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Macroeconomic Modeling of Financial Frictions for Macroprudential Policymaking: A Review of Pressing Challenges

Michael T. Kiley[1]

Structural macroeconomic modeling plays a central role economic policy discussions. Over the past fifty years, the overwhelming majority of such efforts have focused on the structural features of household, firm, and government behavior that lead to cyclical fluctuations in employment and inflation and the roles of monetary and fiscal policy in ameliorating undesirable volatility in economic performance. In recent years, the potential role of *macroprudential policies* in limiting excessive volatility in the financial sector and the consequent effects on economic performance has risen to the fore in academic and policy discussions. While progress in modeling for macroprudential policy analysis has been substantial, there remain many important challenges, and consensus on a core modeling framework remains far away. This note reviews some of the progress witnessed in recent years and challenges that remain.

The consensus modeling framework at central banks

At the Federal Reserve, macroeconomic modeling efforts since the 1960s led to the development of models that captured the central views of macroeconomic thought during their time, including the development of the MPS model from the late 1960s through the early 1980s, the FRB/US model in the 1990s, and dynamic-stochastic-general-equilibrium (DSGE) models in the 2000s. While there has been significant evolution in the structure of these models--and in particular in the modeling of household and firm expectations for future income, inflation, and policymaker behavior, the core elements of all of these models are very similar. Nominal price and wage rigidities contribute to inefficient volatility in economic activity. Household spending is determined by current income, expected future income, and financial conditions, including household wealth and the term structure of interest rates. Spending on productive capital (investment) and the employment decisions of firm are determined by current demand and assessments of the relative payoff to investments in capital vs. returning a firm's earnings to its shareholders (as captured in neoclassical theories of investment in the "user-cost" and "Q" traditions). As a result of these similarities, the channels through which monetary policy can contribute to economic stability are broadly similar across modeling frameworks: Anchoring inflation expectations through a commitment to an inflation target lowers volatility in financial conditions and hence in economic activity and inflation, while countercyclical adjustments in nominal interest rates lead to changes in household wealth, the financing conditions facing firms, and the exchange value of the dollar that contribute to stability in employment and inflation. The channels through which fiscal policy adjustments may stabilize economic performance are also broadly similar across these modeling frameworks.[2] Moreover, these common features and properties are also shared by models used at many central banks around the world.

Missing features

This high level review of modeling frameworks has not mentioned a number of central features of macroeconomic analysis. The notion that maturity transformation by financial intermediaries leaves such institutions vulnerable to runs and that such runs may cause severe contractions in economic activity, as observed in the Panic of 1907, the Great Depression, the recent global financial crisis, and scores of other examples, has not traditionally been an element of macroeconomic models. Neither has the idea that large, unexpected losses on assets held by financial institutions may lead them to reduce their willingness to intermediate, contributing to a decline in asset valuations via fire sales, a contraction in economic activity, and low inflation; nor has the possibility that constraints on household leverage associated with mortgage borrowing and swings in real estate valuations may lead to a sharp contraction in household spending should such leverage constraints bind severely.

Macroeconomic models are necessarily simplifications of reality, and the omission of these factors is understandable (as many of these factors arguably played only a small role in economic fluctuations in the decades prior to the recent financial crisis). And some key policy implications of macroeconomic models have, at least in research so far, proven largely robust to the inclusion of these considerations: For example, the central role of price stability in defining good monetary policy within DSGE models is shared by many such models when leverage constraints on intermediaries or households are incorporated.[3] But it is clear that consideration of these issues is important when thinking about *macroprudential policy questions* such as

- To what degree have higher capital requirements for banks (such as those associated with Basel 3) increased the resilience of the financial sector and contributed to greater economic stability going forward?
- How might cyclical adjustments in macroprudential instruments such as the countercyclical capital buffer or maximum loan-to-value ratios on mortgage loans mitigate undesirable boom/bust credit cycles?
- How do the higher capital and liquidity requirements for financial intermediaries interact over the business cycle? To what extent are such regulations complements (or substitutes)?[4]

