

BuDA: A Bottom-Up Default Analysis Platform for Macrofinancial Analysis Methodology and Surveillance Applications

Jorge A. Chan-Lau¹ Jin-Chuan Duan² Wei Sun³

¹Institute for Capacity and Development
International Monetary Fund

²NUS Business School and Credit Research Initiative
National University of Singapore

³Credit Research Initiative
National University of Singapore

International Monetary Fund, Washington DC, July 17-18, 2017

Outline

- 1 BuDA: A MacroFinancial Tool
 - Financial Stability and Macrofinancial Linkages
 - The BuDA Building Block
 - The Bottom-Up Approach
- 2 The Modeling Approach
- 3 An Illustrative Example
 - 2017 China FSAP
- 4 Course Outline
 - PD Modeling Preliminaries
 - PD Modeling in BuDA
 - Risk Factor Forecasting
 - IMF Surveillance Applications
 - Hands-on Session

Outline

- 1 BuDA: A MacroFinancial Tool
 - Financial Stability and Macrofinancial Linkages
 - The BuDA Building Block
 - The Bottom-Up Approach
- 2 The Modeling Approach
- 3 An Illustrative Example
 - 2017 China FSAP
- 4 Course Outline
 - PD Modeling Preliminaries
 - PD Modeling in BuDA
 - Risk Factor Forecasting
 - IMF Surveillance Applications
 - Hands-on Session

Outline

- 1 BuDA: A MacroFinancial Tool
 - Financial Stability and Macrofinancial Linkages
 - The BuDA Building Block
 - The Bottom-Up Approach
- 2 The Modeling Approach
- 3 An Illustrative Example
 - 2017 China FSAP
- 4 Course Outline
 - PD Modeling Preliminaries
 - PD Modeling in BuDA
 - Risk Factor Forecasting
 - IMF Surveillance Applications
 - Hands-on Session

Outline

- 1 BuDA: A MacroFinancial Tool
 - Financial Stability and Macrofinancial Linkages
 - The BuDA Building Block
 - The Bottom-Up Approach
- 2 The Modeling Approach
- 3 An Illustrative Example
 - 2017 China FSAP
- 4 Course Outline
 - PD Modeling Preliminaries
 - PD Modeling in BuDA
 - Risk Factor Forecasting
 - IMF Surveillance Applications
 - Hands-on Session

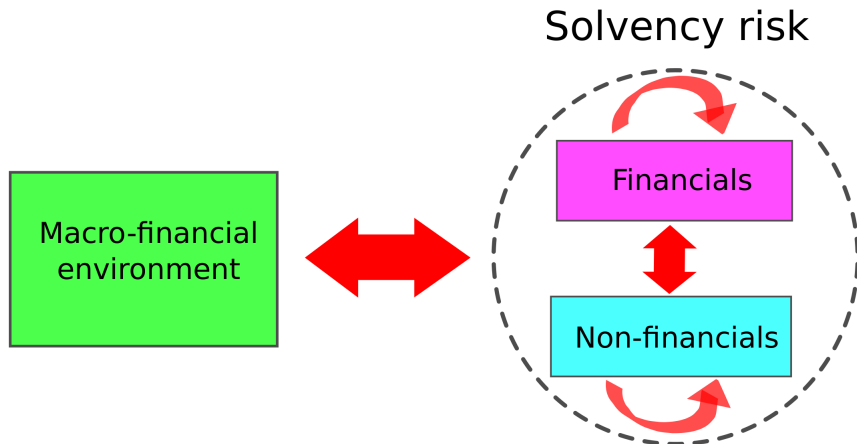
Outline

- 1 BuDA: A MacroFinancial Tool
 - Financial Stability and Macrofinancial Linkages
 - The BuDA Building Block
 - The Bottom-Up Approach
- 2 The Modeling Approach
- 3 An Illustrative Example
 - 2017 China FSAP
- 4 Course Outline
 - PD Modeling Preliminaries
 - PD Modeling in BuDA
 - Risk Factor Forecasting
 - IMF Surveillance Applications
 - Hands-on Session

Macrofinancial Linkages

- Macrofinancial linkages matter for
 - Financial sector surveillance
 - Macroprudential policy design
- Modeling macrofinancial linkages is hard ...
- ... due to numerous feedback loops
 - Macrofinancial environment and firms
 - Financial firms
 - Non-financial firms
 - Financial and non-financial firms

