# 金融機構的風險分類、模型驗證、及壓力測試
# Risks Classification, Model Validation, and Stress Test for Financial Institutions

**Cheng Few Lee 李正福教授**

Distinguished Professor of Finance and Economics, Rutgers University, USA

Editor of Review of Quantitative Finance and Accounting and

Review of Pacific Basin Financial Markets and Policies

cflee@business.rutgers.edu

2018.6.9

第14屆金融與經濟政策研討會

# 演講大綱

A. 引言

B. 金融機構的風險分類

C. 模型驗證(Model Validation)

D. 壓力測試(Stress Test)

E. 總結

# A. 引言

本文首先簡單介紹金融機構所面臨各種不同風險，然後討論模型驗證及壓力測試的重要性與必要性。目前美國聯邦準備銀行要求各金融機構必需確實執行模型驗證及壓力測試。

# B.金融機構的風險分類

## 1. 利息風險(Interest Rate Risk)

The risk incurred by an FI when the maturities of its assets and liabilities are mismatched.

## 2. 市場風險(Market Risk)

The risk incurred in the trading of assets and liabilities due to changes in interest rates, exchange rates, and other asset prices.

## 3. 信用風險(Credit Risk)

The risk that the promised cash flows from loans and securities held by FIs may not be paid in full.

# B.金融機構的風險分類

## 4. 表外風險(Off-Balance-Sheet Risk)

The risk incurred by an FI due to activities related to contingent assets and liabilities.

## 5. 技術及營運風險(Technology and Operational Risks)

**Technology Risk**

The risk incurred by an FI when technological investments do not produce the cost savings anticipated.

**Operational Risk**

The risk that existing technology or support systems may malfunction or break down.

# B.金融機構的風險分類

## 6. 外匯風險(Foreign Exchange Risk)

The risk that exchange rate changes can affect the value of an FI's assets and liabilities located abroad.

## 7. 國家或主權風險(Country or Sovereign Risk)

The risk that repayments from foreign borrowers may be interrupted because of interference from foreign governments.

## 8. 流動性風險(Liquidity Risk)

The risk that a sudden surge in liability withdrawals may leave an FI in a position of having to liquidate assets in a very short period of time and at low prices.

# B.金融機構的風險分類

## 9. 破產風險(Insolvency Risk)

The risk that an FI may not have enough capital to offset a sudden decline in the value of its assets relative to its liabilities.

## 10. Other Risks and the interaction of Risks

■These nine risks are often interdependent.

•Credit and interest rate risks are positively correlated.

•Liquidity risk is correlated with interest rate and credit risks.

■Each risk and its interaction with other risks ultimately affects solvency risk.

# B.金融機構的風險分類

## 10. Other Risks and the interaction of Risks

■Various other risks, often of a more discrete or event type, also impact an FI's profitability and risk exposure.

i) Discrete risks might include a sudden change in taxation.

ii) Changes in regulatory policy constitute another type of discrete or event-type risk.

iii) Finally, more general macroeconomic risks, such as increased inflation, inflation volatility, and unemployment, can directly and indirectly impact an FI's level of interest rate, credit, and liquidity risk exposure.

# C.模型驗證(Model Validation)

- 銀行通常有風險管理的模型去分析銀行所面臨的風險,可是這些銀行風險管理的模型,常面臨到下列的問題:

1. 模型的建立通常以信用風險的分析為主,其他風險,如市場風險、利息風險、表外風險、技術及營運風險等...,沒有直接考慮到。
2. 銀行所用的風險分析模型沒有考慮到法律、會計、及其他經營環境所面臨的問題。
3. 模型的設立常忽略計量經濟與統計理論的要求。

- 所以,在美國,聯邦準備銀行都要求大型銀行設有Model Validation部門。依據聯邦準備銀行之規範準則,模型驗證乃是一組步驟及活動,用來驗證銀行模型是否能達到原來所設定之目標及用途。此外,模型驗證的目的在於找出模型的可行性及其侷限性,並進一步衡量模型可發揮之作用。模型驗證者通常也可提出模型的修正相關建議。模型驗證通常是由獨立部門來執行,如果該金融機構的模型驗證部門不能應付模型的複雜性,也可尋求外面顧問公司協助,以便有效達成驗證的目標。

- Model Validation有四成份:1)觀念設計 2)系統驗證 3)資料驗證及品質衡量 4)步驟驗證。各成份詳細說明請見Appendix A。

- 據我了解,台灣的銀行在這方面業務,還沒有正式推展。

# D.壓力測試(Stress Test)

- 美國聯邦準備銀行在2007-2008金融風暴以後，依據2010Dodd-Frank 法案，2011年開始要求資產大於500億美金的銀行必須做壓力測試。歐洲銀行在最近幾年也開始推動這方面的測試，據我了解，台灣銀行在這方面，尚未開始推動。

