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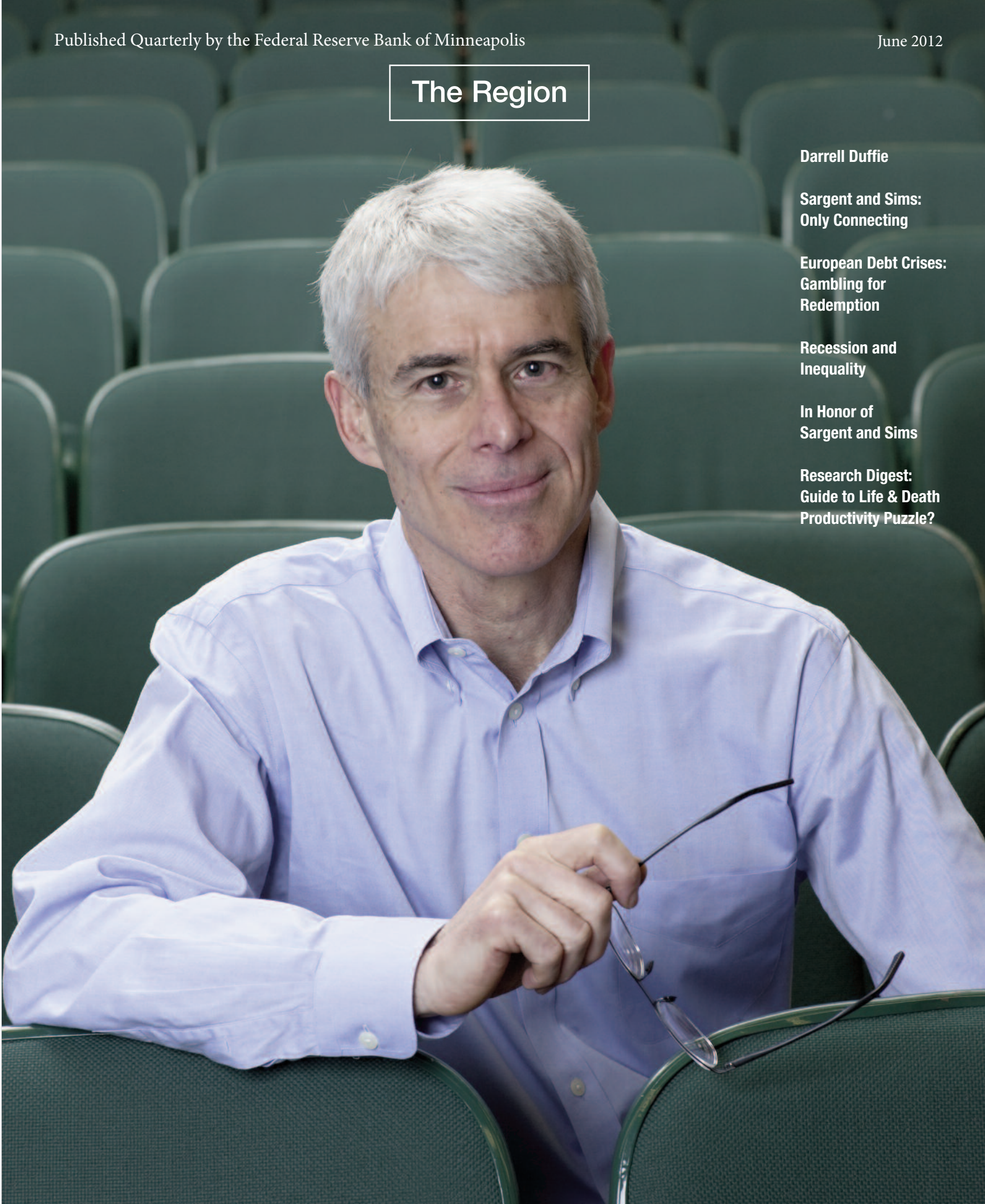

Darrell Duffie

Sargent and Sims: Only Connecting

European Debt Crises: Gambling for Redemption

Recession and Inequality

In Honor of Sargent and Sims

Research Digest: Guide to Life & Death Productivity Puzzle?

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2 Ninth District Notes
Sargent and Sims: Only Connecting
Narayana Kocherlakota

4 Chronic Debt Crises in the Eurozone, 2010-2012
Prolonged recession encourages "gambling for redemption"
Cristina Arellano, Juan Carlos Conesa and Timothy J. Kehoe

12 Interview with Darrell Duffie
Douglas Clement

28 Inequality and Redistribution during the Great Recession
Both reached historic highs; on net, low-earning households became more vulnerable
Fabrizio Perri and Joe Steinberg

38 Celebration Time (Series)
A conference in honor of Thomas Sargent and Christopher Sims
Joseph Mahon

42 Research Digest
Matters of Life and Death
Unmeasured Investment
Douglas Clement and Phil Davies

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NINTH DISTRICT
NOTES

Sargent and Sims: Only Connecting

Narayana Kocherlakota
President
Federal Reserve Bank of Minneapolis

Editor's note: This column is based on remarks presented at a conference in honor of Thomas Sargent and Christopher Sims, held May 4-5, 2012, at the Federal Reserve Bank of Minneapolis. To read more about the conference, go to page 38 in this issue, or visit minneapolisfed.org.

I am still early in my speaking career, but I have already learned one key lesson: You don't want to go on too long when people have gone through a long day of conferencing. So, I will be brief.

Currently, I'm in the process of rereading—for probably the fourth or fifth time—one of my favorite books: *Howards End*, written by E. M. Forster when he was turning 30 years old. It's a wonderful book—full of amazing writing and Forster's remarkable moral sense. I feel that I learn something every time I go back to it.

Howards End is probably most famous for its epigraph: "Only connect …" Now, this epigraph is often interpreted as saying that people should connect with one another. Actually, Forster's message is considerably more interesting. He sees people as having two selves—a spiritual self and a material self—and life is only lived to the fullest when the two are able to connect.

This message may not seem all that relevant to economics per se, yet I find myself asking: Don't we see Forster's two selves within our field in the form of the technical and the intuitive? Like the material in life, mathematical and statistical techniques are the essential tools without which progress is impossible. Like the spiritual in life, intuition is what allows us to understand what the progress truly means. And like the material and the spiritual, it is often hard to bring technique and intuition together. Yet, surely, economics is at its best when it does connect its two selves. It is in that fusion that we are able to shed the fullest light on what was once unclear.

Much of the work of today's honorees—Tom Sargent and Chris Sims—shows how we can accomplish that elusive fusion between technique and intuition. We all could point to many examples in their work of what I have in mind. But we need not go further than two recent and related addresses—Sargent's 2011 Nobel lecture (at http://bit.ly/KOXjuO) and Sims' 2009 Society for Economic Dynamics plenary lecture (at http://bit.ly/L34YEb). Tom's Nobel lecture uses ideas, economic history, mathematics and econometrics

to forge a compelling analogy between America under the Articles of Confederation and the current structure of the European monetary union. Chris' SED lecture uses ideas, economic history, mathematics and econometrics to draw a number of important and not-so-heartwarming conclusions about recent changes in Fed policies and tools.

These talks of Sargent and Sims make it look easy to connect the two selves—the intuitive and the technical—of economics. But I think we all know that it is anything but easy, and I would say that I am glad to have such examples as I struggle every day to make that connection in my own thinking and work.

As I say, *Howards End* is best known for the "Only connect …" epigraph. But it has many other powerful themes. Another is that, throughout the book, Forster emphasizes the tension between two ways of seeing life: seeing it steadily and seeing it whole. Again, I think we can see an analogous tension in economics. After all, we can choose to see our field steadily through the lens of one class of models, one set of methods or one mode of thought. Or we can choose to see our field whole, with all of the messiness of its myriad methods, models and modes of thought.

Personally, I have felt this tension throughout my career. I have spent much of my time learning and so appreciating the range of work in macroeconomics. Doing so has made it challenging, though, to bring the appropriate focus to bear on any particular problem. I have found my reading of Chris' and Tom's work, and my conversations with them over the years, to be inspiring in this regard. To a remarkable—maybe unparalleled—extent, I would say, they do see macroeconomics whole and they see it steadily.

I promised to be brief, so let me wrap up. One of the great things about reading Forster is that he delivers his messages and lessons in subtle ways—they are hidden deep within chapters, and sometimes even deep within paragraphs. I have not lived up to his example tonight! Instead, I have hammered away at two main messages: "Only connect …" intuition and technique and "see macroeconomics whole and see it steadily." Both messages fall into the category of being bromides that are easy to say and not so easy to do. Fortunately, we have the examples of Chris and Tom to guide us. R

Chronic Sovereign Debt Crises in the Eurozone, 2010-2012

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Economic Policy Papers *are based on policy-oriented research by Minneapolis Fed staff and consultants. The papers are an occasional series for a general audience. Views expressed are those of the authors, not necessarily of others in the Federal Reserve System.*

ABSTRACT

Two years after the rescue package for Greece provided by the European Union and the International Monetary Fund in May 2010, sovereign debt crises continue to threaten a growing number of countries in the eurozone. We develop a theory for analyzing these crises based on the research of Cole and Kehoe (1996, 2000) and Conesa and Kehoe (2012). In this theory, the need to frequently sell large quantities of bonds leaves a country vulnerable to sovereign debt crisis. This vulnerability provides a strong incentive to the country's government to run surpluses to pay down its debt to a level where a crisis is not possible.

A deep and prolonged recession, like those currently afflicting many eurozone countries, creates a conflicting incentive, however, to "gamble for redemption"—to bet that the recession will soon end, to sell more bonds in order to smooth government spending and, if indeed the economy recovers, to reduce debt. Under some circumstances, this policy is the best that a government can do for the citizens of its country, but it carries a risk: If the recession continues too long the government either will have to stop increasing its debt or will have to default on its bonds.

The theory suggests that policies that result in high interest rates on government bonds and high costs of default provide incentives for a government to reduce its debt and avoid sovereign default. On the other hand, policies that result in low interest rates and low costs of default provide incentives for a government to gamble for redemption. We conclude that policy interventions taken to date by the EU and the IMF—by lowering the cost of borrowing and reducing default penalties—have encouraged eurozone governments to gamble for redemption.

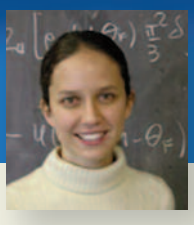
Introduction[1]

Beginning in late 2009, the Greek government had difficulties selling its bonds to private investors, who demanded high interest rates. In May 2010, the European Union (EU) and the International Monetary Fund (IMF) approved a 110 billion euro loan package to the Greek government in return for promises of spending cuts to sharply reduce the Greek public deficit. The plan, negotiated by German Chancellor Angela Merkel and Greek Prime Minister George Papandreou, was intended to cover the borrowing needs of the Greek government through 2013. In spite of this rescue package and another, 130 billion euro, package put together between July 2011 and March 2012, the debt crisis in Greece continues into 2012.

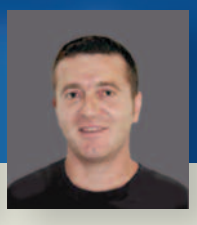
Ireland and Portugal have required similar EU-IMF rescue packages. Cyprus, Italy and Spain have had difficulties selling their bonds. Similar difficulties threaten other members of the European Economic and Monetary Union (EMU)—the countries in the EU that use the euro as their currency, also referred to as the eurozone—like Belgium and France.

In fact, as of April 2012, of the 17 members of the eurozone, only four—Finland, Germany, Luxembourg and the Netherlands—have long-term government bonds with the highest Standard & Poor's rating AAA, while the bonds of five countries—Cyprus, Ireland, Italy, Portugal and Spain—have junk ratings, BBB+ or lower. Greek bonds were

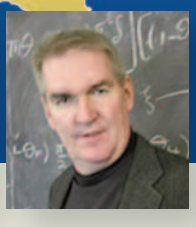
European Union



Cristina Arellano



Juan Carlos Conesa



Timothy J. Kehoe

EU eurozone

given the lowest possible rating, CCC, in July 2011, and are currently not rated, but are listed as SD, meaning that the Greek government has selectively defaulted on some issues.

The countries that have suffered debt crises, or are threatened by such crises, got into trouble in different ways. The two crucial common characteristics are that each of these countries is currently experiencing a deep and prolonged recession and each needs to frequently sell large quantities of bonds, either to finance large fiscal deficits or to roll over—and make interest payments on—a large public debt.

We sketch out a theory for analyzing the European sovereign debt crises based on the research of Harold Cole and Timothy Kehoe (1996, 2000) and Juan Carlos Conesa and Kehoe (2012). In this theory, the need to frequently sell large quantities of bonds leaves a country vulnerable to a financial crisis. This vulnerability gives the government the incentive to pay down its debt to a level where such a crisis is not possible. In the event of a deep and prolonged recession, however, the government has a conflicting incentive to "gamble for redemption"—to borrow to smooth government spending, to reduce the debt if the economy recovers and, possibly, to default if the recession continues for too long.

Using this theory, we analyze the various rescue packages and policy interventions made by the EU and the IMF. Policies that result in high interest rates on government bonds and high costs of default provide incentives for a government to reduce its debt. Policies that result in low interest rates and low costs of default provide incentives for a government to gamble for redemption. We conclude that, up until now, policy interventions by the EU and the IMF have encouraged eurozone governments to gamble for redemption. In the theory we present, a government that gambles for redemption is following a policy that is optimal for the citizens of its country. The policy goals of the EU and the IMF may be different from those of the government of an individual country, however, and, to the extent that the EU and the IMF want the government to reduce its debt to avoid a crisis to preserve the stability of the EU, they should adopt policies to discourage the government from gambling for redemption.

Timeline and some data

The Treaty on European Union—signed in Maastricht, Netherlands, on Feb. 7, 1992, and commonly referred to as the Maastricht Treaty—converted the European Community, which then had 12 members, into the European Union. The treaty established four "convergence criteria" as prerequisites for membership in the EMU. One criterion required a country to have an annual public deficit no greater than 3 percent of GDP and a public debt no greater than 60 percent of GDP. Another criterion required the country to participate in the European Exchange Rate Mechanism (ERM)—set up as a voluntary program in 1979—to maintain its exchange rate in a very narrow band around the European Currency Unit (ECU), which eventually became the euro. The other two criteria imposed restrictions on inflation rates and interest rates.

In the process of ratifying the Maastricht Treaty, Denmark and the United Kingdom obtained opt-out clauses from joining the monetary union. All 15 countries that have joined the EU since 1992 were required to join the monetary union. The ERM suffered a major crisis 1992, with a number of countries forced to drop out, and—when the crisis threatened more countries in 1993—the exchange rates bands were widened considerably. The mechanism was restarted in 1999 and is now referred to as ERM II.

Sweden, which joined the EU in 1995, has managed to exploit a legal loophole to avoid adopting the euro: Its accession treaty required Sweden to join the monetary union after meeting the convergence criteria and participating in the ERM II for two years, but it did not explicitly require Sweden to join the ERM II, and it has not done so. The other seven countries in the EU that are not yet in the eurozone are required to go through the process of participating in ERM II and eventually joining the eurozone.

A timeline of the major events related to the sovereign debt crises that are ongoing in the eurozone is available online. (See the June 2012 *Region* at minneapolisfed.org.)

European leaders had seen the need to coordinate fiscal policy in a monetary union. In 1997, at the insistence of Germany, they adopted the Stability and Growth Pact (SGP), which imposed financial penalties on countries that violated the convergence

criterion that the public deficit not exceed 3 percent of GDP. Nonetheless, when the French and German governments announced that they had violated this deficit limit in 2003, they were not penalized, reducing the credibility of the SGP.

The details (available online) differ on how various countries became vulnerable to sovereign debt crises. In spite of these differences in initial conditions, Greece, Ireland, Italy, Portugal and Spain (GIIPS) share two crucial characteristics: First, as the data in Figure 1 show, the recoveries from the 2008–2009 recessions in these countries have been nonexistent. Notice that, in Figure 1, the German economy has started to recover in 2010 and 2011, if only weakly, while the GIIPS are still mired in recession. Second, as the data in Figure 2 show, the GIIPS have large borrowing requirements because of high deficits or large debts or both.

Self-fulfilling debt crises

The need to frequently sell large quantities of bonds leaves the countries vulnerable to self-fulfilling debt crises of the sort analyzed by Cole and Kehoe (1996, 2000) and Conesa and Kehoe (2012). In such a crisis, if investors expect a government to have trouble repaying its debt, they pay a low price at auctions of new government bonds. The resulting low value of the new bond sales makes it difficult for the government to repay the old bonds becoming due, thus justifying the expectation of a crisis. If, however, investors do not expect the government to have trouble repaying its debt, they are willing to pay a high price for new bonds. This expectation too is self-fulfilling.

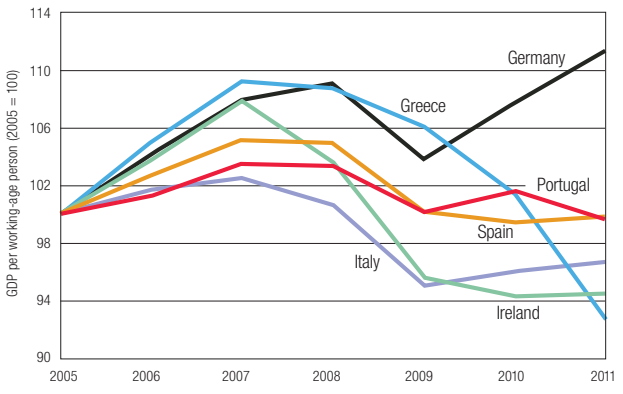
To understand the reasoning in the model, we start by examining two crucial relations: the government budget constraint—which relates sales of new bonds and payments on old bonds to government expenditures and tax receipts—and the relation between the price that investors pay for bonds and the probability of a sovereign default. (These analyses are available online.) We then explain how the government determines its optimal policy and how financial crises can occur.

