

# CRISIS

Vision, status, plans, and questions

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April 8, 2013



# Outline

- Goals and approach
- Planned and present models
- Research questions
- Bank of England's ABM requirements

# CRISIS

- Goals
  - Build tools for policy experiments for central banks
  - Model interaction between financial sector and macroeconomy
  - Create standard software library for agent-based modeling in economics and finance (core is already written).
- CRISIS is intended to be a framework
  - Open source software in MASON/Java
  - Building blocks such as contracts, price formation mechanisms
  - A collection of models rather than a particular model

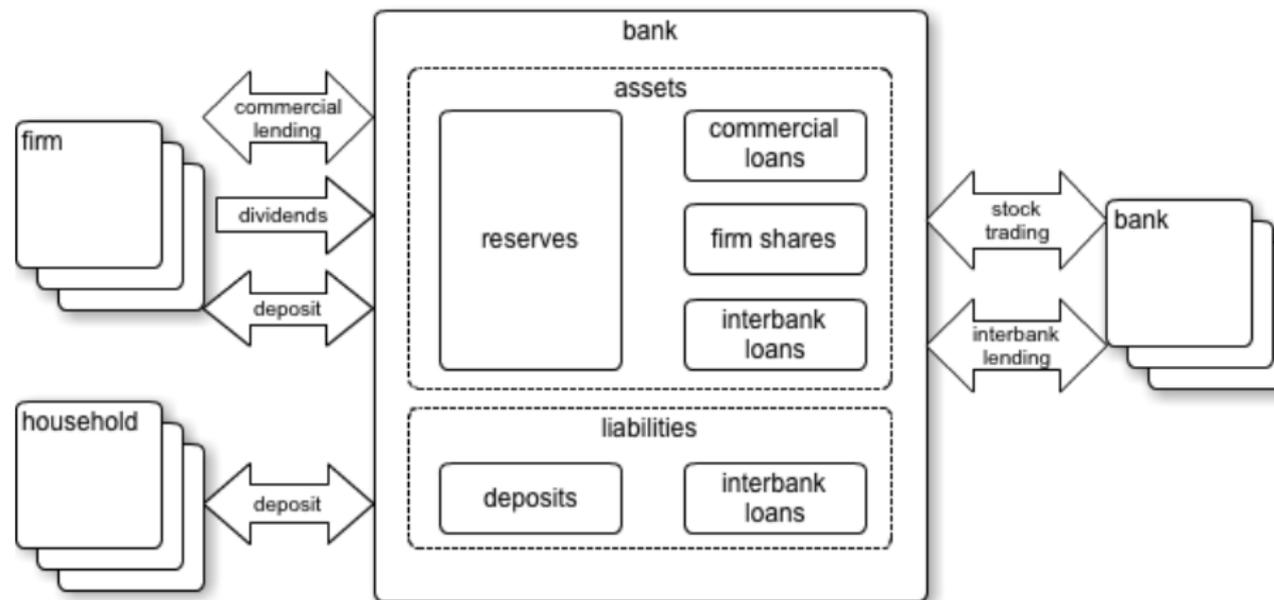
# Approach

- Build organically, starting simple and adding new components as existing components are understood.
- Validate decision rules in a variety of ways
  - Dialogue with domain experts
  - Validation with micro data
  - Economic experiments
  - Online game
  - Evolutionary experiments

