# Remarks

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The last Central Bank Conference two years ago focused primarily on the mechanics of risk management. This Conference has shifted attention to the aggregate "systemic" implications of disruption of financial markets and the roles, if any, of central banks and regulatory agencies in mitigating the cost of such disruption.

Of course, before assessing the roles of regulatory agencies, it is helpful to have a common understanding, even if not a precise definition, of what systemic risk is. Several authors have ventured forward with definitions of systemic risk over the last two days and my reaction, and I suspect the reaction of many of you, was that none of these definitions was completely successful in capturing what, at an intuitive level, we think of as systemic risk. I am not going to attempt a more precise definition. However, perhaps what central bankers have in mind, when we hear so much emphasis placed on systemic risk, is concern about disruption in financial markets that potentially gives rise to the need for intervention. Such periods may coincide with periods of high volatility, but certainly disruption that warrants interventions need not be equivalent to the presence of high volatility.

Pursuing this viewpoint leads naturally to the following two questions: (1) What types of turbulence give rise to a potential need for intervention by central bankers (or other regulatory or multi-national agencies)?; and (2) If intervention is called for, then what form should it take? It may be that periods of turbulence, if I can use that word, during which intervention would be contemplated, are associated with correlated movements in markets and/or correlated defaults. But, of course, this does not imply that the presence of correlated defaults and correlated movements among markets should necessarily lead to an intervention by any regulatory agency. To put this point differently, I have placed on the overhead projector a slide that displays, from 1983 to the present, the movement in speculative grade (all bonds rated below BAA) default rates in the U.S. corporate bond market against a four-quarter moving average of GDP growth. One would certainly come away with the impression that that there are correlated defaults across issuers and that default rates are highly correlated with the business cycle (the correlation of the default rate with GDP is about -.8). Yet I do not think we would argue that these cyclical correlations, by themselves, justify central bank interventions in corporate bond markets. Similarly, correlated movements in asset prices across markets and countries, by themselves, do not call for interventions.

That is, I do not think that correlation *per se* across market prices or default rates is what people have in mind when discussing systemic risk.

What do people have in mind? My thinking about this question has been influenced a great deal by the informative discussions over the last two days. In particular, I have a much better sense of the questions that need to be asked before reaching a conclusion about the merits of policy interventions in turbulent markets. What people seem to have in mind is the possibility that the normal functions of markets and market systems break down in such a way, and on such a scale, that intervention is called for to prevent or mitigate system failure. And the assessment of what is "called for" should be based on an assessment of the trade-offs—the costs and benefits—of intervention, perhaps along the lines of the trade-offs Ed Green laid out for us in earlier discussions.

The papers presented at this conference have addressed a number of important facets of systemic risk and, in reviewing some of the key observations, I find it convenient to distinguish between the three areas of payment systems, banking systems, and securities markets. The papers on systemic risk in payment and settlement systems have been truly fascinating. The papers by Fujiki, Green and Yamazaki, Freixas, Parigi, and Rochet, and the simulation papers, for instance by Muranaga and Shimizu, have made significant contributions to our understanding of the potential sources of disruptions in settlement systems and the potential roles of intervention in the workings of a payment system. The models are stylized and probably do not lead, at this early stage of development, to concrete policy prescriptions. Nevertheless, I found them to provide useful guidance as to the types of circumstances in which policy intervention might be warranted, and also circumstances where it may appear that such an intervention is warranted, but perhaps indeed it is not. That is, this research will hopefully help us identify (and focus on) key variables that will give us "signals" as to whether or not some form of intervention is warranted.

In the banking area, an important contribution of many of the papers presented at this conference is the careful analysis of several case studies of previous banking panics. As several of today's panelists have stressed, such historical studies help us understand how in different market environments and at different times in history, policy interventions have worked under different financial arrangements to mitigate financial crises. Though, at the same time, from a more prospective viewpoint, today's discussion left me wondering how the authors would answer the following question: In our current market environment, with existing financial safeguards in place, should we have serious concerns about bank-runs or other types of systemic crises in the banking sector? Several representatives of the Federal Reserve System expressed the concern that moral hazard problems with regard to central bank interventions in markets have become more severe, because of recent central bank actions. I would like to hear more from other participants here who have been thinking about and researching these issues.

Finally, tuning to the securities markets, this is the area where our ignorance about the consequences of systemic risk seems greatest. Our understanding of the links between market turbulence, the mechanisms which create turbulence, and the potential role for regulatory agencies in mitigating some of its economic consequences remains quite limited. I applaud the authors of the papers that examine spillover effects across market volatilities and returns, globally and domestically. Equally interesting were the papers that examined the behavior of securities prices in particular markets during periods of stress. Yet, the links between these studies and the theme of this conference—systemic risk and the role of central banks or other agencies in mitigating such risk—seems quite weak. Spillover effects—equivalently, correlation in most of these studies—across markets are not equivalent to the presence of systemic risk, in my view.

Since the potential for systemic risk in securities markets is the area closest to my own research, I would like to briefly expand on this last point. Let me take an asset pricing perspective and abstract from problems with payment/settlement systems and the informational problems related to banks and bank runs. Consider the problem of pricing a corporate bond. Though a corporate bond is a defaultable instrument it is, in an important sense, an inherently linear instrument. That is, under reasonable assumptions, we can value the cash flows on a corporate bond by treating the future cash flows as if they are riskless and then discounting these flows by a default-adjusted discount rate. The fact that the bond may default is reflected entirely in the adjusted discount rate, and the value of the sum of cash flows is the sum of their individual values. Moreover, standard "arbitrage-free" pricing methods are applicable and, indeed, this is how corporate bonds are often valued by financial institutions during "normal" times.

