MATLAB-Based Policy Simulator

Regulatory & Risk Analytics (RRA)

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Presentation Outline

- Background and context to Project Navigator
- General project objectives
- Project scope
- Overall approach (and rationale)
- MATLAB-based policy simulator
- Lessons learned (so far!)
Background / Context

- 2012 saw HSBC initiate a period of strategic consolidation from a commercial, operational and technical perspective

- For the global risk function, Regulatory Risk and Analytics, this has meant:
  - a stronger focus at the centre of the organisation in London, coordinating risk-related projects in multiple countries and within multiple regulatory jurisdictions
  - Increasing the level of standardisation across risk methodologies, technologies, governance formats and data models

- WCMR / RRA has an objective to improve the ‘consistency’ of the global rating system and has embarked on a programme of system-wide change to achieve this consistency

- Several separate projects contribute to the Consistency Programme – Project Navigator is one such initiative

- Project Navigator is focused on improving rating assignment – the process of selecting the appropriate ‘path’ for a rating to take through the various models and rating modifiers that comprise the overall rating system
Tactical Heat Map for Project Navigator

RRA ENTERPRISE ARCHITECTURE (Wholesale Credit)

Rating Process Design

Credit Policy / FIM

Rating Process

Credit Approval Workflow Engine

Obligor Data + Capture

Relationship Management

Credit Approval Processes

Model Selection Process

Model Landscape

Legal and Risk Hierarchies

Entity Identifiers

Model Engine

PD Models

LGD Models

EAD Models

Calibration Engine

CAL Solution

HSBC MRS

Rating Phil.

Monitoring / Model Management

Stress Testing

Parental Support Framework

Sovereign Ceiling

Sovereign Support

Override Process

Model Policies and Standards and Governance Processes

Development Planning and Management

Validation Planning / Mgt

Development Process

Calibration Process

Validation Process

Development Resources

Calibration Resources

Validation Resources

DATA

Development

Validation

CRR / PD Outputs

Rating Meta-Data

Account Data

DATA

Validation Planning / Mgt

Development Planning and Management

Data Policy

Data Models

Account Data

Validation Process

Validation Resources

Development Process

Calibration Process

Development Resources

Calibration Resources

Validation Process

Validation Resources

Development Planning and Management

Validation Planning / Mgt

Development Process

Calibration Process

Development Resources

Calibration Resources

Validation Process

Validation Resources

RATING PLATFORM

Systemic Risk Measurement

Credit Approval Processes

Processes

Credit Approval

Obligor Data + Capture

Relationship Management

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Rating Meta-Data

Account Data

DATA

Validation Planning / Mgt

Development Planning and Management

Data Policy

Data Models

Account Data

Validation Process

Validation Resources

Development Process

Calibration Process

Development Resources

Calibration Resources

Validation Process

Validation Resources

Development Planning and Management

Validation Planning / Mgt

Development Process

Calibration Process

Development Resources

Calibration Resources

Validation Process

Validation Resources

PUBLIC
Project Objectives

- The project’s high level objectives are:

(1) To formalise and improve the logic used in determining a given wholesale rating’s *assignment strategy*, including the effects of any *rating modifiers*, towards the final rating;

(2) To automate this logic via algorithms embedded in the banks primary rating systems
Project Scope

The following aspects of the rating system are in scope:

1. **Rating assignment strategy** – the overall strategy that determined the *basis* for a rating, including any models, modifiers, etc used in the determination of the rating

2. **Rating Model Selection** – the process of objectively selecting a model to rate an obligor based on (1) the borrower’s attributes and (2) the collective scope set of the current PD models

3. **Parental Support Framework** (the ‘PSF’) – the replacement of a stand-alone rating with a parent’s rating (or notched derivation)

4. **Sovereign Ceilings** – the application of a ceiling to obligor ratings due to (principally) transfer and convertibility risk (‘T&C’ risk)

