Showing Feasibility of fine grained Reference Data for Systemic Risk analytics

Francis Parr
IBM Research, July 2010
1. Fine grained descriptive data on the financial system is key to detecting buildup of Systemic Risk
   • An instance where need for higher quality data is recognized

2. Shared data model capturing cashflows an important enabler
   • A novel need engaging/integrating existing sources of data

3. Systemic Risk Reference Data POC and feasibility demonstration

4. Completeness, security, privacy and openness questions

5. Summary: applying data quality concepts in an important, novel context
The value of fine-grained descriptive data

- Analytics can be good predictors of behavior only when based on reliable system data
- Fine grained descriptive data on the state and history of the financial system is “objective”
  - Better placed to detect potential future crises than highly aggregated data
- Good descriptive data enables *multiple* analyses of risk
  - A portfolio risk detection approaches needed to avoid model risk
Highly aggregated vs. Fine grained models

1. Network of FSEs with abstract dependency couplings
   - Model / predict viability dynamics
   - Ownership hierarchy

2. Network of FSEs with specified holder and guarantor dependency linkages (MBS)
   - Model / predict asset/liability flows

3. Network of FSEs with:
   - specified holder and guarantor dependency linkages (MBS)
   - Underlying pool and payment structure
   - Model / predict underlying pool cash flows (aggregated data)

4. Network of FSEs with:
   - specified holder and guarantor dependency linkages (MBS)
   - underlying pool and payment model
   - Model / predict individual mortgage default, prepayment behaviors

FSE = Financial Services Entity
Gathering good fine-grained data requires...

- **Gathering high quality, fine-grained financial system data requires**
  - A system of systems architectural schema for the financial system
  - Data models and linkages capturing end-to-end cash flows
  - Unique identifiers for instruments, entities, assets etc
  - Standardized terms, glossaries, payout specifications – rigorous underlying semantics

- **A System of Systems description - cashflow coupled elements**
  - An end-to end “periodic table” view
  - Pluggable extensions within each column

- **Extends concept of publically available Reference Data**
  - Challenge in providing accurate linkages across domains
  - Ownership and identity relationships

- **Regulators will have access to information needed for this model**
  - Visibility to all participants in some domain

- **Standardized semantic and data models benefit many ( all ? ) players**
The Financial System as a “System of Systems” - data and analytics level (Periodic Table of Systemic Risk Models)

<table>
<thead>
<tr>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
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<tr>
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<td><strong>Micro economy (Financed Assets)</strong></td>
<td>Finance System securitization supply chain</td>
<td>Finance System Liquidity (Trading, Hedging, Arbitrage)</td>
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<td>FSE = Financial Services Entity (firm)</td>
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<table>
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FSE = Financial Services Entity

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Semantic / data model and data store has central role in systemic risk

Multiple SR analytics algorithms
- Competing methodologies
- General vs special purpose
- Level of granularity
- Some published, most proprietary

Systemic risk analytics need
- Training and calibration data
- Many sources of data (broad scope)
- Consistently defined data
- Explicit cross domain linkages
- Affordable cleansing/validation costs

Systemic risk users can benefit from
- a standard data model
- Shared data stores / services for generally available data

Multiple data sources
- different data domains
- different data suppliers
- some published, some is “for fee”
- generally available or private

Semantic/data model and data store
- system of systems structure
- capture and analytics intfs

Data retrieve / analytics intf
Data capture / source tagging intf

Macro (real) economy
Micro (real) economy
Instruments
Financial Service Entities
Investors

Information flow
The Systemic Risk Reference Data POC

- **POC** effort established June 2009 by IBM Research and Enterprise Data Management Council (Mike Atkin)
  - [http://www.edmcouncil.org/default.aspx](http://www.edmcouncil.org/default.aspx)

- **Participation:** ECB, Federal Reserve Bank of NY, Freddie Mac, FHFA, Morgan Stanley, Swift, Standard and Poors, Interactive Data, Algo, GoldenSource, Moodys Analytics, MITRE, Polypaths, ....
  - Weekly calls
  - All work product in open shared team room
  - Develop open semantic model term and semantic data model assets

- **Goal:** Demonstrate feasibility of creating end-to-end, explicitly linked, fine grained data capturing mortgages, pools, deals, MBS, holder and guarantor FSE’s using EDM semantics and glossary for base terms

