

# Macroeconomic Modeling of Financial Intermediation: A Review of Tools Used at the Federal Reserve Board and Their Relation to Ongoing Research

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These slides present the author's perspective on ongoing research related to macroeconomic modeling.  
The views expressed herein are solely the author's, and do not reflect those of the Federal Reserve Board or its staff

# Macroeconomic Models at the Federal Reserve Board

- Staff at the Federal Reserve use many “models”
- “Models” are used in a wide variety of contexts
- Perhaps most importantly, “models” are tools that are widely used, but no single model “rules the day”, and model results are just one input into forecasting and policy analysis
- In the remainder of this presentation, I will mainly focus on “structural” macroeconomic models used for forecasting and policy analysis, with a tilt toward models that address issues related to financial intermediation
  - I will focus (almost) exclusively on models used at the Federal Reserve or other central banks, either systematically or on certain projects (including research projects)
  - As a result, this review of models leaves out many important academic contributions that have helped shape the approaches taken by researchers at central banks

# Macroeconomic Models at the Federal Reserve Board

- Staff at the Federal Reserve use many “models”
  - Simple-to-complex time series models
  - Small, “semi-structural” models capturing key relationships that can bring out the intuition behind results (e.g., Fuhrer-Moore (1995), Rudebusch-Svensson (1999) models)
  - A mix of calibrated/estimated dynamic general equilibrium models (e.g., like EDO (Edge, Kiley, Laforte (2008), Chung, Kiley, Laforte (2010) and SIGMA (Erceg, Guerrieri, and Gust (2006))
  - Larger “structural” models (FRB/US (Brayton and Tinsley (1997))

# Macroeconomic Models at the Federal Reserve Board

- “Models” are used in a wide variety of contexts
  - To assist staff analyses and research of monetary policy issues, including
    - The production of forecasts
    - The estimation of latent variables (e.g., “the output gap”, “the state of the business cycle”)
    - The assessment of the effects of monetary policy strategies
  - To analyze the implications of other policies (e.g., fiscal policies). Such analyses
    - Aid monetary policy analyses, contribute to public discussions of the effect of such actions, and engage related research
    - Examples: Elmendorf and Reifschneider (2002), Coenen et al (2012)
  - To analyze issues related to financial stability
    - The use of “macroeconomic” models to consider issues related to financial stability is increasing, and basic research is a significant part of these analyses
    - Example: Macroeconomic Assessment Group reports (BIS (2010))

# Structural Macroeconomic Models: A Review of Common Approaches

- A variety of “structural” models are used for forecasting and policy analysis
- Financial conditions in a large number of central bank models share a Neoclassical view of financial conditions (as discussed in Boivin, Kiley, and Mishkin (2011))

<b>Small, Semistructural (many examples, e.g., Fuhrer and Moore (1995))</b>	<b>FRB/US (Brayton and Tinsley (1997))</b>	<b>EDO (Edge, Kiley, Laforde (2008), Chung, Kiley, Laforde (2010))</b>	<b>SIGMA (Erceg, Guerrieri, Gust (2006))</b>
Loosely motivated equations	Equations reflect explicit dynamic adjustment problem	DSGE model, firm/household optimization (specific functional forms)	DSGE model, firm/household optimization (specific functional forms)
Perhaps an IS curve, Phillips curve, and interest rate rule	Very large (hundreds of equations)	Medium-sized (less than 100 equations)	Multicountry versions can be very large -- medium/small per country
Rational expectations	Reduced-form or Rational expectations	Rational expectations	Rational expectations
Neoclassical view of financial conditions (EH)	Largely Neoclassical view of financial conditions	Largely Neoclassical view of financial conditions	Largely Neoclassical view of financial conditions
Frictionless financial intermediation	Largely frictionless financial intermediation, exog. risk premiums	Largely frictionless financial intermediation, exog. risk premiums	Largely frictionless financial intermediation, exog. and endog. risk premiums



