Conference Summary

Session 1

This introductory session attempts to conceptualize the notion of systemic risk and presents papers undertaking quantitative analyses of the contagion effect.

The first paper by De Bandt (European Central Bank) and Hartmann (European Central Bank) reviews the theoretical and empirical literature and develops a broad concept of systemic risk. Integrating risks within and between banking markets, securities markets and payment/settlement systems, the concept distinguishes, on the one hand, single failures or crashes which cause other financial institutions or markets to crash (contagion) and, on the other hand, macroeconomic shocks which negatively affect a large number of financial institutions or markets simultaneously. The second paper by Schoenmaker (Dutch Ministry of Finance) examines contagion in the bank failures which occurred during the U.S. National Banking Era between 1880 and 1936. It concludes that there is contagion in the sense that if the number of bank failures in a given month is higher than average, then the number of failures in the following month is higher than the conditionally predicted value (controlling for macroeconomic factors). The third paper by Kitamura (Keio University) and Kobayakawa (Bank of Japan) emphasizes the arc-sine feature[1]of the stochastic process, and shows how effectively various types of discipline, such as early closure rule, prevent contagion of failure from spilling over to other players in the financial system.

The discussion by Lacker (Federal Reserve Bank of Richmond) first raised a question about the definition of systemic risk put forth in the first paper. He argued that the definition presupposes the existence of externality, while all the linkages generated in the financial markets represent "voluntary transactions" from which involuntary exposure of one agent to others (i.e. externality) does not arise. He then argued advancement of knowledge can only be achieved by one of the two following methods: one is to seek plausible models which display the same empirically observed phenomenon, and the other is to seek the phenomenon which has been identified by the theoretical models. From this perspective, partial equilibrium models such as that of Kitamura and Kobayakawa are useful as long as they are clear in what they intend to achieve in the models, but a definition of systemic risk should not be put forth unless one has complete and well-articulated models that display systemic risk. Similarly, empirical findings such as that of Schoenmaker show us evidence which is consistent with the contagion effect, but it would be difficult to find evidence that rules out natural alternatives that do not

[1] The arc-sine theorem implies that it is more likely for players to stay continuously on the winning side or the losing side than to switch frequently between the two sides.

rely on externalities.

Owing to these concerns, Lacker suggested an agnostic definition of systemic risk which does not rely on externalities. The definition reads "systemic risk is the risk that significant financial distress occurs at a significant number of institutions at about the same time and seems causally related." He contends this definition does not prejudge the usefulness of the central bank, whereas the normal definition presupposes the role of the central bank in alleviating the effects of externalities that participants are not adequately prepared for. The natural policy response under Lacker's definition is to consider how to roll back the central bank lending commitment, thereby possibly generating a certain degree of moral hazard in case of financial distress, while under the standard definition, this policy implication does not arise.

Hartmann provided the following answers to Lacker's comments. As one can see from the paper, the concept put forward does not presuppose the existence of externalities. Rather do technological and pecuniary externalities build a subset of instances of contagion, one part of the concept put forward. Other elements of this concept are shifts between multiple equilibria and aggregate shocks. Nor does the identification of an externality necessarily imply that central bank intervention is to be recommended (i.e. welfare improving). On the one hand, the existence of other market or policy imperfections in a theoretical model might make the optimal response to the externality alone sub-optimal. On the other hand, even if there exists a theoretically optimal policy response it might not be feasible in practice, e.g. due to asymmetric information.

Following Lacker and Hartmann's discussion, several questions were raised from the floor. The discussion centered on two points: the existence of externalities and the effectiveness of the Diamond and Dybvig[2] model.

With regard to the first point, Rochet (Université des Sciences Sociales de Toulouse) claimed that externality can be defined as any situation where one economic agent affects the utilities of other economic agents; hence, it is existent irrespective of the voluntary nature of financial transactions. With this in mind, Rochet questioned if there is any difference between the two definitions, stressing that externality should not be discarded from Lacker's definition. Wang (Rice University) argued that the concomitance of voluntary trading and externality can be explained by the fact that the central bank bears part of the cost of externality by acting as a lender of last resort (LOLR). In other words, although participation in the market may be voluntary, it does not necessarily mean that participants have to internalize the cost associated with all the adverse events—if they are obliged to incur all possible costs, a market failure may arise. Thus, there is a welfare gain to be made by the participation of the central bank as a lender of last resort. Gibson (Federal Reserve Board) claimed that another way to circumvent the externality argument in the definition of systemic risk is to focus on the

[2] Diamond, D., and P. Dybvig, 1983, "Bank Runs, Deposit Insurance and Liquidity," *Journal of Political Economy* 91, 401-419.

presence of multiple equilibria where a shift from the Pareto-dominant equilibrium to the other is regarded as systemic crisis. Nonetheless, the policy implication of this definition would be ambiguous. Action taken by regulatory authorities to counter a systemic crisis would increase moral hazard on the part of market participants. Pritsker (Federal Reserve Board) further claimed that externalities are not the only kind of market failure. In emerging markets, additional important sources of market failure are market incompleteness, where depositors cannot acquire insurance against the set of possible contingencies that may arise, and asymmetric information. These market failures may mean there is a possible role for government to improve the functioning of markets.

