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Imperfect Knowledge and Post-Crisis Reform of the Financial System

A Sketch of the Conceptual Framework and Policy Proposals*

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*The conceptual framework that underpins this note and some of the main policy responses discussed here have been developed in our 2007 book, ***Imperfect Knowledge Economics: Exchange Rates and Risk***, and subsequent academic papers and newspaper columns cited in the references. The authors are deeply grateful to Edmund Phelps for sharing ideas on his pioneering micro-foundations approach to macroeconomics, which were important in developing the IKE approach. The authors also benefited greatly from many discussions with George Soros, who for decades has emphasized the central role of reflexivity for understanding boom and bust cycles in financial markets and, more broadly, far out of equilibrium situations.

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In an interview with Wolf Blitzer in Des Moines, Iowa, the then Democratic nominee Senator Barack Obama was asked to name his top priority from a list of issues, which included taxes, health care, education, energy policy, and immigration.

"[The] top priority may not be any of those five. It may be continuing to stabilize the financial system. We don't know yet what's gonna happen in January," he said. "None of this can be accomplished if we continue to see a potential meltdown in the banking system and financial system. So that's priority number one – making sure the plumbing works."

Fortunately for the country and, indeed, the world, the now President-elect Obama understands that getting the financial system right must be one of the top priorities he addresses [1]

There are two key issues that need to be tackled:

1) Stabilizing the financial system in the short-term and repairing the plumbing – the flow of credit. (Policy makers have already done much in addressing this issue, by allocating a significant part of the $700 billion rescue plan to recapitalize banks, creating a Commercial Paper Funding Facility,[2] and injecting massive amounts of liquidity through the discount window and by accepting mortgage-backed securities as collateral, as well as a number of other related measures.)

2) Re-regulation of markets and formulation of policy in order to reduce the magnitude and frequency of crises in the future. How do we avoid throwing out the baby with the bath water? That is, how do we regulate and formulate policy while preserving capitalist economies' key feature – their powerful incentives to individuals to devise new ways of doing things?

To deal with the second issue requires a new conceptual framework. The origin of the current crisis lies in the sharp upswing in equity and house prices, followed by a sharp downswing. For example, according to data from Robert Shiller's Web site,[3] the price-earnings (PE) ratio went from 20 in 1995 to 43 in 2000. The subsequent downswing has led to a PE ratio of 15.27 as of last week. As for the housing market, the average price of a home in 1997 was $100,000, according to the Shiller-Case index. Over the ensuing ten years, the price rose to $250,000. Since 2006, house prices have fallen back to $200,000.

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[1] "Obama's top priorities for '09," CNN Interview with Wolf Blitzer, October 31, 2009, http://politicalticker.blogs.cnn.com/2008/10/31/obamas-top-priorities-for-09/.

[2] According to the press release, http://www.federalreserve.gov/newsevents/press/monetary/20081007c.htm, this facility will complement the Federal Reserve's existing credit facilities to help provide liquidity to term funding markets. The CPFF will provide a liquidity backstop to U.S. issuers of commercial paper through a special purpose vehicle (SPV) that will purchase three-month unsecured and asset-backed commercial paper directly from eligible issuers."

[3] See, http://www.econ.yale.edu/~shiller/data.htm

To develop the appropriate policy response to the current financial crisis, we need to understand such fluctuations. The problem is that current policy thinking is based on economic models that do not provide an adequate account of asset price fluctuations.

The key flaw of the contemporary framework is that it does not recognize the important role of imperfect knowledge in driving outcomes in asset markets. Indeed, contemporary models view market outcomes as arising from equilibria that ignore the imperfection of knowledge on the part of market participants and policymakers. Financial markets are normally viewed as being in these equilibria, which can be thought as determining the benchmark level. Swings away from benchmark levels treated as bubbles, which occur because of factors – irrationality or market psychology – that are unrelated to market fundamentals.

But, treating price swings as bubbles, largely driven by non-fundamental factors over which only God may have control, offers very little guidance about which policies can limit the system's vulnerability to crisis. It limits the regulatory response to ensuring transparency of information. Of course, if a sudden reversal in the market occurs, leading to a crisis, policy officials act strongly to restore liquidity and confidence in the financial system. Lacking guidance from economists' models, they can only hope that markets return to their normal equilibrium behavior, and that another bubble will not form anytime soon.