Modeling macrofinancial linkages is difficult

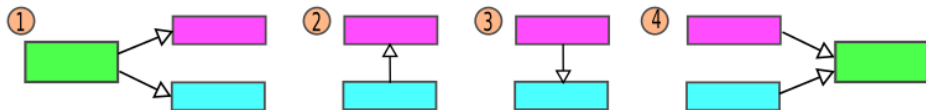


Outline

- 1 BuDA: A MacroFinancial Tool
 - Financial Stability and Macrofinancial Linkages
 - **The BuDA Building Block**
 - The Bottom-Up Approach
- 2 The Modeling Approach
- 3 An Illustrative Example
 - 2017 China FSAP
- 4 Course Outline
 - PD Modeling Preliminaries
 - PD Modeling in BuDA
 - Risk Factor Forecasting
 - IMF Surveillance Applications
 - Hands-on Session

A Sequential Approach to MacroFinancial Linkages

- Break the problem in steps

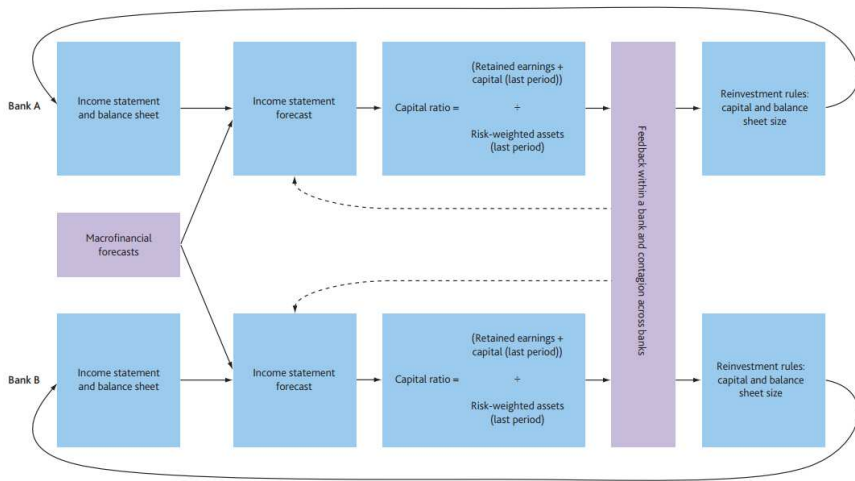


- Examples

- Bank of England RAMSI model (Burrows et al, 2012)
- Bank of Canada MFRAF model (Anand et al, 2014)

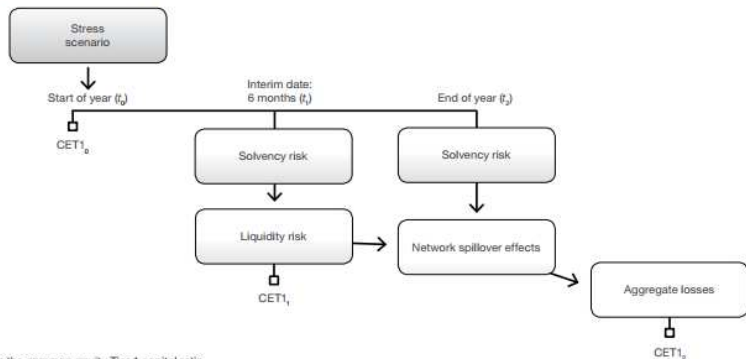
Bank of England RAMSI model

Figure 1 Stylised overview of RAMSI



Bank of Canada MFRAF model

Figure 1: MFRAF: A modular approach to systemic risk



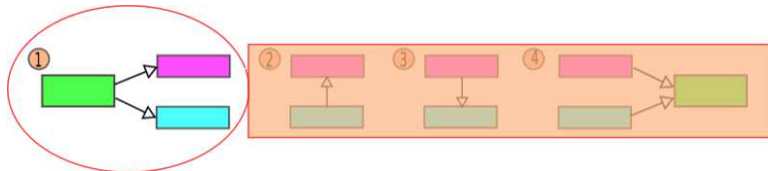
Note: CET1 is the common equity Tier 1 capital ratio.

