

Remarks by John Geanakoplos

I have been given an impossible task of commenting on the wonderful Christiano paper and, at the same time, talking about my theory of the leverage cycle. So I'm afraid I'm going to have to be very brief about both. Christiano argues that the monetary authority has very often erred by pushing interest rates in the wrong direction; it would do better he says by basing its interest rate targets on credit growth as well as on inflation. I shall argue that the regulatory authority would do better still not just by paying attention to credit growth, but by directly controlling it, or more precisely, controlling what I call leverage.

Remarks on Christiano, Ilut, Motto, and Rostagno

The paper is about stock booms and bubbles. It is based on the striking empirical fact that in every stock boom of the last 200 years inflation has been low. It concludes from this empirical fact that setting interest rates by inflation targeting exaggerates booms, because during the boom the Fed is induced to set real rates below the natural rate.

In the model, stock booms are always bubbles caused by misguided monetary policy. They're your fault, Ben! The policy conclusion is that managing interest rates by inflation targeting should be changed. But all is not lost. In the model, setting nominal interest rates based on inflation and on credit growth gives the right nominal rate and

moves the real rate closer to the natural interest rate. So the policy recommendation is to preserve the Taylor rule, but modified to include credit growth, as well as inflation, on the right-hand side.

My sense is that this paper is powerful and important. It has data, it has a new model, it has intricate calculations, it has an empirical fit, it has a stunning conclusion – that all stock booms might be bubbles caused by the Fed - it makes a concrete suggestion for improving the famous Taylor rule, and it focuses our attention on credit growth, which common sense suggests is important. It is an ingenious paper. But the ingenuity feels a little bit to me like Ptolemaic ingenuity. When confronted with new facts, in this case the greatest crash and dislocation since the Great Depression, it answers the question of *Macroeconomic Challenges in the Decade Ahead* by adding another epicycle to the old rule. It adds another term on the right-hand side, but basically pursues the same policy of adjusting interest rates. Now maybe that is the right policy. Maybe interest rates are the only tool we need, even as we add macroeconomic stability to our goals. But I don't think so.

I'm going to make two more critiques, first about the plausibility of the model, and then about the conclusion, taking the model literally. Now the authors seem to believe in their model partly because they couldn't think of another model that would explain this apparently shocking fact that in stock booms inflation is low. In their model, agents get a signal suggesting that costs will go down next period, which ought to raise the natural rate of interest. In the sticky prices version of their model, the agents who are

lucky enough to be able to change prices today lower them, because they fear they might not be able to lower prices tomorrow when costs actually go down. The Fed, responding mechanically to the low prices via the Taylor rule, moves the interest rate down instead of up. This model is a clever variant of the standard macro model. For someone who is an outsider to the field it seems like, whenever macro economists get into trouble, they throw in some technological shocks, or the expectation of technological shocks. If that doesn't do the trick, they make a bunch of stuff sticky. That's what happens in this paper.

You could have imagined another model that explains the stock boom - commodity deflation paradox in which the old Taylor rule does not look so bad. For example, consider a cash-in-advance transactions model of exchange with flexible prices, in which the central bank stands ready to lend a *fixed* stock of money each period. If the relative price of stocks vs. commodities goes up in some period, and the volume of shares traded is not diminished, one would expect to see higher money prices of stocks and *lower* money prices of commodities, since less money would be available to chase goods. In such a model it might be perfectly appropriate for an active monetary authority to respond to unusual transactions needs for money in the stock sector with an increase in the money supply.

The persuasiveness of the paper comes partly from the 200 years where over and over again we see stocks boom with low inflation. What was monetary policy for most of those 200 years? Not the Taylor rule. A lot of it was the gold standard. During much

of that time the money supply might have been approximately fixed. Are we supposed to conclude from the model that there were no bubbles before the Taylor rule?

For my last critique I take the model as truth. In the model, as far as the monetary authority is concerned, credit growth plays a completely proxy, instrumental role. It is useful to pay attention to it because it gives the monetary authority a better idea of what the natural rate of interest is. It enters on the right hand side as information for setting interest rates, not on the left hand side as something to be controlled itself. In the model, however, there might be other proxies that work just as well. Maybe you could throw in wage growth, as well as price growth, on the right-hand side and estimate the natural interest rate that way. If so, then there would be no reason to pay attention to credit growth.