Lacker responded that in the presence of asymmetric information *per se*, market equilibria do not necessarily fail to achieve Pareto optimal. Schoenmaker commented that non-tradability of loans (i.e. market incompleteness) is often the core of market failure in banking. He also said that even tradable products like securities can become suddenly illiquid in the case of a market crash and that this phenomenon aggravates the crisis. Kitamura further commented that the risk of contagion can still exist even if a market is fully informed, i.e. the uncontrollable stochastic nature of financial transactions is sufficient to generate market failure.

The effectiveness of the Diamond and Dybvig model was another focus of discussion. Rolnick (Federal Reserve Bank of Minneapolis) emphasized that the model seems to describe well what one normally perceives as systemic risk, because it exhibits multiple equilibria, where one of them could be interpreted as a system-wide Pareto-dominated equilibrium in which real economic activity is seriously affected.

Several participants pointed out the limitations of the model. First, Lacker said that the model cannot completely distinguish the fundamental shock from the sunspot-type shock, and that the equilibrium and policy implications are different, i.e. multiple equilibria may be discarded depending on the specification of deposit contracts in the model. Second, Hartmann commented that, although the mechanism applied in the model is relevant, a single institutional setting should be enlarged to a multi-institutional setting to enable us to understand the nature of systemic crisis. Third, Weber (Federal Reserve Bank of Minneapolis) mentioned several studies on the contagion effect. Among them, the study of bank closings and failures at the beginning of the Civil War identified that in Wisconsin, most of the banks with their bank-notes collateralized by the southern states' bonds, whose price fell to 1/3 of their original value, went into bankruptcy, while others with their bank-notes collateralized by the northern states' bonds stayed in business. This evidence seems to be consistent with the asymmetric information theory of bank runs rather than the Diamond and Dybvig story.

Finally, Itoh (University of Tokyo) concluded the session by referring to the recent experience in Japan. He mentioned that it is worth noting that the very nature of the Japanese financial system, which possesses features such as cross-shareholding, seems to have played a crucial role in generating crisis. Moreover, as a result of the recent financial modernization, a large degree of friction arises,

which may become a source of systemic risk. He concluded that it would be beneficial to study the link between these institutional features and systemic risk in future lines of research.

Session 2

This session identifies the payment system as a potential source of systemic risk and examines some problems, such as gridlock or settlement delay, that may arise in the system. It then discusses several methods of avoiding these problems.

The first paper by Fujiki (Bank of Japan), Green (Federal Reserve Bank of Minneapolis) and Yamazaki (Hitotsubashi University) studies seemingly contradictory policies by the policy maker, namely the restriction of the exposure to risk generated by one participant to others and the provision of a safety-net whereby the policy maker specifies the loss-sharing rule. It identifies that both policies can be constituents of an efficient risk sharing which involves the transfer of resources from the central bank during a period of financial panic. The second paper by Impenna (Bank of Italy) and Masi (Bank of Italy) studies an interlink of the real time gross settlement (RTGS) and the net settlement system. It examines quantitatively how the settlement delay in RTGS may arise when these systems are interlinked, using the data obtained from the Italian payment systems. The paper concludes that the potential cost is negligible at the aggregate level; nevertheless, significant differences do exist among groups of banks, due to different criteria followed in the liquidity management. The third paper by Freixas (Pompeu Fabra University), Parigi (University of Venice) and Rochet extends the classical Diamond and Dybvig model, and identifies that the gridlock arises as a result of coordination failure. It then concludes that the central bank's function as lender of last resort is an effective tool to prevent gridlock.

Following the three presentations, Hunter (Federal Reserve Bank of Chicago) discussed each paper respectively. With regard to the first paper by Fujiki, Green and Yamazaki, Hunter raised two questions. First, he asked the question of how the model would change if the authors adopted the more realistic assumption that all every agent in the economy values trades with every other agent in the economy. In particular, what would happen if agent 4, interpreted as the central bank by the authors, was concerned with possible failures among any of the agents in the model. It seems clear that such an extension would require the authors to directly address the question of moral hazard, something the paper is fairly silent on in its current form. The second question involves formally modeling agent 4 as a clearing house. While the authors attempt to draw an analogy between agent 4 and a clearing house, Hunter stated that a clearing house model would have to be more symmetric. The feature of clearing house associations, in which all agents would have to value trade with all other agents (members of the clearing house) and stand ready to come to their aid in the case of failure, is not currently captured by the approach used by the authors.