Moreover, addressing such questions requires moving beyond the now-standard incorporation of frictions in nonfinancial firm financing conditions via simple financial-accelerator mechanisms.[5]

Progress to date

Incorporating bank leverage

DSGE models with leveraged financial intermediaries have been considered in a large number of recent academic and central bank research studies. Many of these analyses share a number of features: The leverage of financial intermediaries is limited through some combination of regulatory constraints or market discipline (where the latter typically is some form of participation constraint imposed by investors in bank debt as part of the debt contract between banks and investors); equity is more costly than debt and these leverage constraints are binding at all times, with the latter assumption often made for analytical tractability; and intermediaries are essential in the sense that households have limited ability to directly finance nonfinancial firms.[6]

Some very preliminary policy lessons have been drawn from such exercises. Owing to incentives of financial institutions to assume excessive leverage related to implicit or explicit subsidies (related to taxes, potential bailouts), misalignment of incentives between managers and shareholders, or pecuniary externalities through which intermediary leverage affects movements in market prices, capital requirements substantially above pre-crisis norms likely contribute to economic welfare.[7] While this result is reminiscent of the notion that higher capital requirements are likely to reduce the probability of banking system crises, macroeconomic models typically do not directly consider the possibility of such "nonlinear" events, reflecting both modeling conventions and computational considerations.[8] For example, macroeconomic models contemplating the role of bank capital requirements may include spillovers from distress at institutions on the broader system through pecuniary externalities, but models typically abstract from considerations related to failure of large institutions on other institutions through network linkages. On the computational front, it remains challenging to model the interaction of aspects of the distribution of capital and risks across the financial system and macroeconomic risks, and occasionally-binding leverage constraints on banks or households are often not considered.[9]

An exception to this characterization is the model of Brunnermeier and Sannikov (2014), who study the global dynamics of a stylized model in which leveraged investments in productive capital lead to highly nonlinear equilibrium dynamics of two types. First, large shocks that depress net worth of borrowers have much larger depressing effects on asset prices and investment than large shocks increasing net worth; these dynamics highlight how incorporation of exogenous changes in the volatility of shocks in models approximated via perturbation methods, as in some recent efforts to capture Great-Recession dynamics, are incomplete. Second, the global solution to the model involves an endogenous distribution of borrower net worth in which a period of low volatility leads borrowers to become highly levered, and this high leverage implies that even small adverse shocks can have large adverse consequences; in other words, the model captures a stylized version of the idea that low exogenous risk may contribute to the buildup of endogenous risk, potentially leading to a crisis. Incorporation of such dynamics into the types of DSGE models used for policy analysis has been limited, although efforts to pull insights from the quantitative general-equilibrium literature on "sudden stops" captures some of these ideas and may provide quantitative guidance for macroprudential modeling efforts.[10]

Turning to business cycle implications of more traditional DSGE models, higher capital requirements for intermediaries--within the range considered in policy debates--have very modest effects on macroeconomic volatility; that is, the increase in banking sector resilience that is associated with greater loss absorbing capacity has very little effect on the degree to which adjustments in bank leverage following shocks amplify the macroeconomic consequences of such shocks in several models developed to date. This result is reminiscent of the limited degree of endogenous amplification associated with financial accelerator mechanisms found in some previous studies, and it is not clear whether capturing more nonlinear mechanisms would enhance amplification and the role of intermediary leverage in the transmission of shocks in a manner more similar to the framework of Brunnermeier and Sannikov (2014). As a result, computational advances related to the solution and estimation of models capturing potential nonlinearities, including (but not limited to) a number of occasionally binding constraints, is a promising direction.[11]

Housing and the role of loan-to-value ratios

Incorporation of a leverage constraint in which households borrow against housing collateral has become common, most typically building off the framework developed by Iacoviello (2005). An important recent strand of work analyzes the nonlinear effects of house prices in such a framework. When homeowner wealth is high owing to high housing prices, the borrowing constraint facing borrowers is relatively slack and such borrowers behave more like "permanent-income consumers". In contrast, a collapse in housing prices makes the borrowing constraint bind tightly, limiting the ability of households to smooth consumption and making household spending more sensitive to shocks. Guerrieri and Iacoviello (2014) estimate that these nonlinear effects may account for the very sharp decline in spending in the U.S. Great Recession.