I want to describe a different theory of bubbles in which credit plays an essential role that cannot be ignored. Leverage causes bubbles and it cannot be stopped by increasing interest rates, nor can we come out of the crisis simply by lowering interest rates. Leverage must be managed directly.

Managing the Leverage Cycle

For a long time now, maybe since Irving Fisher, we've come to believe that managing interest rates is the way to do macroeconomic policy. Whenever anything goes wrong, people say change the interest rate. My view is that collateral rates or leverage can be more important and more important to manage. I am recommending that the Fed manage leverage, as well as managing interest rates.

Shakespeare understood the primary importance of collateral 400 years ago. How many of you can remember the interest rate Shylock charged Antonio and Bassanio in *The Merchant of Venice*? Yet, all of you remember the collateral – the pound of flesh. Obviously, Shakespeare thought the collateral was more important. By the way, in the play, when all the boats apparently sink and Antonio is unable to repay the loan, the Court says, “Despite the contract being freely entered into, and despite the importance to commerce of enforcing freely entered contracts, we are going to make a change. We are not going to change the interest rate, but we are going to change the collateral. It should have been a pound of flesh, but not a drop of blood.”

Similarly, I believe today that the regulatory authority ought to be managing collateral rates in addition to interest rates. I've worked on the leverage cycle, as I call it, for over ten years, not quite as long as Shakespeare and with somewhat less attention than Shakespeare received. My oldest published papers on the subject are “Promises Promises” in 1997, about collateral general equilibrium, and “Liquidity Default and

Crashes” in 2003, about the leverage cycle. There I showed that when leverage is high, asset prices tend to rise, and when leverage declines, asset prices fall, sometimes in a violent crash.

There have been other early papers on collateral. In fact, Ben Bernanke was one of the pioneers in emphasizing collateral. However, he didn't really write very much about leverage, or changes in leverage. Instead he emphasized that when collateral goes down in value, the amount that can be borrowed goes down (as would be the case with a constant loan-to-value lending rule). What I emphasized is that the loan-to-value can change dramatically, and it is the rapid change in loan-to-value that is a crucial source of crashes. And as I shall argue, loan-to-value is a variable that can be regulated.

Nevertheless, not only is Chairman Bernanke aware of some of the principles of managing leverage that I am going to talk about, but he used them in 2009. Although he didn't talk about them in his remarks this morning, they actually were part of the Fed policy in dealing with the recent crisis. I think they should have been a bigger part, but they were a part.

What I mean by leverage is loan-to-value on *new* loans. If the loan-to-value is 80 percent, \$20 down gets you a \$100 house. The leverage is five, because your cash down-payment of \$20 has been multiplied by five in the \$100 value of the asset. Loan-to-value and leverage describe the same thing. But let me emphasize it's on new loans. Debt-to-equity is essentially loan-to-value on old loans. Debt-to-equity is also an important ratio,

but different from what I mean by leverage. And the two ratios often go in different directions.

In the Reinhart paper presented earlier today, we saw leverage being defined not on new loans, but on all loans. Reinhart found that historically, under her definition, leverage typically increases for two years after a crisis, and then starts a long slow decline stretching over years. But under my definition, I think she would find that leverage drops abruptly *before* the crash. It is a cause, not a lagging result. How well things are going in the economy usually depends more on the leverage on new loans, not on what is happening to old loans, which often goes in the opposite direction. Of course, as we shall see, the duration of the crisis depends critically on the debt overhang, that is on the loan-to-value on old loans.

The point of my old equilibrium theory of leverage is that supply and demand determine not just the interest rate, but leverage as well. Supply equals demand for a loan is one equation. It is a puzzle. How can one equation determine two variables, interest and leverage? That is part of the reason why leverage has gotten so little attention in economics. It is just awkward for economic theory. That is why, as an economic theorist, I began to think about the subject. I wanted an equilibrium theory of what influences leverage, and what role leverage plays in the economy.

In my theory supply and demand do determine both the interest rate and leverage. (The trick is that there is more than one supply equals demand equation, but I don't have

time to discuss that here). What ends up influencing the interest rate in equilibrium is impatience; what influences leverage in equilibrium is volatility in the short run and, in the long run, innovation (because the economy is always looking for innovative ways to stretch scarce collateral).

