Challenges that the Recent Financial Market Turmoil Places on our Macroeconomic Modeling Toolkit

Remarks at the
2008 Swiss National Bank
Research Conference
September 19, 2008
Zurich, Switzerland

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Today I would like to discuss some of the challenges that the recent turmoil in financial markets poses for research in both financial markets and monetary economics. I am sure that many of you, too, have been struggling with the questions and problems that I will be talking about this evening. And, of course, I need to state from the start that the views I will be expressing are my own and do not necessarily reflect those of my colleagues on the FOMC or in the Federal Reserve System.

Over the years, the research community and policymakers have developed a good framework for thinking about monetary policy reactions to real-side shocks. For instance, if we think about the appropriate policy response to an oil shock, there is widespread agreement on the broad outline of models that are useful to answer the question. Typically, we would turn to a dynamic stochastic general equilibrium model, (DSGE) model, with both nominal and real rigidities; estimate or calibrate the parameters of the model; and then trace out the responses to the real shock under different policy actions—and perhaps under different policy responses. Certainly many details remain disputed, such as the extent of nominal versus real rigidities, or the appropriate form of adjustment costs; these details

are very important, but they do not challenge the basic tools we empirical macroeconomists use for policy analysis.

However, unlike real shocks, we don't, as yet, have such a well-developed toolkit with which to analyze financial shocks. The events of the past year certainly have reminded us of this point. So tonight I would like to discuss some of the difficulties we face in modeling financial shocks, and do so through the prism of the recent turmoil in financial markets.

Let's step back and think about some of the tough questions I am sure all of us have been grappling with over the past year. Can markets easily work around the disruptions to the credit intermediation process that channels funds from savers to borrowers? Or have we experienced a permanent destruction in something we might want to think about as the financial sector capital stock? If so, does the economy need to develop entirely new infrastructures for some types of intermediation, or perhaps will reviving earlier more traditional approaches suffice once the turmoil has abated? And how will we know when markets settle out to the "new normal steady state?" With regard to policy, what—if any—public sector actions can assist this transition? Finally, and most importantly, what are the consequences of this turmoil for the achievement of the Fed's ultimate policy goals—maximum sustainable growth and price stability?

To answer these questions and provide a better basis for policy prescriptions, we need to be able to model how various disruptions in financial markets affect

credit provision, and how these effects, in turn, impact the real economy. Ideally, we would want to analyze these financial developments using a well-articulated and empirically implementable modeling framework. Executing this program is tricky business. And, as I will discuss, I think we still have some work left to do—first in better understanding the fundamentals underlying the current financial shocks and, once we do, in figuring out how to best adjust our empirical models to measure their influence on the macroeconomy.

Section 1: Characterizing Financial Shocks in Theoretical Models

At the Chicago Fed, our initial response to the financial turmoil was to try to classify the financial crisis as a shock that could easily be inserted into a standard DSGE model. [Joke: To me, a model like Christiano, Eichenbaum, and Evans' seems the natural benchmark, wouldn't you agree?]

However, deciding on the appropriate characterization of the shock has turned out to be a frustrating exercise. Modern macro models have identified and estimated a number of "standard" shocks—shocks to total factor productivity (TFP), marginal rates of substitutions, monetary policy, and so on. But less progress has been made with regard to modeling a "financial infrastructure shock."

Now, a term like "financial infrastructure shock" can encompass a large variety of episodes. I will focus on the recent troubles experienced by secondary financial markets, evidenced by the large increase in yield spreads for a wide range of

structured securities and even the failure of certain assets to trade at any price. Of course, these started in the market for mortgage-backed and related securities and then spread to other types of structured finance.

The first step is to look at abstract theoretical models. These have shown that asymmetric information, moral hazard, and agency issues can generate an important role for liquid assets in channeling credit between lenders and borrowers.

One natural starting point is the model of Diamond and Dybvig and the large literature that followed it.[i] These papers consider the problems that information asymmetries pose for the functioning of primary credit markets, the role of liquidity in addressing such problems, and the possibility of speculative runs in such environments. While they traditionally have been applied to the banking sector, they can also be used to think about a broader class of intermediaries that borrow short-term funds to finance less liquid, long-term investments; this broad class may include investment banks, broker–dealers, various off-balance-sheet entities such as structured investment vehicles, and even hedge funds. Accordingly, these models are helpful for thinking about the current situation, in which liquidity shortages have caused a number of markets to seize up and have resulted in run-like activity on some nonbank lenders.