Source: Bank of Canada

BuDA, first step in sequential approach

The **Bottom-Up Default Analysis** BuDA Framework

- Maps macrofinancial scenarios to firms' solvency risk

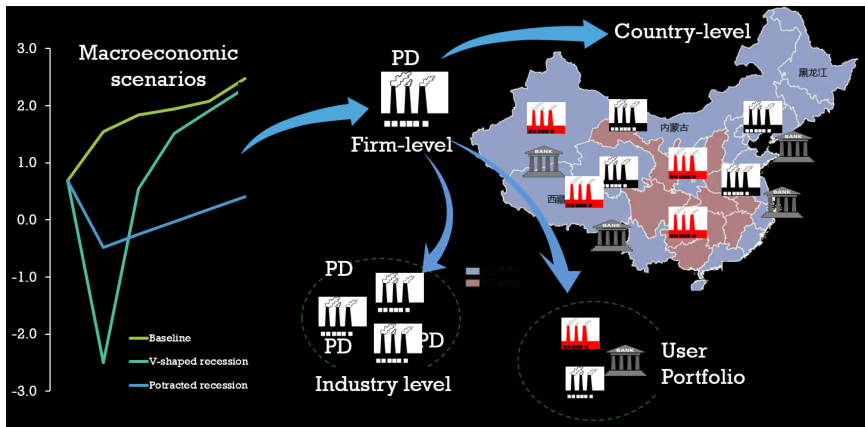


- Mapping based on a **bottom-up** approach
- Focus on default risk, i.e. probabilities of default

Outline

- 1 **BuDA: A MacroFinancial Tool**
 - Financial Stability and Macrofinancial Linkages
 - The BuDA Building Block
 - **The Bottom-Up Approach**
- 2 The Modeling Approach
- 3 An Illustrative Example
 - 2017 China FSAP
- 4 Course Outline
 - PD Modeling Preliminaries
 - PD Modeling in BuDA
 - Risk Factor Forecasting
 - IMF Surveillance Applications
 - Hands-on Session

BuDA uses a Bottom-Up Approach

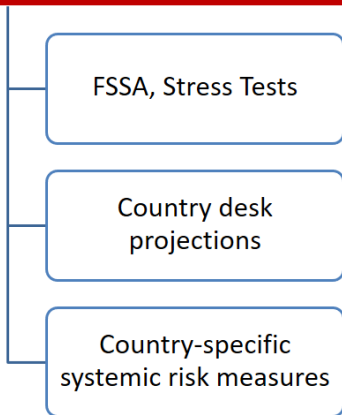


Advantages of the Bottom-Up Approach

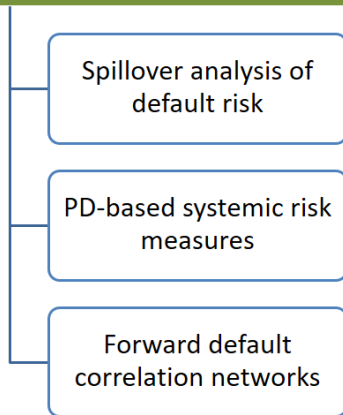
- Single out systemic firms in the analysis
- Analyze specific business sectors
- Focus on large debtors of banking sector
- Identify most vulnerable firms
- Specify arbitrary group of firms (portfolio)
- Suitable for surveillance work