Why are people now saying leverage is important? Every trader knows, if you're leveraged five to one and the asset goes up or down 1 percent, your wealth goes up or down 5 percent. You're more sensitive to changes. And the second thing they say is that since collateralized loans often turn out to be no recourse loans, people can walk away from their debts. "If we had only limited leverage, these banks wouldn't have lost so much money when prices started to go down. And homeowners wouldn't be walking away from their homes."

Of course, I believe those two things are very important, and they played a crucial role in my theory. But there was a third aspect of leverage in my theory which I think is far more important. The real significance of leverage is it allows fewer people to buy more assets and therefore raises the price of assets. Leverage causes bubbles.

In the leverage cycle periods of high leverage produce higher asset prices, while periods of low leverage produce lower asset prices, provided there is no short selling. In Diagram 1 below, you can see why that is. Imagine a continuum of people from top to bottom, who have different views about the value of assets. The people at the top think the assets are worth a lot. The people at the bottom don't think they are worth very

much. This heterogeneity is of crucial importance. Whatever the price is, there are going to be people at the top who think the price is cheap and they'll be the buyers. The people lower down are going to think the price is too much and they will be sellers. The guy who thinks the price is just right, his valuation is equal to the price. You might say his valuation is determining the price.

Marginal Buyer Theory of Price



When leverage goes up, the people at the top can borrow more. Fewer of them are required to hold all the assets, so the marginal buyer goes up and the price rises, not because there is any fundamental change in the economy, but because the marginal buyer is someone who has a higher opinion of the value of the asset. More leverage causes higher asset prices, because it changes the marginal buyer. Most of modern finance basically assumes this heterogeneity away. I am not aware of a single finance or macro textbook that mentions endogenous leverage and its effect on asset pricing.

There are many reasons why agents in reality have heterogeneous valuations of assets. For example there are real differences in risk tolerance – risk averse people value the assets less, even with the same information. There are also real differences in how people can use assets for production. There are also differences in utility from owning assets, like living in a house, for example. And some people maybe are just more optimistic than others.

Over the leverage cycle there is too much leverage in normal times and, therefore, too-high asset prices, and too-little leverage in bad times and therefore too-low asset prices. Leverage cycle crashes always happen in exactly the same way. First there is bad news that causes asset prices to fall because every investor values the assets less. This price fall causes leveraged natural buyers (optimists for short) to lose money and thus hold fewer assets, which causes asset prices to fall more, because the marginal buyer is now lower down the continuum. If the bad news is “scary”, then lenders demand more collateral. This means that the remaining optimists buy even less, and so the marginal buyer must be even further down the continuum and so much more pessimistic, and prices drop even further.

Now what is “scary bad news?” It’s not just bad news, but it is the kind that creates more uncertainty, more volatility. You are at an airport and they say the plane is going to be 10 minutes late. That’s bad, but 10 minutes is really nothing. However, once you hear it is 10 minutes late, you think, “My gosh, maybe it’s going to be an hour late.” That could be really bad.

It is the *uncertainty* the news creates that is critical, not how bad it is. Another example is subprime delinquencies going from 2 percent to 5 percent in January 2007. 5 percent is not catastrophic. However, once it has reached 5 percent and broken the old pattern, investors think maybe it will go to 30 percent or 40 percent. That is what causes people to get nervous. When the lenders get nervous, they ask for more collateral and they force deleveraging. That's the beginning of the crisis.

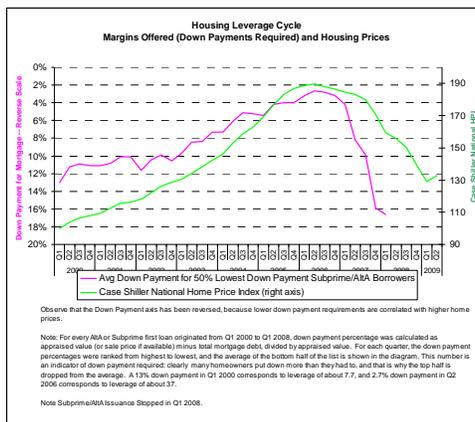
In the aftermath of the leverage cycle crisis, we always see the same thing. There are a huge number of people who have gone bankrupt, but a much bigger group that are teetering on the edge of bankruptcy. So there is a new kind of uncertainty. Who else is going to go bankrupt? And how will they behave while they are underwater? The depth and length of the crisis depends on how much leverage there was to begin with, and on how effective government policy is in reducing the uncertainty.