Optimal government policy and crises

In every time period in the model, the government must decide how much new debt to sell and whether or not to default. We assume that the government is benevolent, in that it values the welfare of consumers, that is, the citizens of the country, who value both private consumption and government expenditures. We also assume that consumers—and consequently the government—value smooth paths of private consumption and government expenditures. Sharp cuts in government expenditures are particularly painful. Defaults are also costly in that they disrupt financial markets, which causes a drop in the GDP of, say, 5 percent—

Figure 1

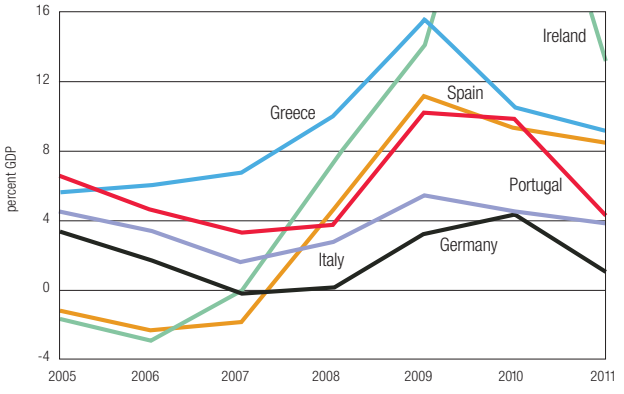
Real GDP per working-age (15-64) person



Source: The data are available at http://www.econ.umn.edu/~tkehoe/.

Figure 2

Net government borrowing



Source: The data are available at http://www.econ.umn.edu/~tkehoe/.
Note: Net government borrowing in Ireland was 31.2 percent of GDP in 2010.

which we refer to as the default penalty—that is available for government expenditures, private consumption and repayment of debt. These assumptions are intuitively appealing and fairly innocuous.

We make a number of other assumptions that are more restrictive to keep the analysis simple. We assume, for example, that tax revenues are a constant fraction of GDP because tax rates are fixed. We also assume that the default penalty is permanent and that, if the government defaults, it is permanently excluded from borrowing. Cole and Kehoe (1996, 2000) model consumers within a country as making private investment decisions, but here—again to keep things simple—we follow Conesa and Kehoe (2012) in having consumers consume all after-tax GDP rather than investing some of it. These assumptions can be relaxed without changing the qualitative results of the model. How much quantitative results change depends on the parameterization, of course, and this is a topic that deserves future research.

A financial crisis is self-fulfilling if the expectation that the government will default causes it to default in a situation where it would otherwise pay for the bonds becoming due. For low levels of debt, self-fulfilling crises are not possible. For higher levels of debt—those above a threshold that we call the upper safe debt limit—self-fulfilling crises are possible. For even higher levels of debt—those above a threshold that we call the upper sustainable debt limit—the government prefers to default rather than pay for the bonds becoming due.

The timing within a period is such that investors decide what price to bid in the auction for new government bonds before the government decides whether or not to default on the old bonds becoming due. Suppose that, before the auction, investors receive some sort of bad news that makes them expect the government to default this period. Under what conditions will this expectation be self-fulfilling? The investors expect that the government will be in default the subsequent period because it is excluded from financial markets. The price that the investors offer for new bonds is the present discounted expected payment in the case of default, which is low or zero. The government can either default or pay for the bonds becoming due. For levels of debt equal to or below the upper safe debt limit, the government prefers to pay for the bonds becoming due and suffer the drop in government expenditures but avoid paying the cost of defaulting. For these low levels of debt, investors will pay a high price, equal to the present discounted face value for new bonds, no matter what the news is. If, however, debt is above the upper safe debt limit, a self-fulfilling crisis occurs if there is bad news. For high levels of debt, those above the upper sustainable debt limit, the government chooses to default even if investors buy the new bonds offered.

The probability that investors assign to receiving bad news in a period is arbitrary.[2] At the beginning of a period, the bad news arrives or it does not. Notice that, in the bond auction in a period, if bad news had not arrived early in the period, then the bond price depends on the probability of receiving bad news in the next period.

Cole and Kehoe (1996, 2000) call the interval of debt levels above the upper safe limit but equal to or below the upper sustainable limit the crisis zone. If debt is in this zone, a self-fulfilling crisis can randomly occur. Since interest rates are high when the debt being sold is in the crisis zone and the probability of a costly default is positive, a government will optimally choose to run surpluses to run its debt down to the upper safe limit. Once debt reaches the upper safe limit, interest rates drop and the probability of default disappears. Since sharp cuts to government expenditures are painful, however, the government may choose to pay down the debt over a number of periods.

In a quantitative model calibrated to match features of European data, Conesa and Kehoe (2012) show that the upper safe limit is about 120 percent of GDP while the upper sustainable limit is about 210 percent of GDP. These numbers make sense in terms of the numbers currently used by policymakers in Europe, in particular, the need to reduce Greek debt below 120 percent of GDP to eliminate the possibilities of future crisis.[3]

Gambling for redemption

As we have just argued, financial crises and defaults on sovereign debt are costly for a country, and the government of a country that finds itself vulnerable to a self-fulfilling crisis has the incentive to pay down its public debt so that it does not need to frequently sell large quantities of bonds. As Conesa

and Kehoe (2012) point out, however, countries that are in deep recessions have an opposite incentive: to cut government spending very slowly and increase the public debt, gambling that a recovery in the economy will lead to a recovery in tax revenues, at which point it can stop increasing the debt. If the country is unlucky and the recession is prolonged, however, the country can find itself more vulnerable to a self-fulfilling debt crisis and ultimately may be forced to default.

Conesa and Kehoe (2012) modify the Cole-Kehoe model so that the country finds itself in an unexpected recession, where GDP is, say, 10 percent lower than its otherwise constant level.[4] This is meant to correspond to the situation in Europe in 2008. In every period there is a constant probability—say 0.2, that is, one in five—that the economy will recover. With this stochastic process, which is like flipping a biased coin with the probability of heads being the probability of recovery, the expected waiting time for a recovery is a number of periods equal to the reciprocal of the probability of recovery. If, for example, the probability of an economic recovery is 0.2 per year, then, at any time where a recovery has still not occurred, the expected waiting time for a recovery is 1/0.2=5 years.

To understand gambling for redemption, consider first the case where self-fulfilling debt crises are not possible because, for some reason, the probability of bad news is zero. Then, because it wants to smooth expenditures as much as possible, a government would optimally choose to borrow when it is in recession at a high bond price equal to the present discounted face value, planning to pay back when the economy recovers. Like a gambler at a roulette wheel who keeps doubling his bet, the government is gambling that the recession will not continue for too long. Unlike the gambler, the government is doing something beneficial while it is gambling. It is smoothing government expenditures, something that the citizens of its country value.

If the recession does go on, there are two possibilities for the equilibrium outcome, depending on the costs of default: If the costs of default are high, the government will borrow less and less each period until its debt converges to an upper limit above which investors know that the government would default. If the costs of default are lower, the government will optimally choose to default after a finite number of periods, borrowing in the period before default at a price equal to the present discounted expected value of the face value if there is a recovery in the next period and the payoff in default if there is no recovery. This is not a self-fulfilling crisis: Investors and the government correctly anticipate default if there is no recovery. The only uncertainty is whether the economy will recover or not.

Consider now the general case where self-fulfilling crises are possible but where the economy is also in a recession from which it might recover. The government faces conflicting incentives. Various outcomes are possible and reasonable, depending on the values of parameters. The government could optimally choose either to pay down its debt to the upper safe limit or to borrow still more, running up its debt, gambling for redemption. The optimal choice depends on the costs of default, the probability of a crisis, and the probability of recovery from recession.

Cristina Arellano (2008) argues that defaults can also occur when GDP is low enough. In her model, countries borrow large amounts in booms because interest rates are low because debt is below the upper safe limit. When a recession hits, however, the same amount of debt may be above the new upper safe limit, and interest rates rise, making it costly to roll over the debt. For a sufficiently large drop in GDP, a level of debt that is safe if GDP is high can be above the upper sustainable limit if GDP is low, in which case the government now prefers to default.

Analyzing EU and IMF policy and extending the model

We can use our theory to evaluate the impact of policies followed by the EU and the IMF. Any policy that decreases the price that a country receives for its bonds (that is, increases the yields that it pays), or increases the costs of default, provides the government with incentives to reduce its debt to exit the crisis zone. In contrast, any policy that increases bond prices (lowers the yields), or lowers the costs of default, provides the government with incentives to gamble for redemption.

The rescue packages listed in the timeline

stopped self-fulfilling crises in Greece, Ireland and Portugal. They also provided credit to countries at lower interest rates than the yields presented in Figure 3. These policies can be interpreted as encouraging gambling for redemption. It is worth pointing out, however, that the rescue packages also explicitly required austerity measures, even if these requirements were later violated, especially in the case of Greece.

One policy that very clearly encourages gambling for redemption is the European Central Bank's Securities Market Program (SMP). The SMP buys bonds of countries whose bond prices fall too low. By propping up their bond prices and keeping yields low, the SMP reduces incentives to pay down the debt and escape the crisis zone. Similarly, the ECB's policy of reducing its repo rate and relaxing collateral constraints to encourage banks to buy government bonds with high yields drives up the price of bonds and encourages gambling for redemption.

Another policy that may have encouraged gambling for redemption was the 50 percent haircut on Greek bonds planned at the European Summit in July 2011 to be imposed on private investors, principally private banks in the EU. By labeling the haircut voluntary, the EU intended to eliminate some costs of default, such as triggering credit default swaps (CDSs), securities that pay the buyer in the event of a default. EU leaders thought that triggering CDSs would be very disruptive to the financial system, both inside and outside Greece. Greece had already reached a debt level that it could not hope to repay, but planning "voluntary" haircuts on Greek bonds signaled other troubled governments that such a reduction in the costs of default might be available for them.

By March 2012, it was clear, however, that this sort of "voluntary" haircut was not feasible, mostly because courts would not rule out claims on CDSs. Greece ended up imposing a much larger haircut, negotiating with the majority of bond holders and enforcing the settlement on the rest of bond holders by appealing to CACs (collective action clauses). There are currently doubts about the legality of this move, however, because the CACs were inserted into the bond contracts retroactively.

A challenge for Europe is how to best design restructuring procedures for countries that might follow Greece into default while minimizing adverse incentives for other countries.[5]

While our theory provides an appealing explanation of why the threat of sovereign debt crises in Europe has been going on for so long, it leaves open a couple of major questions. We can use our theory to understand the behavior of leaders of countries threatened by debt crisis, like George Papandreou in Greece, but it does not help us understand the behavior of EU leaders like Angela Merkel of Germany and Nicolas Sarkozy of France, who have struggled to provide rescue packages. It may be that they too have been gambling for the redemption of the eurozone itself, rather than their national economies. Merkel and Sarkozy may have believed that the only thing that will pull the eurozone out of the danger of debt crises is a vigorous economic recovery from the recession, and they are just trying to hold the EMU together until that happens. It would be useful to develop a model of this.[6]

It is also clear that the institutional design of the EMU—in particular, the mechanisms to enforce fiscal discipline, like the Stability and Growth Pact—is inadequate. European leaders are currently struggling to come up with a better institutional design, and it would be worth developing a theory of the optimal design of the EMU.

A related question is why sovereign debt crises like those in Europe do not currently threaten countries like Japan, the United Kingdom and the United States. These countries, like those in the eurozone, have large public debts and have suffered from the recent recession. Thomas Sargent (2012) presents a provocative narrative arguing that a key difference in the United States is that the central government has the power to raise substantial resources through taxation, a power the EU lacks. Another crucial difference is that each of these countries, unlike the eurozone countries, has its own currency whose value can fluctuate freely in response to changing economic conditions. This too is worthy of further research. R

Endnotes

[1] The authors thank Tito Cordella, Isabel Correia, Patrick Kehoe, Narayana Kocherlakota, David Levine, Thomas Lubik, Fabrizio Perri and Pedro Teles for helpful discussions. They also thank Jose Asturias, Wyatt Brooks and Laura Sunder-Plasssmann for excellent research assistance. The data presented in the figures are available at http://www.econ.umn.edu/~tkehoe.

[2] Cole and Kehoe (1996, 2000) model this news shock as what economic theorists call a sunspot, a random variable that affects the equilibrium only through investors' expectations. The value of bad news is arbitrary and can vary over time, which would account for fluctuations in the spreads in Figure 3 (available online). The arbitrary nature of exactly what constitutes bad news is how the model captures what finance ministers refer to when they complain about their country's bonds being at the mercy of the financial markets.

[3] Whether this gives us more confidence in the quantitative properties of the model or more confidence in European policymakers is an open question.

[4] To keep things simple, we assume that GDP does not have a growth trend. If GDP is 100 before the recession, it falls to 90 during the recession. A recovery is a return to 100. If there is a default during the recession, GDP falls another 5 percent, to 85.5. A recovery now only increases GDP to 95. It is easy to convert the model to one in which the economy is growing at a constant rate and in which neither the qualitative results nor the quantitative results change. In a more complicated model, the shock could affect the growth trend. Mark Aguiar and Gita Gopinath (2006) argue that shocks to growth rates have stronger effects on default incentives than do changes in levels.

[5] David Benjamin and Mark Wright (2009) and Pablo D'Erasmo (2011) provide a theory for renegotiation between a government and a representative of the bond holders. They argue that it is worth delaying restructuring until countries have low default risk and high output because those are times when mutually beneficial outcomes can be obtained more easily. Their results imply that renegotiation is particularly difficult now when many eurozone countries are still deep in recession and where there is substantial uncertainty about the future.

[6] Arellano and Yan Bai (2012) argue that a reason for a lender—and the EU itself has become a major lender to troubled countries though the European Financial Stability Facility and the ECB's SMP and repurchase agreements—to be lenient with a subset of borrowers in default is to avoid other defaults from other borrowers.

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Editor's note: *This is an abridged version of the policy paper, which is available in full at the Economic Policy Papers site at minneapolisfed.org.*

Darrell Duffie

In the increasingly vital yet bewildering world of financial economics, Darrell Duffie is both a deep-level theorist and a hands-on plumber. He marries abstruse theory with solid reality and, unlike most economists, can then lucidly explain this often awkward union to those without his intuitive grasp. Few are better suited, then, to evaluate and clarify key challenges in the aftermath of the recent financial crisis. Duffie can't eliminate the fog, of course, but his insights are among the sharpest.

Over two decades at Stanford's Graduate School of Business, he has studied financial institutions and their networks, securities pricing, credit markets and risk management. This research is not light reading. He generates inscrutable papers on "ergodic Markov equilibria," for example, and was analyzing tri-party repos and credit default swaps before most economists knew they existed.

Fortunately, he also writes for the rest of us. Since the crisis, he has authored scores of commentaries and policy papers, testified before Congress and regulatory agencies, and written books that—in accessible language—illuminate murky financial markets and dissect systemic failure. The highest value of this "popular" work may be that after clarifying the weaknesses of existing practices or proposed policy, he then sets out better solutions that suddenly seem obvious.

In the June *Region*, Duffie guides us through the hotly debated Volcker rule, into the fragility of repo markets and the growing importance of central clearing counterparties, and then on to the mysteries of asset pricing. In the end, we're left with the uncanny (if inaccurate) sense that we actually see things as clearly as he does.

Photographs by Peter Tenzer

IMPLEMENTING THE VOLCKER RULE

Region: Perhaps we can begin with the so-called Volcker rule, which would prohibit banks from engaging in **proprietary trading**.* It seems to be among the most controversial parts of Dodd-Frank.

Earlier this year, you presented at the Securities and Exchange Commission (SEC), expressing concerns about the implementation rules being drafted by regulators, including the Fed, for the Volcker rule. Specifically, you highlighted the degree to which those proposed rules would reduce the market-making capacity of banks and that the void thus created might then be filled by the shadow banking sector, with potentially adverse consequences.

Would you briefly explain your concerns? And perhaps tell us why the costs that you envision might outweigh the benefits that Paul Volcker, the Fed and others foresee.

Duffie: Let's go back to the intent of the statute that Paul Volcker had in mind. As I take it, it's a good intent, which is to lower the risk of failure of banks because they are systemically important and because we do subsidize the deposit insurance system. We wouldn't want to encourage risk taking by banks to become unsafe. So the statute starts by saying, OK, let's therefore remove some risky trading that the bank does on its own account, but let's not remove a number of things, the two most notable of which are underwriting, which was not my main subject, and market making, which was my main subject.

Region: What is "market making"?

Duffie: Market making is providing immediacy to investors. That is, when someone wants to buy quickly, you sell to them if you're a market maker. If someone wants to sell immediately, you buy from them if you're a market maker. And that provision of immediacy is done for an expected return that's designed to compensate the market maker for bearing the risk of changing its inventory to meet the demands of those investors.

So we have the statute, and now we're in a period, as you know, where the agencies, including the Fed, are charged with implementing the statute with rules: rule writing. That process has been delayed out of concern that the implementation the agencies have proposed might have unintended consequences. There were 17,000 public submissions on this—way more than any other rule-writing submission process.

Now, most of those are crank letters, but probably a few hundred or so are serious submissions. Some of them are saying, "Pour it on. We do want to keep risky trading of all sorts out of the banks, and let's not make any allowances unless absolutely needed."

Other submissions, I would say probably a large number of them, are from those like me who feel that this will harm the liquidity of markets because market making will be unintentionally constrained by the proposed rules in a manner I'll describe in a minute.