A more theoretically-sound and empirically-relevant account of asset market fluctuations comes from a new approach to economics that places imperfection of knowledge at the center of analysis.[4] This approach, which we have dubbed Imperfect Knowledge Economics (IKE), does not presume that individuals are irrational, but that they have imperfect knowledge of how asset prices are related to market fundamentals. Indeed, news about fundamentals – e.g., interest rates, earnings, GDP growth rates, central bank announcements – move markets. Asset prices often undergo long swings away from historical benchmark levels, followed by "corrections," because this is how markets "discover" a sensible range of values. Once one recognizes that upswings and downswings depend on how market participants, with their imperfect knowledge, interpret fundamentals, new channels for policy action open up.

Chairman Bernanke's speech on October 15, 2002, offers a fascinating insight into how the current academic framework constrains official thinking about the role of policy in limiting the magnitude and duration of swings in asset markets and reducing capitalist economies' vulnerability to crisis.[5] It also reveals that when policy officials confront

[4] For theoretical and empirical support of this claim, see Johansen *et al* (2008), Frydman and Goldberg (2008), and Frydman *et al* (2008a, 2008b). For a critique of the conventional approach to swings in financial markets that emphasizes the key importance of imperfect knowledge, see Schulmeister (1987) and Soros (1987). Soros (2008) makes use of his reflexivity framework to analyze the current crisis. For an early critique of the Rational Expectations Hypothesis, which is the centerpiece of conventional macroeconomic models, see Frydman (1982), Phelps (1983), and Frydman and Phelps (1983).

[5] For Bernanke's full speech, see http://www.federalreserve.gov/BoardDocs/Speeches/2002/20021015/default.htm. In his speech, Bernanke

reality, they are often forced to interpret it outside the confines of conventional economics. Strikingly, in presenting his own thoughts about how to interpret the macroeconomic episodes of the 1920's and 1990's, Bernanke unwittingly reveals the inadequacy of the model that he uses to contemplate policy. However, the clarity of his arguments enables us to offer our critique and sketch our alternative approach by providing brief responses to major points in Bernanke's speech. (All quotations from the speech are in bold, while our brief responses based on the IKE framework are in italics.[6])

Ben Bernanke (BB): **My talk today will address a contentious issue, summarized by the following pair of questions: Can the Federal Reserve (or any central bank) reliably identify "bubbles" in the prices of some classes of assets, such as equities and real estate? And, if it can, what if anything should it do about them?**

Roman Frydman and Michael D. Goldberg (RF and MG): *As we elaborate in our responses below, recognizing imperfect knowledge does not rule out the possibility that the Fed 1) would in general be able to assess that market prices are far from historical benchmark levels ; and 2) formulate policies that attempt to limit excessive departures from these levels.*

BB: This experience has led a number of observers – including academics, journalists, and businesspeople – to assert that the Federal Reserve should have acted earlier to contain the sharp run-up in stock prices. If the Fed had had the foresight to "prick the bubble" at an early stage, the argument goes, the economy might have been spared needless trauma.

RF and MG: *The idea of pricking bubbles early is misguided. It leads to the view that there is little that policy officials can do, because it is extremely difficult to identify when prices first begin to depart from benchmark levels. Even if officials could identify such departures early on, the standard framework suggests that there is little they can do about them. Moreover, as Bernanke points out, pricking the bubble early may be undesirable,*

BB: the problem of a bubble-popping Fed is much tougher than just deciding whether or not a bubble exists.… In my view, somehow preventing the boom in stock prices between 1995 and 2000, if it could have been done, would have throttled a great deal of technological progress and sustainable growth in productivity and output.

RF and MG: *One of the most important lessons that history teaches us is that markets produce superior outcomes in terms of setting prices and allocating scarce resources among competing wants. This is because everyone, including market participants, policy makers, and economists, has imperfect knowledge of the fundamental relationships that*

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draws on Bernanke and Gertler (1999, 2001) and references therein, which analyze effects of monetary policy in a standard Keynesian model with so-called "rational" bubbles.