- 台灣銀行在陳水扁就任一年左右後，開始推動打消銀行呆帳、加強資本適足率的要求。為此，2000年11月，我協助台灣舉行「經濟高峰會議」。當時我邀請美國Chicago跟Minneapolis聯邦銀行準備區的President及芝加哥大學商學院院長等專家來台討論如何推動台灣的金融改革。此方面的歷史故事在我去年出版的英文自傳*From East to West-Memoirs of a Finance Professor on Academia, Practice, and Policy,* World Scientific Publishing Co., 2017，有進一步闡述。

# D.壓力測試(Stress Test)

- 壓力測試的主要步驟簡述如下：

1. 首先，詳細分析銀行所面臨的十種風險，尤其著重於流動性風險。

2. 然後從將各種風險用統計及計量方法找出財務風險的總指標。所謂Financial Z-Score。此方面的探討可參考*Financial Analysis Planning and Forecasting,* World Scientific Publishing Co., 2017。

- 壓力測試的定義及分類請詳見Appendix B。

# E.總結

- 本文首先簡單介紹金融機構所面臨各種不同風險：利息風險、市場風險、信用風險、表外風險、技術及營運風險、外匯風險、國家或主權風險、流動性風險、破產風險及風險相互作用。

- 然後根據十種風險談到如何運用模型驗證去分析風險模型的可行性及完整性。

- 接著，談到目前美國聯邦準備銀行要求大間銀行需做壓力測試，壓力測試的主要目的，是用來衡量各銀行整體財務狀況是否可經得起經濟循環所面臨的波動及衝擊。

- 希望本文的探討與分析能夠給台灣金融機構的風險管理提出進一步拋磚引玉的建言。希望台灣金融機構能加強風險管理，以避免像2017年慶富聯貸弊案，銀行遭受巨大損失。此外，兆豐金2016年因違反反洗錢法遭受美國聯邦準備銀行巨額開罰。

謝謝諸位先進的聆聽及指教!!!

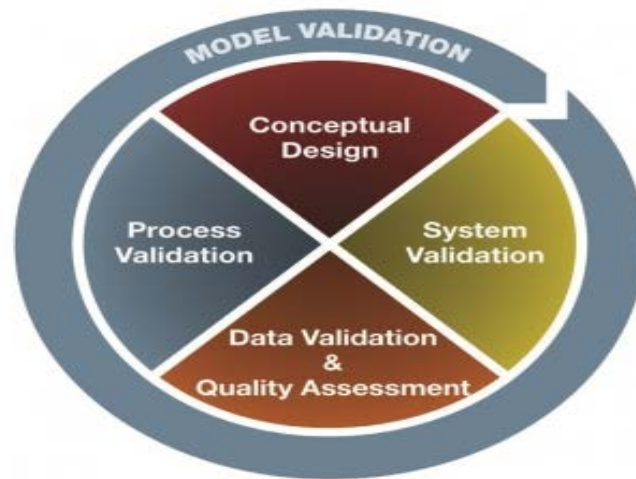# Appendix A. Model Validation: Four Elements of Determining the Accuracy of Your Models

**Written by Clayton Mitchell, Senior Manager at Crowe Horwath LLP** **(19th January 2016)**

- Model validation is defined within regulatory guidance as "the set of processes and activities intended to verify that models are performing as expected, in line with their design objectives, and business uses." It also identifies "potential limitations and assumptions, and assesses their possible impact."

- Generally, validation activities are performed by individuals independent of model development or use. Models, therefore, should not be validated by their owners as they can be highly technical, and some institutions may find it difficult to assemble a model risk team that has sufficient functional and technical expertise to carry out independent validation. When faced with this obstacle, institutions often outsource the validation task to third parties.

# Appendix A. Model Validation: Four Elements of Determining the Accuracy of Your Models

- **The Four Elements**

Model validation consists of four crucial elements which should be considered:



Source: Crowe Horwath LLP analysis

# Appendix A. Model Validation: Four Elements of Determining the Accuracy of Your Models

## 1 Conceptual Design

- The foundation of any model validation is its conceptual design, which needs documented coverage assessment that supports the model's ability to meet business and regulatory needs and the unique risks facing a bank.

- The design and capabilities of a model can have a profound effect on the overall effectiveness of a bank's ability to identify and respond to risks. For example, a poorly designed risk assessment model may result in a bank establishing relationships with clients that present a risk that is greater than its risk appetite, thus exposing the bank to regulatory scrutiny and reputation damage.