- **Approach:**
  - Extend EDM semantic model to cover terms in selected space
  - Develop semantic data model reflecting data entities, their attributes and links
  - Validate semantic data model with feedback from
  - Generate implementation schema; populate with synthetic data – demo queries
  - Couple synthetic data – to participant risk analytics
  - Elaborate input side and data capture

- **Result:**
  - This shows that a regulatory requirement for source tagging by instrument issuers is feasible
  - It provides an example data model for a system risk facility
Overview of Mortgage Backed Securities (MBS) Model

Derivative SFI created referring to Mortgage pool slice or note of fixed size

- SFI / CDO is a derivative
- refers to / based on some set of fixed size pool tranche slices
- possibly commitment to provide or buy a mortgage pool tranche slice.. Terms
- some combining function
- SFI is security with identifier / cusip
- many SFIs could refer to slices from the same mortgage pool

From data perspective, missing reverse linkages
- Mortgage pool tranche -> mortgage loans missing
Overview of proposed POC test Data Flows and Proof of Concept Reference Data Utility Architecture

Reference Data Utility (addressing Systemic risk needs)

POC scope

Integrated workflow for Issuers and their designated agents (Underwriters, trustees, legal,..)

Dictionary updates

Semantic Fact Collection

EDC data dictionary + semantics

Offering documents

Acquire intf

Disseminate intf

Poc subset

Poc input ucs

Poc output ucs

Collection: standards, messaging, GUIs, quality control

Storage: leveraging common industry semantics

Distribution: publish & subscribe, full data downloads, ad hocQuery etc.

IBM POC RefData Implementation

IBM InfoSphere Data Architect

Logical data model

Physical data model

IBM DB2 based runtime + admin

Poc subset

IBM Banking and FM f’work

accurate and consistent access to data for all participants

Data Vendors

Clearing agents

Trading venues

Broker Dealers

Asset Servicers

Asset Managers

Individual Investors

Banks

Custodians

Public, national, international organisations

Settlement agents

Others:
- Financial press
- Journalists
- Compliance-fraud prevention

Global governmental web sites (e.g. Edgar)

Others:
- Financial press
- Journalists
- Compliance-fraud prevention

Accurate and consistent access to data for all participants

POC scope

Dictionary updates

Unified standards for data collection

Unified standards for distribution

POC subset
Status in POC “Semantic fact” repository

1. Generate physical data base schema for POC data model:
   – Translation of POC model using IBM product tools and framework

2. Automated generation of synthetic data to populate POC schema:
   – Show reports to summarize and aggregate synthetic data
   – Show data drill down capabilities and inputs available for calibrating/training analytics
   – Synthetic data includes payment histories at MBS, pool and mortgage granularity level (since this information in principle reported publically)

3. Show value of POC data in enabling predictive “what if” scenario assessment
   – Gather sample “what if” scenarios to evaluate (with synthetic data) from POC work group participants
   – Demonstrate predictive systemic risk analytics for “what if” scenarios
     ▪ With predictive analytics from POC members (IBM will provide one model set)
     ▪ Multiple specialized and proprietary predictive models expected

4. Work with data providers to replace synthetic with real data:
   – Reuse same schema, reports, predictive analytics but now with real predictions
   – May involve data cleansing, transform etc
   – Mixtures of actual and synthetic data (improved distributions) possible
   – Possibly including access controls (as required for operational repository)

5. Could evolve repository for other domains (beyond MBS) content
How complete is this data model?

- **Incremental – segment at a time -- approach necessary to capture behavior of complex financial system**
  - POC focus on Mortgages, pools, MBS, holders necessary

- **POC approach is extensible to other instrument and asset classes**
  - More complex CDOs,
  - More variable underlying asset classes, auto loans, commercial real estate
  - Full FSE ownership hierarchies
  - etc

- **General mathematical pay off function will be required for more complex instruments and derivatives**
  - Base MBS used pooling and tranching only

- **Model must be open ended and extensible**
  - Financial system will continually define novel classes of instrument and investment
  - Systemic risk regulators will capture new instruments as share of market becomes systemically significant
  - Continuous evolution

- **Approach must accommodate multiple regulatory domains**
  - Exchange of data with other regulators important
  - Clearly defined data model aids conversions
What data? Who sees it? Who benefits?