Nonetheless, there is a good deal that these models leave unexplained. They simply take as given the illiquidity of long-term investments that are traded in

primary capital markets in which borrowers and lenders interact directly. They do not explain illiquidity per se. As such, they fall short in explaining the current turmoil, which in large part reflects the sudden illiquidity of some assets that used to be re-traded in very deep secondary markets.[ii]

Recently, Kiyotaki and Moore developed a model in which credit frictions operate not only in the primary market but also in secondary markets.[iii] They trace out some implications for consumption when liquidity seizes up, and have some interesting policy prescriptions that I will discuss in a minute. That said, they too take as given the degree of liquidity: The shock to liquidity is a primitive in their model, with no explanation why some assets that previously were very liquid suddenly stop being traded. Without knowing this, it is difficult to think about the full effects of the shock on economic activity or the way central bank policy ought to react.

Now I think there are some models that give plausible explanations for certain aspects of the current shock to liquidity. One stems from Akerlof's "lemons" paper, which studies markets under adverse selection.[iv] The way this story plays out in the current turmoil starts with the downturn in housing markets leading to an increase in mortgage defaults and an associated drastic reassessment of the risks of investing in mortgage-backed securities. Valuation has been made even more difficult by the fact that recently issued loans have had significantly different default profiles from previous vintages. As a consequence, assets that were previously considered fairly homogeneous and reasonably straightforward to

price suddenly looked much more diverse. As the degree of informational asymmetry was perceived to widen, financial investors became much more concerned about a lemons problem.

As Akerlof showed, adverse selection can generate a vicious cycle that could even lead to a complete market shut down: This is because sellers of high-quality securities drop out, and this depresses the market price and leads more sellers to drop out, thus setting off a continuing cycle of price declines and exit of high-quality assets.

I think this story begins to approximate some of the malfunctions in the mortgage-backed securities market. But it leaves open the question of why liquidity dried up in markets that were not tied to housing. One reason may be that the securitization process was similar across a wide spectrum of financial liabilities. This may have led market participants to worry about the potential for similar lemons problems to emerge among a much broader class of asset-backed paper, generating contagion across financial markets.

While very useful for organizing our thinking, these models provide only highly stylized characterizations of how liquidity problems arise, and they fall short on modeling how they might feed back onto the consumption and investment decisions of households and businesses. So how can we capture the insights from these models and import them to a broader macro setting? And can we incorporate them into models that could be implemented empirically?

Section 2: Empirical Implementations

The first question to ask is whether we can make some straightforward modifications to an otherwise standard-looking DSGE model and obtain useful policy prescriptions. There have been some important efforts to do so in the literature.

A financial market shock may have some characteristics of a DSGE TFP shock: The cost of producing an intermediate input—credit intermediation—has become more expensive. This is how the shock is modeled in recent research by Curdia and Woodford.[v] In their analysis, a negative financial shock increases the costs of intermediation between savers and borrowers, and increases the spread between the interest rates faced by the two groups.

Alternatively, there is a long history of empirical studies of the effects of credit frictions on output and inflation. Here I am thinking about the VAR and other reduced form models meant to capture the influence of the financial accelerator and the credit channel for monetary policy.[vi] Subsequently, some attempts have been made to incorporate these effects into more structural models. Bernanke, Gertler, and Gilchrist (BGG) have incorporated credit frictions from an explicit model of asymmetric information into an otherwise standard business-cycle calibration framework;[vii] in their model, the borrowers' net worth is an important factor that affects the cost of capital. Christiano, Motto, and Rostagno have enriched Bernanke, Gertler and Gilchirst's setup in a medium-scale macroeconomic model that incorporates more economic variables than BGG and

correspondingly includes more shocks.[viii] They show that shocks to financial frictions may be very important in explaining the pattern of investment and stock market valuation in the run-up of the late 1990s and the consequent reversal of 2000–02. De Fiore and Tristani also develop a similar model in the paper presented at this conference.[ix]

These studies are very important and provide us with a very useful perspective. Yet they are identifying financial shocks largely in a reduced-form manner—either as an exogenous increase in interest rate spreads or net worth or as a shift in the demand for capital due to tightening of credit market constraints. To capture the current situation, we need to have a better idea of how the events in financial markets map into the parameters and shocks identified in these models. My feeling is that this probably requires embedding a richer specification of the financial intermediation process into these empirical frameworks.

