Financial Risk Management
Lecture 6. Liquidity Risk

Thierry Roncalli*

*University of Paris-Saclay

November 2020
Overview
The objective of this course is to understand the theoretical and practical aspects of risk management

Prerequisites
M1 Finance or equivalent

ECTS
4

Keywords
Finance, Risk Management, Applied Mathematics, Statistics

Hours
Lectures: 36h, Training sessions: 15h, HomeWork: 30h

Evaluation
There will be a final three-hour exam, which is made up of questions and exercises

Course website
Objective of the course

The objective of the course is twofold:

1. knowing and understanding the financial regulation (banking and others) and the international standards (especially the Basel Accords)

2. being proficient in risk measurement, including the mathematical tools and risk models
Class schedule

**Course sessions**
- September 11 (6 hours, AM+PM)
- September 18 (6 hours, AM+PM)
- September 25 (6 hours, AM+PM)
- October 2 (6 hours, AM+PM)
- November 20 (6 hours, AM+PM)
- November 27 (6 hours, AM+PM)

**Tutorial sessions**
- October 10 (3 hours, AM)
- October 16 (3 hours, AM)
- November 13 (3 hours, AM)
- December 4 (6 hours, AM+PM)

Class times: Fridays 9:00am-12:00pm, 1:00pm–4:00pm, University of Evry
Agenda

- Lecture 1: Introduction to Financial Risk Management
- Lecture 2: Market Risk
- Lecture 3: Credit Risk
- Lecture 4: Counterparty Credit Risk and Collateral Risk
- Lecture 5: Operational Risk
- Lecture 6: Liquidity Risk
- Lecture 7: Asset Liability Management Risk
- Lecture 8: Model Risk
- Lecture 9: Copulas and Extreme Value Theory
- Lecture 10: Monte Carlo Simulation Methods
- Lecture 11: Stress Testing and Scenario Analysis
- Lecture 12: Credit Scoring Models
Additional materials

- Slides, tutorial exercises and past exams can be downloaded at the following address:
  

- Solutions of exercises can be found in the companion book, which can be downloaded at the following address:
  
Lecture 6: Liquidity Risk

- Lecture 7: Asset Liability Management Risk
- Lecture 8: Model Risk
- Lecture 9: Copulas and Extreme Value Theory
- Lecture 10: Monte Carlo Simulation Methods
- Lecture 11: Stress Testing and Scenario Analysis
- Lecture 12: Credit Scoring Models
Bid-ask spread

Definition

The bid-ask quoted spread \( S_t \) is defined by:

\[
S_t = \frac{P_{\text{ask}} - P_{\text{bid}}}{P_{\text{mid}}}
\]

where \( P_{\text{ask}} \), \( P_{\text{bid}} \) and \( P_{\text{mid}} \) are the ask, bid and mid quotes for a given security at time \( t \).

We have:

\[
P_{\text{mid}} = \frac{P_{\text{ask}} + P_{\text{bid}}}{2}
\]
Bid-ask spread

Table: Snapshot of the limit order book of the Lyxor Euro Stoxx 50 ETF recorded at NYSE Euronext Paris – The corresponding date is 14:00:00 and 56,566 micro seconds on 28 December 2012

<table>
<thead>
<tr>
<th>$i^{th}$ limit</th>
<th>Buy orders</th>
<th>Sell orders</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$Q_{i}^{bid}$</td>
<td>$P_{i}^{bid}$</td>
</tr>
<tr>
<td>1</td>
<td>65 201</td>
<td>26.325</td>
</tr>
<tr>
<td>2</td>
<td>85 201</td>
<td>26.320</td>
</tr>
<tr>
<td>3</td>
<td>105 201</td>
<td>26.315</td>
</tr>
<tr>
<td>4</td>
<td>76 500</td>
<td>26.310</td>
</tr>
<tr>
<td>5</td>
<td>20 000</td>
<td>26.305</td>
</tr>
</tbody>
</table>