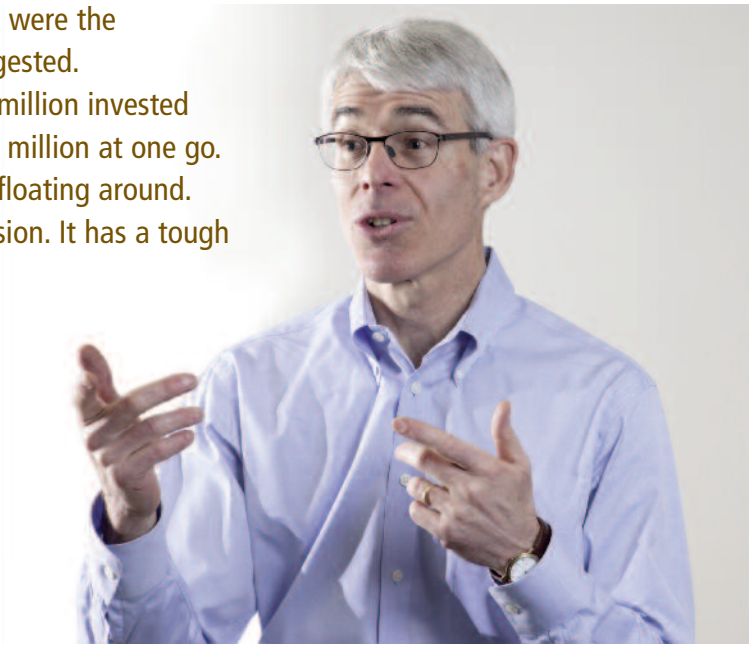
As I also indicated in my submission, if the proposed implementation is adopted and once that void in market liquidity has eventually been filled, we'll have robust market making, but *not* within the regulated banking system. That leaves some concerns about financial stability. We didn't have a very happy experience with large nonbank market makers and other investment banks going into the financial crisis. Part of that experience was due to the fact that these firms weren't well regulated, even relative to banks. You could argue about the quality of regulation of banks, but I would say the majority view is that the investment banks, which at the time were not banks, were much more poorly regulated for capital liquidity and risk taking.

Now that might not happen. Because of the Dodd-Frank Act, we now have the Financial Stability Oversight Council, and it's charged with supervising the risk taking of large nonbanks. And we do have a regime of capital and liquidity requirements for broker-dealers. Some of this market making that would come out of the banks could go into broker-dealers, which would then be supervised by the SEC.

This will harm the liquidity of markets because market making will be unintentionally constrained by the proposed rules. Once that void in market liquidity has eventually been filled, we'll have robust market making, but not within the regulated banking system. That leaves some concerns about financial stability. … I don't think we want to run that experiment.

*Terms highlighted in blue are defined in a glossary on pages 26-27.

Loss buffers and conversion to a variable net asset value were the two alternate proposals that the Squam Lake Group suggested. A third proposal is a redemption gate: If you have $100 million invested in a money market fund, you may take out only, say, $95 million at one go. There will be a holdback. … These three main ideas are floating around. I feel sympathy for the Securities and Exchange Commission. It has a tough decision to make.



But I am concerned about that. The SEC doesn't have a great track record in that area. The capital and liquidity requirements are not under the **Basel III** process. They might adopt capital and liquidity requirements of that type, but they might not. And there is much more limited access to a lender of last resort from the central bank once you're outside of the regulated banking environment. There are some subtleties here, like Section 23A of the Federal Reserve Act, but I won't go into that here.

Overall, I am concerned about where we might end up. We might actually end up better than we are today; we might not. I don't think we want to run that experiment to find out.

Coming back to one part of your question, what is it about the proposed rules that might reduce market making in the banks and cause it to appear somewhere else? As you probably know, there's an approach in the proposed implementation of the Volcker rule that is based on **metrics**. The metrics themselves are not really the main issue. They raise costs for compliance and difficulties like that, which are not my main concern. The key issue is: How might those metrics be applied? In the proposal document, the agencies, including the Fed, are very cautious to say that they are not setting trip wires for these metrics. At this point, they are soliciting comments about how to use the metrics. They also say, however, that market-making profits should come primarily from bid-ask spreads, fees and commissions, and not from price appreciation of the asset that's being taken on or offloaded by the market maker.

Whereas, in fact, if you look at the common practice of market making, it *does* include a substantial amount of risk taking that involves the market maker buying low and selling high later on in the market in order to profit from expected price appreciation. That's one of the ways that the market maker is compensated for taking large chunks of risk.

Region: But is that proprietary trading?

Duffie: Indeed it is. Market making is a form of proprietary trading that Congress decided to *exempt* from its proprietary trading prohibition.

The other aspect of the proposal document suggesting that this kind of robust provision of immediacy by market makers would not be permitted is language to the effect that sudden, dramatic, unpredictable increases in risk would be an indication of trading that is not market making.

In fact, while a lot of market making *is* of the small-risk flow trading type, there are *also* many cases in which an investor wants to offload unpredictably a large amount of risk and will call a market maker to absorb that risk. That would run afoul of the Volcker rule if the agencies applied their metrics with that philosophy. And banks would set up their internal compliance engines to rule out those forms of trading in order to not get dinged by a regulator and have their firms' names in the headlines. They will allocate less capital to taking these kinds of risky market-making trades, and then others will see the opportunity to fill that gap.

As Paul Volcker has predicted, and I think he's right, it's not that we will have illiquid markets forever. Within five, 10 or 15 years, others will come in and, as I said, that will introduce other unintended consequences.

REFORM OF MONEY MARKETS

Region: After you gave your presentation on the Volcker rule, you were accused by some of favoring the financial industry. But it seems you've actually incurred the industry's *disfavor* with your ideas on reforming money market mutual funds—and for that matter, I think also with your recommendation that foreign exchange derivatives not be exempted from the Dodd-Frank swaps requirements.

Could you explain your concerns about these mutual funds, beginning with the role they played in the recent financial crisis? How do you propose they be reformed to prevent those risks in the future?

Duffie: As you know, these funds are treated essentially as cash investments by many investors, both retail and institutional. They are backed by short-term assets like commercial paper and repurchase agreements, which we might talk about later. When there are any concerns about the backing for those money market funds, investors have demonstrated, particularly after the failure of Lehman when one of these money market funds lost money …

Region: The Reserve Fund.

Duffie: Yes, the Reserve Primary Fund. The institutional investors demonstrated that they have very twitchy fingers and will leave almost instantly. And they left not only that money market fund, but the entire prime money market fund complex. Institutional investors took out roughly 40 percent of their holdings in prime funds in the order of two weeks.

Region: Which was roughly how much money?

Duffie: About $300 billion to $400 billion. And that would have continued to the point of ultimate meltdown of the core of our financial system had the Treasury not stepped in to guarantee those money market funds. In a moment, we'll talk about the contagion effect of that meltdown. But just sticking to money market funds for now, economists such as myself who are concerned about this want to encourage the design of these funds so that they are not so prone to flight by institutional investors.

A few ways to do that have been proposed and are now being considered by the Securities and Exchange Commission, which is the primary regulator for money market funds. One of those proposals is to put some backing behind the money market funds so that a claim to a one-dollar share isn't backed only by one dollar's worth of assets; it's backed by a dollar and a few pennies per share, or something like that. So, if those assets were to decline in value, there would still be a cushion, and there wouldn't be such a rush to redeem shares because it would be unlikely that cushion would be depleted. That's one way to treat this problem.

A second way to reduce this problem is to stop using a book accounting valuation of the fund assets that allows these shares to trade at one dollar apiece even if the market value of the assets is less than that.

Region: Instead, **mark to market**?

Duffie: Yes, mark to market. That's called a *variable* net asset value approach, which has gotten additional support recently. Some participants in the industry who had previously said that a variable net asset value is a complete nonstarter have now said we could deal with that.

Region: You and the Squam Lake Group proposed that in a working paper, I believe.

Duffie: Right. Those two measures that I just described, loss buffers and conversion to a variable net asset value, were the two alternate proposals that the Squam Lake Group, of which I'm a member, suggested back in January 2011. [See Baily et al. 2011.] We made a submission to the SEC on its proposed treatment of money market funds.

A third proposal, which has since come to the fore, is a redemption gate: If you have $100 million invested in a money market fund, you may take out only, say, $95 million at one go. There will be a holdback. If you have redeemed shares during a period of days before there are losses to the fund's assets, the losses could be taken out of your holdback. That would give you some pause before trying to be the first out of the gate. In any case, it would make it harder for the money market fund to crash and fail from a liquidity run.

Region: The analogy for a pre-FDIC [Federal Deposit Insurance Corp.] bank run would be the bank temporarily locking its doors.

Duffie: Instead of a bank holiday, it would be like a *partial* bank holiday. You can take out only 95 percent of your deposits, rather than 100 percent. That has the effect of a buffer because each investor in the money market fund is buffering his own or her own investment with the holdback. And that has gotten some support as well.

So now these three main ideas are floating around. The SEC has a serious issue about which of these, if any, to adopt. And it's getting some push-back not only from the industry, but even from some commissioners of the SEC. They are concerned—and I agree with them—that these measures might make money market funds sufficiently unattractive to investors that those investors would stop using them and use something else. That alternative might be better or might be worse; we don't know. It's an experiment that some are concerned we should not run. And, of course, those that sponsor money market funds would definitely not like to run that experiment.

I still believe that the Squam Lake proposals are good. But I think we also need to be aware that the money market fund industry could shrink significantly as a result of any of these proposals. We need to monitor where that liquidity next shows up. Because if it shows up, for example, in ordinary demand deposits in a bank, well, those are insured but only up to a minuscule amount relative to the investments of large institutional investors; $250,000 is essentially nothing for a Pimco or a BlackRock or any large institutional investor.

So if a bank were to become of questionable solvency or liquidity, we could again see some run effects. Unsecured deposits are not backed by anything specific, as opposed to money market funds, which are backed by specific assets. So it is a difficult issue. I feel sympathy for the SEC. It has a tough decision to make.

REFORMING REPO MARKETS

Region: As you know better than most, **repos**, or repurchase agreements, have become the main means for providing liquidity in the money market mutual funds. During the crisis, the repo market failed in a major way and policymakers called for a significant reform of repo market infrastructure.

You've studied tri-party repo markets in particular and worked with the New York Fed in developing proposed changes to its infrastructure. Can you tell us why reform is needed in tri-party repo and why you consider automation so critical? And secondly, in your view, why did the private industry task force assigned responsibility for reform fail, such that the New York Fed felt it necessary to take the reins?

Duffie: That's a great question. Let's start with a description of what tri-party repo is. This concerns, basically, money market funds, which we just discussed—and other cash investors—that lend money over very short terms, like one night, to large banks like JPMorgan, Goldman Sachs, Morgan Stanley and so on.

Region: What types of collateral are used to secure these loans?

Duffie: The large dealer banks secure these overnight loans with securities, typically Treasuries, agencies, corporate bonds and so on. Right now, the majority of it is Treasuries and agencies. Let's start with the legacy system, and then we'll talk about the makeover that has begun. Under the old system, these overnight loans would mature in the morning. The cash investors would be given back their cash plus interest, and the dealer banks would be given back their collateralizing securities.

But the dealer banks needed intraday financing for those securities. That is, between the morning and the afternoon when the next repurchase agreements are arranged, somebody had to finance those securities, and that was done by the tri-party clearing banks. These clearing banks also assist with the arrangement of the repo deals between the dealers and the cash investors.

Region: And there are effectively just two of them.

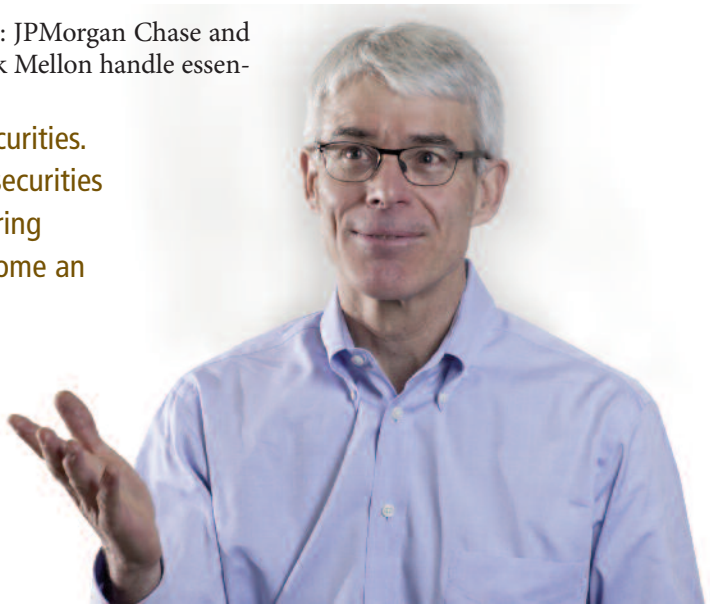
Duffie: Right, two: JPMorgan Chase and Bank of New York Mellon handle essentially all U.S. tri-party deals. As part of this, they provide the credit to the dealer banks during the day. Toward the end of the day, a game of musical chairs would take place over which securities would be allocated as collateral to new repurchase agreements for the next day. All of those collateral allocations would get set up and then, at the end of the day, the switch would be hit and we'd have a new set of overnight repurchase agreements. The next day, the process would repeat.

This was not satisfactory, as revealed during the financial crisis when two of the large dealer banks, Bear Stearns and Lehman, were having difficulty convincing cash investors to line up and lend more money each successive day. The clearing banks became more risk averse about offering intraday credit.

We have to be a bit cautious here. I have a conflict of interest that I need to disclose. I'm a consultant to Lehman in a matter that is related to these issues. I'm under a nondisclosure agreement. Of course, I won't disclose anything here in violation of that agreement.

In any case, the clearing banks got to a point at which they might not agree to provide intraday credit to these banks. And if they had provided it, there was an unlikely but consequential event in

The dealer banks needed intraday financing for those securities. That was done by the tri-party clearing banks. … If the securities were of questionable value or if the leverage at the clearing banks became too large, absorbing all of that might become an issue. Maybe they would say, "No, we won't offer you intraday loans." That could immediately snuff out one of these dealer banks … absent emergency lender-of-last-resort treatment by the Fed.



which they did provide credit and the dealer would fail during the day. The clearing bank would be left on the hook to deal with all of the collateral. That should normally not be fatal, because the collateral was there to back the loan. But the amounts of these intraday loans from the clearing banks at that time exceeded $200 billion apiece for some of these dealers. Now they're still over $100 billion apiece. That's a lot of money.

Region: Potentially unsecured.

Duffie: Well, it *is* secured, by securities. But if the securities, some of them, were of questionable value or if the leverage at the clearing banks became too large, absorbing all of that collateral onto their balance sheets might become an issue for them. Maybe they would say, "No, we won't offer you intraday loans." That could immediately snuff out one of these dealer banks because there's no way they could survive if they couldn't finance their securities for the next day. For operational reasons, a dealer cannot switch to a new clearing bank on short notice. Absent emergency lender-of-last-resort treatment by the Fed, this would basically be the end of whatever dealer bank was on the wrong end of this.

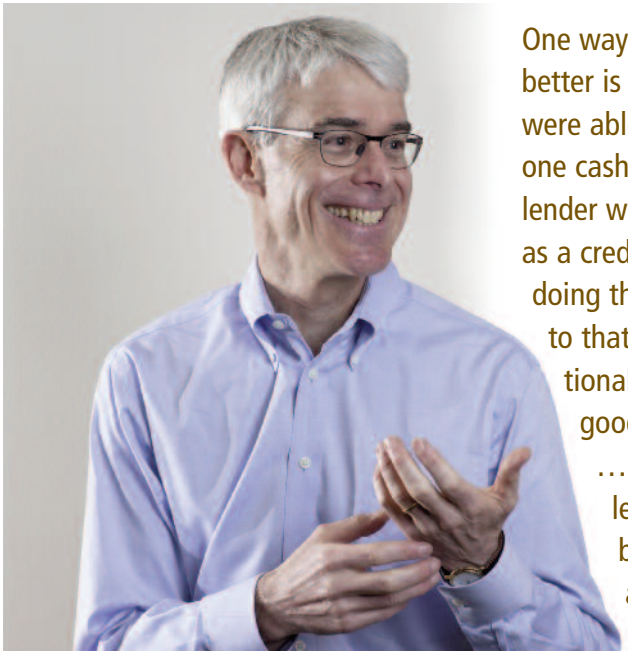
Lehman's portfolio of repurchase agreements was shrinking dramatically through that period as it tried to unwind its positions because of concerns over whether it could, in fact, finance them. Lehman did go bankrupt, as we all know. Lehman's broker-dealer subsidiary kept running for another few days, relying heavily on the Fed for financing of its securities.

AUTOMATING CLEARANCE

Region: In your proposal on reform of tri-party repo infrastructure, you and your co-authors emphasize the need for automated clearance. How would that help?

Duffie: One way the system would run better is if the tri-party banks were able to pass the baton from one cash lender to another cash lender without ever being involved as a creditor themselves. That can be done. It's essentially what's being done in Europe, with minor exceptions.

But doing that or even getting close to that requires very slick operational capability, including very good information technology. And it requires enough *trust* by dealers that the available technology will allocate collateral efficiently to the various loans, so that the dealers will stand back and just allow the information technology to take over and automatically allocate collateral out of the maturing repurchase agreements and into the new repurchase agreements without the clearing bank having to provide interim credit.