Modeling of such transmission channels seems especially important in light of evidence that loan-to-value ratios may be an effective macroprudential tool with which to lean against housing cycles.[12]

Liquidity transformation

The emphasis in the modeling frameworks discussed so far has been on the potential for household or intermediary leverage to amplify the transmission of shocks to macroeconomic activity and the role of regulations in shaping these responses. And the collapse in house prices and the losses on intermediary balance sheets contributed to the contraction in credit supply and therefore were important factors shaping to the Great Recession. But an equally important dynamic, at least in some narratives, was the "run" on the financial system (e.g., Gorton and Metrick, 2012). The economic mechanisms at play are familiar from Diamond and Dybvig (1983): Intermediaries issued liabilities that were redeemable in the short run, but backed by long-term assets which--should a run occur--could only be sold at a discount determined endogenously; in such conditions, a coordinated run by "depositors" may emerge as an equilibrium if conditions support a sufficiently low fire-sale price for the intermediaries' assets.

To date, few DSGE models incorporate such mechanisms. One factor limiting progress has been the fact that the existence of a run equilibrium often coincides with an equilibrium in which no run occurs, and typical DSGE computational techniques do not incorporate potential switches between alternative equilibria as a source of financial and economic fluctuations.[13] Gertler and Kiyotaki (2015) is one example integrating a bank-run equilibrium into a DSGE model. However, their analysis is not of economic fluctuations, but rather focuses primarily on the conditions that may allow a run as an equilibrium. This partial step forward does have some intuitive policy-related payoffs: For example, a bank run equilibrium is less likely if capital at intermediaries is high, as in this case the ratio of runnable liabilities to illiquid assets is lower and hence the equilibrium fire-sale price of such assets is higher, limiting the possibility of a run equilibrium.

Pulling together the pieces

This review has highlighted substantial progress. Several areas appear ripe for greater integration.

Many of the models discussed that analyze macroprudential issues abstract from price and wage rigidities. This abstraction creates challenges. First, the qualitative properties of models with and without nominal price and wage rigidities in response to shocks can differ substantially from that of models with such nominal frictions; in certain cases, the responses of the economy to shocks can have opposite signs depending on whether the model does or does not have nominal price rigidities, and a model's properties need not approach the "flexible price" version as price rigidities approach zero.[14] Moreover, such models cannot consider the interaction of monetary policy and macroprudential policies.

More generally, many contributions focus on one set of financial frictions and do not consider their interaction or relative quantitative importance. Guerrieri and Iacoviello (2015) consider an occasionally-binding constraint on household borrowing and the role of the fluctuations in house prices; Kiley and Sim (2015) and Iacoviello (2015) model leverage constraint on intermediaries and the role of shocks to this constraint in fluctuations in credit supply and economic activity; Lindé, Smets, and Wouters (2016) estimate a model with financial accelerator mechanisms facing nonfinancial firms and changes in the volatility of shocks. Each of these frictions is plausible. Nut the quantitative findings in such studies likely depend importantly on the fact that each study focuses on an individual friction: For example, Guerrieri and Iacoviello (2014) attribute a large share of the decline in activity to the decline in house prices and the effects of the zero-lower bound on nominal interest rates; Iacoviello (2015) attributes roughly equal shares of the decline in output during the Great Recession to the losses born by banks and the effect of falling house, but does not consider the effect of the zero-lower bound because the model has no nominal rigidities; Lindé, Smets, and Wouters (2016) attribute a large share of the decline to a tightening in the credit frictions facing nonfinancial firms and the zero-lower bound. Such findings probably stem from each studies focus on one friction, and seem unlikely to be robust to examination of multiple frictions within the same model.