Green replied to the point raised by Hunter that the defect of the Diamond and

Dybvig model is that when there is a public guarantee of payment systems, the crisis will not happen in equilibrium, which unfortunately is not true. It requires big public expenditures to get out of a crisis. Moreover, those problems are exacerbated because of the delay in negotiating a public settlement due to *ex post* haggling between the broad public and citizens with bigger stakes directly in the financial systems. One of the implications of the model is that one has to understand the costliness of delay, and perhaps the policy priority ought to be to establish the *ex ante* perspectives where there are consistent expectations among all the stakeholders about what to expect from whom in the event of financial crisis, and also about what the financial system is giving to people who do not have big stakes in being a direct participant in normal times in return for that protection.

With regards to the paper by Impenna and Masi, Hunter raised a few concerns about the analytical framework of the paper. First, authors need to describe in detail how the real time gross settlement system and the net settlement system are interlinked with each other in order to show how the adverse consequences of the one would affect the other. Second, regarding the measurement of cost of delay, it seems to represent an average cost but not the maximum cost, because the authors simply take the average daily net outflows of the cash leg of the security settlement system and multiply it by an estimated probability of delay. Third, Hunter raised a concern about the rationale for the conditions on the specification of the probability of delay. Analysis of the maximum cost perhaps requires looking at a different type of calculation, namely one more focused on the loss associated with a small probability event, that is, a systemic event.

Impenna first agreed to insert a clearer description (e.g. by a chart) of the linkage between the security settlement system and the RTGS system in the Italian context. Then he replied that the estimated cost of the delay is referred to as the *maximum cost* in the paper since the calculation implicitly assumes the highest possible concentration (only one operator); the higher this concentration, the greater the systemic impact of a given amount of net outflow in the security settlement system. As for the outflow data, the authors adopted the only feasible methodology of considering the average of the existing time series of realized daily net outflows. Finally, he agreed that the definition of the probability of delay still needs further scrutiny; as for the settlement failure ratio, it is relevant in determining the cost of delay especially for branches of foreign banks.

Concerning the paper by Freixas, Parigi and Rochet, Hunter pointed out that the key concern from a policy perspective is how to set up a transfer mechanism that minimizes the danger of gridlock, but the paper does not seem to derive much about how to implement the Pareto-dominant equilibrium. In addition, the paper discusses the strategic default of the participants, but what one is more concerned about is the possibility of an exogenous shock that could lead to the collapse of the payment system. Lastly, he mentioned that it seems necessary that the paper provides an *ex ante* mechanism that prevents the negative spillover of bad banks which cannot honor checks before they are actually written; hence, the systemic crisis is prevented. What is not clear is how to insure this mechanism, particularly

in a world with deposit insurance.

Lastly, Shinoda (Fuji Bank) concluded that all the papers provided us with refreshing perspectives on how we view such problems inherent in the payment system. As a banker who has been involved in the development of the payment system in a private institution, he emphasized that such academic contributions as well as profound discussions have to be incorporated into actual policies, and it requires further collaboration of central bankers, regulatory authorities and the private sector. He also mentioned that in recent years we have experienced a dramatic development in the infrastructure of payment and settlement systems in each country. Numerous examples can be found in the Japanese systems, such as the FEYCS (Foreign Exchange Yen Clearing System) which intends to follow Lamfalussy Standards in December 1998, BOJ-NET which has already announced that the net settlement mode will be abolished by the end of 2000, and JB-NET, which started to implement DVP (delivery versus payment) settlements of corporate and municipal bonds. Also in the field of cross-border payments, remarkable improvements such as the setting up of the CLS (continuous linked settlement) have been observed. Finally, he added a few more comments on future issues in the payment system. The main themes are: whether the coexistence of gross and net settlement systems can be justified from a cost perspective, whether the role of the central bank as a lender of last resort will be still crucial after substantial improvements have been made in payment systems, and how the characteristics of correspondent banking will be changed.

Session 3

This session comprised five empirical studies on market behavior. The first two papers examine how macroeconomic announcements affect price formation and liquidity in a domestic market and return and volatility spillover across the global markets.

The paper by Fleming (Federal Reserve Bank of New York) and Remolona (Federal Reserve Bank of New York) analyzes how the U.S. Treasury market behaves when public information arrives. Using high frequency data on prices, trading volume, and bid-ask spreads, they find that a major macroeconomic announcement induces a striking two-stage adjustment process. In the first stage, the announcement leads to a sharp and instantaneous price change, a lull in trading volume, and a dramatic widening in the bid-ask spread, reflecting the market's initial response to pure public information. In the second stage, trading volume surges and persists along with high price volatility and moderately wide bid-ask spreads as investors trade to reconcile residual differences in their private views. The paper by Connolly (North Carolina University at Chapel Hill) and Wang (Rice University) examines the role of macroeconomic announcements in explaining correlated movements in equity returns and volatility across the markets in the U.S., the U.K., and Japan. Connolly stressed the first part of their results, where they found that return spillover phenomena are observed only in

one direction, from the U.S. to the other country in the full sample period.