One reason is that there are dimensions along which financial capital is not like the typical intermediate input in a DSGE model. In a number of theoretical models, financial inputs can be subject to discontinuities: Seemingly small changes in the borrowers' net worth or perceived risk can bring about radical consequences in market performance. Perhaps the recent events in the mortgage-backed and related structured security markets are an example of such a breakdown—indeed, one that is of macroeconomic importance.

Such discontinuities are a challenge for our standard empirical models. These models are typically solved by taking a local approximation around a balanced growth path. This approach is not designed to capture discrete jumps in equilibria. In addition, some of the estimated coefficients in our standard models may not be invariant to the onset of a liquidity crisis. This suggests that a regime-shifting model could be helpful, with a "normal" regime alternating with a "liquidity crisis" regime. But, still, how should we parameterize the crisis regime? If we observed liquidity crises often, we could estimate these parameters. But we don't experience crises very often, so it's asking a lot of any empirical model to accomplish this identification. [Joke: Now, don't get me wrong. As a central banker, I'm delighted that we can't estimate these shifts very well. I'm certainly not hoping for more observations of financial crises! But the paucity of data does present problems for us as econometricians.]

So my guess is that we can not gain a good deal of insight into when markets will "return to normal," and what "normal" will look like from these models' estimated impulse response functions. Indeed, the rarity of crisis events and changes in the structure of markets makes it difficult to use even simple statistics, such as risk spreads and volatility measures, to gauge the path to the "new normal."

Section 3: Policy Issues

Now let me turn to the policy dimension of the challenges that I have discussed so far. Modern models usually say there is little the public sector can do to offset a cyclical contraction in technology except to offset, to some degree, rigidities

that affect the economy's response to the shock. This implication would carry over to financial shocks if we simply chose to model them as a negative cost shock to an intermediate input.

However, there are reasons to believe that financial shocks may be very different when it comes to policy prescriptions. For one thing, the Fed and other financial regulators are themselves part of the intermediation infrastructure. This means that we potentially have a number of alternative policy instruments that might directly affect the way the economy responds to a financial shock.

Since last August, the FOMC's policy decisions have been calibrated in part to avoid an "adverse feedback loop" between disruptions to financial market stability and the real economy. This focus has influenced both the setting of the funds rate and the implementation of a number of new policies.

In this context, the Fed has added a number of new lending facilities: the Term Auction Facility, the Term Securities Lending Facility, and the Primary Dealer Credit Facility. These directly impact the intermediation process independently of the federal funds rate—indeed, we have purposefully sterilized the effects of these facilities on the funds rate.

In addition, on September 7 the Department of Treasury added a new lending facility for Government Sponsored Enterprises (GSEs). This is aimed at supporting the flow of credit to mortgage markets and the associated liquidity of mortgage-backed securities.

Such policies do have counterparts in some of the work I cited earlier. As an example, in Kiyotaki and Moore's analysis, efficiency may be enhanced if the central bank offers more liquid assets to the private market in exchange for less-liquid ones. This is the case even though the central bank intervention has no effect on the liquidity of each class of assets. However, this strategy is potentially even more important if adverse selection is in play because here the intervention does affect liquidity. By allowing newly illiquid assets to be used as collateral, the central bank may be setting a floor on their value, which may undo—or at least limit—the vicious cycle that I described earlier in the Akerlof model. This could buy time for information to spread among market players and reinvigorate the intermediation process—perhaps in a different form, though, than how it operated in the pre-turmoil period.