# Incorporating Financial Frictions into Macroeconomic Models – Exogenous Shocks

- Fluctuations in financial frictions play a key role in how policy models are used
  - In EDO, exogenous fluctuations in a risk premium account for the lion's share of macroeconomic fluctuations
  - In SIGMA, key risks from international conditions often are modeled as exogenous fluctuations in a risk premium (for example, on dollar assets (e.g., flight-to-safety movements) or foreign private-sector borrowing rates)
- Emphasis on exogenous movements in risk premiums reflects both the simplicity of the models and the fact that amplification of other shocks through fluctuations in risk premiums is often moderate (or less) in such models (e.g., Boivin, Kiley, and Mishkin (2011))
- Modeling of exogenous risk premiums – some exogenous factor ( $X(t)$ ) that drives a wedge between the return on a risk-free asset and the return to investors in a private asset (e.g., physical capital, residences, consumer durables).
  - Example: Smets Wouters (2007) risk-premium shock (e.g., most important shock in EDO)
$$1 = E_t M(t+1)R(t+1)X(t+1)$$
  - Increase in risk premium leads to lower consumption and investment

# Incorporating Financial Frictions into Macroeconomic Models – Endogenous Frictions

- Frameworks popular for modeling behavior of households or nonfinancial firms
  - Collateral Constraints (e.g., loan-to-value constraints for housing, Iacoviello (2005)). Debt must be less than some fraction of the market value of an asset.

$$B(t) \leq \mu Q(t)K(t)$$

- A tighter collateral constraint – reflecting, for example, a decline in asset values ( $Q(t)$ ) or exogenous shocks to collateral constraint ( $\mu$ ) (i.e., change in loan-to-value required, etc.)
  - depresses investment and consumption by the constrained household
- Financial Accelerator (e.g., Bernanke-Gertler-Gilchrist (1999)). Debt financing limited by net worth of borrower

$$1 = E_t (M(t+1)R(t+1))$$

$$Q(t) = E_t \left( \frac{M(t+1)}{X(t+1)} (MPK(t+1) + Q(t+1)) \right)$$

$$E_t X(t+1) = F \left( \frac{N(t+1)}{Q(t)K(t+1)} \right)$$

- A decline in asset values boosts spread ( $X$ ), lowers investment; similar implications for some exogenous shocks, such as an increase in idiosyncratic risk of investment projects

# Incorporating Financial Frictions into Macroeconomic Models – Intermediation

- Extensions to models of intermediation
  - Use models of frictions for nonfinancial firms to think about intermediaries
  - Example: Impose a capital/leverage constraint on intermediaries, much in the same way an exogenous collateral constraint might be imposed, to think about influence of balance sheet conditions for macroeconomic outcomes
- Such extensions need to think about special features of intermediaries. For example, intermediaries
  - Finance investment and provide liquidity services
  - Have access to cheap debt-like financing because of liquidity services associated with deposits/short-term liabilities, taxes, or other features – creating high leverage
  - Engage in maturity transformation – financing long-term investment (lending) using short-term liabilities