With regards to the paper by Fleming and Remolona, Schoenmaker raised a question from the floor whether any differences are observed between the effects of policy announcements and scheduled macroeconomic announcements. If the effect of policy announcements could be less than that of macroeconomic announcements, then policy could be transparent and predictable. Fleming responded that policy announcements have a weaker impact on the market than the most important macroeconomic announcements. Hunter and Yotsuzuka (Hosei University) encouraged the authors to take into account the degree of surprise in each announcement. Hartmann commented that it would be interesting to compare the authors' findings to the announcement reactions in the foreign exchange market.

Concerning the paper by Connolly and Wang, Ito (Hitotsubashi University) questioned the result regarding the volatility spillover and asked whether the measurement time frame of return and announcement is consistent. Connolly responded to the first question that the result shows that the announcements partly explain volatility-spillover phenomena. Wang agreed with the importance of Ito's second point and explained how they dealt with the point.

The last three papers focused on market behavior during periods of stress. The paper by Lasfer (City University of London), Melnik (Haifa University), and Thomas (City University of London) analyzes the stock price behavior observed after a sharp price change. They find that a positive abnormal price movement follows a positive price shock and vice versa in the short term; these results are inconsistent with the over-reaction hypothesis. The post-shock abnormal performances are significantly larger in emerging markets than in the developed markets. Patel (JP Morgan Securities) and Sarkar (Federal Reserve Bank of New York) examine stock market crises in the developed, Asian, and Latin American markets using dollar-denominated returns. They find differences in the characteristics of stock market crises between developed and emerging stock markets. Contagion phenomena within a region are frequently observed, although contagion phenomena across regions are rarely observed. Correlation analysis of country stock returns shows that international diversification is beneficial for dollar-denominated investors with horizons of more than six months. The paper by Yoshifuji (Bank of Tokyo-Mitsubishi) and Demizu (Bank of Tokyo-Mitsubishi) explores a mechanism of financial market movements during a period of stress by applying the idea of complexity theory. The results show markets can be classified into three types by pattern of stress occurrence determined by the shape of frequency distribution and the degree of fitness to "law of power." Based on a model which applies genetic algorithms, they find that price movements including extreme shocks can be generated, while a normal stochastic model cannot generate such price movements.

Singleton (Stanford University) pointed out that Lasfer, Melnik, and Thomas' rejection of the over-reaction may be due to sampling bias induced by excluding additional shocks that occurred within ten days after an initial shock; large price movements in one direction are sometimes followed by quick correction to the

opposite side. Prisker commented that it would be interesting to compare the result with currency-adjusted returns.

Regarding the results of Patel and Sarkar, Singleton commented that higher return correlations during periods of large price movements could be a purely statistical result. He asked whether the same result could emerge naturally from an analysis based on a stochastic volatility model calibrated by the data. Prisker suggested that since the crises might partly be caused by a run-up of the dollar, it would be interesting to analyze stock returns data in the local currency.

Finally, the moderator Shirakawa (Bank of Japan) wrapped up the session. He stressed that empirical studies on market behavior enhance our understanding of systemic risk and market liquidity is one of the key concepts. It is hard to understand market liquidity itself because market participants' behavior and market liquidity affect each other. In order to understand this complex feedback mechanism, we should figure out the stylized facts on market liquidity by conducting empirical research. He identified two approaches as the future courses of empirical studies on market liquidity: expanding the scope of markets and exploring newly developed methodologies. With regard to the scope of markets, it would not be informative to examine the liquidity of one market in isolation, considering that market participants migrate to markets where they perceive more liquidity. We should understand market linkages by expanding our empirical studies in two directions, namely the scope of products and geographical coverage. Also we could apply newly developed methodologies such as processing and analyzing high frequency data, complexity theory, genetic algorithms, chaos theory, and neural networks. These attempts are still experimental, but we should appreciate the possibilities that they offer us in shedding light on certain aspects of market liquidity, otherwise not possible by traditional economic theory.

Session 4

In this session, the implications of market design for financial stability were discussed. The first two papers study the effects of circuit breakers on market stability. Muranaga (Bank of Japan) and Shimizu (Bank of Japan) generate market crashes in an artificial market model and explore the effects of a trading halt on market behavior. The paper by Goldstein (University of Colorado at Boulder), Evans (Federal Reserve Bank of New York), and Mahoney (Federal Reserve Bank of New York) presents a high-frequency empirical analysis of the effectiveness of New York Stock Exchange Rule 80A which limits destabilizing index arbitrage trades. These two papers both point out the effectiveness of the circuit breaker.