- A validation should independently challenge the underlying conceptual design and ensure that documentation is appropriate to support the model's logic and the model's ability to achieve desired regulatory and business outcomes for which it is designed.

# Appendix A. Model Validation: Four Elements of Determining the Accuracy of Your Models

## 2 System Validation

All technology and automated systems implemented to support models have limitations. An effective validation includes: firstly, evaluating the processes used to integrate the model's conceptual design and functionality into the organisation's business setting; and, secondly, examining the processes implemented to execute the model's overall design. Where gaps or limitations are observed, controls should be evaluated to enable the model to function effectively.

# Appendix A. Model Validation: Four Elements of Determining the Accuracy of Your Models

## 3 Data Validation and Quality Assessment

- Data errors or irregularities impair results and might lead to an organisation's failure to identify and respond to risks. Best practise indicates that institutions should apply a risk-based data validation, which enables the reviewer to consider risks unique to the organisation and the model.

- To establish a robust framework for data validation, guidance indicates that the accuracy of source data be assessed. This is a vital step because data can be derived from a variety of sources, some of which might lack controls on data integrity, so the data might be incomplete or inaccurate.

# Appendix A. Model Validation: Four Elements of Determining the Accuracy of Your Models

**4 Process Validation**

- To verify that a model is operating effectively, it is important to prove that the established processes for the model's ongoing administration, including governance policies and procedures, support the model's sustainability. A review of the processes also determines whether the models are producing output that is accurate, managed effectively, and subject to the appropriate controls.

- If done effectively, model validation will enable your bank to have every confidence in its various models' accuracy, as well as aligning them with the bank's business and regulatory expectations. By failing to validate models, banks increase the risk of regulatory criticism, fines, and penalties.

- The complex and resource-intensive nature of validation makes it necessary to dedicate sufficient resources to it. An independent validation team well versed in data management, technology, and relevant financial products or services – for example, credit, capital management, insurance, or financial crime compliance – is vital for success. Where shortfalls in the validation process are identified, timely remedial actions should be taken to close the gaps.

# Appendix B. Stress Testing

Source: Investopedia (www.investopedia.com)

**Regulatory Stress Testing**

•Following the 2008 financial crisis, regulatory reporting for the financial industry and specifically banks was significantly expanded with a broader focus on stress testing and capital adequacy mainly due to the 2010 Dodd-Frank Act. Beginning in 2011, new regulations in the United States required the submission of Comprehensive Capital Analysis and Review (CCAR) documentation for the banking industry. CCAR documentation requires banks to report on their internal procedures for managing capital and banks are required to include various stress-tested scenarios.

Read more: Stress Testing https://www.investopedia.com/terms/s/stresstesting.asp#ixzz5H3l6fM7w

# Appendix B. Stress Testing

- In addition to CCAR reporting, systemically important banks in the United States deemed too big to fail by the Financial Stability Board, typically those with greater than $50 billion in assets, must provide stress tested reporting on planning for a bankruptcy scenario. In the government's most recent reporting review of these banks in 2016, there were eight too big to fail systemically important banks.

- Currently, BASEL III is also in effect for global banks. This is a global reporting stress test that requires reporting documentation on banks' capital levels with specified requirements for stress testing of various crisis scenarios.

Read more: Stress Testing https://www.investopedia.com/terms/s/stresstesting.asp#ixzz5H3lJ2hrV

# Appendix B. Regulatory Stress Testing

**Stress Testing for Risk Management**

- In investment portfolio management, stress testing is also commonly used for determining portfolio risk and setting hedging strategies to mitigate losses. Portfolio managers use internal proprietary stress testing programs to manage and test their portfolios against market occurrences and potential events.

- Asset and liability matching stress tests are also widely used in business and investment management. Asset and liability matching stress tests can be used by companies to ensure proper internal controls and procedures. Retirement and insurance portfolios also greatly utilize stress testing to ensure efficient streams of cash flow and payout levels.

Read more: Stress Testing https://www.investopedia.com/terms/s/stresstesting.asp#ixzz5H3po4iOc

# Appendix B. Regulatory Stress Testing

**Types of Stress Testing**

- The use of Monte Carlo simulation is one of the most widely known methods of stress testing. This type of stress testing can be used for modeling probabilities of various outcomes given specific variables. Factors considered in the Monte Carlo simulation often include various economic variables.

- Companies can also turn to professionally managed risk management and software providers for various types of stress tests. Moody's Analytics is one example of an outsourced stress testing program that can be used for portfolio stress testing.

Read more: Stress Testing https://www.investopedia.com/terms/s/stresstesting.asp#ixzz5H3qdAwgp