We have $P_{t}^{bid} = 26.325$ and $P_{t}^{ask} = 26.340$, implying that the mid price is equal to $P_{t}^{mid} = (26.325 + 26.340) / 2 = 26.3325$. We deduce that the bid-ask spread is:

$$S_t = \frac{26.340 - 26.325}{26.3325} = 5.696 \text{ bps}$$
Bid-ask spread

Figure: An example of a limit order book
- The **effective spread** is equal to:

\[ S^e_\tau = 2 \left| \frac{P_\tau - P^\text{mid}_t}{P^\text{mid}_t} \right| \]

where \( \tau \) is the trade index, \( P_\tau \) is the price of the \( \tau \)th trade and \( P^\text{mid}_\tau \) is the midpoint of market quote calculated at the time \( t \) of the \( \tau \)th trade.

- The **realized spread** is equal to:

\[ S^r_\tau = 2 \left| \frac{P_\tau - P^\text{mid}_{t+\Delta}}{P^\text{mid}_{t+\Delta}} \right| \]

Generally, \( \Delta \) is set to five minutes.

**Price impact** \( \Rightarrow P^\text{mid}_{t+\Delta} \neq P^\text{mid}_t \)
The trading volume $V_t$ indicates the dollar value of the security exchanged during the period $t$:

$$V_t = \sum_{\tau \in t} Q_{\tau} P_{\tau}$$

where $Q_{\tau}$ and $P_{\tau}$ are the $\tau^{th}$ quantity and price traded during the period. Generally, we consider a one-day period and use the following approximation:

$$V_t \approx Q_t P_t$$

where $Q_t$ is the number of securities traded during the day $t$ and $P_t$ is the closing price of the security.
The turnover is the ratio between the trading volume and the free float market capitalization $M_t$ of the asset:

$$T_t = \frac{V_t}{M_t} = \frac{V_t}{N_t P_t}$$

where $N_t$ is the number of outstanding ‘floating’ shares

⇒ The asset turnover ratio indicates how many times each share changes hands in a given period
The liquidation ratio $\mathcal{LR}(m)$ measures the proportion of a given position that can be liquidated after $m$ trading days.
Liquidation ratio

Computation of the liquidation ratio

We denote \((x_1, \ldots, x_n)\) the number of shares held in the portfolio. For each asset that composes the portfolio, we denote \(x_i^+\) the maximum number of shares for asset \(i\) that can be sold during a trading day. The number of shares \(x_i(m)\) liquidated after \(m\) trading days is defined as follows:

\[
x_i(m) = \min \left( \left( x_i - \sum_{k=0}^{m-1} x_i(k) \right)^+, x_i^+ \right)
\]

with \(x_i(0) = 0\). The liquidation ratio \(\mathcal{LR}(m)\) is then the proportion of the portfolio liquidated after \(m\) trading days:

\[
\mathcal{LR}(m) = \frac{\sum_{i=1}^{n} \sum_{k=0}^{m} x_i(k) \cdot P_{i,t}}{\sum_{i=1}^{n} x_i \cdot P_{i,t}}
\]
### Liquidation ratio