Surveillance Applications of the Bottom-Up Approach

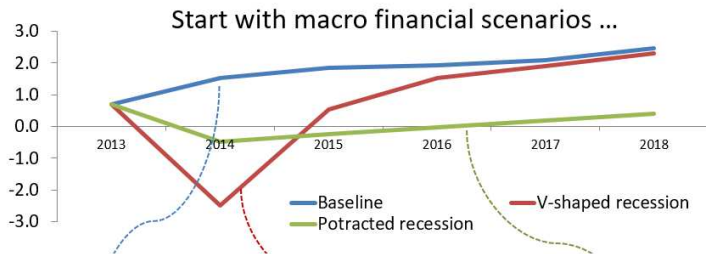
Bilateral



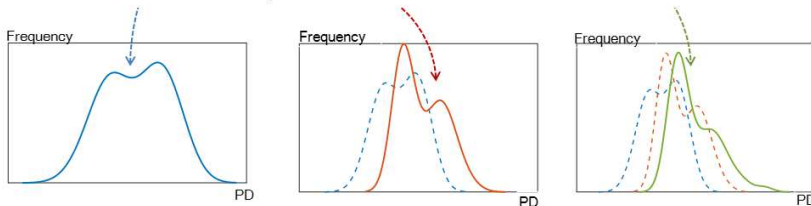
Multilateral



BuDA generates default risk distributions



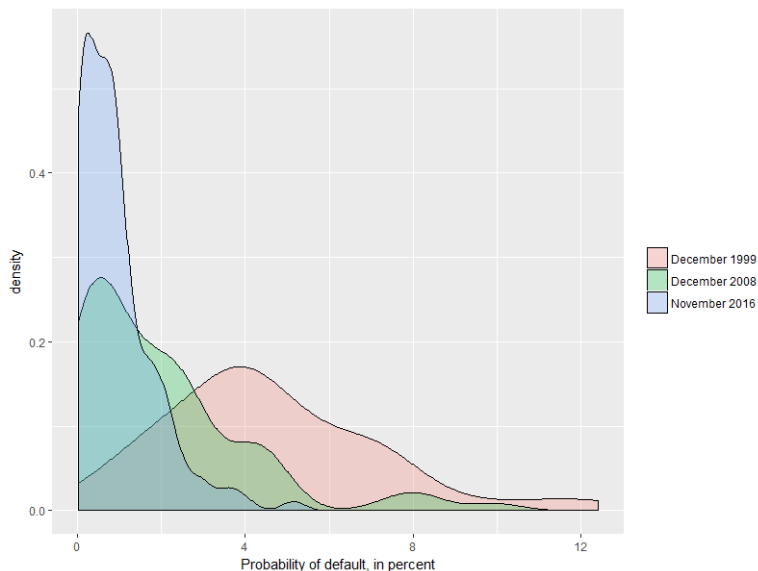
... and estimate ex-post distribution of PDs of individual firms



Why risk distributions matter

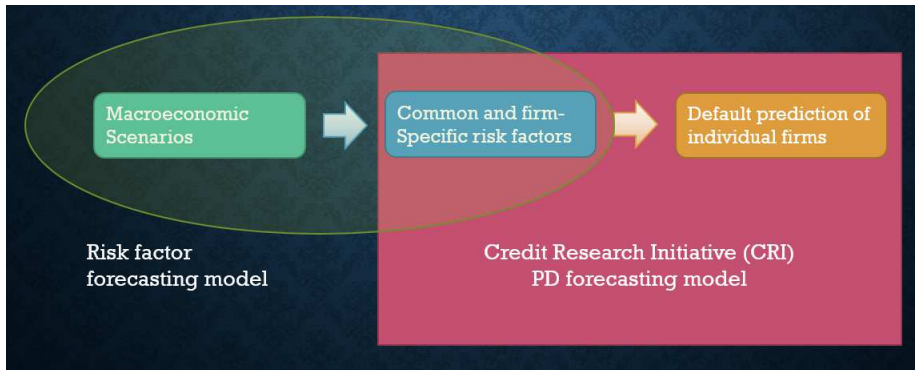
- Distribution more informative than aggregate risk measures
- Basis for modeling aggregate fluctuations
 - Granular origins of aggregate fluctuations (Gabaix, 2011)
 - Network origins of aggregate fluctuations (Acemoglu et al, 2012)
- Useful for constructing early warning and/or cyclical indicators

Distribution of default risk, Chinese financial firms



BuDA "Two" Regression Approach

- Regression model for risk factor prediction, conditional on scenario variables
- PD forecasting model, conditional on risk factors