Takayama (MTB Investment Technology Institute), as the discussant for the two papers, first presented three features of the circuit breaker in Japan: the standard of invoking the breaker with respect to the price change is narrower than that in the U.S.; the trading halt period in Japan is much shorter than that in the U.S.; the circuit breaker in Japan is not activated twice a day. He suggested that

the model presented in the paper by Muranaga and Shimizu might be more sophisticated if it incorporates traders' utility maximizing behavior, traders' positions, and restrictions on arbitrage traders. Commenting on the paper by Goldstein, Evans, and Mahoney, he recommended that the authors calculate returns in three- or five-minute intervals instead of one-minute intervals if the lack of minute-by-minute data is not negligible. Given the non-negative constraint of the parameters and the existence of intraday seasonality, he suggested that they could extend their model by applying EGARCH and/or periodic GARCH.

Hotsuki (Bankers Trust) argued that practitioners would not regard the circuit breaker as a cost. Goldstein answered that it would depend on the market participants' characters and their trading strategies. Fleming pointed out the possibility that the observed price volatility calculated in the paper by Goldstein, Evans, and Mahoney may be smaller than what it is in fact because of the existence of non-synchronous trading.[3] Goldstein explained that they analyzed the futures markets in addition to cash markets in order to avoid the problem of non-synchronous trading.

The last three papers examine the behavior of related financial markets during periods of stress. The paper by Kodres (International Monetary Fund) and Pritsker presents a theoretical framework of contagion between financial markets. Their model is a multiple-asset rational expectations model, in which an idiosyncratic shock to one market is transmitted to other markets through market participants' cross-market hedging. The paper by Brown (New York University) and Steenbeek (Erasmus University) analyzes the behavior of Nikkei stock-index futures price around the period of the Kobe earthquake and the Barings collapse. The paper by Ganley (Bank of England) and Trebeschi (Bank of England) shows the results of testing for linkage between stock indices and related futures contracts in the U.K., U.S., Canada and Germany around the time of the October 1997 correction.

Sarkar pointed out that the most interesting result of the paper by Kodres and Pritsker is that it shows the role of information asymmetry during the process of contagion. He suggested that they present the results in a more straightforward way by taking out derivative dealers from the model and allowing informed traders to receive different, but correlated, information. He also discussed issues raised by the paper's assumption that markets in different countries are analytically equivalent to different markets in one country.

Pritsker responded to Sarkar's points by saying that derivative dealers in the model play a role in modifying the size of price movements if other market participants are unaware of their dynamic hedging. Even without derivative dealers, the model generates contagion and large price movements. Concerning

[3] Market indices are typically calculated using the latest transaction prices for the component securities. The component securities do not all necessarily trade at the same time, however, with some securities reacting with a lag to new information. This leads to the problem of non-synchronous trading whereby the recorded value of an index does not equal its true value. One implication of non-synchronous trading is that market index values may differ significantly from index futures prices, particularly when securities prices are moving sharply and when trading among some securities is infrequent or delayed.

the suggestion regarding the information correlation, he stressed that they would refrain from assuming that private information is correlated across markets because making this assumption generates contagion through a correlated information channel that has been examined by others. Instead, this paper emphasizes a different mechanism, cross-market hedging, that has not yet been formally examined.

Schoenmaker asked Kodres and Pritsker what kind of policy prescription for extra transparency could reduce the information asymmetry. Pritsker answered that one of the crucial information asymmetries existing in markets is knowledge of a firm's financial condition and its financing opportunities. Improved disclosure requirements and securities filings might make markets less susceptible to contagion or make the magnitude of its effects smaller. Kodres commented that there is some evidence in the empirical literature that there is information asymmetry in emerging markets between foreign and domestic investors. She emphasized that the empirical literature has reached conflicting results on whether foreign or domestic investors are better informed.

Rochet encouraged the authors to consider the wealth effect and causality. Hartmann raised the question of how the authors distinguish between "contagion" and normal price propagation, which can be explained by spillover effects between markets, and whether this type of non-normal propagation can be exhibited by the model. Pritsker responded to the questions by saying that their multiple asset model can induce large price changes, but, because of linearization that was performed to maintain tractability, it cannot generate discontinuous price movements such as those in the single-asset Gennotte and Leland model.[4] He also added that the paper explains time variations in the pattern of contagion and therefore explains why we might have observed smaller spillovers in the past than at the current time.

Hartmann suggested that the paper by Brown and Steenbeek should control for the size of ups and downs of price changes, because the distribution of stock price returns is asymmetric. Ito (Hitotsubashi University) asked Steenbeek if there was a systemic risk because the Singapore International Monetary Exchange does not have a loss sharing rule, although the Osaka Stock Exchange does. Steenbeek answered that they did not find this story in the analysis but an explicit increase in risk premium was observed there.