**Table:** Statistics of the liquidation ratio (size = $10 bn, liquidation policy = 10% of ADV)

<table>
<thead>
<tr>
<th>Statistics</th>
<th>SPX</th>
<th>SX5E</th>
<th>DAX</th>
<th>NDX</th>
<th>MSCI EM</th>
<th>MSCI INDIA</th>
<th>MSCI EMU SC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>$m$ (in days)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>88.4</td>
<td>12.3</td>
<td>4.8</td>
<td>40.1</td>
<td>22.1</td>
<td>1.5</td>
<td>3.0</td>
</tr>
<tr>
<td>2</td>
<td>99.5</td>
<td>24.7</td>
<td>9.6</td>
<td>72.6</td>
<td>40.6</td>
<td>3.0</td>
<td>6.0</td>
</tr>
<tr>
<td>5</td>
<td>100.0</td>
<td>58.8</td>
<td>24.1</td>
<td>99.7</td>
<td>75.9</td>
<td>7.6</td>
<td>14.9</td>
</tr>
<tr>
<td>10</td>
<td>100.0</td>
<td>90.1</td>
<td>47.6</td>
<td>99.9</td>
<td>93.9</td>
<td>15.1</td>
<td>29.0</td>
</tr>
<tr>
<td><strong>$\alpha$ (in %)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>1</td>
<td>5</td>
<td>11</td>
<td>2</td>
<td>3</td>
<td>37</td>
<td>21</td>
</tr>
<tr>
<td>75</td>
<td>1</td>
<td>7</td>
<td>17</td>
<td>3</td>
<td>5</td>
<td>71</td>
<td>43</td>
</tr>
<tr>
<td>90</td>
<td>2</td>
<td>10</td>
<td>23</td>
<td>3</td>
<td>9</td>
<td>110</td>
<td>74</td>
</tr>
<tr>
<td>99</td>
<td>2</td>
<td>15</td>
<td>29</td>
<td>5</td>
<td>17</td>
<td>156</td>
<td>455</td>
</tr>
</tbody>
</table>

Market liquidity
Funding liquidity
Regulation of the liquidity risk

Conventional liquidity measures
Other liquidity measures
The liquidity-adjusted CAPM

### Liquidation ratio

**Table:** Statistics of the liquidation ratio (size = $10 bn, liquidation policy = 30% of ADV)

<table>
<thead>
<tr>
<th>Statistics</th>
<th>SPX</th>
<th>SX5E</th>
<th>DAX</th>
<th>NDX</th>
<th>MSCI EM</th>
<th>MSCI INDIA</th>
<th>MSCI EMU</th>
<th>MSCI SC</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t$ (in days)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>100.0</td>
<td>37.0</td>
<td>14.5</td>
<td>91.0</td>
<td>55.5</td>
<td>4.5</td>
<td>9.0</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>100.0</td>
<td>67.7</td>
<td>28.9</td>
<td>99.8</td>
<td>81.8</td>
<td>9.1</td>
<td>17.8</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>100.0</td>
<td>99.2</td>
<td>68.6</td>
<td>100.0</td>
<td>98.5</td>
<td>22.6</td>
<td>40.4</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>100.0</td>
<td>100.0</td>
<td>99.6</td>
<td>100.0</td>
<td>100.0</td>
<td>43.1</td>
<td>63.2</td>
<td></td>
</tr>
<tr>
<td>$\alpha$ (in %)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>13</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>1</td>
<td>3</td>
<td>6</td>
<td>1</td>
<td>2</td>
<td>24</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>90</td>
<td>1</td>
<td>4</td>
<td>8</td>
<td>1</td>
<td>3</td>
<td>37</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>99</td>
<td>1</td>
<td>5</td>
<td>10</td>
<td>2</td>
<td>6</td>
<td>52</td>
<td>152</td>
<td></td>
</tr>
</tbody>
</table>

Other liquidity measures

- Hui-Heubel liquidity ratio

\[ H_t^2 = \frac{1}{T_t} \left( \frac{P_{t, \text{high}} - P_{t, \text{low}}}{P_{t, \text{low}}} \right) \]

- Hasbrouck-Schwartz variance ratio

\[ VR = \frac{\text{var}(R_{t,t+h})}{\text{var}(R_{t,t+1})} \]

- Amihud measure

\[ \text{ILLIQ} = \frac{1}{n_t} \sum_{t} \frac{|R_{t,t+1}|}{V_t} \]

- Implicit spread of Roll (1984):

\[ \tilde{S} = 2 \sqrt{-\text{cov}(\Delta P_t, \Delta P_{t-1})} \]
“[…] there is also broad belief among users of financial liquidity – traders, investors and central bankers – that the principal challenge is not the average level of financial liquidity… but its variability and uncertainty” (Persaud, 2003).
We note $R_{i,t}$ and $L_{i,t}$ the gross return and the relative (stochastic) illiquidity cost of Asset $i$. At the equilibrium, Acharya and Pedersen (2005) showed that:

$$\mathbb{E} [R_{i,t} - L_{i,t}] - r = \tilde{\beta}_{i} \cdot (\mathbb{E} [R_{m,t} - L_{m,t}] - r)$$

where $r$ is the return of the risk-free asset, $R_{m,t}$ and $L_{m,t}$ are the gross return and the illiquidity cost of the market portfolio, and $\tilde{\beta}_{i}$ is the liquidity-adjusted beta of Asset $i$:

$$\tilde{\beta}_{i} = \frac{\text{cov} (R_{i,t} - L_{i,t}, R_{m,t} - L_{m,t})}{\text{var} (R_{m,t} - L_{m,t})}$$
“We define funding liquidity as the ability to settle obligations with immediacy. Consequently, a bank is illiquid if it is unable to settle obligations. Legally, a bank is then in default. Given this definition we define funding liquidity risk as the possibility that over a specific horizon the bank will become unable to settle obligations with immediacy” (Drehmann and Nikolaou, 2013).
“Traders provide market liquidity, and their ability to do so depends on their availability of funding. Conversely, traders’ funding, i.e., their capital and margin requirements, depends on the assets’ market liquidity. We show that, under certain conditions, margins are destabilizing and market liquidity and funding liquidity are mutually reinforcing, leading to liquidity spirals” (Brunnermeier and Pedersen, 2009).
Relationship between market and funding liquidity risks

Figure: The liquidity nodes of the financial system

Relationship between market and funding liquidity risks

![Diagram showing the relationship between market and funding liquidity risks.](image)

- **Subprime crisis**
  - Credit risk
  - Banks
    - Funding risk
    - Asset management
      - Market risk
      - Stock market
        - Collateral risk
        - Banks
  - Feedback loop

**Figure**: Spillover effects during the 2008 global financial crisis

Thierry Roncalli
The liquidity coverage ratio is defined as:

\[
\text{LCR} = \frac{\text{HQLA}}{\text{Total net cash outflows}} \geq 100\%
\]

where the numerator is the stock of high quality liquid assets (HQLA) in stressed conditions, and the denominator is the total net cash outflows over the next 30 calendar days

⇒ The underlying idea of the LCR is that the bank has sufficient liquid assets to meet its liquidity needs for the next month.
An asset is considered to be a HQLA if it can be easily converted into cash. Therefore, the concept of HQLA is related to asset quality and asset liquidity.

Characteristics used by the Basel Committee for defining HQLA:

- fundamental characteristics (low risk, ease and certainty of valuation, low correlation with risky assets, listed on a developed and recognized exchange);
- market-related characteristics (active and sizable market, low volatility, flight to quality).
## High quality liquid asset

### Table: Stock of HQLA

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
<th>Haircut</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level 1 assets</strong></td>
<td>Coins and bank notes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sovereign, central bank, PSE, and MDB assets qualifying for 0% risk weighting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Central bank reserves</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Domestic sovereign or central bank debt for non-0% risk weighting</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Level 2 assets</strong></td>
<td>(maximum of 40% of HQLA)</td>
<td></td>
</tr>
<tr>
<td><strong>Level 2A assets</strong></td>
<td>Sovereign, central bank, PSE and MDB assets qualifying for 20% risk weighting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Corporate debt securities rated AA− or higher</td>
<td>15%</td>
</tr>
<tr>
<td></td>
<td>Covered bonds rated AA− or higher</td>
<td></td>
</tr>
<tr>
<td><strong>Level 2B assets</strong></td>
<td>(maximum of 15% of HQLA)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RMBS rated AA or higher</td>
<td>25%</td>
</tr>
<tr>
<td></td>
<td>Corporate debt securities rated between A+ and BBB−</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td>Common equity shares</td>
<td>50%</td>
</tr>
</tbody>
</table>
High quality liquid asset

Level 2 assets are subject to two caps. Let $x_{HQLA}$, $x_1$ and $x_2$ be the value of HQLA, level 1 assets and level 2 assets. We have:

$$x_{HQLA} = x_1 + x_2$$

s.t.\[
\begin{align*}
  x_2 &= x_{2A} + x_{2B} \\
  x_{2A} &\leq 0.40 \cdot x_{HQLA} \\
  x_{2B} &\leq 0.15 \cdot x_{HQLA}
\end{align*}
\]