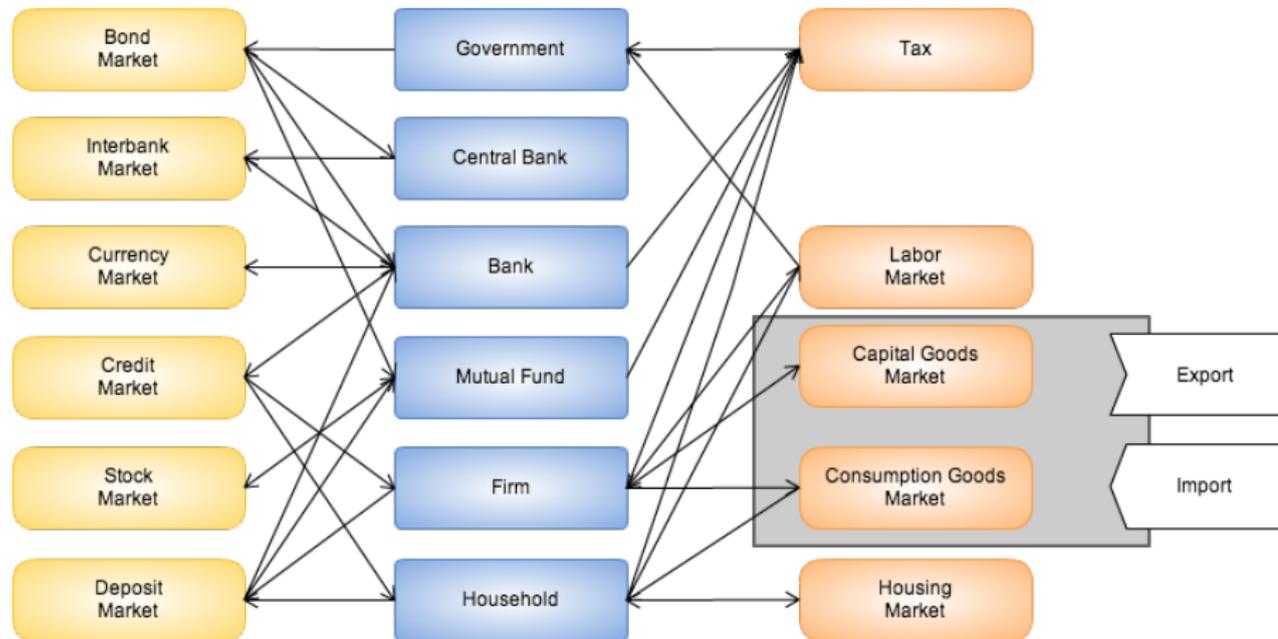
# Planned and present models

- We specify framework, not decision rules. Will build library of models within a given interaction spec.
- What we have now: Mark I macro economy with one nondurable good, Mark II financial model with competing banks.
- What we are working on:
  - Mark II real economies: capital and durable goods, alternative production functions, decision rules, . . . .
  - Closed financial system, central bank, government, bond market, enhanced households, ...
- Mark III will have elaborate financial system and real economy with multiple sectors, input-output structure.

# Mark II financial models



# Proposed model framework for Nov. 2013



# Enhancements to the agent-based models

- *Mark II macro-model design.* We need to finalize the spec for the Mark II macro model and discuss how we are going to implement it.
- *Mark III macro planning.* What will Mark III have in it?
- *Enhancements to financial model.* What enhancements do we need to the financial model and who will implement them?
- *Central bank.* The Vienna group has been leading an effort to add a central bank. They should describe this to us to solicit feedback.
- *Government.* We need to add a government that collects taxes, employs workers, issues bonds, and other functions. What features are essential? Who is going to implement this?

# Enhancements to the agent-based models

- *Labor market.* A recent paper by Guerrero and Axtell shows that the social structure of labor markets is very important.
- *Housing market.* We will soon need to add a housing market. Shall we import the model from the Washington/INET project and if so how will we do that? If not what will be do instead?
- *Foreign sector.* It is essential that we have inputs and outputs for the economy. This is actually a tricky point, as it is not clear how to make them completely exogenous, rather we need to model the supply and demand so we get a sensible production, consumption, etc. for the internal economy. We also want a concept of a foreign currency.
- *Investors.* Right now we assume that all households are workers, but as we all know, the rich behave very differently and play an important role in the economy.

# Enhancements to the agent-based models

- *Targeting a particular country?* I have proposed that we target a particular country, such as Finland. We should discuss the pros and cons of this approach and formulate a plan for making the decision.
- *Data and calibration.* What data sets will we need to calibrate the model? How will we perform the calibration? How will this affect the design of the model above?
- *Building bridges to traditional economics.* We have proposed to make one or more simple agent-based models that connect to standard economic models, such as those on which simple DSGE models are based. How do we do this?

# Interaction with non-ABM parts of the project

- *Experiments.* What is the status of current experiments? What other experiments should we consider doing? How to make use of our ability to unplug components of the model and replace by humans?
- *Complex systems analysis.* What are the plans of J-Ps group? What do we need to do to enhance interaction between J-Ps group and the modeling effort above?
- *Online game.* How do we connect the online game to developments in the model? What is current thinking about the online game? Do we have anything that can be played while at Leiden?

# Dissemination

- *Website*. What do we want to have on it? Who is the target audience? Strategy for software dissemination. When should we release our first open source version? Shall we use github?
- *Events*. What events should we plan? Do we have a final meeting similar to the one we are currently at? Should we organize a summer school in 2014? Meeting of stakeholder user group? Advisory board?
- *Book*. Shall we write a book? What publishers to approach? How do we divide the work?
- *Future proposals*. Where will we find funding to go forward beyond the three years of the project?

# Research questions

- Leverage
- Macroprudential stress testing
- Maturity transformation
- Volker rule
- Risk management policies
- Effect of central bank
- Too big to fail

# Research questions

- Quantitative easing
- Interaction of vectors of contagion
- Bailouts
- Default
- Fiscal policy
- Trust and confidence: Rational vs. emotional
- Distribution of wealth
- Market microstructure

# Bank of England: Understanding the effects of macroprudential capital tools on financial stability and the macroeconomy

The Financial Policy Committee is seeking directive powers over leverage ratios, sectoral capital ratios (i.e. capital charges corresponding to particular sectors of the economy), and a counter-cyclical capital buffer for financial institutions as instruments to enhance the resilience of the UK financial system (see Bank of England (2011, 2012)). Our objective is to understand the likely effects of these instruments on key economic outcomes of interest including (1) systemic risk (i.e. probability of systemic crises), (2) the supply of credit to the real economy, and (3) long-term economic growth.