Fleming raised two issues on the paper by Ganley and Trebeschi: the so-called problem of non-synchronous trading, and whether it is appropriate to consider the risk-free rate to be constant within a trading day.

Finally, Suto (Chuo University) wrapped up the session. With regard to the circuit breaker, we need to consider the overall value of the rule. The benefit obtained by reduced price volatility should be balanced against the cost of depriving market participants of trading opportunities. As for the behavior of related

[4] G. Gennotte and H. Leland, 1990, "Market Liquidity, Hedging, and Crashes," *American Economic Review*, Vol. 80, No. 5.

financial markets, we could obtain deeper insights about the linkage between global financial markets and contagion by exploring the mechanism through which hedging markets fall into malfunction. She pointed out the information supply and information dissemination issues in terms of optimal transparency to secure market stability as an area to be explored in the future. For example, how and when should macroeconomic news be announced in order to ensure that it is spread among all market participants quickly and evenly? How and when should information of events and other information of risks be disclosed? In this context, it might be important to discuss an inter-market information networking system.

Session 5

This section concerns new approaches to risk management, covering subjects varying from credit risk modeling and the Japanese public financial sector to risk information system.

The first paper by Duffie (Stanford University) and Singleton (Stanford University) surveys some computationally tractable models for simulating correlated default times on portfolios of loans, bonds, OTC derivatives, and other credit positions. The second paper by Miyazaki (Hosei University) and Saito (Osaka University) treats the postal savings system and the fiscal investments and loans program in Japan as an integrated financial institution, and presents a theoretical framework to assess the market risk involved in this public financial system. The third paper by Gibson explores the likely effects of the falling cost of assembling risk information on the behavior and organization of a financial firm by examining several models of the firm in the presence of asymmetric information.

Concerning the first paper, Hotsuki pointed out that there exist two different alternative models for credit risk, a default-based model and a credit mark-to-market model, and that the models in the paper are categorized into the former. In the default-based models, a challenge typically arises when credit risk and market risk are to be integrated in one consistent model for the value-at-risk calculation and capital allocation. On the other hand, in the credit mark-to-market models, where credit risk is quantified based on observable credit pricings in the market, market risk and credit risk are efficiently integrated. A problem is that we cannot observe sufficient numbers of prices of credit risk bearing instruments.

Singleton replied that the models of the paper are pricing models and that the framework has been used by those who think about not only the evaluation of corporate bonds but also about the evaluation of all credit sensitive instruments. If information for calibration is available, the models can provide evaluation formulae for prices of defaultable financial assets. Singleton also asserted that this is completely compatible with market and credit risk integrated systems.

Rochet also made comments on the first paper by Duffie and Singleton. He first referred to Singleton's remark that it is difficult to distinguish the correlation between default and that between intensity of default. Then he pointed out that

the distinction is very important in terms of central bank intervention because if contagion is in fact only correlated with intensity of default then we do not need any individual intervention of the central bank but only global management of liquidity.

Concerning the second paper by Miyazaki and Saito, Hotsuki commented with regard to one of the conclusions of the paper that the current rule for determining interest rates on postal savings accounts reflects the values of put options embedded in the accounts with reasonable accuracy. He asked whether this conclusion of fair pricing is coincidental under certain market conditions or the conclusion is expected to hold systematically.

Saito replied that the model in the paper is not exactly equal to the actual postal savings accounts and that, for several reasons, what is calculated in the paper is basically the lower bound of the option value.

Konishi (Waseda University) also commented on the second paper. First, he asserted that the real issue is not a matter of incorporating the option premium into pricing but the better management of risk on the part of a government agency. Second, he pointed out that the presence of the government in the market has often functioned as an excuse of the private sector in analyzing risk, which he called systemic moral hazard on the part of the private sector. He emphasized the importance of the question of to what extent, why, and how the government should be in, or function in, the market.

To conclude the session, Hotsuki made three points. First, he asserted that even the most sophisticated financial institutions are a long way from being able to model event risk or systemic risk. Considering materiality and frequency of such risk, we acknowledge the necessity of enhancing our risk management models.

Second, Hotsuki asserted that, even if risk modeling is enhanced to incorporate event risk and systemic risk, the risk management behavior of individual firms would not substantially change. This is because any financial firms with strong risk management expertise know that we cannot rely too much on models, and hence their risk management behavior relies on both quantitative and qualitative assessment.

Hotsuki concluded that if we have better risk management models, their most significant impact in the reduction of systemic risk would come from the improved collective behavior of market participants through the transparency of risk information instead of changes in the behavior of individual institutions. The third paper has a suggestion on “Generally Accepted Risk Principles” for disclosure. He also asserted that a consistent regulatory framework with transparent risk disclosure would credibly support the stability of the financial system.

Session 6

This session concerns how systemic risk can be prevented, especially what central banks can do as a LOLR in contagious situations.