The leverage cycle would occur even with completely rational agents; it gets much worse with irrationality. For example, if in the boom irrational lenders thought prices could only go up, leverage would get absurdly high, or if as bad times approached panicked investors sold everything, prices would fall much faster. But I won't talk about irrationality today.

I believe our financial history is full of recurring leverage cycles. I can vouch for the ones I lived through first hand, which became crises in 1998 and in 2007-10. I'm hoping somebody like the Reinharts – in fact, maybe you, Larry Christiano – could use

that ingenuity to document and study earlier leverage cycles. One problem is that there is not much data on historical collateral rates. There is a lot more work that could be done about this.

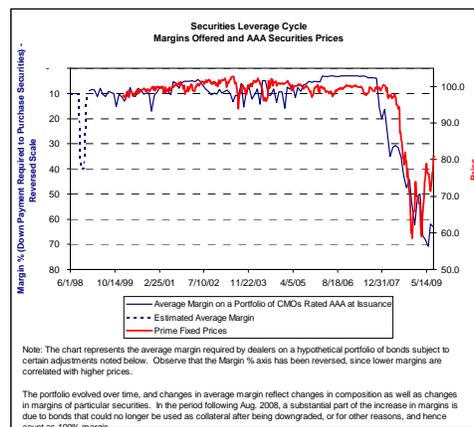
The current crisis I believe is a clear example of a leverage cycle crash after a long leverage boom. And for this we do have some data. In the diagram below, the green line is Shiller's famous housing index. In 2000, it was at 100 on the right-hand scale. By the second quarter of 2006, it hits 190, a 90 percent increase in six years. Then it goes down 30 percent or so from there. Shiller has famously said that it was irrational exuberance driving prices up. And, when the narrative changed because people decided things can't go up forever, they started telling bad stories, so everyone got depressed, and the prices went down.



I believe the housing boom and bust was more a matter of leverage than of irrational exuberance. In the pink line above I give the average loan-to-value for securitized subprime and alt-A loans. The left vertical axis measures loan-to-value from 0 percent at the bottom to 100 percent at the top, or equivalently, the down-payment measured from 0 percent at the top to 100 percent at the bottom. You can see that the average down-payment goes from 14 percent (that is 86 percent loan-to-value) in 2000 to 2.7 percent in the second quarter of 2006. In exactly the same quarter Q2 2006 that leverage hits its maximum, so do home prices. It is not irrational exuberance, I say, but leverage that caused housing prices to go up and then go down.

In the third diagram, you see the analogous leverage-price diagram for prime mortgage-backed security bond prices. Measured along the right vertical axis, the prices in the red curve stay close to 100 until the beginning of 2008 when they start to fall, eventually declining all the way to 70. Leverage is measured as in Diagram 2 on the left vertical axis, and is given by the blue curve. These Repo down-payments (margins) are data the Fed should be keeping, but apparently the Fed didn't closely monitor Repo margins before the crisis. The hedge fund Ellington Capital Management that I work with gave me the history of margins they were offered, averaged over a large portfolio of prime mortgages. You see that down-payments were at 10 percent in 1998, then in the 1998 leverage cycle crisis they jumped to 40 percent, then went back to 10 percent very quickly when the crisis subsided. Margins eventually went down to 5 percent in 2006 – so 20-to-1 leverage. Then in 2007 leverage began to collapse, and afterward you see prices and leverage collapsing together. Leverage on these AAA bonds, measured

