

# **The Subprime Mortgage Crisis and Macroeconomic Models**

Franco Chingcuanco, Jareth Holt, and Neha Mehta

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## **Summary**

The subprime mortgage crisis of 2007 and ensuing global financial crisis were failures of economic policy and financial institutions. Key elements of these failures were noted as early as 2001, and Raghuram Rajan gave a warning to top members of the Fed in 2005, two years before the crisis. Why were these critiques ignored? In this memo, we examine the role of economic policy and models in allowing the financial crisis to occur. We also critique these models and offer insights on what the crisis means for future economic policy.

## **Outline of the Crisis**

The subprime mortgage crisis involved many actors. These actors can be divided into four broad sets: the homeowners buying mortgages; the banks and government-sponsored entities (GSEs, e.g. Fannie Mae) supplying mortgages; the “shadow banking” institutions (e.g. hedge funds) creating and trading mortgage-backed investments (MBIs); and the Federal Reserve System (Fed) and SEC regulating the other three actors. The crisis occurred when several previously independent trends, each involving only two or three of these sets of actors, suddenly interacted.

The first trend was the movement towards a more affordable and equitable housing. Policies in the 1970s and 1990s aimed at getting banks and the GSEs to cover lower-income housing. These policies unintentionally inspired predatory lending. Mortgage fraud became prevalent; brokers lowered underwriting standards, allowing the subprime nature of mortgages to be overlooked (Frieden, 2004). The push for housing was also one of the causes for rising house prices.

The second trend was the increasing role of shadow banking institutions in the housing market. The MBI market expanded as housing prices increased and new types of MBI were created. This expansion was aided by the credit rating agencies, which – like the mortgage brokers – employed lax standards in their reviews and gave high ratings to risky investments. Investment banks thus became huge players in the mortgage market previously occupied only by the GSEs.

The third trend was decreasing regulation of both the traditional and shadow banking sectors. The Financial Services and Commodity Futures Modernization Acts deregulated the banking industry and the use of credit default swaps, the key hedging options for MBIs. In 2004, the SEC suspended the net capital rule for several investment banks, allowing them to leverage at a much higher rate. In addition, the Fed lowered interest rates to their lowest levels. Low rates pushed deregulated financial markets toward riskier investments.

These trends combined to produce the subprime mortgage crisis. Low- and middle-income homeowners, targeted by predatory lending practices, defaulted on their mortgages at much higher rates than predicted. The defaults lowered house prices and caused even highly-rated MBIs to lose value. The shadow banking sector stopped purchasing MBIs and employed their credit default swaps. The traditional banking sector, especially the GSEs, was left holding the debt for millions of mortgage defaults. The final result was the near-insolvency of both the traditional and shadow banking sectors, creating a financial crisis.

### **Rajan's Warnings**

Many complex interactions led to the crisis, but there were also simple but important truths being ignored by decision-makers. Raghuram Rajan presented some of these truths at a 2005 Fed symposium (Krugman, 2009). Rajan (2006) argued that the financial sector's practice of tying compensation to performance encourages risk-taking. Managers are incentivized to take on "tail risks": high average returns with a small probability of severe consequences. The short-term performance evaluation of managers hides these tail risks that materialize over the long-term. Securitized subprime loans are an example of a tail risk.

Another ongoing practice was benchmarking performance against a manager's peers, which causes herding behavior. Herd behavior, in turn, distorts asset prices away from fundamentals (i.e. starts bubbles). When tail risks materialize and prices correct themselves, Rajan (2006) warned that "the inter-bank market could freeze up" - a financial crisis. He also pointed out that the Fed's low risk-free interest rates drive investors towards riskier assets with higher returns. Rajan was not a supporter of the Fed's reactionary position of letting bubbles burst and minimizing the ensuing damages by altering monetary policy, instead he supported an active role in preventing bubbles.

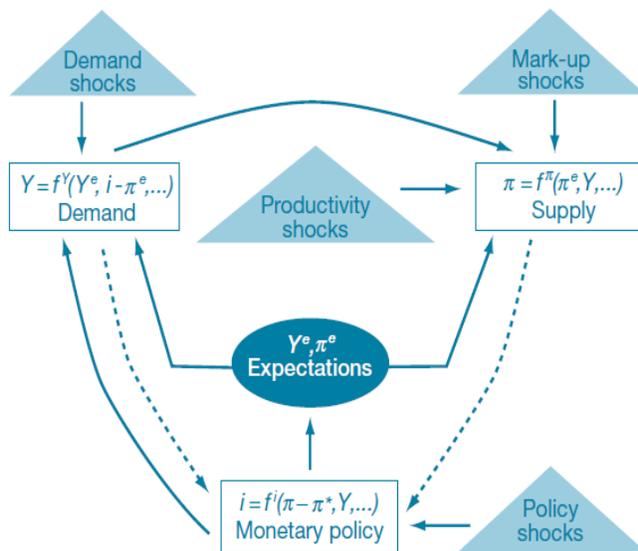
Alan Greenspan and other economists in the audience dismissed Rajan's warnings. Two years later, these warnings came to fruition with a full-blown financial crisis. Why were Rajan's words not heeded when his arguments were supported by sound reasoning and data? While multiple factors need to be considered, this memo focuses on the role of economic models. Specifically, Dynamic Stochastic General Equilibrium (DSGE) models are considered, which is class of models used by Fed in formulating policy. The next section gives a brief overview of DSGE models, followed by an examination of their limitations in predicting the financial crisis.