- **Reference data on instruments is in principle public / generally available**
  - If combined with ratings, valuations etc often distributed for fee
  - A standard end-to end data model needed to combine reference date from multiple sources

- **Regulators will have access to private bank and FSE holdings data (from all FSEs)**
  - Must be held securely – access controls
  - Must be correctly linked to reference data
  - Provides a start point for estimating systemic risk

- **Banks and FSEs have**
  - Detailed knowledge of their own holdings
  - Access to public reference and market data
  - Estimates of counterparty holdings

- **Underlying asset histories (e.g mortgage payment) needs privacy protection**
  - Feasible through appropriate anonymization + aggregation

- **All above parties obtain benefit from standardized semantic and data model**
  - Combining generally available data from multiple sources with private data
  - Reduce costs and improve quality of generally available reference data
  - For fee information distributors benefit from growth of “broad scope risk analytics”

- **=> Successful Systemic Risk effort must build on interests of market players**
Data for systemic Risk: summary

- **Transparency into financial systems at the transaction level is now practical**
  - Due to steady Moore’s law decrease in processing and storage costs

- **Fine grained descriptive data enables multiple risk analysis and modeling approaches**
  - A portfolio of analyses is best approach to detect incipient systemic risk
  - Fine-grained more “objective” than aggregated data; better for detecting the “next crisis”

- **Gathering high quality fine grained financial system data requires**
  - A system of systems architectural schema for the financial system
  - Data models and linkages capturing end-to-end cash flows
  - Unique identifiers for instruments, entities, assets etc
  - Standardized terms, glossaries, semantics, payout specifications – rigorous underlying semantics

- **Systemic Risk Reference Data POC demonstrates feasibility in context of MBS**
  - End to end model relating: mortgages – pools – MBS – issuer/holder
  - Model validated in discussion with industry (POC) participants
  - Illustration subset populated with synthetic data – interfacing to analytics

- **Completeness, security, privacy and openness questions**

- **Conclusions and next steps (in the regulatory context):**
  - The POC approach can be generalized and applied to broader segments of financial system
  - Continuing work on capture/input gathering side and on coupling to analytics
  - Next step: combining data and stress testing in a systemic risk cloud

- **This is an example of adapting data quality concepts in a novel context**
  - Potential for legislatively driven document originator tagging
Backup Material
High Quality data is central to systemic risk analytics

- A standard semantic and data model for financial system entities and their relationships is a key enabler for the growth and use of systemic risk analytics

- A single standardized data model will meet the analytic needs of most users and reduce data collection, cleansing and validation costs

- The semantic/data model connects:
  Financial system reference, transaction and position data from many sources and domains
  Multiple systemic risk analytic algorithms (general / specialized, public / proprietary)

- A “system of systems” component structure is used for the financial system model
  For extensibility and flexibility – novel financial instruments will always be introduced
  Defines required explicit linkages of each entity to finer grained underlying entities and data

- The semantic fact input interface and associated glossary
  Enables consistent source document tagging and data entry by domain experts
  Enables coherent aggregation of data from multiple sources and data domains
  Enables organizations to consistently extend generally available data with their private data

- The query/retrieval interface allows a variety of system analytics to use and be calibrated from financial system data combining:
  Generally available data (both for fee and published)
  Extended with restricted position data available to particular user organizations
Financial Systems may be the most complex systems we deal with

Traditionally, modeling and analysis of risk in Financial systems was attempted only with broad aggregate measures, (market indexes, weighted average coupons, …)

With steadily falling processing and storage costs (Moore’s law) …

… it is now practical to capture the state and recent history of a financial system at the transactional level using High Performance Computing (HPC)

Leading investment banks have been using intensive computing for trading risk, and, since the 2008 crisis, extending this for “broad scope” counterparty and liquidity risks

European Systemic Risk Board, US Office of Financial Research establish need for regulatory understanding of Systemic Risk

IBM Research launched a Systemic Risk Initiative in January 2009 to address this potential
  – Advance analytics relating to risk in complex systems
  – Financial system stability analysis as initial goal

This talk is on “How to gather high quality data needed for HPC systemic risk analytics”
### Holder Guarantor Matrix

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<thead>
<tr>
<th>Holder (Million)</th>
<th>VALUE</th>
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<th>GUARANTOR_12</th>
<th>GUARANTOR_13</th>
<th>GUARANTOR_14</th>
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### Diagrams

- Guaranator Matrix Visualization
- Holder Distribution
- Guarantor Contribution

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### Notes held by FSE_1

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<tr>
<th>Notes ID</th>
<th>Original Value (M$)</th>
<th>MBS ID</th>
<th>Guarantor FSE Name</th>
<th>Holder FSE Name</th>
<th>Percent of MBS</th>
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Principal Payment on MBS’s in a single deal
# Mortgages in the Pool

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