We require a model environment with which to understand the effects of the macroprudential tools proposed by the FPC. The model should deliver insights into the causal mechanisms at work in determining likely outcomes of interest. The outputs of the model should be intelligible and amenable to interpretation by policymakers who, for example, would want to know why a particular outcome arose. For example, suppose the model suggested that a  $x\%$  increase in leverage ratios would reduce the probability of a systemic crisis by  $y\%$ . We would need to

- be able to understand the mechanisms at work in delivering this outcome;
- be satisfied that the model possessed some form of predictive validity
- be able to gain a clear sense of the sensitivity of the key results to parameter values, changes in modelling assumptions, agent behaviour, etc (i.e. perform sensitivity analysis).

# Bank of England: Model Structure

We would propose starting with as simple a model as possible, limiting the number of moving parts to those that are absolutely essential to studying the causal mechanisms at work. Ideally, the model would be parsimoniously calibrated and be amenable to studying the effects of variation in different types of behaviour and different policy stances. We do not propose strong constraints on your modelling approach, but as a guide, it would be useful if any model contained, at a minimum:

# Bank of England requirements

- Banks, subject to regulatory intervention by a macroprudential authority, which make loans to different sectors of the economy (e.g. households, firms, other banks, and foreign borrowers), and which raise funds from other agents in the economy (eg household savers and a foreign sector);
- Other foreign banks which may not be subject to FPC regulatory intervention (and therefore a potential source of leakage);
- A network of inter-bank connections amenable to simple calibration;

# Bank of England requirements

- Borrowers (e.g. households, firms, other banks, foreign sector) who borrow to finance some activity (e.g. house purchases, production) and face a default decision which could impose losses on banks.
- A risk-return framework for banks, with different sectors representing varying degrees of riskiness for banks (potentially related to the default decision of borrowers);
- Bank creditors (e.g. household savers, other banks), who decide how much funding to grant banks, and whether or not to roll it over each period.

# Bank of England: Definition of policy variables

The policymaker would control each financial institutions:

- Leverage ratio = Total Bank Loans / Bank equity capital;
- Countercyclical Capital Buffer = Bank equity capital / Total Bank Loans weighted by the riskiness of different sectors according to risk weights chosen by the macroprudential authority;
- Sectoral Capital Buffer = Risk weights for sector  $x$  (which would require more capital to be held against exposures to sector  $x$ );

# Bank of England: Exogenous shocks

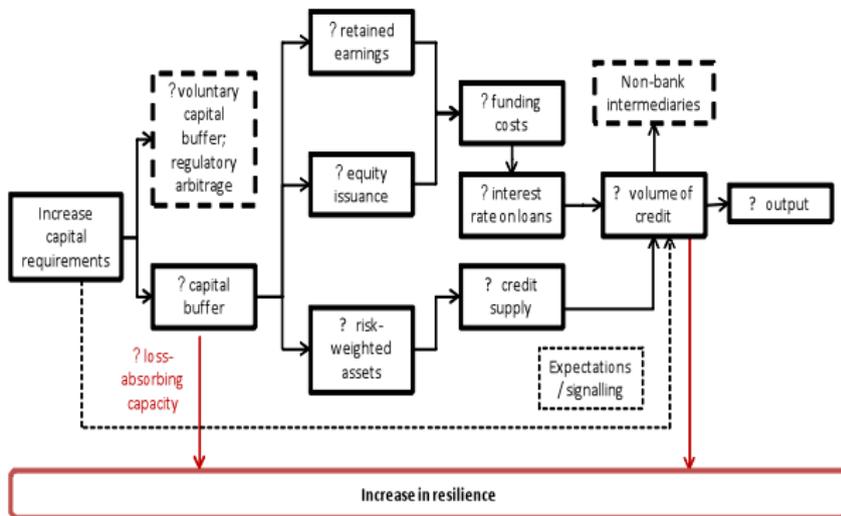
The model could include various sources of shocks, possibly including

- Shocks to the willingness/ability of borrowers of different classes to re-pay bank loans;
- Shocks to bank equity capital;
- Shock to bank funding costs;
- Shocks to the foreign sector;
- Shocks to sectoral returns;

# Data Bank of England has

- Large exposures data. Used to calibrate a network of inter bank exposures for use in network models;
- Panel dataset of UK banks balance sheet lending decisions, capital requirements, and profit/loss flows, at a quarterly frequency dating back to c.1992;
- Detailed bank balance sheet data collected from banks published accounts used in the Bank of Englands RAMSI stress testing model (see references below).

# Transmission map



# Proposed model framework for Nov. 2013

