi & Wu:2005): Deep out-of-money put options are very expensive on market indexes across the world, more so for longer-term options, in defiance of central limit theorem.
Defaults can come from either structural constraints or large unexpected negative market shocks.

- Firms with more financial and investment flexibility can drastically reduce their probability of structural default via dynamic rebalancing of their capital structures based on market conditions.
  - Banks are more equipped to take advantage of this principle more than any other types of firms.

- Large negative unexpected market shocks are not only difficult to hedge and expensive to insure against, but also often generate self-exciting spirals both sequentially and cross-sectionally.
  - Often the source of systemic risk that warrants close monitoring, careful scenario analysis from the top level.
  - Large banks are often at the center of the self-exciting behavior.
  - Many bank regulations are designed with the original purpose of mitigating the occurrence and impact of systemic shocks.
Appendix: The Basel Accord

- It is a global, voluntary regulatory framework on bank capital adequacy, stress testing and market liquidity risk.
- While the details are complex, the processes are politicalized, the accord highlights of the key determinants of credit risk and its contagion.
- Summary changes from Basel II to Basel III:
  - Tightening the capital requirements on the trading book
  - Raising the quality and transparency of the capital base through stricter rules on eligibility of instruments to be included in capital and introduction of a new core Tier 1 ratio, ‘Common Equity T1’ (CET1)
  - Enhancing risk coverage through strengthening counterparty credit risk capital requirements arising from derivatives...
  - Supplementing risk-based capital requirements with a non-risk-based leverage ratio
  - Reducing pro-cyclicality, promoting countercyclical capital buffers
  - Introducing a global liquidity standard comprising a stressed liquidity coverage ratio and a longer-term structural liquidity ratio
  - Addressing systemic risk and interconnectedness.