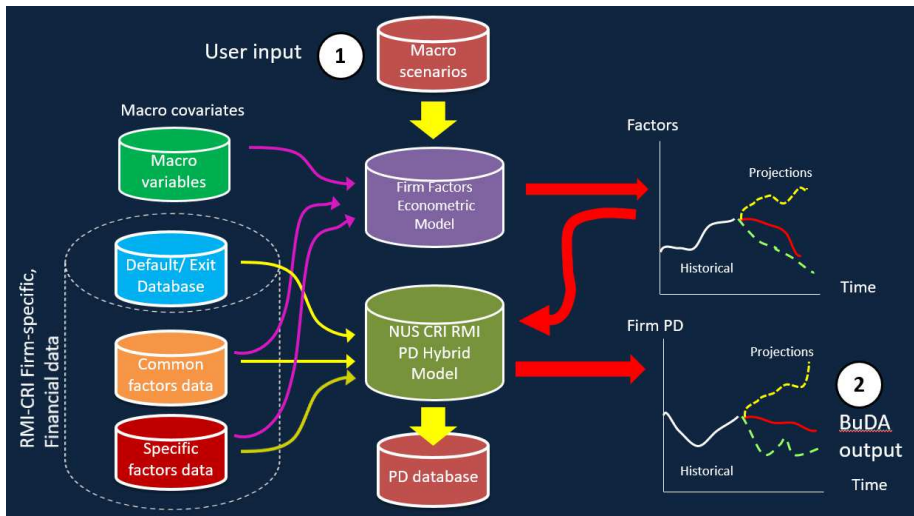


Risk Factors for Forecasting PDs

Nature	Description	Level/Trend 1,2/
Economy-wide	Return of domestic stock market index	Current
	Short-term domestic interest rate	Current
Firm-specific	Financial statements-based factors	
	Liquidity (cash + short-term investments/total assets)	Trend and level
	Profitability (Net income/total assets)	Trend and level
	Market-based factors	
	Distance-to-default (volatility adjusted leverage)	Trend and Level
	Size (market capitalization relative to median market capitalization)	Trend and Level
	Market misvaluation (market cap + total liabilities/ total assets)	Current
	Idiosyncratic volatility	Current

1/ The level is computed as the 12-month average value of the factor.

2/ The trend is computed as the difference between the current value of the factor and its 12-month average



BuDA — Bottom-up Default Analysis Version 2.0

Testing Region(s)

- United States
- Canada
- China**
- India
- Indonesia
- Japan
- Malaysia
- Philippines
- Singapore
- Thailand
- Argentina
- Brazil
- Colombia
- Chile
- Jamaica
- Mexico
- Peru
- Venezuela

☒ User-Supplied Portfolio

Basic Parameters

Testing Time Point: 2016 11

Prediction Horizon: 12 month(s) Note

Number of Simulations: 1000 Note

Macroeconomic Scenarios

☐ GDP ☐ UNEMP ☐ CPI ☐ NEER
☐ IBOR ☐ GSCI ☐ VIX Note

☒ User-Supplied Note ☐ Model Macros Note

Sample Period

From 1990 01 To 2016 11

☒ Sample period up to the testing time point
☐ Whole sample period
☐ User-specified sample period

Other Settings

☐ Actual Realizations ☒ Dynamic Plotting Note

Advanced Settings

Testing Industry(s)

- ☐ All
- ☒ Non-financial
- ☐ Financial
- ☐ Basic material
- ☐ Communications
- ☐ Consumer (cyclical)
- ☐ Consumer (noncyclical)
- ☐ Energy
- ☐ Industrial
- ☐ Technology
- ☐ Utilities

Run

BuDA is developed by Jin-Chuan Duan and Weimin Miao of National University of Singapore (NUS) in collaboration with Jorge Chan-Lau of International Monetary Fund with the active support by NUS Risk Management Institute's Credit Research Initiative team.

Outline

- 1 BuDA: A MacroFinancial Tool
 - Financial Stability and Macrofinancial Linkages
 - The BuDA Building Block
 - The Bottom-Up Approach
- 2 The Modeling Approach
- 3 **An Illustrative Example**
 - **2017 China FSAP**
- 4 Course Outline
 - PD Modeling Preliminaries
 - PD Modeling in BuDA
 - Risk Factor Forecasting
 - IMF Surveillance Applications
 - Hands-on Session

Scenario Variables

- Real GDP growth
- Inflation rate
- Policy rate
- NEER
- Money market rate
- 10-year government bond yield

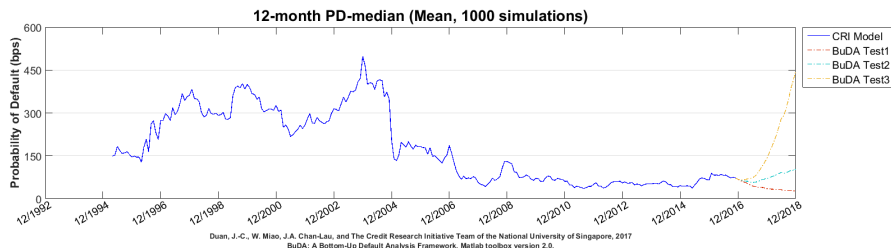
Scenarios

Two-year scenarios

- Baseline
 - 6.0 percent GDP growth
- Adverse
 - 4.5 percent GDP growth
- Severe
 - 2.8 percent GDP growth