Developing such complicated models will be difficult, as computational issues arise and the data may not be especially informative about key parameters. For this reason, macroprudential policy discussions may be increasingly informed by macroeconomic models in coming years, but microeconomic analyses of the distortions in individual markets and the policy actions that can mitigate such distortions will likely remain central.

References

Akinci, Ozge and Ryan Chahrour, 2015. "Good News Is Bad News: Leverage Cycles and Sudden Stops." Federal Reserve Bank of New York Staff Reports, no. 738, September.

Akinci, Ozge and Jane Olmstead-Rumsey, 2015. "How Effective are Macroprudential Policies? An Empirical Investigation." Board of Governors of the Federal Reserve System, International Finance Discussion Papers Number 1136, May.

Angelini, Paolo & Laurent Clerc & Vasco Cúrdia & Leonardo Gambacorta & Andrea Gerali & Alberto Locarno & Roberto Motto & Werner Roeger & Skander Van den Heuvel & Jan Vlcek, 2015. "Basel III: Long-term Impact on Economic Performance and Fluctuations," Manchester School, University of Manchester, vol. 83(2), pages 217-251, 03.

Begenau, Juliane. "Capital Requirements, Risk Choice, and Liquidity Provision in a Business Cycle Model." Harvard Business School Working Paper, No. 15-072, March 2015. (Revised November 2015.)

Bernanke, Ben S. & Gertler, Mark & Gilchrist, Simon, 1999. "The financial accelerator in a quantitative business cycle framework," in: J. B. Taylor & M. Woodford (ed.), Handbook of Macroeconomics, edition 1, volume 1, chapter 21, pages 1341-1393.Elsevier.

Blanchard, Olivier, 2014. Where Danger Lurks. Finance & Development, September, Vol. 51, No. 3.

Blanchard, Olivier, 2015. "Rethinking Macro Policy: Progress or Confusion. Chapter 28 in Progress and Confusion: The State of Macroeconomic Policy (MIT Press, 2016).

Boivin, Jean & Kiley, Michael T. & Mishkin, Frederic S., 2010. "How Has the Monetary Transmission Mechanism Evolved Over Time?," in: Benjamin M. Friedman & Michael Woodford (ed.), Handbook of Monetary Economics, edition 1, volume 3, chapter 8, pages 369-422, Elsevier.

Brayton, Flint, Thomas Laubach, and David Reifschneider, 2014. "The FRB/US Model: A Tool for Macroeconomic Policy Analysis," FEDS Notes, April.

Brayton, Flint and Eileen Mauskopf, 1985. "The Federal Reserve Board MPS Quarterly Econometric Model of the U.S. Economy," Economic Modelling, vol. 3 (July), pp. 170-292.

Coenen, Günter, Christopher J. Erceg, Charles Freedman, Davide Furceri, Michael Kumhof, René Lalonde, Douglas Laxton, Jesper Lindé, Annabelle Mourougane, Dirk Muir, Susanna Mursula, Carlos de Resende, John Roberts, Werner Roeger, Stephen Snudden, Mathias Trabandt and Jan in't Veld., 2012. "Effects of Fiscal Stimulus in Structural Models." American Economic Journal: Macroeconomics, 4(1): 22-68.

Congressional Budget Office, 2012. Report on the Troubled Asset Relief Program--October 2012.

Dagher, Jihad, Giovanni Dell'Ariccia, Luc Laeven, Lev Ratnovski, and Hui Tong, 2016. "Benefits and Costs of Bank Capital" IMF Staff Discussion Note, March, International Monetary Fund.