Now suppose that the probability of default, or recovery in the event of default, is itself dependent on market prices. This circumstance may be what Bob Litterman had in mind when he referred to endogenous pricing. In this case, it turns out that the pricing problem for a corporate bond is fundamentally different than the previously described case. Specifically, pricing is no longer linear and, in particular, the price of a corporate bond is no longer the discounted sum of the prices of its promised cash flows. While we can, in principle, formally accommodate this type of non-linearity in our pricing models, the models typically used by trading desks and risk management teams are of the linear type.

Thus, if we encounter circumstances where there is endogeneity of price determination in the sense of dependence of the probabilities of default or recovery on market prices, or market participants act as if this is so, then a fundamental nonlinearity may immediately enter market price behavior and our basic pricing models no longer hold. Systemic risk in securities markets might be thought of as the simultaneous occurrence of this type of non-linearity in pricing across several markets or instruments. Taking this perspective, it seems difficult, if not impossible, to examine empirically the phenomenon of market stress-induced endogenous pricing using a standard, linear valuation framework.

It is interesting to note that liquidity crises, or at least one view of such crises,

is isomorphic to this default problem. What I have in mind is viewing a substantial change in the liquidity of a security as an unpredictable change in market value much like default. In the case of a liquidity crisis, one does not lose all of the market value prior to default so, by analogy to the default case, there is a fractional recovery (or equivalently loss) of market value. In a systemic liquidity crisis, the fractional losses depress the prices of several instruments simultaneously. And, just as in the default example, if the loss fraction or the "intensity" of the crisis depends endogenously on market prices, then nonlinear pricing will apply.

Returning to my default example, these remarks about nonlinear pricing and joint endogeneity of prices in several markets should be distinguished from the type of correlated default I discussed in my own presentation. In my research on simulating correlated defaults, there are simultaneous jumps in the probabilities of default, but the hazard rates of default (the default intensities) were taken to be exogenous processes. Therefore, pricing was linear. One way to highlight the distinctions between linear and nonlinear pricing, is to think about the 25 standard deviation analogy that Bob Litterman gave when discussing recent events in global bond markets. Recent events were clearly outside the scope of the shocks and reactions embodied in most risk management and pricing systems. Were the failures of existing systems because we had mis-specified the distributions of the "shocks" in our models? Are shock distributions not only non-normal, but with much fatter tails than we had accommodated? Or was it the case that there was too much linearity in our pricing systems and that recent events lead to nonlinear and large responses of market prices to large, though not extreme, economic shocks? That is, was there endogenous price reaction, perhaps along the lines of the preceding remarks on price dependence of default and liquidity premiums? I suspect that it is the latter concern, and not the former concern about mis-specified shock distributions, that most people are worried about when we experience large deviations from "normal times."

The level of ignorance that we have about the nature of liquidity crises and non-linearity in pricing is illustrated by two episodes that several of the panelists have already discussed. One is the market's reaction to Greenspan's recent, unexpected cut in interest rates. I, like Bob Litterman, am amazed at the apparent consequences of Greenspan's action for stabilizing markets. While the markets' reactions could be interpreted within the nonlinear pricing settings discussed a few minutes ago, it remains unclear to me what mechanism would have brought about the endogeneity and consequent non-linearity to begin with.

The second episode is the intervention by the Federal Reserve System in the LTCM bail out. On this issue my views differ somewhat from those of at least some of the panelists. To me, the key issue was not whether LTCM was too big to liquidate. I believe that liquidation of LTCM would likely have caused major, further disruptions in financial markets. Rather, I think the key question is whether private agents, acting without the intervention of regulatory agencies, would

have reached a resolution of the problem on their own without forcing total liquidation of the portfolio. In other words, pertinent questions would seem to be: (1) Were private agents willing to step in and buy out the portfolio of LTCM?, and (2) If they had stepped in would they have aggravated market conditions by forcing an immediate liquidation of the positions? With regard to the second question, the answer is clearly no. A consortium of financial firms essentially took over the positions of LTCM and it has been proceeding with an orderly liquidation of portions of the portfolio. This is as would be expected, since firms injecting their own capital into LTCM or any other financial investment would have no incentive to liquidate immediately if this would lead to a substantial loss of value. Regarding the first question, there has been debate in the press about whether there were private bids for the balance sheet of LTCM that would have been viable in the absence of some intervention by the New York Federal Reserve. And it is difficult to know how the bidding would have proceeded had the Federal Reserve not become involved in negotiations (Would other bidders have surfaced? Would LTCM taken the Buffet bid given no apparent alternative? etc.). Given the themes of this conference and the expressed concerns about moral hazard problems created by the actions of the Federal Reserve, one could cogently argue that their intervention, even though not involving an immediate financial outlay, exacerbated the moral hazard problem. Furthermore, one might reasonably question whether the intervention materially affected the eventual allocation of capital between the bidders and the principles of the hedge fund. Or wonder whether the intervention prolonged or reduced the pain of dealing with the situation.

In sum, even if we all agree that a large financial institution may be "too big to liquidate," the nature and timing of interventions, if any, by regulatory agencies is a complex issue. And the question of whether recent interventions were socially optimal is one that seems to have not yet been fully addressed. More generally, on the issue of systemic risk, the non-linearity associated with default and illiquidity is an issue that was not given the same attention that was given to the issues of systemic risk in settlement and banking systems. I hope that more attention will be devoted to these securities market issues at the next Central Bank Conference.

Finally, the central banks hosting this conference, and the Bank of Japan in particular, have done a wonderful job in organizing this conference. Participation has certainly helped me think through the many important issues that have been discussed over the last two days.