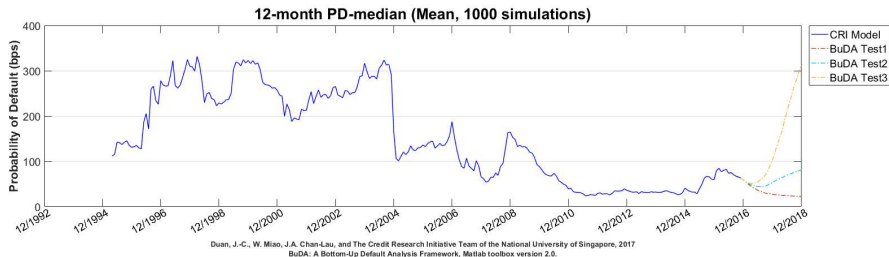
Results

135 financial firms



Results

2075 non-financial firms



Outline

- 1 BuDA: A MacroFinancial Tool
 - Financial Stability and Macrofinancial Linkages
 - The BuDA Building Block
 - The Bottom-Up Approach
- 2 The Modeling Approach
- 3 An Illustrative Example
 - 2017 China FSAP
- 4 **Course Outline**
 - **PD Modeling Preliminaries**
 - PD Modeling in BuDA
 - Risk Factor Forecasting
 - IMF Surveillance Applications
 - Hands-on Session

PD Modeling Preliminaries

- Default events
- Main approaches for modeling PDs
- Forward intensity models
- Distance-to-Default nuances
- Risk factors useful for forecasting PDs

Outline

- 1 BuDA: A MacroFinancial Tool
 - Financial Stability and Macrofinancial Linkages
 - The BuDA Building Block
 - The Bottom-Up Approach
- 2 The Modeling Approach
- 3 An Illustrative Example
 - 2017 China FSAP
- 4 **Course Outline**
 - PD Modeling Preliminaries
 - **PD Modeling in BuDA**
 - Risk Factor Forecasting
 - IMF Surveillance Applications
 - Hands-on Session

PD Modeling in BuDA

- The Duan-Sun-Wang Model: Why other exits matter
- The CRI default database
- Estimation of the DSW model: practical considerations
- DSW model accuracy
- Differences between CRI PDs and Moody's EDFs
- PD availability via CRI or Thomson-Reuters

Outline

- 1 BuDA: A MacroFinancial Tool
 - Financial Stability and Macrofinancial Linkages
 - The BuDA Building Block
 - The Bottom-Up Approach
- 2 The Modeling Approach
- 3 An Illustrative Example
 - 2017 China FSAP
- 4 **Course Outline**
 - PD Modeling Preliminaries
 - PD Modeling in BuDA
 - **Risk Factor Forecasting**
 - IMF Surveillance Applications
 - Hands-on Session

Risk Factor Forecasting

- Forecasting risk factors with macrofinancial variables
 - Mixed frequency modeling
 - Linear model
- Performance of macro-forecasting equations
- Variable contribution to PD forecast

Outline

- 1 BuDA: A MacroFinancial Tool
 - Financial Stability and Macrofinancial Linkages
 - The BuDA Building Block
 - The Bottom-Up Approach
- 2 The Modeling Approach
- 3 An Illustrative Example
 - 2017 China FSAP
- 4 **Course Outline**
 - PD Modeling Preliminaries
 - PD Modeling in BuDA
 - Risk Factor Forecasting
 - **IMF Surveillance Applications**
 - Hands-on Session

Current Applications

Article IV Consultation

- Canada
- Chile
- Indonesia
- United Arab Emirates

Multilateral Surveillance

- WHD Regional Economic Outlook

Outline

- 1 BuDA: A MacroFinancial Tool
 - Financial Stability and Macrofinancial Linkages
 - The BuDA Building Block
 - The Bottom-Up Approach
- 2 The Modeling Approach
- 3 An Illustrative Example
 - 2017 China FSAP
- 4 **Course Outline**
 - PD Modeling Preliminaries
 - PD Modeling in BuDA
 - Risk Factor Forecasting
 - IMF Surveillance Applications
 - **Hands-on Session**

Using BuDA in your country work

- Introduces Matlab implementation of the BuDA platform
- Case study: Stress Test of European Banks