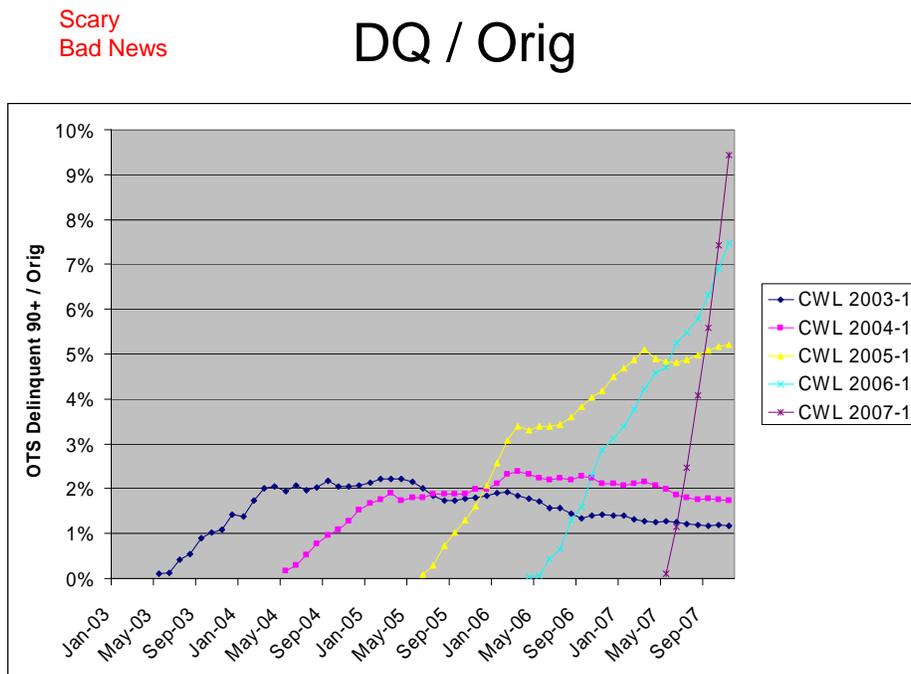
properly as loan-to-value on new loans, starts to collapse before prices and is part of the reason for the collapse of prices. The de-leveraging comes before the fact, not two years after the fact. Of course much of the de-leveraging in the diagram (and in other time series of security prices) comes simultaneously with the fall in prices. Falling prices makes rational lenders demand more collateral, which in turn lowers prices, making lenders ask for still more collateral and so on.



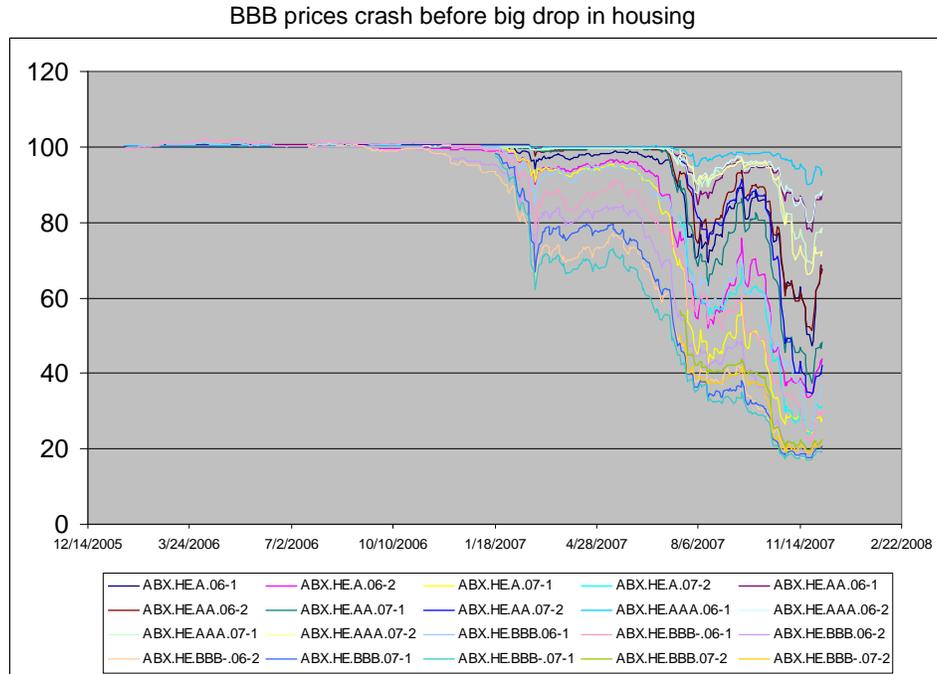
What caused prices and leverage to go down? What was the scary bad news? To listen to the conventional accounts, the crisis began with housing prices suddenly plummeting, completely unexpectedly, out of the blue. In the second diagram, you see housing went down slowly. It's a nice slow curve. It goes up, it stops going up, and then it comes down slowly. That housing prices stopped going up is not really a surprise from the leverage cycle vantage point. Down-payments cannot go below 0 percent, so as