[6] This note is intended to sketch the key conceptual issues and policy responses in a broadly accessible form. We are working on a fuller treatment of the issues within an explicit mathematical framework.

drive market outcomes such as asset prices. Friedrich von Hayek argued that the division of "knowledge which is not given to anyone in its totality" is the key to understanding that central planners could not, in principle, substitute for markets. What markets do, of course, is to account for the myriad bundles of knowledge and intuition in determining prices. Prices fluctuate and undergo swings because this is how markets "discover" a sensible range of values and in doing so, separate the wheat from the chaff.

Hayek concluded from his penetrating analysis of markets' key role in taking advantage of and engendering the division of knowledge that, because no single actor can have the "totality of knowledge" that market participants possess, state intervention is on the whole highly detrimental rather than helpful to the proper functioning of capitalist economies.

However, as much as we appreciate Hayek's insights and share his fundamental critique of central planning, the IKE view of market fluctuations implies the need for government intervention to limit the excesses that sometimes occurs in the normal functioning of markets. Indeed, the recent crisis has painfully demonstrated this need. But, as Bernanke makes perfectly clear, adopting the wrong policy runs the risk of throwing the baby out with the bathwater. Unfortunately, contemporary economic theory, which seems to suggest early "bubble popping," leads to precisely such wrong policy prescriptions.

BB: The Fed likewise has two broad sets of policy tools: It makes monetary policy, which today we think of primarily in terms of the setting of the overnight interest rate, the federal funds rate. And, second, the Fed has a range of powers with respect to financial institutions, including rule-making powers, supervisory oversight, and a lender-of-last-resort function made operational by the Fed's ability to lend through its discount window. By using the right tool for the job, I mean that, as a general rule, the Fed will do best by focusing its monetary policy instruments on achieving its macro goals – price stability and maximum sustainable employment – while using its regulatory, supervisory, and lender-of-last resort powers to help ensure financial stability.

RF and MG*: Even under a framework that recognizes imperfect knowledge, using interest rates with a view to the real side of the economy while focusing the Fed's regulatory, supervisory, and lender-of-last-resort powers on the financial system makes sense. Of course, ensuring the proper functioning of the payment system and sufficient liquidity is very important. However, if what Bernanke means by financial stability is eliminating price swings in financial markets – those that conventional models treat as abnormal deviations from otherwise equilibrium behavior – this kind of stability would amount to replacing the judgment of the market with that of the Fed.*

As many would agree, striving for this kind of "stability" would undermine financial markets' important role in efficiently allocating scarce capital to the real economy. However, while markets fluctuate as a part of their normal functioning in separating the wheat from the chaff, price swings from benchmark values sometimes become excessive, and can become detrimental to the health of both the financial system and the real

economy. It is these occasionally excessive fluctuations that policy officials can and should address. The IKE framework rationalizes such interventions and provides guidelines for how to formulate such policies.

BB: As I will argue today, I think for the Fed to be an "arbiter of security speculation or values" is neither desirable nor feasible.

RF and MG: *Bernanke concludes from this important insight that monetary policy should not be used to prick bubbles and thus replace the market's judgment concerning asset values, which although imperfect, is superior to any person's or group's. Of course, recognizing imperfect knowledge would lead one exactly to this view. But, while the imperfection of knowledge precludes the Fed's role as arbiter of values, this does not imply the Fed should simply do nothing. What it does imply is that whatever policies are contemplated should not only leave the determination of values to the markets; they should also help markets determine values better. Limiting excessive price swings does exactly that.*

Our view may seem contradictory: on the one hand, we argue that policy officials have imperfect knowledge, and that we therefore must rely on markets to set values. On the other hand, we argue that the very fact that knowledge is imperfect creates a need for policy intervention to limit excessive swings from benchmark levels. But this need arises from the fact that the sharp reversals that follow such excessive fluctuations have substantial costs and consequences for the functioning of the financial system and the economy as a whole. These costs are not internalized by profit-seeking market participants who continue to push asset prices away from benchmarks, despite being aware that they are already too far. Therefore, the state must attempt to limit the social costs of this externality through policy and regulatory measures designed to limit the magnitude and duration of swings.

As long as interventionist measures are aimed at limiting excess in market fluctuations, rather than at "pricking the bubble early," the state can help markets function better without presuming that it knows more than they do. In fact, the market does know more, and it "knows," just as policy officials do, when asset values are far away from the benchmark levels. But decentralized incentives and corporate governance arrangements lead market participants in some circumstances to push asset prices excessively away.