### **Dynamic Stochastic General Equilibrium Models**

Policy makers have always struggled to develop forecasting models that satisfy the Lucas Critique. Robert Lucas (1976) pointed out that many economic models have parameters which are not policy-invariant. Such a model then incorrectly predicts responses to policy changes.

In response to the Lucas Critique, DSGE models were developed. The basic framework of DSGE from Sbordone et al. (2010) is reproduced below, which includes three interacting agents: firms, households and the government (see figure). The household demand ( $Y$ ) is a function of

the nominal interest rate ( $i$ ) and other variables. The firms use the demand to determine prices, employment rates, and hence inflation ( $\pi$ ). Government uses supply and inflation values to set



the nominal interest rate. Shocks in the market are represented as exogenous, stochastic changes in demand, productivity, and price. Agents are assumed to have “rational expectations,” meaning they are aware of the external random shocks that might affect them in the future.

DSGE models have become the *de facto* standard of macroeconomics, and the Fed uses models of this kind to determine monetary policy. The approach is dynamic since agents have expectations about the future; it is stochastic since uncertainties are

explicitly incorporated as shocks to the model; and it is in general equilibrium since the market clears every period.

### **Failure of DSGE Models**

DSGE models are known to accurately predict the short-term, but they lack robustness in the long term (Garcia, 2011). Nobel Laureate Joseph Stiglitz blames the financial crisis on the Fed’s decision to let the housing bubble grow, which is in part due to the predictions of DSGE models. The Fed focused on keeping inflation low to control price distortions and ignored far larger distortions due to the bubble (Stiglitz, 2011). While these decisions were influenced by Greenspan’s belief in fully efficient markets, Stiglitz notes that the “standard model” (i.e. DSGE) used by the Fed and most mainstream macroeconomists has fundamental problems. This section highlights the limitations of the DSGE approach, focusing on its assumptions as well as technical issues in fitting the model to data and making predictions.

### **Model Assumptions**

One major critique of DSGE models is that they do not represent the financial sector (Garcia, 2011). This absence stems from the assumption that markets are fully efficient and always clear. Since the financial sector is assumed to always tend to equilibrium, the DSGE approach focuses only on modeling macroeconomic fundamentals. This approach precludes markets with friction, defaults, insolvencies, and illiquidity, which are all common imbalances in financial markets. This strong belief in efficient markets where assets are always priced right blinded economists and their models to the housing bubble (Krugman, 2009).

Another common critique of DSGEs is the assumption of rational agents. Greenspan (2010) himself conceded to this problem in a hearing before Congress: “[T]hose of us who have looked to the self-interest of lending institutions to protect shareholders' equity, myself especially, are in

a state of shocked disbelief.” While investment managers who bet against tail risks are not rational by standard definitions – they were setting themselves up for huge losses – Rajan (2006) noted that this was the “rational” choice to pursue given the incentive structure.

In addition to rational agents, DSGE models also assume agents have rational expectations. This assumption means that households and firms are fully aware of external random shocks that might affect their futures (Sbordone et al., 2010). This assumption is inherent for markets to clear every period, since agents react to external shocks properly by making optimal inter-temporal choices that dampen these disturbances towards a new equilibrium (Garcia, 2011). However, most empirical research provides counter-evidence to this claim, showing that agents display irrationality in the face of new information (Colander et al., 2010).

### **Model Fitting**

Another set of critiques leveled against the DSGE approach pertain to model fitting. Schorfheide (2011) shows that DSGE model parameters obtained through data fitting are sensitive to the model specification, data sample period, data definitions, and estimation procedures – they are unstable parameters. This instability introduces significant uncertainties in the inferences made using DSGE models. An et al. (2012) demonstrate that parameter instability may have contributed to the unexpected losses Wall Street firms experienced in the financial crisis. Specifically, they found that mortgage default prediction models underestimated the 2006 default rate mainly because the conditions prior to the collapse of the bubble, reflected in the 2003 data used, were very different from those in 2006.