One way the system would run better is if the tri-party banks were able to pass the baton from one cash lender to another cash lender without ever being involved as a creditor themselves. But doing that or even getting close to that requires very slick operational capability, including very good information technology. … Right now, it's basically legacy technology. Imagine baling wire, Scotch tape and staples.

Region: So it speeds the process, and it also removes discretion.

Duffie: It removes discretion in a number of ways. It removes the discretion of the dealer who might not trust the efficiency of the information technology and wants to interfere in the process by saying, "No, no, we didn't want those securities into *those* loans. We wanted them into *these* loans because that's more efficient." If the information technology is very good, trustworthy and robust, they could just stand back and let that happen.

Moreover, the dealers might say, "Look, we also want the ability to quickly extract some particular Treasuries or agencies that a customer would like to buy. We'd like the ability to extract those from the pool of collateral backing some loans and replace them easily with other stuff."

You need good information technology to handle all of that efficiently. This sort of technology exists right now, but it's basically legacy technology. Imagine baling wire, Scotch tape and staples. It's going OK but it's not gotten to the point where the New York Fed as the primary regulator of this repurchase agreement market is satisfied that it's robust to the default of a dealer. Therefore, the New York Fed, in effect, pulled the plug on the industry project because it was going too slowly toward a satisfactory removal of the clearing banks from the credit provision in this market.

Region: You've pointed out that European tri-party repo is more efficient, more automated. I can't believe

their technology is that much better. Is their market smaller?

Duffie: In fact, their technology is somewhat better because they started later. When the eurozone came into being in 2001, they had the advantage of not having legacy technology because there was no legacy eurozone. They invested in very good infrastructure and good technology. And they have the advantage you just described of having a smaller market.

Region: Can you give a sense of the relative scale?

Duffie: Well, in Europe, the banks do a lot of the financing of European corporations directly with bank loans. Securities are used less. Moreover, in Europe, securities are often held on bank balance sheets with general financing, rather than on broker-dealer balance sheets, where the cheapest financing is through repo. The corporate bond market in total is much smaller, perhaps about half the size. At the end of 2010, the European tri-party repo market was only about one-fourth the size of the U.S. market, based on data from the International Capital Market Association.

EUROZONE

Region: What is your sense of the fundamental problems in the eurozone? It's not repro markets, since apparently they're better than ours. It's not **credit default swap** speculation—you've said elsewhere that that's not really the issue in Greece. But what then would you propose to solve the fundamental problems in the eurozone? I think you said recently that Europe will "muddle through." That's pretty tempered optimism.

Duffie: Yes, I'm afraid that a good scenario, looking forward from this point, is that over time they're able to recapitalize their banking system and to put some firewalls around peripheral sovereign defaults, so they will have time to eventually restructure the eurozone itself.

The tri-party clearing banks are highly connected, and we simply could not survive the failure of probably either of those two large clearing banks without an extreme dislocation in financial markets, with consequential macroeconomic losses. That's not a good situation. We should try to arrange for these tri-party clearing services to be provided by a dedicated utility, a regulated monopoly.

The recent eurozone banking and sovereign credit crises are partly symptomatic of the very structure of the eurozone that was baked in at the turn of the century, when it was agreed to have a monetary union but not a fiscal union.

Comparisons are made with the United States, whose states also have a monetary union but not a fiscal union. These are not apt comparisons. These European countries are sovereigns; they are not constitutionally required to balance budgets. They rely on the euro as a common currency, but can be overly reliant on the cheap financing available through a stable, large currency zone and can get themselves into trouble. And some of them have done that.

Now there's a damned-if-you-do and damned-if-you-don't problem. The larger, wealthier countries such as Germany and the Netherlands are in a position where they are able to forestall the deepest crises caused by banking problems and peripheral country defaults by putting more of their capital into play. That may simply discourage weaker sovereigns from taking care of their own fiscal problems and kick the can down the road. They may have to do it again.

On the other hand, if they don't contribute significant capital to stop these short-term banking and sovereign defaults from occurring, at least disruptively, then Europe could be thrown into a very significant financial crisis and associated deep recession.

So the "muddle through" scenario is some of this and some of that. Each time the richer European countries give up a little bit more capital, they demand a bit more financial discipline. It's going to be a long, hard road. There are no simple fixes to this.

I would agree with [Harvard University's] Ken Rogoff, for example, on the deeper structural problems that they're facing. They'll eventually come, I think, toward a fiscal union of some sort, possibly with some departing members or at least some taking "sabbaticals." I think Ken used that term.

Eventually, they'll probably get something closer to what they want. But in the meantime, this is harming their growth because the banking system is not vibrant enough to provide a lot of credit, and investors are scared about putting much money at risk right now, with the uncertainty about the eurozone.

Region: It's either short-term pain or long-term pain.

Duffie: Yes, "muddle through." If they can manage to do that, that's good news. What we *don't* want is a sudden banking crisis, which I was worried about last fall until these giant LTROs [long-term refinancing operations] came out of the ECB. I'm referring to long-term refinancing operations by which the European Central Bank, in two rounds now, has provided close to a trillion euros of liquidity to banks, secured by a very wide range of collateral for three years. The terms are very generous to the banks.

Despite the headlines these days, Greece is not going to be a big problem for Europe. In fits and starts, [Greece is] going to default again; I think that's pretty certain. But [it's] not going to

cause the rest of Europe a deep, financial crisis in itself. The precedents that are being set, though, for Greece are important when handling other countries that could get into trouble in the future.

THE ROOTS OF SYSTEMIC RISK

Region: Perhaps now we could discuss the roots of systemic risk in financial markets. Many analysts of the crisis have emphasized interconnectedness. And certainly that's embodied in Dodd-Frank, that interconnections among systemically important financial institutions need to be addressed in order to mitigate future systemic risk.

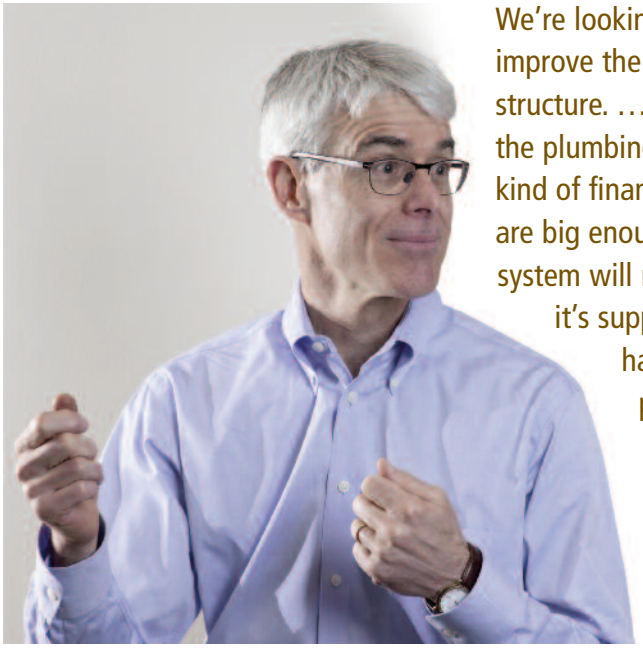
But a number of observers like Peter Wallison of the American Enterprise Institute and John Cochrane at the University of Chicago have argued that the interconnectedness theory is flawed. They suggest that it's really a "common shock" to the system that causes systemwide stress: that a decrease in an asset that's widely held, like real estate, is what led to the crisis.

You've done a great deal of research on correlated default, information transmission in financial markets, liquidity in repo and other markets, the mechanics of bank failure. Do you tend to lean toward the interconnectedness perspective or the common shock theory?

Duffie: John and Peter are both good friends. I think there are elements of their view that are correct. That is, there were relatively few instances in this crisis in which investor B defaulted because they didn't get paid back by investor A.

Nevertheless, there is a substantial amount of connectedness in financial markets through such things as the potential for a fire sale. So if a bank fails and needs to sell its securities in a hurry, the prices of those will likely go down: That could cause a contagion effect for other owners of the same assets.

Then there are forms of interconnectedness that didn't actually result in dominoes during the crisis *because* of government interventions. For example, when AIG was on death's door, a number of very large banks were exposed to AIG on credit derivatives and would have been stressed considerably had it not been for the action of the government to, in effect, bail out AIG.



We're looking at years of work to improve the plumbing, the infrastructure. … If not well designed, the plumbing can get broken in any kind of financial crisis if the shocks are big enough. Then the financial system will no longer function as it's supposed to, and we'll have recession or possibly worse.

Similarly, as we discussed a few minutes ago, money market funds were in the process of melting down. Let's trace through what would have happened had the Treasury not guaranteed those funds. Without that intervention, it's conceivable—in fact, I would say even *likely*—that money market funds would have withdrawn financing so rapidly from the dealer banks through the tri-party repo market that the survival of some dealers would have been under exceptional pressure. That's because, unfortunately, they were overly reliant on short-term loans obtained from money market funds through the repurchase agreement market.

That is a form of connectedness that doesn't sound exactly like the domino story but does need to be addressed, in my view.

And that's only one example. There are others. For example, **central clearing counterparties** [CCPs] are now going to be a big part of our new financial system. They are *very* connected to some large market participants.

The tri-party clearing banks are *highly* connected, and we simply could not survive the failure of probably either of those two large clearing banks without an extreme dislocation in financial markets, with consequential macroeconomic losses.

So if you take, for example, the Bank of New York Mellon, it really *is* too interconnected to fail, at the moment. And that's not a good situation. We should try to arrange for these tri-party clearing services to be provided by a dedicated utility, a regulated monopoly, with a regulated rate of return that's high enough to allow them to invest in the automation that I described earlier. A dedicated utility would not have much moral hazard. It would not have the legal scope for investing in other kinds of risky things, *only* doing tri-party repo—in light of the interconnectedness problem.

FINANCIAL PLUMBING

Region: This leads to the paper you have drafted for the Fed's conference later

this month. [See Duffie 2012.]

You mention in that paper that some progress has been made, especially in terms of capital and liquidity requirements for regulated banks. But you also say that much needs to be done to address the plumbing of the financial infrastructure.

Then you cite six things, some of which we just discussed. They range from broadening access to liquidity in emergencies to lender-of-last-resort facilities, to engaging in a "deep forensic analysis" of prime brokerage weakness during the Lehman collapse.

And then you touch upon tri-party repo markets, wholesale lenders that might gain prominence if money market funds are reformed and therefore shrink, pursuing cross-jurisdictional supervision of CCPs and developing plans for their failure, and including foreign exchange derivatives in swap requirements.

It's a daunting amount of work. Each one of those is a major effort.

Duffie: Yes, it's a big project.

Region: Indeed, and we haven't even gotten the Volcker rule implemented yet—that'll be a while—let alone, tri-party market reform. Well, could you tell us the key principles that underlie these efforts, given what you said about systemic risk and its sources?

A fundamental objective seems to be a desire to design and regulate major parts of the infrastructure that, as you put it, are too important to fail. Regulated utilities, for example.

Duffie: Correct. And there has been a lot of progress made, but I *do* feel that we're looking at years of work to improve the plumbing, the infrastructure. And what I mean by that are institutional features of how our financial markets work that can't be adjusted in the short run by discretionary behavior. They're just there or they're not. It's a pipe that exists or it's a pipe that's not there. And if those pipes are too small or too fragile and therefore break, the ability of the financial system to serve its function in the macroeconomy—to provide ultimate borrowers with cash from ultimate lenders, to transfer risk through the financial system from those least equipped to bear it to those most equipped to bear it, to get capital to corporations—those basic functions which allow and promote economic growth could be harmed if that plumbing is broken.

If not well designed, the plumbing can get broken in any kind of financial crisis if the shocks are big enough. It doesn't matter if it's a subprime mortgage crisis or a eurozone sovereign debt crisis. If you get a big pulse of risk that has to go through the financial system and it can't make it through one of these pipes or valves without breaking it, then the financial system will no longer function as it's supposed to and we'll have recession or possibly worse.

None of these risks that you deftly summarized is *likely* to occur in the next few years, but we shouldn't hesitate, in my view, to invest in a safer and sounder financial system, with the thought in mind that some time in the next 10, 20, 30 or 40 years, we could have another major financial crisis. Or, that by investing in this manner, we can forestall some of those financial crises. Preparedness is important. The cost/benefit analysis, while difficult to do, would probably bear out those recommendations.

MEASURING SYSTEMIC RISK

Region: You have also proposed a very pragmatic, plumbing sort of strategy for measuring systemic risk: the 10×10×10 proposal. Would you summarize that for us?

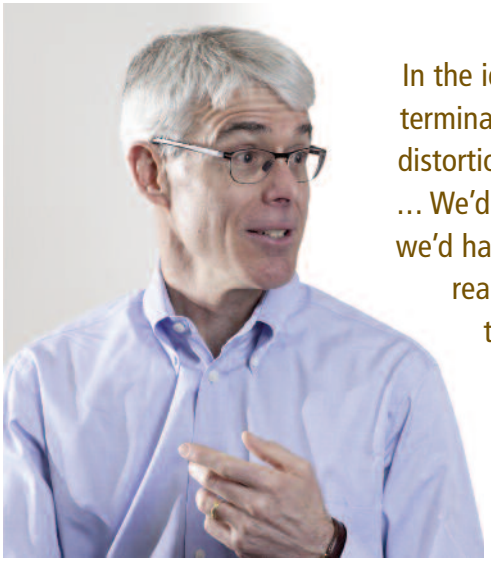
Duffie: Sure. Again, the philosophy is that our financial system is an interconnected system of financial entities, whether they're market utilities or dealer banks or large investors, hedge funds and the like. Until the last few years, our primary approach to monitoring the quality of our financial system insofar as safety and soundness, has been to look at each of the players in the system and analyze whether they're robust enough—especially if they're systemically important—to withstand the kinds of shocks to which they might be subjected.

"How much is enough?" The capital requirements of large banks going into the last financial crisis were generally not enough. I think even the banks would agree. … So "more" is an easier answer than coming up with an exact figure. I would err on the safe side. … The cost of getting it too high is less, in my view, than the cost of getting it too low.

I think we have gotten to the point at which we need to now consider not just the *nodes* in the network, but the *links* that connect them, and to begin to monitor the financial system as though it's a network. In my proposal, we would have the most systemically important firms report to their regulator their exposures to a range of shocks *not only to themselves* (for example, what would a 50 percent reduction in the value of the stock market do to their balance sheet), *but also* how much gain or loss they would experience relative to each of their largest counterparties for that shock.

So I call this "10×10×10" (not that *10* is necessarily the right number) because there would be, let's say, 10 large, systemically important reporting firms, and for each of, let's say, 10 crisis scenarios, they would report their own gain or loss *and* their gain or loss relative to each of their 10 largest counterparties for that shock.

They might not be the same counterparties for one shock as for another. And some of those counterparties



In the ideal world, we'd all be sitting at our terminals watching for every possible price distortion. … We'd all jump in like piranhas. … We'd drive out those price distortions and we'd have very efficient markets. But in the real world, you know, we all have other things to do, and we're not paying attention. So we do rely on providers of immediacy, and we should expect that prices are going to be inefficient in the short run and more volatile.

might not be among the 10 systemically important firms. They could be hedge funds outside of the reporting system or insurance companies or sovereigns or quasi-sovereigns.

By monitoring those links, we will understand where the hotspots are, what scenarios give the greatest concern. It would allow us to ask supervisory questions. We'll understand which counterparties or creditors are most exposed to certain kinds of shocks and to whom they're most exposed. A supervisory conversation that a regulator might have with a large bank could include the question, "Did you realize that the hedge fund with which you

More About Darrell Duffie

Current Position

Dean Witter Distinguished Professor of Finance, Graduate School of Business, Stanford University; Coulter Family Faculty Fellow, 2011-12; on faculty since 1984

Professional Service

Member, Scientific Council, Duisenberg Institute, since 2010

Member, Scientific Committee, Swiss Finance Institute, since 2010

Member, Council, Society of Financial Econometrics, since 2009

Senior Fellow, Stanford Institute of Economic Policy Research, since 2009

Member, Squam Lake Working Group, since 2008

Member, Working Group on Global markets, Hoover Institution, since 2008

Member, Board of Directors, Pacific Institute of Mathematical Sciences, since 2007

Member of the Financial Advisory Roundtable, Federal Reserve Bank of New York, since 2006

Research Associate, National Bureau of Economic Research, since 1997

Honors and Awards

President, American Finance Association, 2009-10

Minerva Foundation Lecturer, Columbia University, 2011

Tinbergen Institute Finance Lecturer, Duisenberg Institute, 2010

Elected fellow, American Academy of Arts and Sciences, 2007

Clarendon Lecturer in Finance, Oxford University, 2004

Financial Engineer of the Year, International Association of Financial Engineering, 2003

Distinguished Teacher, Doctoral Program, Graduate School of Business, Stanford University, 2003

NYSE Prize for Equity Research, Western Finance Association, 2002

Fellow and Member of the Council, Econometric Society, since 1997

Publications

Author of, among other books, *Dark Markets*, Princeton University Press, 2012; *Measuring Corporate Default Risk*, Oxford University Press, 2011; *How Big Banks Fail—And What to Do About It*, Princeton University Press, 2010; *Dynamic Asset Pricing Theory*, Princeton University Press, 3rd edition, 2001. Published extensively in academic journals and elsewhere, with research on security markets, risk management, asset pricing theory and financial market innovation.

Education

Stanford University, Ph.D., engineering economic systems, 1984

University of New England (Australia), master of economics (economic statistics), 1980

University of New Brunswick (Canada), B.S. in civil engineering, 1975

have this large position also has large positions in the same direction with several other large banks? Does that give you any concern about the liquidity impact if this hedge fund had to unwind its position, and you and the other large banks in this asset class would have to unwind or sell collateral associated with that kind of a scenario?"