# Incorporating Financial Frictions into Macroeconomic Models – A Model of Intermediation

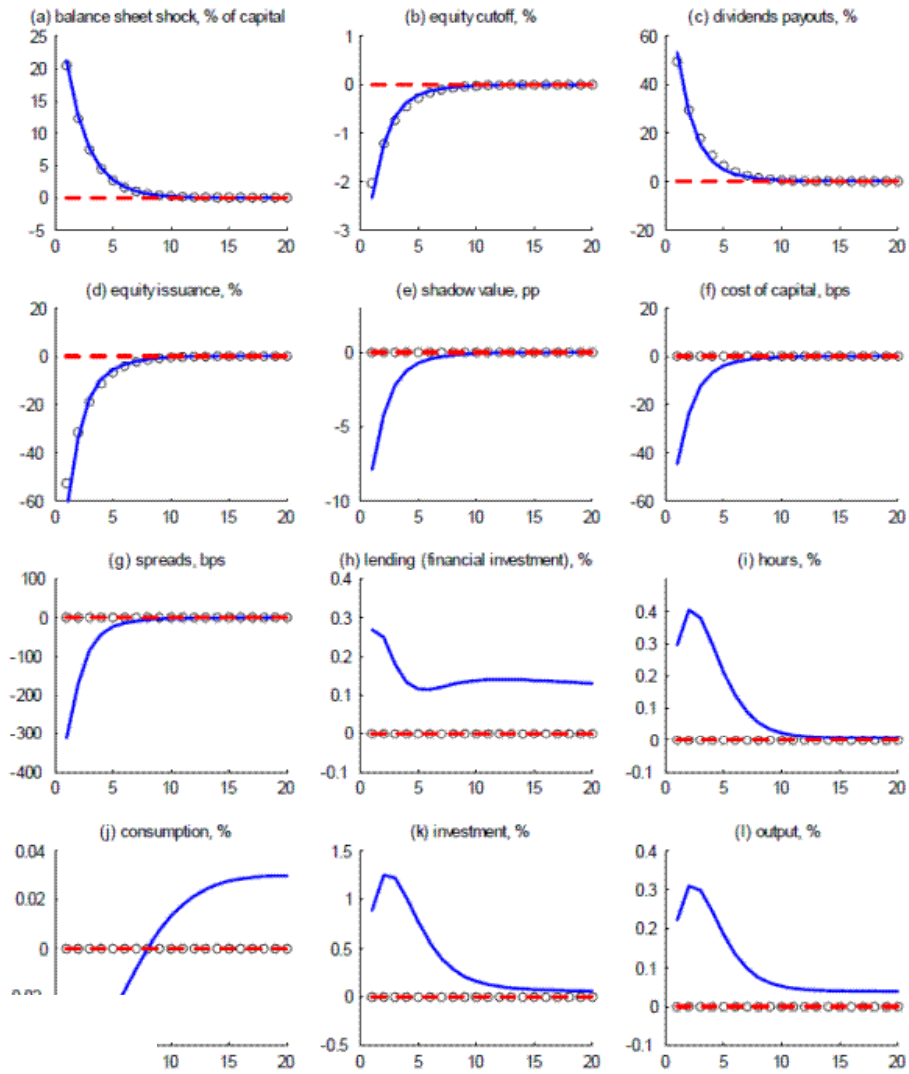
- A model of intermediaries in the presence of financial frictions (Kiley and Sim (2011), (2012))
  - **Intermediaries are essential** – households direct investment activities through intermediaries
  - **Debt financing is cheap** (liquidity services, tax preference), but bankruptcy is costly (limited recovery)
  - Internal funds cheaper than external funds (e.g., **costly to issue equity**)
  - **Maturity mismatch** – timing of returns creates funding risk, yielding time-variation in the value of cash on the balance sheet and hence willingness to lend (precautionary behavior)
  - Implications: **Capital policy** that trades off benefits of debt financing and the risk of having to raise external funds
- Key equation and implications: Pricing equation for lending rate
  - $M(t+1)X(t+1)$  is the stochastic discount factor of the intermediaries, which prices assets throughout the economy as household savings are channeled through intermediaries

$$1 = E_t M(t+1)R(t+1)X(t+1)$$

- Similar to He and Krishnamurthy (2010), who assume risk-averse intermediaries
- Precautionary behavior of intermediaries reflects mis-match between assets and liabilities – lending commitments that cannot be unwound in response to changes in value of assets
- Key role for “willingness to lending” (e.g., Lown and Morgan (2006))