BB: The second part of my prescription is for the Fed to use its regulatory, supervisory, and lender-of-last-resort powers to protect and defend the financial system. In particular, alone and in concert with other agencies, the Fed should ensure that financial institutions and markets are well prepared for the contingency of a large shock to asset prices. The Fed and other regulators should insist that banks be well capitalized and well diversified and that they stress-test their portfolios against a wide range of scenarios.

RF and MG: *If "the large shock" means a sharp reversal, one must make sure that stress testing takes into account how far asset prices are from the benchmark, so that*

such testing allows for the risk of a major reversal. To institutionalize the importance of acknowledging imperfect knowledge, we, together with Edmund S. Phelps, have called for new regulation that would require every rating agency not only to evaluate risk under alternative scenarios, but also to issue a rating for each scenario.[7] *Such multiple ratings for a single security by each agency would make explicit the contingent character of predictions stemming from imperfect knowledge.*

Our proposal recognizes that if the ratings agencies had been required to make explicit how their ratings would have changed under the alternative assumption that, for example, housing prices would fall back to benchmark levels, the markets would have feared greater loss rates, decreasing demand for mortgage-backed securities. This would have reduced the volume of mortgages originated and thus, ultimately, the amount of bad paper that banks ended up holding.

Moreover, making imperfect knowledge explicit would help address the conflict of interest that is endemic to the rating process. Requiring the agencies to rate securities under one or more pessimistic scenarios as well as the optimistic one would make it harder for them to deliver rosy ratings in return for business from the investment banks and other issuers of securities.

BB: The Fed can also contribute to reducing the probability of boom-and-bust cycles occurring in the first place, by supporting such objectives as more-transparent accounting and disclosure practices and working to improve the financial literacy and competence of investors.

RF and MG: *Many of our existing regulations are designed to achieve transparency of information. For example, public companies must make available their financial statements, on the theory that investors can then assess the value of an asset and how much of it they would like to hold. Clearly, more needs to be done. For example, making transparent the positions in derivatives held by market participants is crucial. But, because knowledge is imperfect, this is far from sufficient. What the crisis has demonstrated is that more than information is required for prudent investment decisions. Financial markets need regulation to bring to light the imperfect knowledge of those who are in the business of providing assessments of financial assets.*

BB: Thus, to declare that a bubble exists, the Fed must not only be able to accurately estimate the unobservable fundamentals underlying equity valuations, it must have confidence that it can do so better than the financial professionals whose collective information is reflected in asset-market prices. I do not think this expectation is realistic, even for the Federal Reserve. Moreover, I worry about the effects on the long-run stability and efficiency of our financial system if the Fed attempts to substitute its judgments for those of the market. Such a regime would only increase the unhealthy tendency of investors to pay more attention to rumors about policymakers' attitudes than to the economic fundamentals that by rights should determine the allocation of capital.

[7] ***Financial Times,*** October 20, 2008.

I will give one illustration of the potential pitfalls of relying too heavily on ratio indicators, even in the hands of the most sophisticated practitioners. In December 1996, before my time at the Board, John Campbell of Harvard and Robert Shiller of Yale made a presentation at the Fed, in which they used dividend-price ratios and related measures to argue that the stock market was overvalued.…Though Campbell and Shiller were among those warning of a bubble in stock prices, and deserve credit for doing so, we should not lose sight of a simple quantitative point: According to their published article, their analysis of dividend-price ratios implied that, as of the beginning of 1997, the broad stock market was priced at *three times* its fundamental value (Campbell and Shiller, 1998, p. 13). At that time the Standard & Poor's 500 index was about 750, compared with a close of 842 on October 1 of this year. I do not know, of course, where the stock market will go tomorrow, much less in the longer run (that's really my whole point).

RF and MG*: This part of Bernanke's speech brings to light the sharpest difference between contemporary macroeconomic models, which ignore imperfect knowledge, and IKE models, which place imperfect knowledge at the center of the analysis. Once one recognizes that knowledge is imperfect, swings away from benchmark levels do not occur because individuals do not know what these levels are. Indeed, although market participants have diverse views concerning the benchmark value, stock prices had moved up so far by 1997 that many would have agreed with Campbell and Shiller that the market was overvalued. The point is not that they disregarded the benchmark level in trading, but that traders knew that, although prices had climbed very high by 1997, history shows that moving even farther away is possible. In such an uncertain situation, individuals in the market may well downplay the departure from the benchmark and instead base their forecasts and decisions on the movement of short-term fundamentals, such as the most recent, as opposed to trend, growth in the economy or the level of interest rates.*

Of course, persistent swings away from the benchmark do not last forever. While movements in market fundamentals may lead bulls to bid the value of an asset even higher, they simultaneously become more concerned about a counter-movement back to the benchmark – and thus capital losses – which moderates their desire to increase their long positions.