Diamond, Douglas W & Dybvig, Philip H, 1983. "Bank Runs, Deposit Insurance, and Liquidity," Journal of Political Economy, University of Chicago Press, vol. 91(3), pages 401-19, June.

Erceg, Christopher J. & Luca Guerrieri & Christopher Gust, 2006. "SIGMA: A New Open Economy Model for Policy Analysis," International Journal of Central Banking, International Journal of Central Banking, vol. 2(1), March.

Gertler, Mark & Kiyotaki, Nobuhiro, 2010. "Financial Intermediation and Credit Policy in Business Cycle Analysis,"in: Benjamin M. Friedman &

Michael Woodford (ed.), Handbook of Monetary Economics, edition 1, volume 3, chapter 11, pages 547-599 Elsevier.

Gertler, Mark & Nobuhiro Kiyotaki, 2015. "Banking, Liquidity, and Bank Runs in an Infinite Horizon Economy," American Economic Review, American Economic Association, vol. 105(7), pages 2011-43, July. Guerrieri, Luca, and Matteo Iacoviello, 2015. "Occbin: A Toolkit to Solve Models with Occasionally Binding Constraints Easily," Journal of Monetary Economics, March, vol. 70, pp. 22-38.

Gorton, Gary & Metrick, Andrew, 2012. "Securitized banking and the run on repo," Journal of Financial Economics, Elsevier, vol. 104(3), pages 425-451.

Guerrieri, Luca, and Matteo Iacoviello, 2014. "Collateral Constraints and Macroeconomic Asymmetries," International Finance Discussion Papers 2013-1082, Board of Governors of the Federal Reserve System.

Guerrieri, Luca, and Matteo Iacoviello, 2015. "Occbin: A Toolkit to Solve Models with Occasionally Binding Constraints Easily," Journal of Monetary Economics, March, vol. 70, pp. 22-38.

Guerrieri, Luca & Iacoviello, Matteo & Covas, Francisco & Driscoll, John C. & Kiley, Michael T. & Jahan-Parvar, Mohammad & Queraltó, Albert & Sim, Jae W., 2015. "Macroeconomic Effects of Banking Sector Losses across Structural Models," Finance and Economics Discussion Series 2015-44, Board of Governors of the Federal Reserve System (U.S.).

Iacoviello, Matteo, 2005. "House Prices, Borrowing Constraints, and Monetary Policy in the Business Cycle," American Economic Review, American Economic Association, vol. 95(3), pages 739-764, June.

Iacoviello, Matteo, 2015. "Financial Business Cycles," Review of Economic Dynamics, vol 18(1), pp.140–163.

Kara, Gazi Ishak, and S. Mehmet Ozsoy (2016). "Bank regulation under fire sale externalities (PDF)," Finance and Economics Discussion Series 2016-026. Washington: Board of Governors of the Federal Reserve System.

Kiley, Michael T., 2013. "Output gaps," Journal of Macroeconomics, Elsevier, vol. 37(C), pages 1-18 (2013).

Kiley, Michael T. & Sim, Jae W., 2014. "Bank capital and the macroeconomy: Policy considerations," Journal of Economic Dynamics and Control, Elsevier, vol. 43(C), pages 175-198.

Kiley, Michael T. & Sim, Jae W., 2015. "Optimal Monetary and Macroprudential Policies: Gains and Pitfalls in a Model of Financial Intermediation," Finance and Economics Discussion Series 2015-78, Board of Governors of the Federal Reserve System (U.S.).

Kocherlakota, Narayana, 2016. "Fragility of Purely Real Macroeconomic Models," NBER Working Papers 21866, National Bureau of Economic Research, Inc.

Lindé, Jesper & Frank Smets & Rafael Wouters, 2016. "Challenges for Central Banks' Macro Models". Mimeo, Sveriges Riksbank, April.