5. **Risk Hierarchies/Networks** – recognising the effects of control, and economic interdependency, through networks of relationships

6. **Rating event audit trails** – implementing an information rich body of meta-data that captures and accurately reflects all of the attributes, decisions and thresholds that led to the final rating
Overall Project Approach

- Solve all related problems within the same cycle (= ‘anything to do with rating assignment’)

- Form a cross-functional team from Credit Strategy, Policy, Analytics, Technology

- Project attributes:
  - High complexity (especially in the interaction between components)
  - Unknown levels of regionally-based variation in requirements and regulatory constraints
  - Rapid changes anticipated throughout project
  - Aggressive timelines set by senior management

- Our conclusion: use a simulator … a policy simulator … in a rapid prototyping mode

- A simulator implies coding … but what sort of code exactly?
  - In what language?
  - With what structure?
  - Developed in what environment?
Further Considerations

Points to consider:

1. modular-but-interrelated nature of the core problems...
2. unknown location of final solution(s)...
3. the requirement to conceive, implement and test certain algorithms...
4. a need to somehow process a large number of policy ideas (rating scenarios)...
5. the need to visualise results quickly and easily...
6. the need for several people to work on the problem simultaneously, passing fragments of code around and then integrating them into the simulator...
7. plus a maintainability burden due to high levels of changes within the project...

... all implied that (1) an object-oriented approach in (2) an interpreted environment would be ideal

- MATLAB in its object-oriented mode is almost perfectly designed for this sort of work
De-romanticising the Development Process

Traditional (idealised) development cycle:…

1. Business problem identified
2. High level solutions generated
3. Formal requirements elicited
4. Functional specification drafted
5. Development
6. Internal testing
7. User Acceptance Testing (UAT)
8. Release to production

…and what can happen in practice:

1. Identify business problem
2. High level solutions generated
3. Formal requirements elicited
4. Functional specification drafted
5. Development
6. … logical problems in business concept uncovered
7. … minor/major revisions to key concepts
8. … re-commencement of development
9. Internal testing
10. User Acceptance Testing (UAT)
11. … further concept revisions arising from UAT
12. … remedial development work
13. … additional (hopefully final) round of UAT
14. Release to production
15. … bugs identified from the live environment
16. … remedial programming
17. … re-release
High-Level Structure of Problem Solving Process

- **Identify** issues (central themes, specific problems, etc)
- **Frame** issues as *rating scenarios requiring a formal resolution*
- **Examine** and set the HSBC ‘house view’ on key issues
- **Define** the solution for each rating scenario (potentially involving a wider group of stakeholders)
- **Convert** rating scenarios into benchmark test cases and/or map them on to actual cases
- **Generate** an array of additional test cases to probe solution boundaries
- **Code** the solutions into the simulator (directly altering modules to reflect solutions, policies, etc)
- **Run** the test cases through the simulator, collate
- **Review** strategies and solutions
Central Work Cycle

- **Project Scope**
- **Issues List**
- **Candidate Solutions**
- **Classes**
- **Simulator**
- **Results**
- **Conclusions**
- **Selected Solutions**
- **High-Level Requirements**
- **Functional Specification**
- **Resolved Scenarios**
- **Policy Changes**

**Key Scenarios**

**Test Cases**

**Active Components (Objects):**
1. Obligor object
2. Model landscape object (collective scope set)
3. Rating model selection (RMS)
4. Parental Support Framework (PSF)
5. Sovereign Ceiling (SC)
6. Effective Risk Hierarchy / Network (ERH) object

**Key Results (per case):**
1. CRRs
2. Rating ‘path’
3. Intermediate states
Class Library Overview
Visual Scenario Template

Model used to rate parent

Corporate parent

Sovereign

T&C Risk

Country border

Model used to rate borrower

HSBC Office (1) in-country

FCY

HSBC Office (2) external

FCY

Borrower

CRR

100%

LCY
Test case 001 (example only)