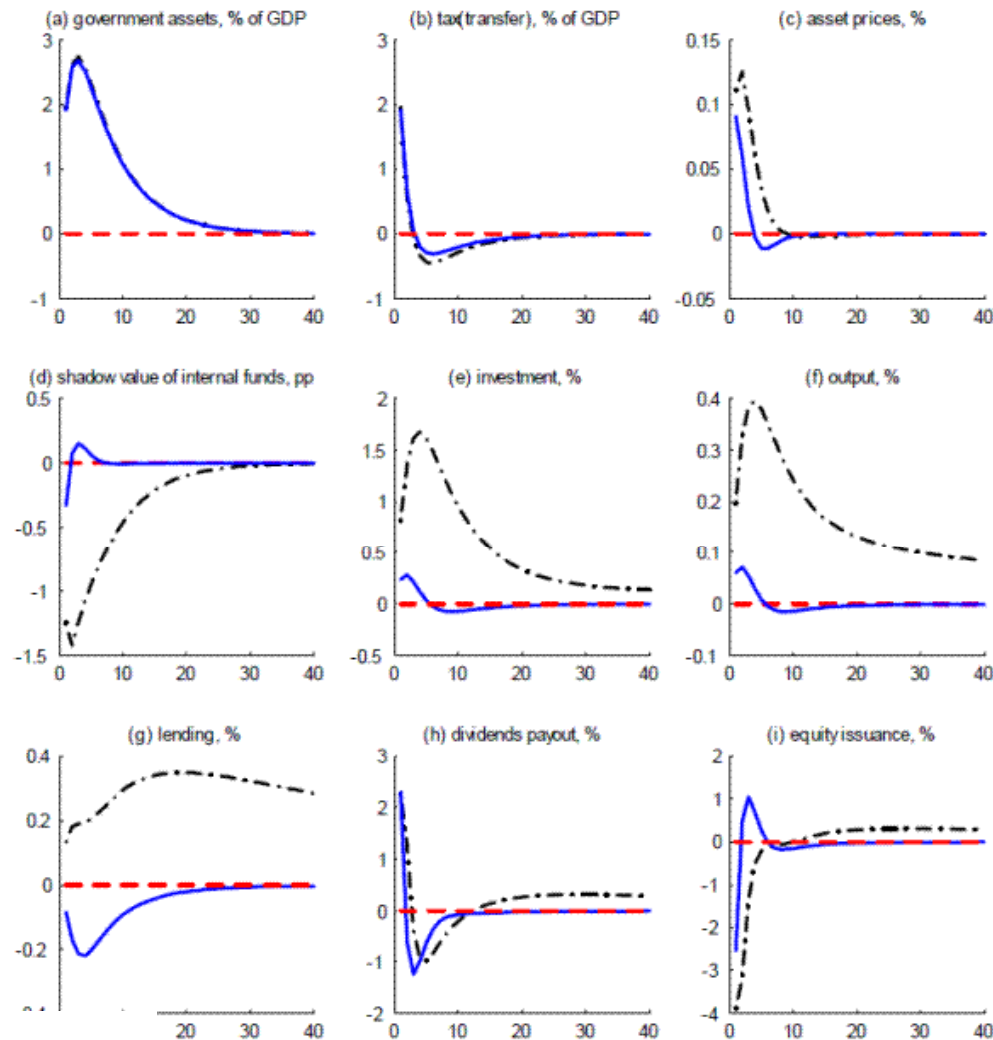
# Incorporating Financial Frictions into Macroeconomic Models – Some Model Implications

- **Willingness to lend** is adversely affected by any adverse shift in balance sheet condition/risk