Of course, the information would need to be treated very confidentially at a disaggregated level. But some of the information could be given to the public at a more aggregated level so that the public could also consider managing or repricing these risks in a way that would improve the health of the financial system. We wouldn't want to panic anyone, though, by suddenly revealing that a certain financial institution had extreme exposures to some scenario.

Region: Essentially, this is sort of an "enhanced" stress test?

Duffie: It's basically a network version of a stress test. From private conversations, I think certain regulators are already doing some of this.

At some point, we may hear more about what regulators are doing in this area. I've had many discussions about this not only with U.S. regulators, but in the United Kingdom, Switzerland and the European Central Bank, among others. It's much more effective if it's done on a global basis because, of course, the network doesn't stop at the boundaries of the United States.

SQUAM LAKE AND CAPITAL REQUIREMENTS

Region: The Squam Lake report recommended setting high capital requirements to mitigate risk of systemically important financial institutions. You've echoed that recommendation in your Volcker presentation and elsewhere in your work. Two questions occur. First, how do you set the right level of capital? That is, what's the *right* ratio of regulatory capital to assets? And second, how do you know that firms won't respond to higher capital requirements by actually taking greater risks as they seek profit on the remaining, nonregulatory capital?

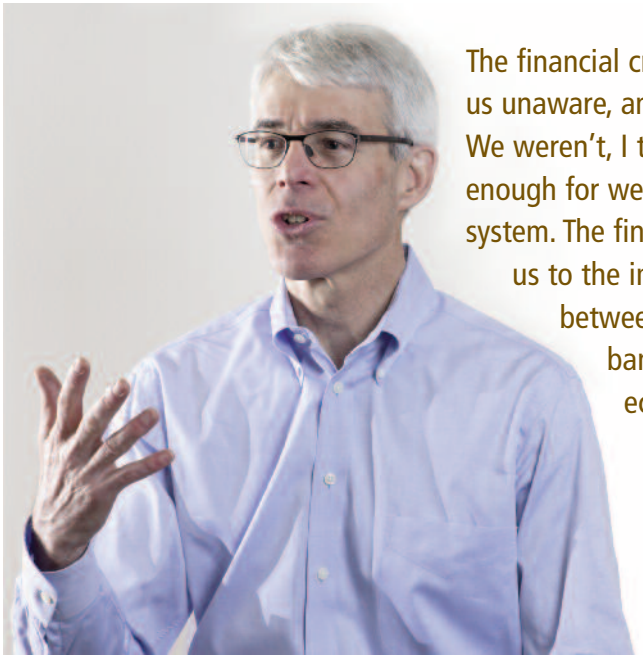
Duffie: The first question is by far the harder one, which is, "How much is enough?" And so far, I haven't seen any academic or regulatory studies that have a strong conceptual foundation for saying 8 percent or 4 percent or 12 percent is enough. We know that, as measured, the capital requirements of large banks going into the last financial crisis were generally not enough. I think even the banks would agree. While each individual bank might say that *it* was fine, they'd also say that the banking system in general was undercapitalized. And certainly that view of the European banking system currently prevails.

So "more" is an easier answer than coming up with an exact figure for how much. The Basel III requirements unfortunately are going to be delayed, although because of the eurozone crisis, they're being accelerated there somewhat. But they're a step in the right direction.

I would err on the safe side. The Swiss standard, which is roughly double the capital requirements under Basel III, is a good example. One concern is that if each country were to set a standard on its own, then none would have sufficient incentive because banking might migrate to another banking center; there would be a loss of competitiveness. Or possibly even worse: a migration of bad risk or even an increase in risk. So it should be done in a coordinated fashion. I think the Basel III process is a good framework in which to do that.

The cost of getting it too high (within reasonable ranges) is less, in my view, than the cost of getting it too low. Some of the banks have suggested that raising capital requirements would significantly reduce the appetite for banks to make loans and provide other banking services. I haven't seen any strong research to justify that view.

It would likely harm the position of the shareholders of those banks because they benefit from leverage. That's a well-understood idea. They have an option to take gains, but if things get bad enough, they have no further losses because of their limited liability. So shareholders would suffer with higher capital requirements. But I am not con-



The financial crisis caught almost all of us unaware, and I am including myself. We weren't, I think, looking broadly enough for weaknesses in the financial system. The financial crisis has alerted us to the important connection between asset market behavior, banking and the macroeconomy.

vinced that banking activities would be reduced dramatically by higher capital requirements. Basel III is certainly not overly aggressive in my view.

Region: And how do you know that firms won't respond to higher capital requirements by taking greater risk with nonregulatory capital?

Duffie: I don't believe, by the way, in the idea that capital should be just gross assets times some fraction. I think you do want to have risk weights. After all, derivatives, for example, require almost no investment in assets, but they can have a tremendous amount of risk per dollar up front. So I think you do need to tune the capital to the type of risk that's taken. If that's done in a judicious way, the opportunity to try to make up with extra risk for additional pressure to create returns for investors, I think, will be forestalled. The risk weights are very important. And I would point not only to the capital but also particularly to the liquidity, which in all of the discussions we had earlier was a key element. It isn't just whether you are solvent. It is also whether you are able to get enough cash on short notice to meet your obligations, say, overnight.

"IGNORANCE IS BLISS"?

Region: In his recent presidential address to the Econometric Society, Bengt Holmstrom suggested that there may be a certain level of desirable opacity in financial markets, that in some situations a *lack* of complete transparency is vital for liquidity.

Given your research on information transmission in financial markets and the effect of search and investor inattentiveness on asset pricing, what are your thoughts about this idea?

Duffie: Well, as Bengt, my friend, himself points out, that is true only so long as the quality of the opaque asset is not brought into question. So, for example, with a **collateralized debt obligation**, as long as there are no concerns, it's wonderful that investors who rely on these for collateral or as a source of risk taking in return for a yield—as long as they *don't* become concerned about the quality of those assets, they won't need to invest time in understanding the incredibly complicated prospectuses of these collateralized debt obligation deals.

I've actually examined them for some research with Nicolae Gârleanu—they are *really* hard to sort out. It would be unfortunate if investors, each individually, had to try to figure them out in order to judge whether there were problems in them. Ideally, that's why investors delegated the monitoring of some of these more complex instruments to rating agencies, but the rating agencies did not get this right either. I have been on the board of directors of Moody's Corporation since the month after Lehman failed. The market for relatively complex structured credit products has nearly disappeared.

We do benefit from the opaqueness of some assets, but only so long as it is commonly agreed that the asset is safe. But we can get into a situation where all of a sudden the quality of the asset is called into question. And then we get extreme adverse selection; almost no one wants to touch the asset. What was your friend when you viewed the asset as safe is now your enemy and possibly becomes a source of market illiquidity. That's exactly what led to the TARP legislation in Congress. The original idea of that TARP deal, despite its ultimate application, was to get around the opacity of some of these complicated assets by having the government buy them and absorb the risk.

ASSET PRICES AND CAPITAL FLOWS

Region: In your presidential address to the American Finance Association, you examined different impediments to capital flow and their effect on asset prices. You look at search frictions (such as those due to market opaqueness) and limits on intermediation (like inventory imbalances, including those during the recent crisis), and then you focus on investor inattentiveness—including a striking Tiger Woods anecdote that I hadn't heard before.[1]

You've studied investor inattention for over 20 years, and in your address, you point out that it has substantial influence on price dynamics by thinning markets. Would you briefly explain this effect, and tell us about the relative contributions of each of these factors—search frictions, limited intermediation and investor inattention—to price dynamics?

Duffie: Sure, and these ideas also intersect with what we discussed earlier, with respect to the Volcker rule. The first really interesting research in this area was by Merton Miller and Sandy Grossman, in 1988 when they pointed out that not all investors are present and participating at all times in financial markets, buying and selling whatever assets others are bringing to the market. [See Grossman and Miller 1988.]

They pointed out that *because* of that inattention by many investors, we rely on professional investors called market makers or liquidity providers to be there and to absorb these sudden demands for immediacy by those who feel they must sell or must buy quickly. Of course, these market makers and other liquidity providers are not going to take the associated risk with almost no reward; they're going to require a price concession. And the fewer are the investors that are actively participating in a market on a given day, the more the price concession would have to be for liquidity providers to absorb that risk.

We can imagine the sale of a large block of stock. Only a few professional liquidity providers, such as market makers, are there to absorb the block onto

their balance sheets. Everyone else is too small to take much, or is not paying attention on that day. The liquidity providers will each have to take a large fraction of that large block. So investor inattention means large price concessions for large blocks of stock or other assets, such as corporate bonds or Treasuries. Market makers will eventually lay off these positions over time at a profit to themselves.

The greater the inattention of the ordinary investor, the greater are these swings in prices caused by price concessions at times of liquidity shocks of this type, and the greater are the resulting long-term reversals in price over time. I've been looking at this issue for some time.

After Miller and Grossman, probably the next milestone in this literature is a paper by Markus Brunnermeier and Lasse Pedersen in which they describe what they called market liquidity and funding liquidity. [See Brunnermeier and Pedersen 2008.] They made that distinction because the ability of market makers to obtain financing for themselves, their funding liquidity, will determine in part the market liquidity of assets. If market makers are not well capitalized or have small risk limits or because regulations such as the Volcker rule are not able to absorb large chunks of risk on short notice, then the liquidity of the corresponding assets will be less.

In the ideal world, we'd all be sitting at our terminals watching for every possible price distortion caused by demands for immediacy. We'd all jump in like piranhas to grab that, we'd drive out those price distortions and we'd have very efficient markets. But in the real world, you know, we all have other things to do, whether it's teaching or interviewing economists or whatever, and we're not paying attention.

So we *do* rely on providers of immediacy, and we *should* expect that prices are going to be inefficient in the short run and more volatile than they would be in a perfectly efficient market, but in a natural way. I have been studying markets displaying that kind of price behavior to determine in part how much inattention there is or how much search is necessary to find a suitable counterparty for your trade.

FINANCE AND MACRO

Region: Let me ask you about finance and macroeconomics. The recent crisis has certainly brought greater prominence to financial economics. But for decades, up until the 1960s perhaps, financial economics was given little recognition in macroeconomic theory. The Nobel awards first honored it in 1990 with the prize to Markowitz, Miller and Sharpe. And in 1997, to Merton and Scholes.

But after the crisis, is enough being done to integrate financial economics into broader macroeconomic scholarship?

Duffie: Well, I would say it's by far the largest growth area in Ph.D. dissertations that I've seen in a long time.

Region: And not just at Stanford?

Duffie: No, not just here. Prior to the financial crisis, there was a surge of interest in finance in areas like corporate governance, compensation, behavioral finance and many other important areas. But the financial crisis caught almost all of us unaware, and I am including myself. We weren't, I think, looking broadly enough for weaknesses in the financial system. The financial crisis has alerted us to the important connection between asset market behavior, banking and the macroeconomy.

The importance of mechanisms like collateral for loans, for example. That's probably one of the most frequently researched topics now for Ph.D. students in the general area of finance and macro. Before the financial crisis, the topic was almost exotic. So definitely the agenda has changed. The integration of macro and finance has been a big improvement in my view.

Region: Thank you very much.

Duffie: It's been a great pleasure. R

—Douglas Clement
March 7, 2012

Endnote

[1] In his American Finance Association presidential address, Duffie refers to a *Wall Street Journal* article (Feb. 19, 2010) that reported, "Investors took time out from trading to watch [Tiger] Woods apologize for his marital infidelity. … New York Stock Exchange volume fell to about 1 million shares, the lowest level of the day at the time in the minute Woods began a televised speech. … Trading shot to about 6 million when the speech ended." (Patterson, Michael, and Eric Martin, 2010, Wall Street takes break for Tiger Woods' apology: Chart of day, Bloomberg)

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Glossary

Basel III

The Basel III accords are international regulatory standards adopted in 2010-11 by members of the Basel Committee on Banking Supervision. The standards focus on capital requirements, stress testing and liquidity risk, and are intended to improve the banking sector's ability to absorb shocks, improve risk management and increase transparency. The reforms target both bank-level regulation and systemwide risk.

Central clearing counterparty (CCP)

The Dodd-Frank Act requires that standard derivatives traded by major market participants be cleared through a regulated CCP that will stand between counterparties trading over-the-counter derivatives. ("Over-the-counter" refers to securities transactions through broker-dealer networks, rather than large exchanges like the New York Stock Exchange or Nasdaq. A derivative is a financial instrument in which value is based indirectly on other assets, like commodity futures, stock options and risk swaps. It's basically a contract between buyer and seller that specifies payment terms based on the underlying asset's value at a specific date.)

The idea of a CCP is to buffer each counterparty against potential default by the other, thereby mitigating systemic risk due to one default propagating subsequent defaults. CCPs might also increase transaction efficiency.

Collateralized debt obligation

CDOs are investor securities backed by a pool of loans, bonds or other assets. Like other asset-backed securities, they are usually divided into "tranches," or subsections, by maturity date and risk level, with riskier tranches paying higher rates of return. While CDOs were initially promoted as a means of reducing risk through diversification, many analysts suggest that their complexity and lack of regulatory oversight instead raised systemic risk. CDO volume increased dramatically in the early 2000s, but the market collapsed during the recent financial crisis.

Credit default swap (CDS)

A CDS is essentially an insurance contract that allows a buyer and seller to trade risk. It compensates the buyer

against losses in the event of a loan default or other credit event. The seller profits by charging a premium for such protection.

For example, a CDS would be an agreement between parties A and B regarding the potential default of company C. (Although recent CDS news has involved potential default on the sovereign debt of nations, rather than companies.) Party A wants insurance against C's default—perhaps it has invested in C—and is willing to pay party B a stream of payments, similar to paying insurance premiums, for that insurance. If C does default, B will pay a specified amount to A. If C doesn't default, however, B retains the CDS payment stream, just as a health insurance company wouldn't return premiums to a healthy customer.

Mark to market

Mark to market is setting the price of an asset or liability to reflect current market valuation, rather than historical book value. Often referred to as "fair value" accounting, marking to market seeks to provide an accurate picture of existing (or recent) market conditions, in contrast to cost accounting based on transactions from the more distant past; book value established through cost accounting may prove inaccurate if asset values change quickly and significantly. Thus, marking to market may provide greater real-time accuracy (assuming relevant markets are transparent and prices readily accessible), particularly during financial crises.

Metrics

The proposed rules for implementation of the Volcker rule provide a set of metrics (or measures) that would enable regulators to evaluate whether banks are in compliance with the Volcker rule. Further, the rules would enact sanctions for significant increases in risk associated with market making or significant profits due to changes in price (as opposed to profits due to revenues from bid-to-ask price spreads, which are permitted by the Volcker rule).

These regulatory metrics are technical measures of factors such as bank risk and revenue-to-risk ratios, including Risk and Position Limits, Value at Risk (VaR), Stress VaR and Risk Factor Sensitivities. VaR, as one example, measures statistically the adverse impact that potential changes in market rates and prices could have on a bank's portfolio value.

Proprietary trading

Proprietary trading is a term used to describe a bank or other financial institution seeking profit through speculative trading with its own funds rather than by earning commissions through processing trades for its clients. The Volcker rule would prohibit this proprietary trading because it may encourage undue risk taking by financial institutions that are insured explicitly or implicitly by government, and thereby raise systemic risk. The rule does, however, permit certain exceptions to this prohibition, including those related to "market making"—that is, trading to provide asset immediacy or liquidity to facilitate investor activity.

Repo

Short for (sale and) repurchase agreement, a repo is a contract that combines the sale of a security with an agreement to repurchase the same security at a specified price at the end of the contract period. Effectively, it's a secured or collateralized loan—a loan of cash against a security offered as collateral.

"Tri-party repo" is a form of repo in which a third party—a clearing bank—provides clearing and settlement services to the cash investor and collateral provider. If the investor and provider instead engage directly with one another, rather than through a clearing bank, it is called a "bilateral repo." In the 2000s, the tri-party repo market became the primary funding source for securities dealers. During the financial crisis, the tri-party repo market experienced little change in "haircuts," or percentage discounts between cash deposit and security collateral; by contrast, haircuts increased dramatically in the bilateral repo market.

Inequality and Redistribution during the Great Recession

Both earnings inequality and government redistribution rose to historic highs. On net, low-earning households have become more vulnerable

Fabrizio Perri and Joe Steinberg
Federal Reserve Bank of Minneapolis and
University of Minnesota

Introduction[1]

Although there is little doubt that the Great Recession constituted a watershed for overall business cycle dynamics in the United States, the jury is still out on its distributional consequences. Did economic inequality change significantly during the recession? If so, which dimensions—income earnings, wealth and consumption—saw the largest changes? And what impact did government policies, such as taxes and transfer programs, have over this time period on both inequality and economic well-being?

Analyses focused on the first two years of the downturn seem to find no increase in economic inequality; indeed, some report a decline. For example, a recent comprehensive volume (Jenkins et al. 2011) that analyzes income distribution in 21 Organisation for Economic Co-operation and Development (OECD) countries (including the United States) across the Great Recession sees "little change in household income distributions in the two years following the downturn." Heathcote et al. (2010b) and Petev et al. (2011) study inequality in consumption expenditures in the United States up until 2009 and also find little change (if anything, they find a decline).

A longer-term view, however, suggests that high levels of unemployment and the large drop in housing prices, both of which started during the Great Recession but persisted well after, might have had longer-term adverse distributional consequences. In particular, the recession may have left a significant fraction of the U.S. population with very little wealth (due to the fall in asset prices) and poor labor market prospects (due to high unemployment).