We deduce that one trivial solution is:

$$\begin{cases}
  x^*_{HQLA} = \min \left( \frac{5}{3} x_1, x_1 + x_2 \right) \\
  x^*_1 = x_1 \\
  x^*_2 = x^*_{HQLA} - x^*_1 \\
  x^*_{2A} = \min (x^*_2, x_{2A}) \\
  x^*_{2B} = x^*_2 - x^*_{2A}
\end{cases}$$
Example

We consider the following assets:

1. Coins and bank notes = $200 mn
2. Central bank reserves = $100 mn
3. 20% risk-weighted sovereign debt securities = $200 mn
4. AA corporate debt securities = $300 mn
5. Qualifying RMBS = $200 mn
6. BB+ corporate debt securities = $500 mn
### Table: Solution of the exercise

<table>
<thead>
<tr>
<th>Assets</th>
<th>Gross Value</th>
<th>Haircut</th>
<th>Net Value</th>
<th>Capped Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1 assets</td>
<td>(1) + (2)</td>
<td>300 0%</td>
<td>300 300</td>
<td></td>
</tr>
<tr>
<td>Level 2 assets</td>
<td>1 200</td>
<td>825 200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2A (3) + (4)</td>
<td>500 15%</td>
<td>425 200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2B (5) + (6)</td>
<td>700</td>
<td>400 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(5)</td>
<td>200 25%</td>
<td>150 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(6)</td>
<td>500 50%</td>
<td>250 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1 500</td>
<td>1 125 500</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

⇒ The stock of HQLA is equal to $500 mn
Total net cash outflows

The value of total net cash outflows is defined as follows:

\[
\text{Total net cash outflows} = \text{Total expected cash outflows} - \min\left(\text{Total expected cash inflows, } 75\% \text{ of total expected cash outflows}\right)
\]
Total net cash outflows

Table: Cash outflows of the LCR

<table>
<thead>
<tr>
<th>Liabilities</th>
<th>Description</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Retail deposits</strong></td>
<td>Demand and term deposits (less than 30 days)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stable deposits covered by deposit insurance</td>
<td>3%</td>
</tr>
<tr>
<td></td>
<td>Stable deposits</td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td>Less stable deposits</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td>Term deposits (with residual maturity greater than 30 days)</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Unsecured wholesale funding</strong></td>
<td>Demand and term deposits (less than 30 days) provided by small business</td>
<td></td>
</tr>
<tr>
<td></td>
<td>customers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stable deposits</td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td>Less stable deposits</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td>Deposits generated by clearing, custody and cash management</td>
<td>25%</td>
</tr>
<tr>
<td></td>
<td>Portion covered by deposit insurance</td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td>Cooperative banks in an institutional network</td>
<td>25%</td>
</tr>
<tr>
<td></td>
<td>Corporates, sovereigns, central banks, PSEs and MDBs</td>
<td>40%</td>
</tr>
<tr>
<td></td>
<td>Portion covered by deposit insurance</td>
<td>20%</td>
</tr>
</tbody>
</table>
Total net cash outflows

Table: Cash outflows of the LCR

<table>
<thead>
<tr>
<th>Liabilities</th>
<th>Description</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Secured funding transactions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>With a central bank counterparty</td>
<td></td>
<td>0%</td>
</tr>
<tr>
<td>Backed by level 1 assets</td>
<td></td>
<td>0%</td>
</tr>
<tr>
<td>Backed by level 2A assets</td>
<td></td>
<td>15%</td>
</tr>
<tr>
<td>Backed by non-level 1 or non-level 2A assets with domestic sovereigns, PSEs or MDBs as a counterparty</td>
<td>25%</td>
<td></td>
</tr>
<tr>
<td>Backed by level 2B RMBS assets</td>
<td></td>
<td>25%</td>
</tr>
<tr>
<td>Backed by other level 2B assets</td>
<td></td>
<td>50%</td>
</tr>
<tr>
<td>All other secured funding transactions</td>
<td></td>
<td>100%</td>
</tr>
<tr>
<td><strong>Additional requirements</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Margin/collateral calls</td>
<td></td>
<td>≥ 20%</td>
</tr>
<tr>
<td>ABCP, SIVs, conduits, SPVs, etc.</td>
<td></td>
<td>100%</td>
</tr>
<tr>
<td>Net derivative cash outflows</td>
<td></td>
<td>100%</td>
</tr>
<tr>
<td>Other credit/liquidity facilities</td>
<td></td>
<td>≥ 5%</td>
</tr>
</tbody>
</table>
## Total net cash outflows