The first paper by Rolnick, Smith (University of Texas at Austin), and Weber attributes New England's relatively good economic performance during the Panic of 1837 to the existence of the Suffolk Bank which was a private bank that played the role of a LOLR by acting as a clearinghouse for all the banknotes circulating in the region. The second paper by Shimizu and Ui (Bank of Japan) examines successive failures of Japanese financial institutions and focuses on the role of contagious expectation. It derives the policy implications including that providing market participants more accurate information on financial institutions would be beneficial for preventing market failure as a consequence of contagious expectation. The third paper by Goodfriend (Federal Reserve Bank of Richmond) and Lacker explores central bank lending on the analogy of private lines of credit and points out the undesirable consequences of central bank lending such as moral hazard. It concludes that no simple institutional mechanisms can credibly limit central bank lending but that mimicking the steps to build up a reputation for price stability over time may be the only practical way to credibly commit to limited lending of central banks.

Nakaso (Bank of Japan), the session moderator, illustrated the three routes by which systemic risk manifests itself: 1) loss of price discovery function, 2) loss of payment and settlement services, and 3) loss of credit allocation function. Then he raised the following three questions. The first question is 'Does the LOLR function contribute to recovery of the real economy?' This question is related to the third route illustrated above. He indicated his doubt as to whether a LOLR should reinforce financial intermediaries' capital positions. The second question 'Does the LOLR function contribute to maintaining market functions?' is related to the first route of systemic risk. Nakaso pointed out that kinds of information provided for market participants should be carefully considered depending on the market conditions. For example, a commitment to support a certain bank in a crisis situation may give market participants the impression that the bank's liquidity position is bad enough to need support from the central bank and lead to an adverse consequence. The third question is 'Does the LOLR function impair the soundness or the reputation of the central bank?' In a crisis situation where a systemic risk is perceived imminent, there is the dilemma that the central bank has no alternative to lending by itself while it aims to build up a good reputation and to prevent moral hazard by a commitment to limited lending.

Before moving to the free discussion, there were rejoinders from the paper givers on Nakaso's propositions. Weber gave some evidence related to Nakaso's three questions from the Suffolk Bank experience. Regarding the first question, Weber pointed out there was no loss of payment services during the Panic of 1837 since banknote clearing services continued and the Suffolk Bank's major role was extending credit so as to maintain the functioning of economic activity. Secondly, in order to avoid the moral hazard problem that impairs the efficiency of market functioning, the Suffolk Bank applied a kind of Bagehot rule in that it took collateral and charged the penalty rate of 2% per month on the credit extended to the banks. Thirdly, the Suffolk Bank's profitability and dividend rate remained steady

during the panic period, which indicates that its lending activities did not impair its soundness. Ui replied with regard to the second question that central bank lending will not give an adverse signal if accurate information is already disclosed and he reiterated that a central bank's commitment to the provision of lending will help prevent a bad consequence. Lacker said in his response to the last question that direct lending to a troubled institution involves moral hazard issues and that a natural alternative is to conduct open market operations to stabilize market rates or to lend to other institutions and let the market decide whether or not to allocate funds to a troubled institution.

Rochet pointed out that the case study of the Suffolk Bank in the first paper indicates that there are economies of scope between note-clearing and lending. He wondered if a central bank might be invented since there are economies of scope between lending and monitoring and also asked why the market cannot play the same role as a central bank provided that central banks only lend to solvent institutions. Lacker responded there is a trade off between central bank lending to avoid systemic risk and the cost of moral hazard observed in cases like that of the IMF (International Monetary Fund). Weber pointed out that the Suffolk Bank's actions were a market response, and it played the role of monitoring banks all over, which indicates that there are economies of scope between lending and monitoring. Rolnick emphasized that moral hazard is a serious issue and that the Suffolk Bank applied the strict rule of lending only to solvent institutions and at a penalty rate.

Green claimed that the benefit of the financial sector is that it can supply financial contracts which help achieve higher economic growth while its cost is that it creates a situation where one agent's risk taking imposes an externality on another agent but avoiding such externality gives low economic growth. In the context of this trade off, he argued there are three alternatives for organizing the economy and the financial system: a narrow banking system that gives a small chance of systemic crisis but also ensures that there is low economic growth, a laissez-faire banking system that refuses intervention by the public sector because of the costs on taxpayers but accepts exposure to recurrent episodes of systemic crisis, and a banking system that allows public intervention to rescue it by supplying the necessary funds to cover a hole in the system and supports high economic growth. He concluded that none of the three choices is superior to the others so one has to make a choice among them.

Schoenmaker raised a question from the floor regarding the third paper with respect to the asymmetric information problem. He wondered whether systemic risk could be avoided as long as monitoring can not fully eliminate the imperfect information problem. Imperfect information is at the heart of banking. Goodfriend responded that the paper is not arguing that private lines of credit and monitoring can totally eliminate systemic risk so that central banks can cut off lending. What it claims is that relying too much on central bank lending is wrong.