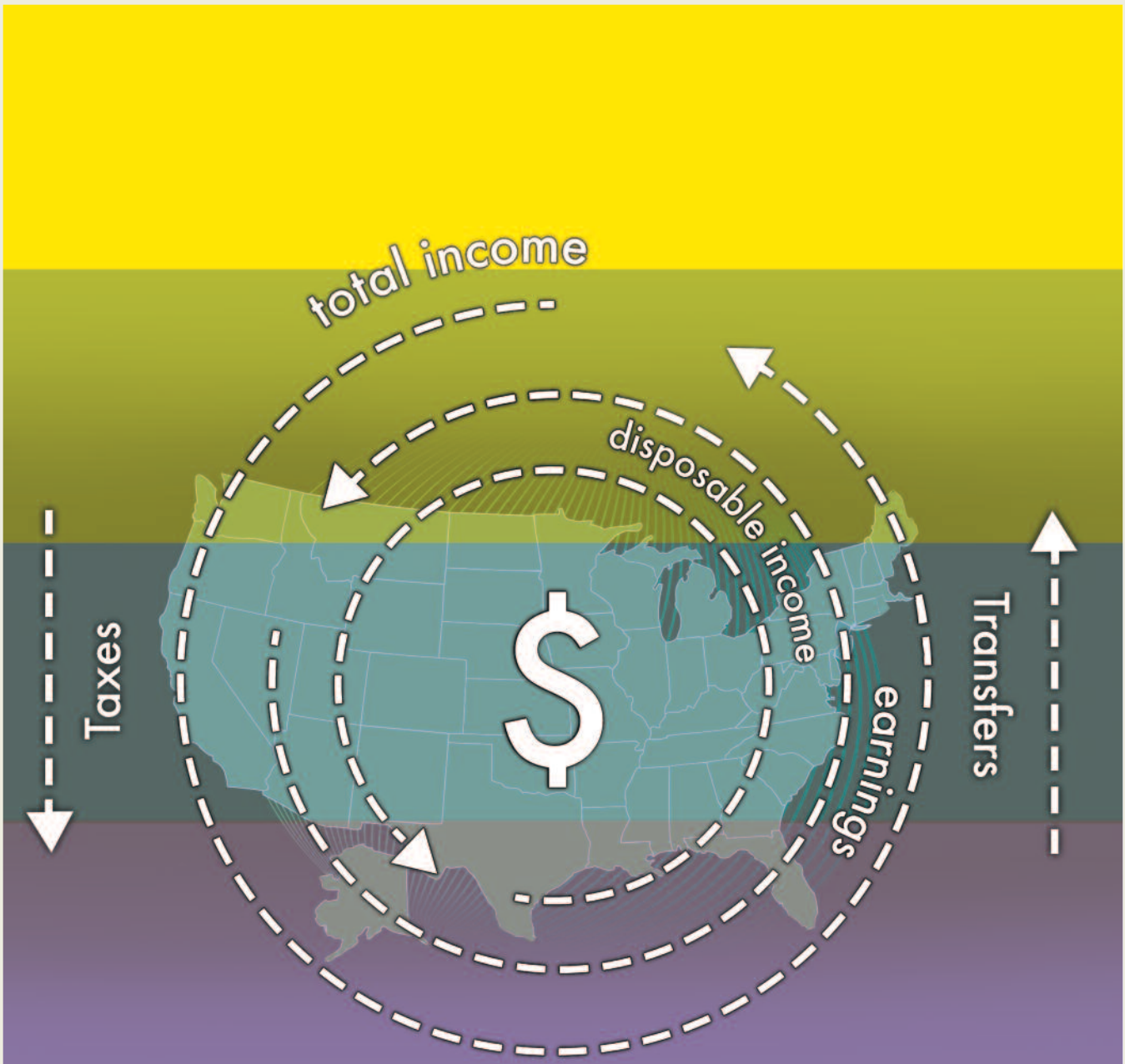
Economic Policy Papers *are based on policy-oriented research by Minneapolis Fed staff and consultants. The papers are an occasional series for a general audience. Views expressed are those of the authors, not necessarily of others in the Federal Reserve System.*

ABSTRACT

In this paper, we explore the impact of the Great Recession on economic inequality and redistribution in the United States. We analyze many sorts of inequality (in earnings, disposable income, consumption expenditures and wealth) for different sections of the economic distribution.

Here we highlight three central findings.

- In 2010, the bottom 20 percent of the U.S. earnings distribution was doing much worse, relative to the median, than in the entire postwar period. This is because their earnings (which includes wages, salaries, and business and farm income) fell by about 30 percent relative to the median over the course of the recession. This lowest quintile also did poorly in terms of wealth, which declined about 40 percent.
- Redistribution through taxes and transfer programs reached historically high levels in 2010. As a result, spending power, captured by disposable income and consumption expenditures on nondurables, of this same lowest 20 percent did not significantly change relative to other economic groups during the recession.
- Although government redistribution protected households from *fully* bearing the impact of an earnings decline, households that experienced such a decrease nonetheless endured sizable drops in disposable income and drops in consumption expenditures.



Fabrizio Perri

Joe Steinberg

The goal of this paper is to paint a more complete picture of the distributional impact of the Great Recession, including more recent data from 2010 and part of 2011. Most importantly, this paper considers inequality in a wide array of variables, such as earnings, disposable income, consumption expenditures and wealth, and looks at inequality for all of these variables at different sections of the economic distribution.

Our first finding is that during and after the Great Recession, the bottom of the U.S. earnings distribution has fallen dramatically. This is the result of historically high unemployment and nonparticipation. *In terms of earnings, the bottom 20 percent of the U.S. population has never done so poorly, relative to the median, during the whole postwar period*. We also show that *this group experienced rapidly declining wealth.*

Despite this, we find that inequality in disposable income and consumption did not increase at either the top or bottom of the distribution, confirming the findings of other studies. In other words, the same bottom 20 percent of the earnings distribution that fared so poorly during the Great Recession in terms of earnings and wealth is in pretty much the same relative position in terms of disposable income and consumption in 2010, after the recession officially ended, as it was in 2006, before the start of the recession.

Such a divergence of trends in earnings and disposable income at the bottom of the distribution is unprecedented in U.S. history, and we show that it is mainly due to government transfers and taxes, as opposed to private components of unearned income.

We conclude our study using panel analysis (i.e., following a specific set of households through time) to better assess the role of government taxes and transfers. This allows us to distinguish between the experience of a given section of the income distribution (e.g., the bottom 20 percent of the distribution, whose members change each period) and the experience of a fixed group of households (e.g., those households that were at the bottom 20 percent of the distribution in 2006 but whose position may have changed by 2010. If the "Smiths," say, were in the bottom fifth in 2006, we use panel analysis to understand where the Smiths ended up later on).

Our main finding is that *although the bottom 20 percent of the earnings distribution experienced constant disposable income or consumption expenditures despite earnings losses, individual households that face earnings losses and enter the bottom 20 percent group do suffer significant losses in disposable income and small losses in consumption.*

Our main substantive conclusion is that government redistribution in the Great Recession was at historical highs and partially shielded households from experiencing large declines in disposable income and consumption expenditures. The same households, though, have experienced losses in net wealth, and this might make them more vulnerable to further or more persistent earnings declines in the future.

We believe our analysis provides useful data to inform the policy debate about whether or not, looking forward, the government should take a more aggressive role in providing assistance for households that experience earnings losses.

Income inequality in U.S. recessions: Some historical perspective

We start our analysis by putting the Great Recession in historical perspective, in particular by comparing the patterns of income inequality in the Great Recession with patterns of inequality in previous recessions.

Throughout this paper, we focus mostly on two simple measures of inequality: the 50/20 ratio and the 95/50 ratio. These are ratios of percentiles in the economic distribution. For example, the 50/20 ratio for income is the ratio of median income (the "50") to the income of the richest household in the bottom fifth of the income distribution (the "20"). The 95/20 ratio for earnings is the ratio of the lowest-earnings household in the top 5 percent of the earnings distribution (the "95") to the median earnings figure.

These ratios have two advantages over other inequality indicators. First, as ratios of variables, they are easy to translate directly into inequality magnitudes and inequality changes. The second advantage is that they concisely capture inequality at the bottom and at the top of the distribution, respectively.

In terms of income measures, we first focus on three measures of household resources. *The first is*

earnings, which includes wages, salaries, and business and farm income from all household members. The second is *total income*, which includes all sources of household income, including not only earnings, but also interest, dividends, rents, private transfers (such as alimony and child support) and government transfers (such as Social Security, unemployment insurance and welfare). The last measure is disposable income, which subtracts tax liabilities from total income.[2] To account for different household sizes, we divide all three measures of household income by the number of "adult equivalents" in the household.[3]

Figures 1 and 2 report the evolution, from 1967 to 2010, of the 95/50 ratio and of the 50/20 ratio for these three measures of household resources.

Figure 1 confirms the finding, highlighted by several authors (e.g., Piketty and Saez 2003), that inequality at the top of the distribution has increased substantially during the 1980s and the 1990s. It also shows that there was an increase in earnings inequality during the Great Recession. This increase was due to the fact that median earnings per adult equivalent fell quite substantially from 2008 to 2010 (from around $26,300 to roughly $24,700), while earnings of the 95th percentile have been more stable (about $89,170 to $88,640).

Notice also that the increase in earnings inequality resulted in a rise in inequality in *total* income but not *disposable* income, suggesting that taxes reduced the differential impact of the recession on the top and on the median. Overall, though, the changes in inequality at the top of the distribution were small compared with changes at the bottom, as seen in Figure 2.

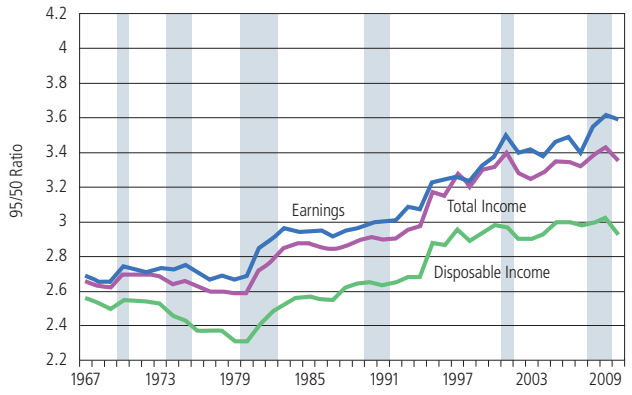
The first feature of Figure 2 that we want to highlight is *an extraordinary fall of the bottom of the earnings distribution*. This is captured by the 50/20 ratio, which increased sharply during the recession from roughly 2.7 to nearly 3.5. Note that the 50/20 ratio rises in all recessions, which are, by definition, periods of increasing unemployment. Higher unemployment raises the fraction of households with no or very low earnings, and this causes the 20th percentile of the earnings distribution to fall relative to the median, thereby raising the 50/20 ratio.[4]

But note that while unemployment in 2010 was slightly below its postwar historical high,[5] the 50/20 ratio in the same year was well above its previous historical high, reaching almost 3.5, while in previous recessions it never exceeded 3. This suggests that the cause for the high inequality at the bottom is not just unemployment but also nonparticipation in the labor market.

A second feature seen in Figure 2 is that the 50/20 ratios in both total income and disposable income have much lower levels and, during the Great Recession, experienced much smaller increases than the 50/20

Figure 1

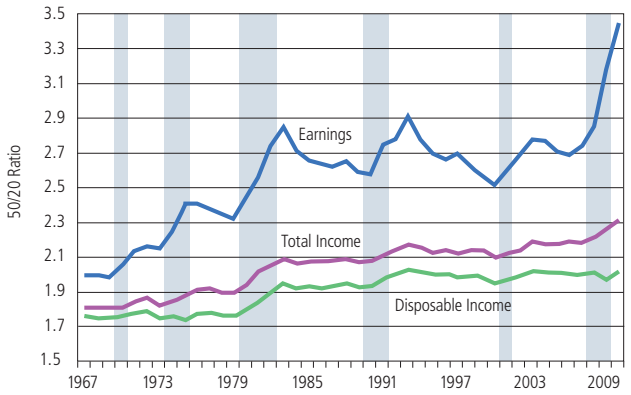
Inequality at the top of the distribution



Note: Shaded areas represent years that contain at least one quarter classified as recession by the National Bureau of Economic Research.

Figure 2

Inequality at the bottom of the distribution



Note: Shaded areas represent years that contain at least one quarter classified as recession by the National Bureau of Economic Research.

ratio in earnings. Indeed, despite the substantial increase in earnings inequality, *inequality in disposable income was about the same in 2010 as in 2003.*

This lack of change is quite remarkable; in all previous U.S. recessions, with the exception of that in 1973, disposable income inequality at the bottom increased. Constant inequality in disposable income during recessions has been experienced in some European countries (Sweden, for example; see Domeji and Flodén 2010), but it is unusual in the United States. This suggests that mechanisms like private or government transfers played an important role in mitigating the effect of the Great Recession on inequality in disposable income. The next section investigates the impact of such mechanisms in greater detail.

Income inequality in the Great Recession: Getting to the bottom of it

First we look more closely into the large increase in earnings inequality at the bottom of the distribution, and then we identify more precisely the causes of the divergence between inequality in earnings and in disposable income.

Earnings are the product of hours worked and wages per hour, and the CPS provides data on hours worked per household. Following a similar analysis to that done by Heathcote et al. (2010a) for previous recessions, Figure 3 plots average real earnings, average hours worked and average disposable income for the bottom 20 percent and the middle 10 percent of the earnings distribution. In both panels, all statistics are "normalized" (or mathematically set) to 1 in 2008.

Three features of this figure are quite striking. The first is that the increase in earnings inequality was the result of a large absolute (and not relative) fall of earnings at the bottom of the distribution. The top panel shows that earnings at the bottom fell more than 30 percent (in real terms) from 2008 to 2010, while the bottom panel shows only a moderate 5 percent earnings fall for the middle.

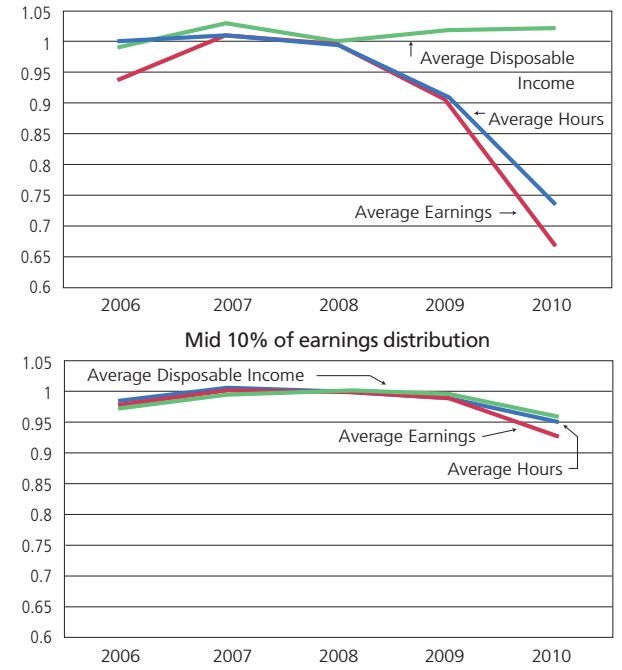
The second is that the sharp fall in earnings at the bottom can be attributed largely to the decrease in total hours worked, which fell by 25 percent, and not to a possible change in hourly wage rates.

The third striking feature of this figure—evident in the top panel—is that the sharp fall in hours worked and earnings for the bottom 20 percent of households did not result in a parallel decline in disposable income.

Taken together, these three facts suggest that government and private support for unemployed individuals played a major role in muting the impact on disposable income of lower earnings and employment during the Great Recession.

Our analysis of individual components of disposable income found, not surprisingly, that unemployment benefits contribute greatly to the lack of increase in disposable income inequality as do taxes (most likely through the Earned Income Tax Credit program). Overall, it appears that government programs, as opposed to other non-earned-income categories like interest or dividends, best explain why increased earnings inequality did not increase income inequality during the Great Recession.

Figure 3 **Earnings, hours worked and disposable income: The bottom 20 percent and the mid 10 percent**



Note: For ease of trend comparison, all data are set at 1 for 2008. Data are also adjusted for inflation.

Consumption inequality during the Great Recession

Previous research on inequality (e.g., Blundell and Preston 1998 and Krueger and Perri 2006) has suggested that the distribution of consumption expenditures, not of income, gives greater insight into the distribution of household well-being. Financial markets permit consumption expenditures that are more closely related to a household's lifetime resources (sometimes referred to as the "permanent income" of the household). Consumption, therefore, is a better indicator of the well-being of the household.

This logic might also be relevant in evaluating the distributional impact of the Great Recession, for two reasons.

One reason is that current consumption better reflects expectations about future income prospects than do current earnings—an individual who expects to lose his/her job may well reduce expenditures even when she/he is still employed.

We have just established that during the Great Recession, inequality in disposable income did not increase because government transfers like unemployment insurance supported disposable income of low-earnings households. But if shocks to earnings are persistent and transfers to low-income households have limited duration, then the permanent income of some low-earnings households will fall, and so we would expect to see a drop in consumption expenditure, despite stable disposable income.

The other reason consumption expenditures might be a better indicator of distributional changes is related to the fact that the defining event of the Great Recession was the large fall of asset prices, particularly of housing.

Consider two households with the same income but very different shocks to the value of their wealth. Looking only at income would not inform us about distributional changes between them, but looking at consumption would, as the households would adjust their consumption in response to changes in their net wealth. More concretely, when housing prices fall, households feel less wealthy and spend less—even when their salaries and other income streams do not change.