Maliar, Lilia and Serguei Maliar, 2015, "Merging simulation and projection approaches to solve high-dimensional problems with an application to a new Keynesian model" Quantitative Economics 6/1, pages 1-47

Malin, Benjamin, Dirk Krueger, and Felix Kubler, 2007. "Computing Stochastic Dynamic Economic Models with a Large Number of State Variables: A Description and Application of a Smolyak-Collocation Method." NBER Working Paper No. 13517, October.

1. The author is Senior Associate Director, Division of Financial Stability, and Senior Adviser, Division of Research and Statistics, at the Federal Reserve Board. Email: mkiley@frb.gov. The views expressed herein are those of the author, and do not reflect those of the Federal Reserve or its staff. Return to text

2. For descriptions of related models and their similarities, see Brayton and Mauskopf (1985), Erceg, Guerrieri, and Gust (2006), Boivin, Kiley, and Mishkin (2010), Coenen et al (2012), Kiley (2013), and Brayton, Laubach, and Reifschneider (2014). Return to text

3. For example, Iacoviello (2005) presents a model with a leverage constraint on mortgage borrowing; Kiley and Sim (2015) present a model with intermediation. Both models imply that good monetary policy focuses on price stability. Return to text

4. Kara and Oszoy (2016) consider this question is a simple, finite-period model. Return to text

5. Such financial accelerator mechanisms (e.g., Bernanke, Gertler, and Gilchrist, 1999) have now become standard in New-Keynesian models of the type used by central banks. While such models have been helpful in incorporating and understanding the role of credit spreads in cyclical fluctuations, existing implementations do not appear to alter significant the propagation of shocks in such models (e.g., Boivin, Kiley, and Mishkin, 2010; Lindé, Smets, and Wouters, 2016). Return to text

6. For example, see Gertler and Kiyotaki (2010), Begenau (2015), Clerc et al (2015), and the review of models in Covas et al (2015). Return to text

7. For example, see Angelini et al (2015) and Begenau (2015). Return to text

8. For a discussion of the links between bank leverage banking crises, see Dagher et al (2016). Return to text

9. Challenges accounting for the interaction of distributional and aggregate risks has been a challenge in many areas (e.g., Malin, Kreuger, and Kubler, 2007). For work on occasionally-binding constraints, see Guerrieri and Iacoviello (2014, 2015) and Maliar and Maliar (2015). Return to text

10. For example, see Akinci and Chahrour (2015). Return to text

11. For example, Guerrieri and Iacoviello (2015), Maliar and Maliar (2015), and Lindé, Smets, and Wouters (2016) examine solution and estimation with a number of occasionally-binding constraints. Such considerations may be especially important in discussions of the potential for countercyclical capital buffers to limit credit boom/bust cycles. In a model in which equity is costly and the countercyclical capital buffer is always binding, tightening the buffer during a boom and easing the buffer during a bust lowers the amplitude of fluctuations in both directions; in a model in which the privately-desired capital ratio fall during booms and rises during busts may involve changes over time in which constraint is binding, leading to more complex dynamics and potential challenges in gauging the effects of a countercyclical capital buffer. Clerc et al (2015) consider a model in which the countercyclical capital buffer is assumed to bind at all times. Kiley and Sim (2015) derive a time-varying market capital ratio that would interact with a regulatory capital constraint. Return to text

12. For example, see Akinci and Rumsey (2015). Return to text

13. One approach to assessing the implications of multiple Nash equilibria associated with runs would be to assume exogenous switching between the run and no-run equilibria; such an assumption would illustrate the dynamics following a run, but cannot assess how policies affect the probability of a run. Return to text

14. For example, Kiley (2016) illustrates how the signs of the response of the economy to technology shocks under a passive monetary policy across sticky-price and flexible price versions of the same model, and how some models 'f price rigidity do not approach the flexible price limit as price rigidities are reduced. This result is similar to the "fragility" of purely

real models emphasize in Kocherlakota (2016). Return to text

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