Melnik pointed out the difficulty of pricing risk and insurance, especially in an emergency. He said a loan commitment is only a partial insurance and central

banks find it difficult to price emergency lending. Rolnick referred to risk-adjusted deposit insurance as an example and agreed on the difficulty of pricing risk and necessity of having a market for risk.

Gibson pointed out that large banks use ALM (assets and liabilities management) technologies as a substitute for purchasing liquidity insurance. As a result, they do not face liquidity problems when solvent except in very rare cases like the 1985 computer failure at the Bank of New York. Large banks do use central bank discount window lending when they become insolvent and have to submit to an orderly resolution. He also pointed out that underpricing of liquidity insurance might be more serious for international problems such as a sovereign default and the IMF's LOLR function. Lacker agreed with Gibson's view that the use of central bank lending is observed mostly in the closure of insolvent banks, but he reiterated that central bank lending should not be extended to insolvent banks which private lines of credit would not be applied to.

Trimble (Bank of England) emphasized the importance of the quality of banking supervision in identifying problems in banks before they became critical. When banks became insolvent, supervisors were faced with difficult decisions but in the U.K.'s experience, there had been times when it had not been appropriate to use public funds to support those institutions. He pointed out that these could be highly political decisions. In the U.K., in order to maintain the soundness of the central bank's balance sheet, a government guarantee would be required against its LOLR in support of a large bank.

Goldstein illustrated the point that there will be events where the consequences may change over time by referring to the case of the Citicorp. He argued that a LOLR function can prevent negative externality and that it was not easy to just say no to LOLR operations.

To conclude the session, Nakaso claimed that a LOLR function proves to be useful when it is combined with another set of policies that contains a moral hazard problem. A LOLR function can be conducted in a variety of forms including direct lending to troubled institutions as well as open market operations, but it is important to strike a balance between the cost of moral hazard and the benefit of achieving systemic stability and take account of cost-efficiency as well as long-term economic welfare. He also pointed out that the central bank as a lender would require information regarding the financial conditions of borrowing institutions, but there is a fundamental issue yet to be considered whether the central bank should conduct a supervisory function and have direct access to the information.

Session 7

The panel session offered the views of panelists from various backgrounds on systemic risk in today's market and future issues to be considered by each partici-

pant, such as academics, risk managers, and policy makers.[5]

Following the panelists' remarks, some aspects of systemic risk which had not been much discussed were raised from the floor. The first point was how the financial system structure, especially the degree of dominance of bank-intermediation in a country, affects the character of systemic risk in the market or country. Recent financial stresses observed in countries such as Thailand, Russia, Indonesia were referred to as prospective examples of the effect of financial structure on systemic risk. The second point was in which direction we should seek a solution, to assist or to restore price systems in order to avoid serious problems of non-price allocation. Although a non-market type solution is more likely to be employed, historical examples have included private bank solutions to the LOLR question. We should bear in mind the limitations of central banks with respect to systemic crises. Sweden had a massive insolvency crisis and cooperation with the government, which should ultimately address insolvent institutions, was necessary. In Korea and South East Asia, banks had very large foreign currency exposure and international cooperation was necessary.

In concluding the panel session as well as the entire conference, Singleton stressed three areas where he felt future research is particularly needed. First, along with several of the panelists, he appealed for more research that interprets the recent global economic events in the context of models of financial markets, and that draws out the potential roles for policy actions, if any. Second, Singleton noted the potentially important interplay between the regulatory process and market behavior during periods of stress. The reactions of market participants and security prices during periods of financial turbulence are not independent of the initial conditions set, to a large extent, by regulators. In particular, the availability of markets for hedging, the liquidity of cash and derivatives markets, and the transparency of these markets are closely linked to regulatory authorities' policies regarding the legality of certain security designs, the costs of financing positions (borrowing and lending securities), and disclosure. Comparative studies, across different market "designs" and different time periods, of the reactions of markets under stress would be beneficial. The final area of research mentioned by Singleton was the pricing of the balance sheet risks faced by financial institutions. Looking beyond Value at Risk to the shape of the "tail" of portfolio return distributions, how much would it cost institutions to insure against losses due to infrequent market turbulence? How should the costs of this insurance be apportioned within the firm across business units? Would charging desks for exposures, in a way that would almost surely reduce P&L during "normal" times yet reduce bankruptcy risk during turbulent times, increase overall shareholder value? Such explicit pricing mechanisms would surely increase the transparency of risks within firms and markets. For these and other reasons they warrant further exploration.

[5] Part II of this volume includes each panelist's remarks addressed at the beginning of this session excluding those of Ken P. Y. Cheng from Hong Kong Monetary Authority.