Related to model fitting issues is the need for representative data. Eichengreen (2008) notes that the risk models banks used prior to the crash were estimated from periods of low volatility. The sample period did not cover rare events such as a drop in housing prices, which prevented the models from fully appreciating the risks borne by these investments. In his remarks to the American Economic Association, Greenspan (2004) also warned about the need to feed macroeconomic models with representative data to ensure forecast accuracy. Greenspan (2010) also alludes to data issues as one of the core reasons for the financial crisis: “The whole intellectual edifice, however, collapsed... because the data inputted into the risk management models generally covered only the past two decades, a period of euphoria.”

There is also a tradeoff between theoretical coherence and empirical fit. Schorfheide (2011) shows that although DSGE model are based on superior theory, they suffer poorer fit compared to pure statistical models because statistical models do not impose the assumptions embedded in DSGE. This tradeoff hints at the possibility that the data may even contradict the DSGE framework and assumptions.

### **Analysis**

Despite these shortcomings, DSGE models were trusted by the Fed and other economists who believed in the mainstream school of thought. The DSGE assumptions of efficient markets and general equilibrium inherently disallowed bubbles and crises. Hence, while DSGE models may

have been the magic tool to the decision makers, they were not meant to anticipate a crisis (Stiglitz, 2011). The DSGE approach was so entrenched that economists who considered alternative methods were often ignored and their work went unpublished (Colander et al., 2011).

The model fitting issues raised earlier could be mitigated with proper verification and validation (V&V) and uncertainty quantification (UQ) steps that are part of the formal modeling exercise. It is common practice to check for outliers, test for parameter significance, etc., i.e. verification steps to ensure the model was built right. Hindcasting exercises and other comparisons to historical data are examples of typical validation steps (Sbordone et al., 2010). Uncertainty can also be quantified using simulations to generate ranges of possible parameter estimates and their predictions. However, DSGE (and other econometric models) are only as good as the data they are based on. Hence, it is doubtful whether any V&V or UQ procedures could have helped the Fed predict the crash without sufficient data that reflect conditions of a crisis.

## **Conclusion**

Several modeling lessons can be drawn from the subprime mortgage crisis. Perhaps the most universal lesson is the danger of homogeneity in approach, both inside and outside of academia. Colander et al. (2011) note that “the methodological preference for single actor models has extremely handicapped macroeconomic analysis and prevented it from approaching vital topics”. Economic research trends over the last several decades have been towards more elegant DSGE models, crowding out alternatives. As a result, no complete or credible alternative models were available for decision-making during the crisis. The critiques of Rajan and others were relevant, but there was no system in place to turn them into policy actions.

Another lesson is that uncertainty and confidence communication are incredibly important. The sensitivity of DSGE models to parameter instability and their general forecast skill could have been brought to the attention of policy-makers. The over-reliance on conceptual models was also an issue; e.g., the beliefs that low interest rates would provide recovery from a recession or that a broader array of financial derivatives will always lead to more accurate and stable prices.

After the financial crisis, economists have started to improve on the limitations of existing DSGE models (Colander, 2010). However, Stiglitz (2011) points out that a “Copernican revolution” is what is needed in macroeconomics, rather than these “Ptolemaic exercises.” Robert Solow (2010) echoed this sentiment in his statement before a Congress hearing on the future of DSGE models in policy “the DSGE model has nothing useful to say about anti-recession policy... There are other traditions in macroeconomics that provide better ways...” However, given that alternative model forms, such as Agent Based Computational Economics, are unfortunately still in their infancy, it appears that incremental improvements to the DSGE may be the current way forward. This is perhaps why the Fed still continues to develop DSGE models (see Del Negro & Schorfheide, 2012; Brave et al., 2012).

### **Discussion Questions**

1. All models requiring parameters to be estimated from data are inherently limited to predictions covered by the data they are based on. Hence, all models of these types, including most econometric models, are ultimately vulnerable to catastrophic events not observed before. Are there ways around this predicament?
2. Related to the issue of representative data is the idea of temporal transferability. Model parameters are estimated from data, and these parameters are assumed to be temporally transferable across the forecast horizon. However, as An et al. (2012) show, conditions can suddenly change causing parameter instability, which led to huge Wall Street losses during the financial crisis. Greenspan (2004) recognizes this as well “We often fit simple models only because we cannot estimate a continuously changing set of parameters without vastly more observations than are currently available to us.” Can you think of modeling paradigms that do not suffer from this problem?
3. Alan Greenspan did not listen to Raghuram Rajan’s warnings to a large part because of his ideology about efficient markets. Greenspan (2004) also pointed out that the reactionary position the Fed has used in previous bubbles has been effective in mitigating their consequences. Is there anything that Rajan, or other economists, could have done to convince Greenspan to rein in subprime lending to avert the financial meltdown?
4. The DSGE methodology had such a stronghold in contemporary macroeconomics that it is very challenging to pursue alternative approaches that could have offered a better chance in preventing the financial crisis. If the Fed, top journals, and the leading macroeconomists from academia and industry all profess by the DSGE, what institutional reforms could be used to ensure minority voices are heard?

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