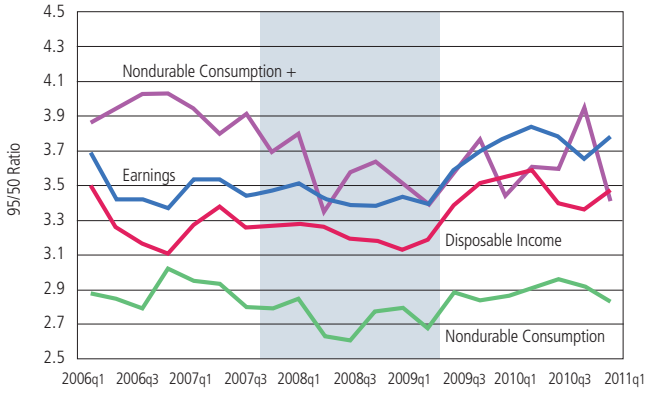
For these reasons, understanding the evolution of consumption distribution during the Great Recession may shed light on the impact of the recession. Here we present household-level consumption data from the Consumer Expenditure (CE) Interview Survey. The CE Survey is a rotating panel of households that are selected to be representative of the U.S. population. Each quarter the survey reports, for the cross section of households interviewed (about 6,000), detailed demographic characteristics for all household members, detailed information on consumption expenditures for the three-month period preceding the interview and information on income, hours worked and taxes paid over a yearly period. The most recent data available are from the first quarter of 2011.

The statistics we present track closely those analyzed earlier. We start with inequality at the top, captured by the 95/50 ratio, together with inequality in earnings and disposable income (from the CE sample). Figure 4 reports measures of inequality in expenditures on nondurable goods (labeled "Nondurable Consumption") and inequality in expenditures on nondurables plus a few durables such as cars and furniture (labeled "Nondurable Consumption+").[6]

Overall, the figure suggests that despite some swings in the inequality measures, the Great Recession did not significantly change inequality in consumption for households at the top of the distribution.

Figure 4

Consumption and income inequality at the top



Note: Shaded area represents the Great Recession.

Notice how, in the initial phase of the recession, inequality in both consumption measures seemed to fall; this might be simply due to the large fall in purchases of durables that took place in the middle of the recession. If many consumers stop purchasing durables, fewer large consumption expenditures are recorded and, hence, inequality at the top falls. Consistent with this hypothesis is the fact that by the end of 2010, inequality in expenditures at the top returned to the same level as in 2006.

Figure 5 reports inequality at the bottom, the 50/20 ratio. The plot lines for earnings and disposable income mimic closely those observed for CPS and, perhaps not surprisingly, given the steady path of disposable income over these years, inequality in consumption barely moves during the Great Recession.

Figures 4 and 5 suggest an overall stability of consumption inequality over the course of the Great Recession.

In the last part of this section, we investigate the issue further by focusing, as we did in Figure 3, on the bottom 20 percent of the earnings distribution. Figure 6 plots, for the bottom 20 percent of the earnings distribution in each quarter, average earnings and disposable income, average nondurable and nondurable+ consumption and average total net wealth, all normalized to 1 in 2007q4.

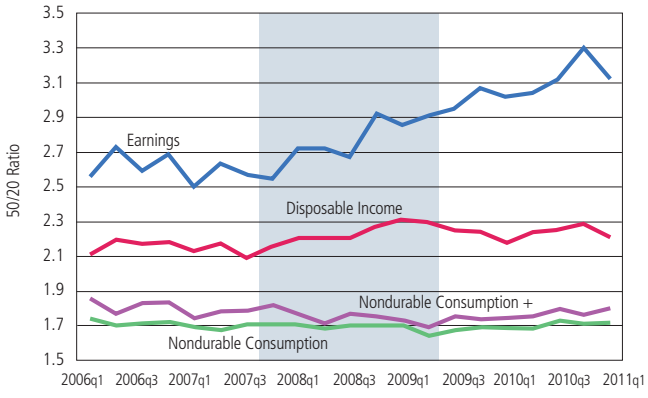
First, notice that earnings and disposable income behave very similarly to the corresponding CPS series in Figure 3. Nondurable consumption tracks disposable income closely and does not seem affected by the fall in earnings. In contrast, both the average wealth and the nondurable+ series for this group fall considerably.

It would no doubt be difficult—and certainly it is outside the scope of this paper—to establish a causal link between the fall in earnings and in wealth of this group. Nevertheless, the figure suggests that the bottom 20 percent of the earnings distribution in 2010 was a very different group than it was in 2007. The bottom 20 percent groups in 2010 and 2007 had the same disposable income, but both earnings and wealth of the 2010 group were 40 percent lower. In absolute terms, this means that the average wealth of the bottom 20 percent fell from around $80,000 in 2007 to a little over $50,000 in 2010. The lower wealth is particularly important, as it makes this group more vulnerable if government support for low-earnings households were to cease.

A panel analysis

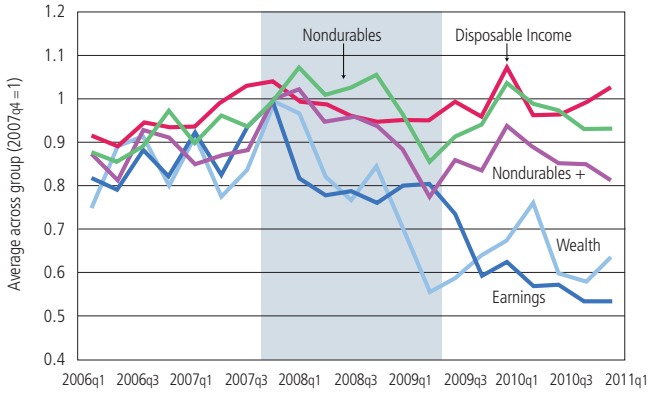
The cross-sectional data analyzed in the previous sections show that while earnings for the bottom 20 percent of households fell dramatically over the

Figure 5 **Consumption and income inequality at the bottom**



Note: Shaded area represents the Great Recession.

Figure 6 **Consumption, income and wealth for the bottom 20 percent of earnings distribution**



Note: Shaded area represents the Great Recession.

Great Recession, disposable income in the same group was virtually constant. However, these cross-sectional data do not necessarily tell us how *individual* households are faring over time, since the group of households in the bottom 20 percent changes each year; some previously higher-earnings households move into the bottom 20 percent, and some households that were previously in the bottom 20 percent move out of it.

In this section, we use panel data from the Panel Study of Income Dynamics (PSID) to study the importance of two components of the bottom 20 percent group: (1) changes in income and expenditures of households that stay in the group, and (2) changes in the composition of the group.[7]

In particular, we look at a series of statistics for a particular group: the bottom 20 percent of the earnings distribution.

We find that earnings for the bottom 20 percent rose slightly between 2006 and 2008, by about the same amount as in the cross-sectional data in Figure 3. Disposable income rose as well.

What we want to highlight is that while disposable income for the bottom 20 percent *as a whole* rose slightly between 2006 and 2008, this increase is due only to a change in the group's composition. The panel analysis allows us to control for these compositional effects and shows instead that, *on averag*e, households in the bottom 20 percent of the earnings distribution in 2008 actually suffered a significant decline in disposable income.

Putting this in actual dollar figures might make the point clearer: While the bottom 20 percent of households experienced an average disposable income increase of $228, this was simply because the 2008 income of those shifting into the group was higher than the 2006 income of those who left the bottom earnings quintile.

This panel analysis reveals that looking at simple cross-sectional measures of inequality is not enough to assess the full distributional impact of the Great Recession. It suggests that although government redistribution policies—taxes, unemployment insurance and others—have provided an important cushion against the effect of earnings declines on disposable income and consumption, they have not fully shielded households' disposable income from these earnings fluctuations.

This further suggests that the Great Recession could have indeed had major redistributive effects at the bottom of the distribution. As panel data become available on the 2009-10 period, in which earnings of the bottom 20 percent fell dramatically (seen in Figure 3), it will be especially important to monitor the disposable income and consumption of households that moved into the bottom 20 percent in 2008 and remained there for the remainder of the Great Recession. For those that remain in the bottom 20 percent, their depleted wealth may not have been enough to prevent persistently low earnings from impacting consumption and welfare.

Conclusions

This paper provides an empirical analysis of inequality and redistribution during the Great Recession.

On one hand, we find that redistribution (through taxes and transfers) from high-earnings to low-earnings households in the United States was at its historical high, which possibly explains the calls by some for cutbacks in government programs that provide such assistance. On the other hand, we provide evidence that households that experience a severe earnings loss also face a large loss in disposable income and a loss in consumption, and that low-earnings households have become, during the course of the Great Recession, more vulnerable due to large losses in wealth.

This analysis should help inform future policy action regarding the extent of social insurance. For example, it could assist in assessing the consequences of extending, or curtailing, the duration of unemployment insurance benefits. R

Editor's note: *This is an abridged version of the policy paper, which is available in full at the Economic Policy Papers site at minneapolisfed.org.*

Endnotes

[1] The authors thank Doug Clement and Kei-Mu Yi for valuable comments.

[2] The Current Population Survey (CPS) does not provide data for disposable income for all years in the sample. Therefore, we compute disposable income figures with TAXSIM, a widely used tax simulation program provided by the National Bureau of Economic Research. In years for which we have disposable income from the CPS, summary measures of disposable income in the CPS are very similar to our measures.

[3] Following the commonly used OECD scale, the number of "adult equivalents" in a household is a weighted sum of household members in which the first adult is given a weight of 1, each additional adult has a weight of 0.7 and each member under the age of 17 has a weight of 0.5.

[4] For more on how unemployment affects the dynamics of inequality over the business cycles, see Castañeda et al. (1998).

[5] The U.S. unemployment rate in 2010 was 9.6 percent, just under the postwar high of 9.7 percent in 1982.

[6] Specifically, the nondurable expenditures category includes expenditures on food and beverages, utilities and fuels, education, medical supplies, clothing and personal care, reading and transportation services. The nondurable+ category adds to this purchases of cars, furniture, jewelry and durable entertainment goods.

[7] To see this more precisely, let's define the following relation: $\bar{Y}_{B20}(t)-\bar{Y}_{B20}(t-1)=\alpha(\bar{Y}^{Stay}_{B20}(t)-\bar{Y}^{Stay}_{B20}(t-1))+(1-\alpha)(\bar{Y}^{In}_{B20}(t)-\bar{Y}^{Out}_{B20}(t-1))$ where $\bar{Y}_{B20}(t)$ is the average income measure of the bottom 20 percent of the earnings distribution in period t, α represents the share of households that stay in the bottom 20 percent, $\bar{Y}^{In}_{B20}(t)$ is the average income of the households that enter the bottom 20 percent at time t (and were not in the bottom 20 percent in period t-1) and $\bar{Y}^{Out}_{B20}(t-1)$ is the average income of the households that were in the bottom 20 percent at t-1 and exited the group at time t. The equation highlights that observed changes in the corss-sectional data $(\bar{Y}_{B20}(t)-\bar{Y}_{B20}(t-1))$ are driven both by changes in income/expenditures of households that stay in the group (the term $(\bar{Y}^{Stay}_{B20}(t)-\bar{Y}^{Stay}_{B20}(t-1))$ and by changes in composition of the group (the term $(\bar{Y}^{In}_{B20}(t)-\bar{Y}^{Out}_{B20}(t-1))$).

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Virtual Fed

Professor Chairman

Ben Bernanke is, of course, best known as the head of the Federal Reserve and the man who helped guide the economy during the turbulent financial crisis that emerged in 2007. But before he became Fed chair in 2006, he was an economics professor for nearly a quarter of a century. In March 2012, Bernanke brought together his old and new careers by delivering four lectures about the Federal Reserve—its origins and mission, its role in the Great Depression and in the Great Recession, and its challenges in the aftermath of the financial crisis—to a group of undergraduates at George Washington University in Washington, D.C.

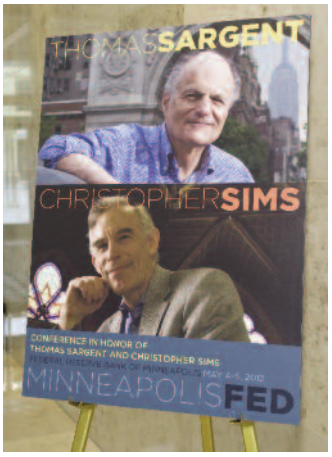
Demand was high for Bernanke's classes; unfortunately, the university could accommodate in-person attendance by only 30 students. But the Fed's Board of Governors recorded the lectures and put them on the web. Now, all those who wish they could have been at the Bernanke talks in March can do so virtually, whenever it's convenient for them. Classroom lecture videos and transcripts are available at the Fed website, along with presentation slides and a reading list:

http://www.federalreserve.gov/newsevents/lectures/about.htm

—Joe Mahon

Celebration Time (Series)

Last October's economics Nobel Prize announcement was greeted with much joy—but no surprise—at the Minneapolis Fed. After all, the two laureates, Thomas Sargent and Christopher Sims, had long affiliations with the Research department at the bank as well as with the economics department at the University of Minnesota. And they were instrumental in forging a partnership between the two institutions during the 1970s that saw the development of major breakthroughs in economic thought and continues to produce cutting-edge research to this day.



So it was natural that the Minneapolis Fed should host a conference in honor of the two scholars. Economists from all over the world who studied with or were influenced by Sargent and Sims came to the bank on May 4 and 5 to pay tribute to them and to present research that follows their enduring legacy.

Both men have produced an extensive range of contributions to many areas of economics—macroeconomics, econometrics, financial economics, and monetary theory and policy analysis, for example. But the thread that binds this work is devotion to development of mathematical models and empirical methods (with an important role for expectations) in order to rigorously investigate how economic "shocks," as well as policy changes, influence the macroeconomy.

Consistent with this breadth, the research presented at the conference spanned a variety of topics. For example, New York University's Giovanni Violante kicked off the second day, presenting joint research with the Minneapolis Fed's Jonathan Heathcote and Kjetil Storesletten about how workers' ability to insure against risks to their earnings relates to the recent rise in inequality in the United States. The clever innovation in their paper involves fitting the model to data to measure how insurance has changed over time.

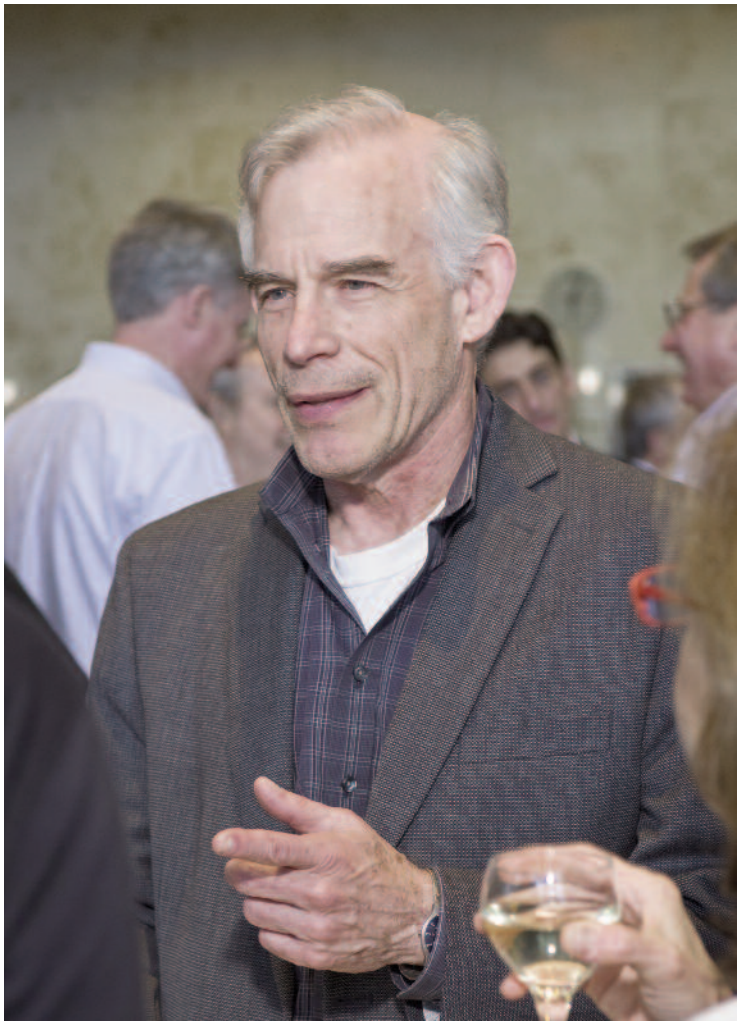
Not surprising, in light of the recent financial crisis, many papers were on financial topics or on the intersection of macroeconomics and finance. Others covered topics in public finance, business cycles and information economics. (Papers and presentations can be found online at: minneapolisfed.org/research/events/2012_05-04/index.cfm.) But the conference wasn't all serious research. Participants shared stories, some heartwarming and some humorous, about studying and working with Sargent and Sims. These included dinner remarks by Minneapolis Fed President Narayana Kocherlakota (see page 2).

And then there were the skits, in which conference organizers gently lampooned Sargent's and Sims' personalities. One highlight was a reenactment of a collaboration by the two, played by Heathcote and Cristina Arellano, in which Nobel laureates Edward Prescott and Robert Lucas, playing themselves, walked through and mocked them. "What is all this mumbo-jumbo engineering gobbledygook?" Prescott asked. "I don't know," Lucas responded, "but we'd better not get involved."