This concept of risk builds on a neglected insight of John Maynard Keynes, who was keenly aware of the centrality of imperfect knowledge for understanding price fluctuations in asset markets. Moreover, relating the riskiness of holding an open position in an asset market to the asset's divergence from the benchmark level suggests a novel way to think about how central banks can influence the market to limit excessive price swings.

Although the asset price ultimately reverts back to its benchmark level, in a world of imperfect knowledge market participants might ignore this possibility in the near term. This opens an important role for central banks and other policy officials in helping markets place more weight on long-term considerations such as departures from the

benchmark and, in doing so, helping to reduce the magnitude and duration of price swings in asset markets.

The starting point of such policies is for the central bank to announce on a regular basis a range of benchmark values for key asset markets – such as those for equity, housing, and foreign exchange – that is consistent with historical evidence and theoretical knowledge about what would be considered non-excessive. It would also provide a comprehensive explanation of its estimates. This proposal would be the financial equivalent of what central banks already do with respect to inflation targeting. The idea is that when asset prices move beyond the announced range of non-excessive departures, the announcement of such departures would likely heighten traders' concern that other traders will consider it increasingly risky to hold open positions that imply further movement away from the benchmark. This should moderate their willingness to increase their long positions, thereby limiting the magnitude of the asset swing.

But, there is more that policy officials can do to limit excessive price swings in asset markets. These actions are market-specific. For example, in currency markets, we have called on monetary authorities to intervene at unannounced times to push exchange rates back toward benchmark levels.[8] *Such action is not intended to eliminate the currency swing, but to limit its magnitude and duration by encouraging market participants to place more weight on the departure from the benchmark level in their trading. Once imperfect knowledge is recognized, regular announcements of a range of non-excessive departures is not enough.*

For other asset markets, such as those for equities and housing, this type of "limit the swings" policy, which would involve buying and selling in the market by the Fed, may be unattractive. However, there are other policy tools that can help influence market participants to place greater weight on departures from the benchmark in their trading. The idea is that as an asset price moves beyond the range of non-excessive departures, margin and other capital requirements should increase for those who want to take positions that push the asset price farther away from the benchmark. Such limit the swings changes in capital requirements could be set to become effective automatically when the asset price moves beyond the non-excessive range. However, since every long swing is different -- the benchmark itself can change over time due to change in technology and the social context and the factors influencing magnitude and duration also change --l the Fed should be given discretion to widen or narrow the range as our imperfect knowledge unfolds. Any such decisions should be accompanied by detailed explanations, which would serve not only to influence market participants to pay greater attention to departures from the benchmark, but would enable quality control by the public on the Fed's assessment. Moreover, because the Fed would announce and explain its view of departures from the benchmark regularly, say monthly, as it does now with the inflationary outlook, this combination of announcements and changes in capital requirements would make it more risky for individual traders to push the asset price

[8] For a formal analysis and further discussion, see Frydman and Goldberg (2004, 2007a), For an op-ed on this issue, see Frydman and Goldberg (2007b).

further away from the non-excessive range and thereby help them to place more weight on benchmark values in their trading decisions.

This limit the swings set of strategies does not imply that central banks should attempt to confine asset prices to a pre-specified target zone. Given the enormous size of daily volumes in asset markets, such attempts almost always fail, leading to crises. Instead, the limit the swings changes in capital requirements and bank's regular announcements of a range of benchmark values aims to heighten traders' perception of the increased risk of capital losses from betting on increased departures.[9]

Again, the point is not that market participants do not know when an asset price is far from the benchmark level, but that market participants, because of corporate control arrangements and other incentive mechanisms, sometimes place too much weight on short-term market fundamentals in their trading.[10] *The key idea behind IKE's policy proposals is not that the "Fed cannot substitute its judgments on stocks for the market's," but that it can and should act to limit the duration and excessive magnitude of asset swings. In this way, limit the swings policies would help markets and society at large to refocus their attention away from the short-term to longer term considerations.*

BB; Further, the fact that a particular rise in asset prices happens to be followed by a price decline does not prove that the initial increase was irrational or unjustified – sometimes strategies that are perfectly reasonable *ex ante* just don't pan out, as every bridge player knows. Because risk-taking is essential for economic dynamism, we do not want an economy in which investors and businesspeople are not free to take bets that might turn out.