**Table:** Cash inflows of the LCR

<table>
<thead>
<tr>
<th>Receivables</th>
<th>Description</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maturing secured lending transactions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Backed by level 1 assets</td>
<td></td>
<td>0%</td>
</tr>
<tr>
<td>Backed by level 2A assets</td>
<td></td>
<td>15%</td>
</tr>
<tr>
<td>Backed by level 2B RMBS assets</td>
<td></td>
<td>25%</td>
</tr>
<tr>
<td>Backed by other level 2B assets</td>
<td></td>
<td>50%</td>
</tr>
<tr>
<td>Backed by non-HQLAs</td>
<td></td>
<td>100%</td>
</tr>
<tr>
<td><strong>Other cash inflows</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Credit/liquidity facilities provided to the bank</td>
<td></td>
<td>0%</td>
</tr>
<tr>
<td>Inflows to be received from retail counterparties</td>
<td></td>
<td>50%</td>
</tr>
<tr>
<td>Inflows to be received from non-financial wholesale counterparties</td>
<td></td>
<td>50%</td>
</tr>
<tr>
<td>Inflows to be received from financial institutions and central banks</td>
<td></td>
<td>100%</td>
</tr>
<tr>
<td>Net derivative receivables</td>
<td></td>
<td>100%</td>
</tr>
</tbody>
</table>
The bank has $500 mn of HQLA. Its main liabilities are:

1. Retail stable deposit = $17.8 bn ($15 bn have a government guarantee)
2. Retail term deposit (with a maturity of 6 months) = $5 bn
3. Stable deposit provided by small business customers = $1 bn
4. Deposit of corporates = $200 mn

In the next thirty days, the bank also expects to receive $100 mn of loan repayments, and $10 mn due to a maturing derivative.
We calculate the expected cash outflows for the next thirty days:

\[
\text{Cash outflows} = 3\% \times 15000 + 5\% \times 2800 + 0\% \times 5000 + 5\% \times 1000 + 40\% \times 200
\]
\[
= $720 \text{ mn}
\]

We estimate the cash inflows expected by the bank for the next month:

\[
\text{Cash inflows} = 50\% \times 100 + 100\% \times 10 = $60 \text{ mn}
\]

We deduce that the liquidity coverage ratio of the bank is equal to:

\[
\text{LCR} = \frac{500}{720 - 60} = 75.76\%
\]
Net stable funding ratio

It is defined as the amount of available stable funding (ASF) relative to the amount of required stable funding (RSF):

\[
\text{NSFR} = \frac{\text{Available amount of stable funding}}{\text{Required amount of stable funding}} \geq 100\%
\]

- The available amount of stable funding (ASF) corresponds to the regulatory capital plus some other liabilities.
- The required amount of stable funding (RSF) is the sum of weighted assets and off-balance sheet exposures.
Leverage ratio

- It is defined as the capital measure divided by the exposure measure.
- This ratio must be below 3%.
- The capital measure corresponds to the tier 1 capital.
- The exposure measure is composed of four main exposures:
  1. On-balance sheet exposures
  2. Derivative exposures
  3. Securities financing transaction (SFT)
  4. Exposures and off-balance sheet items
References

- Basel Committee on Banking Supervision (2013)

- Basel Committee on Banking Supervision (2014)

- Basel Committee on Banking Supervision (2017)

- Roncalli, T. (2020)