housing down-payments approach their minimum, one would expect housing prices to stop increasing. What is surprising is how fast leverage comes down just after Q2 2006. What happened? What was the scary bad news?

The scary bad news was that delinquencies on subprime loans started going up at the end of 2006. In diagram 4 we see that historical delinquencies as a percentage of original balances for Countrywide deals asymptote at 2 percent. But in January 2007 the delinquencies on 2005 and 2006 loans were already approaching 5 percent.



The result was that the subprime BBB ABX index collapsed in January and Feburary of 2007, as we see in Diagram 5.



It may seem surprising that an increase in delinquencies from 2 percent to 5 percent could cause such a drop in the subprime security index. I argued earlier this shouldn't be surprising, because of the leverage effect, to which I shall return momentarily. But first let me mention another crucial piece of scary bad news. The introduction of CDSs (Credit Default Swaps) played a vital role in the subprime crash. Before their introduction, a pessimist couldn't leverage his views. CDSs didn't become standardized for mortgages until the end of 2005. Only then could you could easily leverage your position as a pessimist. All those guys at the bottom of the continuum in Diagram 1, who earlier just had to stand by and shake their heads at the high subprime prices, could thereafter weigh in with money behind their opinion. This was bound to push the marginal buyer lower and to have a big effect on asset prices.

The twin pieces of scary bad news, rising delinquencies and the introduction of CDS, should, according to my theory, create a sharp decline in leverage on subprime securities as nervous lenders ask for more collateral. I do not have the data on subprime security collateral, but I have the next best thing. As buyers of subprime securities get more nervous, one would expect them to prefer pools with subprime loans that have bigger down-payments. And that is just what we see in Diagram 2. Leverage on subprime loans collapses just after January 2007. And I believe that is what led to the housing price collapse.

Let me conclude my discussion of the 2000-2010- leverage cycle by briefly mentioning some reasons why this last leverage cycle was worse than its predecessor cycles. First, leverage reached levels never seen before in previous cycles. I don't have time here to say why, but if someone asks me I'll explain. Second, we had a double leverage cycle, in securities on the Repo market, and on homes in the mortgage market. These cycles fed off each other, and as we saw, as security prices fell and leverage collapsed there, leverage followed down in the housing mortgage market. Third, CDS played a huge role, and had been absent from previous cycles. CDS helped optimists leverage at the end of the boom, but most importantly, it provided an opportunity for pessimists to leverage, and so made the crash much faster than it would have been without them. Lastly, because leverage got so high, and then prices fell so far, a huge number of people and businesses ended up underwater, including 14 million homeowners. This debt overhang is playing a big role in our current malaise.

So what should be done about the leverage cycle? Something to prevent it from getting too high, and then something to get out of the problem once there is a crash.

To prevent leverage from building up, we have to monitor it by collecting not only debt-to-equity ratios on a large variety of institutions, but also loan-to-value leverage data on all kinds of securities and assets. We have to put derivatives like CDS on an exchange, or something similar. I don't have time to explain it, but CDS are just another way of leveraging. So you have to monitor the leverage of derivatives just like you'd monitor the leverage of asset purchases. During normal times, loan-to-value leverage should be regulated. The Fed or another body that is given the authority should simply say, "You can't loan at 2 percent down on houses. You can't make Repo loans with .5 percent down. You can't write CDS insurance unless your initial margin is comparable to the margin on buying the security. And if you want to buy CDS insurance, you also have to put comparable margins down."