SERIAL NO: TestCase-001

- **Customer Risk Ratings**
  - Final_CRR: 2.2
  - China: 1.2
  - Parent: 3.1
  - Child: 1.2

- **Distribution of Turnover by Region**
  - US: 1%
  - EU: 23%
  - AP: 17%
  - LA: 11%
  - ME: 19%
  - NA: 28%

- **Recommended Model(s) to Rate Obligor**
  - GLCS Model: 100%
  - Sovereign PD Model: 50%
  - Banks PD Model: 20%
  - Mid-Market PD Model: 10%

- **Industry**
  - 30% - 4500 - Construction
  - 25% - 5500 - Hotel
  - 20% - 5200 - Retail
  - 15% - 7000 - Real Estate
  - 10% - 5000 - Auto

- **Effective Risk Hierarchy (ERH)**
  - Parent1: CRR 1.2
  - Guarantor1: CRR 3.1
  - Guarantor2: CRR 2.1
  - Parent2: CRR 2.1
  - Obligor1

- **Network Perspective**
  - Supplier1: CRR 2.1
  - Supplier2: CRR 2.1
  - Supplier3: CRR 2.1
  - Client1: CRR 2.1
  - Client2: CRR 2.1
  - Client3: CRR 2.1
  - Client4: CRR 2.1
  - Client5: CRR 2.1

- **Approved by Working Group:** YES/NO
Navigator Class Library

- Relatively large number of classes given the number of sub-problems involved
- High levels **encapsulation** of every functional aspect of the Navigator project
- **Namespaces** (packages) and class folders used to organise code
- Methods written to keep the ‘**public interface**’ as clean / standard / logical as possible
- Delegation principle followed to keep the classes as loosely coupled as possible
- **Collections of objects** used for managing the rating model selection problem
- Classes become natural ‘locations’ or ‘hooks’ for key algorithms (e.g. classification, matching, etc)
- ‘Composition’ based relationships fairly common (very little ‘inheritance’ at this stage)
- Boundary elements (classes) are mock objects for future interfaces, and points of integration
Next Stages

- The base library has been developed for all sub-problems plus a foundational structure for running test cases
- In the next phase, we begin running policy test cases, refining the code, mocking up interfaces to simulate the key user cases
- Now that more of the geographically-specific requirements are known, the class library will also undergo a metamorphosis that accommodates these regional variations
- To avoid creating a mess of rigid code, we will now start using design patterns more liberally across the simulator design
- We will be using the ‘Strategy pattern’ to give certain modules the flexibility they need to choose a bespoke set of parameters, constraints or algorithms based on the attributes of the Obligor object
- We will simplify our control of the overall application using the ‘Observer pattern’ to coordinate the interaction between classes
- This last step will allow us to keep all of the modules loosely coupled – a desirable quality given that the final set of solutions will probably be distributed across
- All of the design patterns we have encountered so far (mainly from JAVA texts, but also Python and Ruby texts) seem to translate relatively easily in to MATLAB
Lessons Learned

- MATLAB is a brilliant prototyping environment – especially for non-programmers!
- Scripting is seductive but the discipline of classes/objects is worth the effort
- Class libraries are time-consuming to create in the first place but the modular structure has already shown benefits
- MATLAB’s object-oriented syntax is clean, simple and easy to understand
- We have found pure ‘test driven development’ (TDD) to be a challenging approach to maintain in the face of (very) high ambiguity and (rapidly) changing requirements
- We prefer a sort of loose, informal prototyping that proceeds from idea → scripts & functions → script-facilitated classes → classes wrapped in a GUI-managed session (a quasi-app)
- We’ve learned through experience to integrate as continuously as possible
- GUIs are extremely simple to code in MATLAB – we recommend building GUIs for any repetitive task (and make the decision early to build them)
- Important to position the prototype correctly in people’s minds