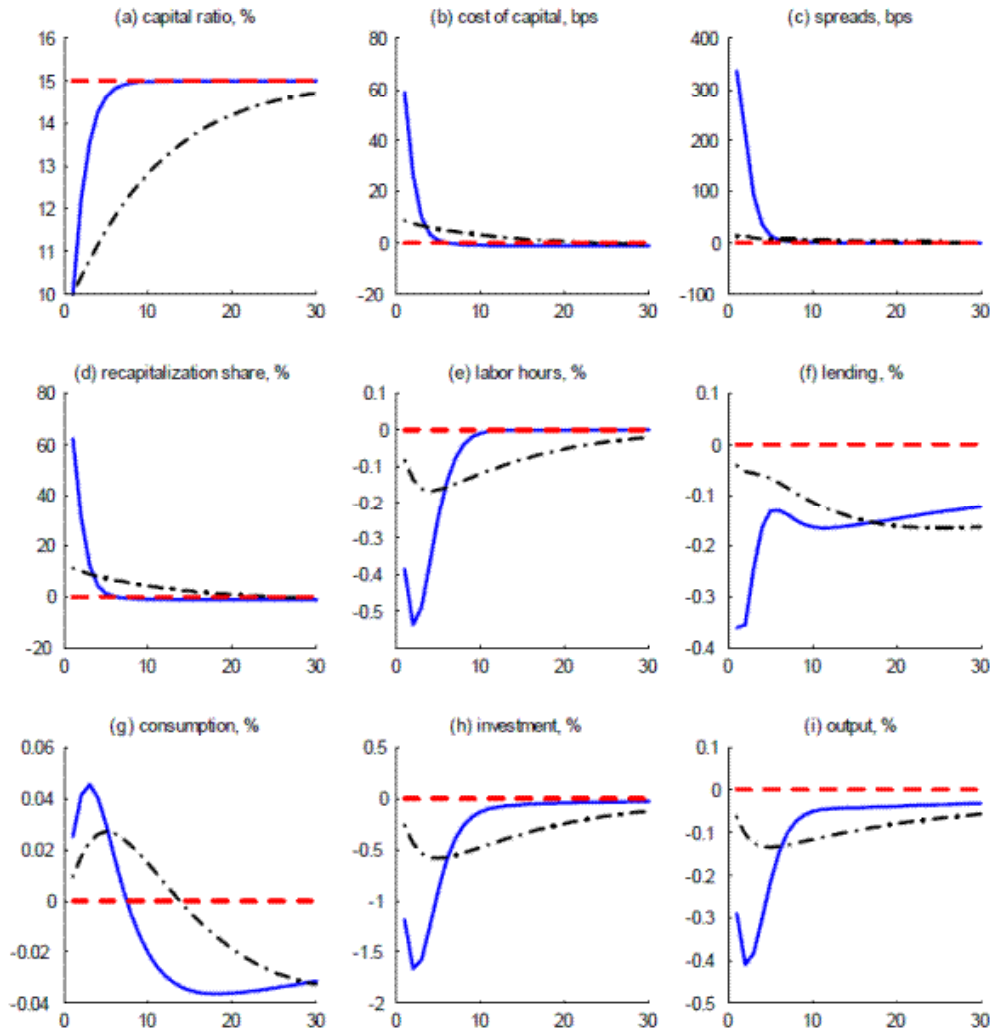
# Incorporating Financial Frictions into Macroeconomic Models – Some Model Implications (2)

- **Crisis policies** – capital injections differ from asset purchases because of *crowding out*



# Incorporating Financial Frictions into Macroeconomic Models – Some Model Implications (3)

- **Transition to Basel 3** – slow transition may lower transition effects by facilitating capital accretion using internal funds



# Incorporating Financial Frictions into Macroeconomic Models – Further Examples

- Crisis policies such as
  - Capital injections vs. asset purchases (Kiley and Sim (2011, 2012))
  - Government-financed intermediation (Gertler and Karadi (2011,2012))
- Implementation of Basel 3 (BIS (2010), Kiley and Sim (2011))
- Research questions relating to macroprudential regulation
  - Stabilization properties of policies that adjust capital requirements in response to credit indicators (e.g., Christensen, Meh, and Moran (2011))
    - This research investigates questions raised by, for example, the Basel 3 countercyclical capital buffer proposals from the BIS (for a discussion and references, see Edge and Meisenzahl (2011))
    - Examine alternative macroprudential approaches – e.g., leaning against financing spreads (Kiley and Sim (2012))
  - Cyclical adjustment of loan-to-value ratios
    - Leaning against the wind through LTV adjustments may ameliorate housing cycles (Lambertini et al (2011))

# Incorporating Financial Frictions into Macroeconomic Models – Some Important Challenges

- Asset prices don't move a great deal in response to many shocks in dynamic general equilibrium models
  - Amplification of shocks through financial frictions requires significant asset price movements
  - Therefore, models rely on large, exogenous fluctuations
  - As a result, macro models may not provide a lot of insight into emerging fragility – that is, how seemingly small shocks may lead to significant fluctuations
- Models typically only model a small degree of heterogeneity and of financial flows
  - Example: Models in which intermediation is essential often ignore or have trivial treatments of equity and debt financing by nonfinancial firms
- Macro models typically ignore interconnectedness and importance of large institutions
  - Network approaches are not intertwined with dynamic macro model agenda to date
- Models are importantly shaped by issues related to tractability
  - Models are typically small
  - Models are most often solved via perturbation methods – highly nonlinear aspects (e.g., an occasionally binding constraint, or dynamics not easily captured by a local approximation) are therefore not considered

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