Allow me to mention four of the six reasons I have given elsewhere why monitoring and regulating leverage should be based at least partly on loan-to-value ratios on new loans (asset based leverage) for all borrowers and lenders, rather than solely according to debt-equity ratios of entire institutions (investor leverage). First, leverage in the system can move away from regulated institutions. Second, limiting the overall leverage of an institution can sometimes incentivize it to choose riskier investments that are leveraged less. Third, as we have seen, investor leverage and asset leverage often

move in the opposite direction. Fourth, it is harder to lie about asset based leverage because separate reports will be obtained from both the borrower and the lender.

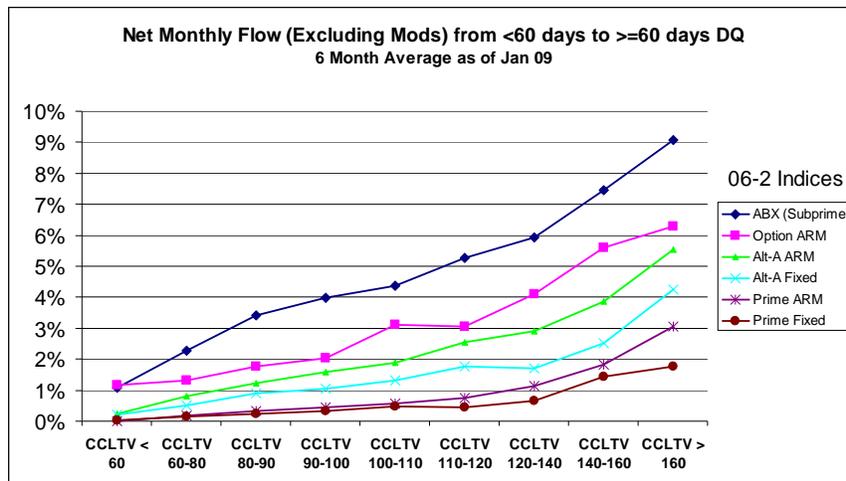
If, despite efforts to curtail leverage, the crisis begins anyway, the only way to get out is to reverse the three standard causes of leverage cycle crises: Reduce the uncertainty, re-leverage the system (to moderate levels), and inject optimistic capital to make up for the lost demand from the suddenly bankrupt or insolvent optimists. I only have time here to say a few words about the first two.

During the crisis and its aftermath, what looks like a demand problem – no one is borrowing at the going low interest rate – is really a collateral problem. Lenders are asking for so much collateral that investors can't borrow because they don't have the collateral. What the Fed has to do is to go around the banks and lend directly on less collateral, not at lower interest rates. In fact, that is one of the things the Fed and Treasury did that helped get us out of the depths of the crisis. It could have been done on a much broader scale. But the bravery to do something that had never been done before played a critical role in helping avoid a worse catastrophe.

After a major crisis has stabilized, the most important uncertainty becomes who will go bankrupt. The next thing the government needs to do is to resolve that uncertainty, for example by forcing lenders to write down principal. Debt overhang causes terrible deadweight losses. Once a homeowner is far enough underwater, he is not going to fix his house to raise its value when he knows he will probably lose it eventually

anyway. Throwing him out of the house for defaulting also incurs huge costs. Subprime lenders on average recover less than 25% of their loan from foreclosing. It takes 18 months to 3 years nowadays to throw somebody out of his house, during which time the mortgage is not paid, taxes are not paid, the house is not fixed, the house is often vandalized, and realtor expenses are incurred. If write down principal, get more for lender and borrower!

A major reason many homeowners stopped paying in this crisis has been that they are underwater. Diagram 6 indicates that homeowners with current loan-to-values well below 100 percent rarely default, whereas subprime borrowers with loan-to-value at 160 percent were defaulting at the rate of 8 percent per month in 2009.



- Homeowners defaulting primarily because they are underwater.
- Reducing their interest rates temporarily will not solve the problem,
- but make it worse.

By writing down principal on subprime loans so that the homeowners are above water, lenders and borrowers can both gain. The biggest policy mistake we made in the current crisis was entrusting mortgage modifications to the Servicers and the banks. The servicers do not own the mortgages and thus do not have the same incentives as the bond holders or the homeowners to write down principal. And the big bank lenders are afraid of taking an immediate loss on their books, even though they will incur a bigger loss down the road by foreclosing. I wrote about this two years ago in two op-eds with Susan Koniak in the *New York Times*, predicting a foreclosure fiasco if the government did not act.

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