When a research conference is held in someone's honor, the honoree doesn't usually present his or her own work. But in this case, each day of the conference finished with one laureate presenting new research of his own: Sargent's paper looked at optimal taxation policies when consumers can't perfectly smooth out shocks to their incomes and taxes are used for redistribution; Sims presented a model to explain how prices often make big jumps, rather than adjusting smoothly. The papers were highly technical, cutting-edge research on fundamental problems in economics and testament to their authors' sustained drive, engagement and brilliance. During these presentations, Sargent and Sims each, characteristically, offered insightful critiques of the other's paper; such parries and counterparries occurred throughout the conference. Indeed, this sharp, constructive interplay made evident why the Nobel Committee awarded the much-deserved 2011 prize to them jointly.

—Joe Mahon

Thomas Sargent



Christopher Sims

Marc Giannoni, Sam Schulhofer-Wohl and Edward Prescott

Giovanni Violante and Robert Lucas

Narayana Kocherlakota

James Bullard, Harald Uhlig and Michael Woodford

Fabrizio Perri

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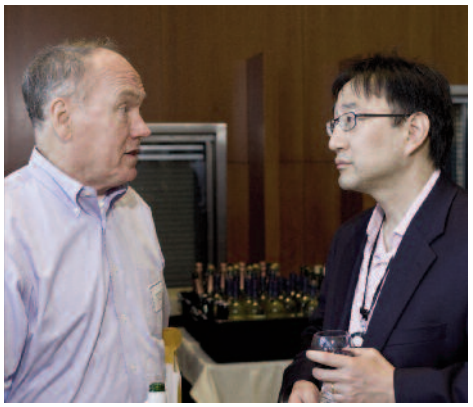
Robert Litterman

Harald Uhlig and Fabio Canova

Lawrence Christiano and Ellen McGrattan

Marco Del Negro



Edward Prescott and Kei-Mu Yi

Alessandra Fogli, Kjetil Storesletten, Jonathan Heathcote and Juan Pablo Nicolini

Victor Ríos-Rull

Edward Prescott, Neil Wallace and Narayana Kocherlakota

Richard Rogerson, James Schmitz and Lee Ohanian

Lee Ohanian, Timothy Kehoe and Gary Hansen

Andrea Raffo

Lawrence Christiano

Gary Stern, Victor Ríos-Rull and Clarence Nelson

Christopher Sims and Thomas Sargent

Hitoshi Tsujiyama and Maria Belfiori

Ariel Zetlin-Jones, Narayana Kocherlakota and Larry Jones

Patrick Kehoe

James Lyon and Arthur Rolnick

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Research Digest

In this issue, Research Digest *summarizes recent work by*

- **Motohiro Yogo and his colleagues**
  on helping households make better decisions about insurance and annuities
- **Ellen McGrattan and Edward Prescott**
  on why labor productivity rose during the Great Recession even though GDP plummeted

PHOTOGRAPH BY STEVE NIEDORF

Better Guidance on Matters of Life and Death

Motohiro Yogo (pictured above) and his colleagues develop a straightforward tool to improve household decisions about insurance policies and annuities.

Research Digest

Choosing a life insurance, supplemental health insurance or long-term care policy for ourselves or our families is a daunting intellectual exercise, complicated by deep emotion. Determining how to save toward retirement (rather than spending now) is equally demanding. Knowing how long one might live, what it may cost to do so, whether good health will continue and estimating the medical expenses if it doesn't—all this involves intricate calculations of risk. Compounding the difficulty: a bewildering range of financial products that offer solutions to these personal conundrums.

Paralysis and procrastination are common responses to such complexity; many of us simply avoid decisions about household insurance. Aware of this reaction, advisers from insurance firms and financial funds stand at the ready, delighted to explain the benefits their products offer, but customers are well aware—or should be—that their advice may be less than objective.

Clear risk measures are available for stock and bond products themselves. For equities (and the mutual funds composed of them), a variable known as "beta" measures risk relative to the market's overall average. For bonds, investors need look only at duration (short-, intermediate- or long term). While not foolproof, these yardsticks are invaluable tools for investment decisions.

A comparably simple and objective gauge for measuring relative risk of insurance products might be a great aid for those deciding which life or supplemental health or long-term care insurance policies to purchase, or where to build a nest egg through an annuity.

But for these household insurance decisions—in matters of, quite literally, life and death, and in sickness and health—there has been little in the way of disinterested guidance.

In a recent paper, "Health and Mortality Delta: Assessing the Welfare Cost of Household Insurance Choice," economists Ralph Koijen of the University of Chicago, Stijn Van Nieuwerburgh at New York University and Motohiro Yogo from the Minneapolis Fed investigate this gap and develop two tools that individuals and advisers can use for unbiased judgments on the relative risk of life, supplemental health and long-term care insurance policies, as well as annuity products.*

They call their measures "health delta" and "mortality delta." The former indicates the payoff that a given policy will provide to its owner should the owner suffer ill health. "The health delta at a certain age," Koijen explained via email, "is the difference in the payoff of a financial product in poor health relative to being in good health in the next period." And mortality delta is the difference in payoff between the holder being dead or alive at a specific age. (Thus, the term "delta," which mathematicians and economists use to denote difference or change.)

"Each household has an optimal exposure to health and mortality delta that depends on preferences (e.g., risk aversion and bequest motive) and characteristics (e.g., birth cohort, age, health, and wealth)," write the economists. "Optimal portfolio choice simplifies to the problem of choosing a combination of health and longevity products, not

A simple and objective gauge for measuring relative risk of insurance products might be a great aid for those deciding which life or supplemental health or long-term care insurance policies to purchase, or where to build a nest egg through an annuity.

But for these household insurance decisions there has been little in the way of disinterested guidance.

*The paper is available online via http://bit.ly/KcFCAM. A video presentation is online at http://bit.ly/Md21lD.

Research Digest

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necessarily unique, that replicates the optimal health and mortality delta."

In addition, they estimate the financial benefit a household would reap from using these measures—put differently, the cost of not doing so. According to their calculations, this welfare cost is extremely high: 28 percent of the total wealth of a median household headed by a 51- to 58-year-old, and most of this value is accounted for by mortality delta—the choice of optimal life insurance or annuity plans, rather than health delta—supplementary health or long-term care insurance.

Finding delta

While the outcomes of their paper—both the deltas and their worth—are fairly straightforward, the process of discovery is rather complex. It begins with a model based on life-cycle theory—the idea that people's consumption and savings preferences and patterns are shaped by their expected lifetime incomes.

The economists' model therefore includes a family that faces risk of death and ill health that affects how long family members expect to live, how much they spend on health care and how much they value consumption and wealth. To prepare for the future, they can invest in a variety of household insurance policies, from life insurance to private annuity plans to health insurance policies that supplement government programs like Medicare.

In developing the model, the economists introduce their unique contribution: the deltas that represent health and mortality risk measures. Again, health delta measures the differential payoff that a policy delivers in poor health relative to good health, and mortality delta is a measure of differential payoff delivered at death relative to good health in the next period.

In a series of figures based on hypothetical policies, they illustrate the relative benefits of various household insurance choices. They find, for instance, that short-term life insurance generates high mortality delta per dollar invested relative to long-term life insurance. The same is true (in their hypothetical) for health insurance: "Short-term health insurance is a relatively inexpensive way to deliver wealth to poor health, especially for younger policyholders."

The economists then derive an optimal solution to the life-cycle problem, under the reasonable assumption that "markets are complete" (that is, markets exist under all conditions for all products and assets at perfect equilibrium prices). The solution is "a useful theoretical benchmark," they note. A household's optimal portfolio choice of health and longevity products—given its specific preferences and unique characteristics—will replicate this optimal health and mortality delta solution.

Further, this benchmark helps them to develop a formula for measuring the cost when households deviate from the optimal insurance solution—either because markets aren't complete (perhaps borrowing or portfolio constraints exist, or firms may not offer necessary products for households with certain characteristics) and/or households make suboptimal choices (perhaps because they lack the clear guidance that deltas offer).

Calibration and welfare cost

To bring greater realism to the research, the economists calibrate their model with data from a survey of U.S. households whose members are older, the Health and Retirement Study carried out by the Institute for

Research Digest

Social Research at the University of Michigan. The economists focus particularly on households whose male respondent is age 51 and older when surveyed, and they calibrate with survey data on out-of-pocket health expenses (including insurance premiums), on income, on the face value of life insurance policies, on annuities (including pensions from employers) and on net worth. It's crucial, of course, that they include the survey's data on pricing and ownership of health and longevity products.

With the data from the survey, they're able to calculate actual health and mortality risk or delta implied by each household's ownership of longevity products (life insurance and annuities) and health products (supplemental health insurance and long-term care policies). With these calculations, they're able to examine whether household characteristics explain variation in choices of such products and find that they probably don't—that other factors such as incomplete markets or suboptimal choices are at play.

They then calculate the cost to the median household of deviating from the optimal solution. Again, the estimated cost is remarkably high: "The lifetime welfare cost for households aged 51 to 58 is 28.49 percent," they write, "equivalent to a 28 percent reduction in lifetime consumption." And deviations regarding

An Optimal Portfolio for Mr. Average

With a brief illustration, the economists show how their statistical "Joe Average," a male in good health at age 51, can choose existing health and longevity products to replicate the optimal delta. The table below provides their figures for optimal health and mortality deltas (panel A), the optimal portfolio to achieve these delta figures (panel B) and the cost of buying the recommended portfolio (panel C).

According to these calculations, Mr. Average should buy about $5,000 worth of short-term life insurance, spend less than half that on short-term health insurance and put a considerable amount into bonds. As Joe ages, though, he'll want to spend much less on short-term life—indeed, nothing by the age of 67, and a lot more on deferred annuities and bonds until he's in his 90s, when short-term life insurance makes much more sense. In fact, the economists suggest that "insurance companies may want to package life insurance and annuities into a 'life-cycle product' that automatically switches from life insurance to annuities around retirement age."

The Optimal Portfolio Changes as One Ages

	Age 51	Age 75	Age 99
Panel A Optimal health and mortality delta (thousands of 2005 dollars)			
Health delta	7	-20	83
Mortality delta	188	-132	-185
Panel B Optimal portfolio to replicate optimal delta (units)			
Short-term life insurance	188	0	0
Deferred annuity	0	23	95
Short-term health insurance	1.80	0.53	0.85
Bonds	60	219	193
Panel C Cost of the optimal portfolio (thousands of 2005 dollars)			
Short-term life insurance	5	0	0
Deferred annuity	0	110	83
Short-term health insurance	2	3	44
Bonds	58	210	185
Total Cost	**65**	**323**	**312**

Source: From Table 10 in "Health and Mortality Delta: Assessing the Welfare Cost of Household Insurance Choice"

Research Digest

longevity products such as life insurance and annuities, not health products, account for nearly all the reduction. Better guidance would clearly help.

Indeed, to demonstrate, the economists provide an example (see sidebar on page 45) that shows how advisers and households can use deltas to shape an optimal portfolio.

Getting specific

The economists are quite pointed in their recommendations both to insurance companies and to household advisers. Companies, say the economists, should report health and mortality delta for the insurance products they offer. And financial advisers "should guide households on the optimal exposure to health and mortality delta over the life cycle, based on their preferences and characteristics." This guidance should lead to improved decision making by households and better offerings from companies. "We hope that the introduction of these risk measures will facilitate standardization, identify overlap … identify risks that are not insured by existing products, and ultimately lead to new product development."

—Douglas Clement

Edward Prescott Ellen McGrattan

Unmeasured Investment

Ellen McGrattan and Edward Prescott discuss how intangible capital may explain rising labor productivity during economic downturns

For much of the period after World War II, changes in labor productivity were a useful gauge of how well the U.S. economy was faring; workers produced more goods and services per hour during booms than they did during recessions. In fact, economic output and labor productivity—the ratio of gross domestic product to hours worked—often moved in synchrony as the nation's economic fortunes waxed and waned. But since the mid-1980s the two measures have become less correlated over the business cycle; during the Great Recession, labor productivity increased even as GDP plummeted.

This statistical disconnect has led some researchers to question real business cycle theory—the idea that cyclical fluctuations in the

Research Digest

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Research Digest

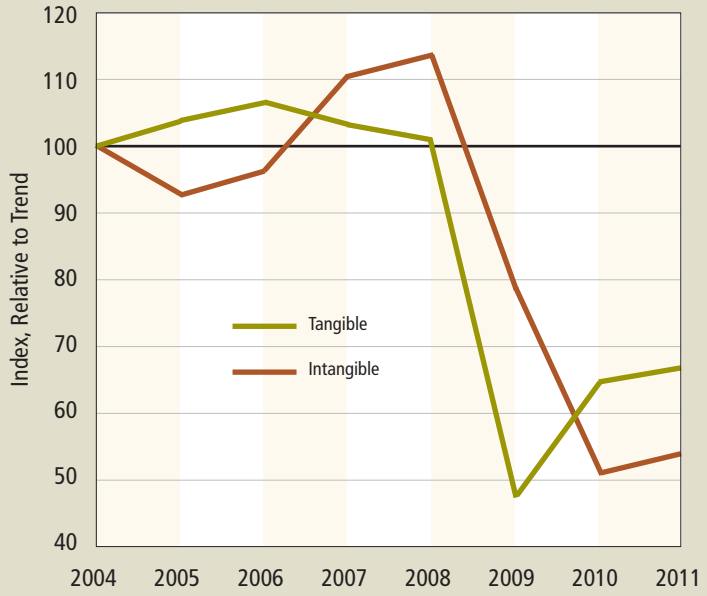
economy are driven in large part by shocks to the productivity of capital and labor. (To be more precise, shocks that are nonmonetary—that is, unrelated to changes in money supply.) If, according to RBC models of aggregate decisions by households and firms, such shocks typically cut output more than hours worked during downturns, how could labor productivity have risen as GDP fell during the last recession?

Recent research by Ellen McGrattan and Edward Prescott, Minneapolis Fed monetary advisers and economists at the University of Minnesota and Arizona State University, respectively, suggests that the divergent paths of GDP and labor productivity during the downturn and at other times in recent decades isn't as strange as it seems—and that eulogies for existing RBC aggregate theory are premature.

In "The Labor Productivity Puzzle" (Minneapolis Fed Working Paper 694, online at minneapolisfed.org), McGrattan and Prescott find that when established theory includes intangible capital, it accurately predicts the behavior of the actual U.S. economy. Investment in intangible capital is a type of business investment that isn't counted in the standard measure of labor productivity (GDP divided by hours worked in the market sector).

Predicted real per capita business investments, 2004–2011

(Relative to a 1.9% geometric trend in real per capita GDP)



Quantifying the intangible

Intangible capital consists of assets that can't be touched and are difficult to measure—spending on things such as research and development, marketing and worker training that add value to a company but are usually reported as expenses rather than as capital investment. As such, most investment in intangible capital is not included in GDP, part of the national accounts kept by the federal government. (For further background on intangible capital, see "The Untouchables" in the December 2005 *Region*, online at minneapolisfed.org.)

For McGrattan and Prescott, two leading proponents of the use of quantitative, dynamic business cycle modeling to analyze macroeconomic trends, including intangible capital investment in total economic output is the key to making sense of head-scratching countercyclical movements in labor productivity over the past 25 years.

The economists theorized that labor productivity as measured by national accounts might not give a complete picture of the dynamics

Research Digest

of production and labor in a cyclical economy. Would productivity trends during the last depressed period look different if *intangible* investment as well as tangible investments such as new buildings and equipment were counted in official government measures of total economic output? By not including intangible investment in GDP, government figures may underestimate the fall in total, or true, economic output during a downturn—and therefore true labor productivity (total output divided by total hours worked) may decline rather than increase.

"Fewer and fewer people are arguing that [intangible investments] are negligible," McGrattan said in an interview. "And if intangible investments are declining like tangible investments in a recession, then there really isn't much of a puzzle in terms of labor productivity movements."

To test their theory, McGrattan and Prescott developed a model economy in which shocks to the production efficiency of businesses affect the output of goods, services and new intangible capital. A key assumption of the model is that these shocks are "nonneutral"; that is, changes in productivity due to factors such as technological innovation and government regulation affect the creation of new intangible capital differently from the creation of tangible goods and services counted in GDP.

The 2008 financial crisis plays no role in the simulation, because the investigators chose to focus on nonmonetary (or "real") shocks rather than disruptions that could be attributed to monetary policy, tighter credit or other financial factors that impede investment. "We wanted to see what happens if you don't have the usual financial factors in there—not one word about banks, the Federal Reserve, the collapse of Lehman Brothers, et cetera," McGrattan said.

Not so puzzling after all

The economists assumed that shocks in their model were large enough to produce changes in GDP and hours worked comparable with economic data, but didn't try to match observations on business tangible investment. It turns out that the shocks had a dramatic impact on business investment decisions during the economic downturn; in the model, both tangible and intangible investment fell by about half before starting to recover (see chart on page 47).

The sharp drop in intangible investment contributes to a decline in actual economic output greater than that measured by official government GDP accounts. This implies that in the actual U.S. economy, true labor productivity declined significantly during the recent recession—a finding consistent with established aggregate theory based on the neoclassical model of economic growth. Thus, McGrattan and Prescott's experiment solves the labor productivity puzzle by reconciling the apparent mismatch between theory and economic data that show labor productivity bucking the GDP trend. "The addition of intangible capital and nonneutral technology to the model was crucial in accounting for high productivity and low GDP during the period," they write.

So in the real economy, did intangible investment fall during the downturn? Economists and statisticians struggle to measure intangible capital directly. But McGrattan and Prescott note that R&D investment and advertising spending—important components of intangible investment—both declined sharply relative to their long-term trends after 2008.

As for evidence of negative shocks curbing capital formation and other economic activity during the downturn, the economists point to costs incurred by businesses to comply with increased federal regulation, including tightened financial rules and environmental standards. Federal regulatory spending and employment increased after 2007, while GDP declined.

—Phil Davies