RF and MG: *As we discussed above, fluctuations are how markets separate the wheat from the chaff.*

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[9] By focusing only on limiting excessive departures from the benchmark, limit the swings changes in capital requirements should not be viewed as simply "countercyclical capital requirements," which are sometimes thought to apply throughout the entire cycle. However, when proposing "countercyclical capital requirements," Alan Greenspan seems to have interpreted them as "limit the swings" measures. As he put it in his May 2005 interview with the ***Financial Times,*** "There are virtually no bad loans made at the bottom of the cycle. The bad loans are all made at the top" http://www.ft.com/cms/s/0/c78994f0-2b65-11dd-a7fc-000077b07658.html. Economists have proposed such countercyclical capital requirements for small open economies that have had to deal with much more frequent and severe financial crises. For example, see Ocampa (2001) and references therein.

[10] The key reason why corporate control mechanisms necessarily exacerbate the role of short-term considerations in decision-making also stem from imperfect knowledge. Indeed, the control structure of the vast majority of financial institutions requires that individuals responsible for portfolio decisions are accountable to someone else within the firm or others, such as customers and shareholders. Because it is unknown when the asset price will start reverting to the benchmark, the decision maker, and the financial firm itself, cannot explain losses that might result from betting on short-term trends instead of long term considerations. See Kay (2004) for a related discussion of the implications of imperfect knowledge, which he calls obliquity, for decision-making. For extensive analysis and empirical evidence on the role of imperfect knowledge for understanding corporate governance arrangements and dynamism in the US and Europe, see Frydman *et al* (2006) and references therein.

BB: But I suspect that Campbell and Shiller's implicit estimate of the long-run value of the market was too pessimistic and that, in any case, an attempt to use this assessment to make monetary policy in early 1997 (presumably, a severe tightening would have been called for) might have done much more harm than good.

RF and MG: *This insight, that interest rates should be targeted to the real economy and not to stabilizing financial markets, has also been emphasized by Alan Greenspan. In sharp contrast to this view, critics of the Greenspan era argue that the Fed has been largely responsible for the recent prices swings in the housing and equity markets, and thus the current financial crisis, by keeping interest rates too low for too long.*

But this view is misguided. The great swing in housing prices occurred primarily not because short-term interest rates were kept too low, but because regulators loosened the constraints on Wall Street. With their wings unfettered, investment bankers figured out a way to buy up low-priced sub-prime mortgages, bundle them into mortgage-backed securities that the ratings agencies were willing to bless with their highest ratings, and re-sell them at much higher prices. OPEC and Asian economies, which had amassed huge reserves of dollars from their massive current-account surpluses, could not get enough of these high-yielding securities. This great money machine would not have been stopped even if the Fed had raised short-term interest rates. Although this may have slowed the economy – an outcome that Chairman Greenspan seemed to have been resisting – the great boom in home financing, with its consequent impact on housing prices, would likely have continued unabated.

But, while low short-term interest rates in the U.S. are not to blame for the current crisis, this is not the case with the ideological view, embraced by Greenspan and others, that asset markets would self-regulate and that they could be trusted to avoid excessive valuations. Our proposals for policy intervention, which are aimed at limiting only excessive price swings, recognize that the task at hand is not to replace the judgment of markets with burdensome regulation and the judgment of the state.

There is a great danger that the rush to re-regulate the financial system may go too far. There are already voices arguing that capitalism is finished. But there is no substitute for markets. As Greenspan himself recently acknowledged,[11] what the current crisis has exposed is a serious flaw in the ideological view that markets are self-regulating. It should now be no less obvious that the same flaw afflicts contemporary economic thinking that aspires to give this extreme view a scientific underpinning.

[11] For Greenspan's testimony to Congress on October 23rd, 2008, see http://clipsandcomment.com/wp-content/uploads/2008/10/greenspan-testimony-20081023.pdf.

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