Interestingly, our Term Securities Lending Facility, which the Fed implemented in mid-March, roughly corresponds to the Kiyotaki and Moore recommendations. Our approach with regard to accepting and valuing collateral has been very careful in minimizing the credit risks assumed by the Federal Reserve Banks. Nonetheless, any plan that offers price support, even indirectly, does entail some potential risk to our balance sheet and could have other costs in terms of distorting price signals and moral hazard fallout. Kiyotaki and Moore do not provide any insight into these costs. So, we are left with many questions. How long should the central bank intervention last and how large should it be? What are its effects on the incentives for market participants to acquire information before a crisis unfolds? What markets deserve our attention? After all, Akerlof's

original example was about the used car market; I certainly would not want the Fed to start accepting used cars as collateral! [Joke: Of course, Detroit is in my District, and I am sure the policy would have some fans there].

Even once we answer these questions, we have to address the implications of the new policy tools for our ultimate policy mandates of promoting maximum sustainable growth and price stability. This includes accounting for the interaction between the new tools and our traditional instrument of monetary policy—the short-term interest rate. An important component of this analysis is thinking about the degree to which the impaired assets used to be close substitutes for what some may call “traditional money.” If they were good substitutes, does a market breakdown that renders these assets illiquid create a potentially deflationary shock? If not, are there inflationary implications from swapping liquid Treasury securities for less-liquid assets or expanding the direct lending facilities that use such assets as collateral?

This question brings us back to the notoriously difficult issue of identifying the channels through which liquid assets generate price pressures, especially in the short run. And, as an empirical question, we are faced with identifying which credit aggregates or interest spreads best capture the relevant degree of substitutability.

Conclusion

To answer all of these challenging questions, it will be extremely useful to seek a more unified perspective of the role of financial frictions in modern macroeconomic models. In this way, we will be able to identify the independent roles of our traditional monetary policy tools and our new lending facilities, as well as the interaction between the old and new tools. Developing these models is up to the research community—from the research shops at central banks to academic departments to independent think tanks. And we policymakers are eagerly awaiting the results.

[i] Douglas W. Diamond and Philip H. Dybvig, 1983, "Bank runs, deposit insurance, and liquidity," *Journal of Political Economy*, Vol. 91, No. 3, June, pp. 401–419.

[ii] Of course, defining liquidity is something the profession has been struggling with for a long time, and there is a vast literature to which I cannot do justice here. I will just point to the important contributions by Allen and Gale (1994, 2004) that have analyzed the incentives for market participants to carry enough liquidity to engage in active trading. See Franklin Allen and Gale, 2004, "Financial intermediaries and markets," *Econometrica*, Vol. 72, No. 4, July, pp. 1023–1061; and Allen and Gale, 1994, "Limited market participation and volatility of asset prices," *American Economic Review*, Vol. 84, No. 4, September, pp. 933–955.

[iii] Nobuhiro Kiyotaki and John Moore, 2008,"Liquidity, business cycles, and monetary policy," Princeton University, mimeo; Nobuhiro Kiyotaki and John Moore, 2005, "Financial Deepening," *Journal of the European Economic Association: Papers and Proceedings*, Vol. 3, pp. 701–713; and Nobuhiro Kiyotaki and John Moore, 2003, "Inside money and liquidity," London School of Economics, mimeo.

[iv] George A. Akerlof, 1970, "The market for 'lemons': Quality uncertainty and the market mechanism," *Quarterly Journal of Economics*, Vol. 84, No. 3, August, pp. 488–500.

[v] Vasco Curdia and Michael Woodford, 2008, "Credit frictions and optimal monetary policy," Columbia University, mimeo.

[vi] See Ben S. Bernanke and Mark Gertler, 1995, "Inside the black box: The credit channel of monetary policy transmission," *Journal of Economic Perspectives*, Vol. 9, No. 4, Fall, pp. 27–48, and references therein.

[vii] Ben S. Bernanke, Mark Gertler, and Simon Gilchrist, 1999, "The financial accelerator in a quantitative business cycle framework," *Handbook of Macroeconomics*, Handbooks in Economics, Vol. 15, No. 1C, Amsterdam, New York, and Oxford: Elsevier Science, North-Holland, pp. 1341–1393.

[viii] Lawrence Christiano, Roberto Motto, and Massimo Rostagno, 2007, "Financial factors in business cycles," Northwestern University, mimeo.

[ix] Fiorella De Fiore and Oreste Tristani, 2008, "Optimal monetary policy in a model of the credit channel," European Central Bank, mimeo.