The Economics of Financial Stability: Research Workshop at the OeNB

Martin Summer[1]

On July 7–8, 2008, an international group of researchers met at the Oesterreichische Nationalbank (OeNB) in Vienna to present and discuss current research on Financial Stability. Hyun Song Shin from Princeton University and Martin Summer from the OeNB's Economic Studies Division, who jointly organized this research workshop, titled the program "The Economics of Financial Stability".

Financial Stability Analysis Needs More Economic Concepts

Why is there a need to emphasize the economic aspect of financial stability? Is this not an economic problem par excellence? An answer to this question was provided by Peter Mooslechner, Director of the OeNB's Economic Analysis and Research Department. In his opening address, he pointed out that recent financial stability research at central banks was strongly rooted in concepts based on statistics and actuarial mathematics where financial stability issues are often treated by abstracting away from the underlying economics. From an economic point of view, the determination of prices of financial assets and the risks borne by the investors are core issues which have to be explained. In the financial stability research rooted in actuarial mathematics these prices are often assumed as exogenous. Economics focuses on the explanation of behavior and how collective behavior determines financial stability. The purely statistical approach usually abstracts away from behavior and assumes the perspective of a risk manager of a given portfolio at a financial institution. From the perspective of central bank research there is also another issue. Research on financial stability and on monetary analysis is usually conducted in different departments. There is a practical delineation between both fields that is in strong contrast to their real world interaction. An economic perspective on financial stability issues reveals the connection between financial stability and monetary research, while a pure risk management approach obscures it. So in this respect, there is a potential benefit from the discussion about the specifically economic approach to understanding issues of financial stability.

Explaining Liquidity, Business Cycles and Monetary Policy by the Interaction of Borrowing and Liquidation Constraints in Financial Markets

The first paper presented by *Nobuhiro Kiyotaki*, Princeton University, and coauthored by *John Moore*, University of Edinburgh, had the title *Liquidity, Business Cycles and Monetary Policy*. The paper presents a monetary macroeconomic framework that explains how shocks to productivity and liquidity determine asset prices and economic fluctuations. The model is applied to the analysis of monetary policy. The theoretical aim is to provide a canonical model that can easily be combined with some standard models used in modern macroeconomic theory.

In the model entrepreneurs and workers produce a homogenous output from capital and labor. The economy is a monetary economy where fiat money is in fixed supply and is an asset together with physical and human capital. While workers cannot borrow against future labor income, entrepreneurs can

JEL classification: C15, G20, G28, G32
Keywords: integrated analysis of market and credit risk, risk management, foreign currency loans, banking regulation

[1] *martin.summer@oenb.at.*

borrow against investment into physical capital when they get access to a new investment opportunity. Not all entrepreneurs do have investment opportunities in each period. Hence, there is a need for financial markets that transfer resources from savings to investment. There are two mechanisms that limit the financial market's capacity to allocate funds between savers and investors: On the one hand, there are financing constraints. Entrepreneurs are not able to raise the full present value of their investment as the ability of a financial investor to enforce the entrepreneur to completely fulfill his future financial commitments is limited. On the other hand, there is a liquidity wedge between money and the existing financial claims. There is a liquidation limit to securities at any point in time, called limited resaleability. An entrepreneur can always fully sell his money holdings but he can only partially sell his financial claims at any point in time. Both constraints are modeled by two exogenous parameters. As a third agent in addition to entrepreneurs and workers the public sector can change the money supply, enter the market for financial claims, and add to aggregate demand for resources.

The equilibrium, concept uses standard competitive equilibrium ideas where agents maximize their respective objective functions taking prices of goods and assets as given. In equilibrium these prices adjust in a way to balance supply and demand in all markets. Equilibria are analyzed in a neighborhood of a steady state. Depending on the exogenous parameters – i.e. borrowing and resaleability constraints, the fraction of entrepreneurs with investment opportunities, and the depreciation rate of physical capital – there are non-monetary and monetary equilibria. In a non-monetary equilibrium, borrowing and liquidity constraints have no force, money is not needed, the first best allocation is achieved, and the return on the financial asset is approximately equal to the time preference rate. In a monetary equilibrium, money is in circulation and the interaction of borrowing and liquidity constraints generates a feedback between asset markets and output. In particular, the equilibrium capital stock is below the first best, the return on equity is below the time preference rate, and the expected rate of return on money is below the expected rate of return on equity. The expected return on equity contingent on having an investment opportunity in the next period is lower than the expected return on money. Thus, unlike in modern standard models of monetary economics, there is a spectrum of interest rates and the interaction between monetary policy and the real sector cannot be summarized by a single rate.

The equilibrium allows for a recursive representation that opens a perspective on equilibrium dynamics in the face of shocks to aggregate productivity and liquidity. A liquidity shock, modeled by a drop in the resaleability parameter, decreases the ability of investing entrepreneurs to finance their investment. For entrepreneurs without an investment opportunity the financial asset will lose attractiveness as a means of saving relative to money. Thus, the price of the financial asset has to fall and the value of money rises. This drop in the asset price increases the down payment per unit of investment and a decline in investment occurs that is only partially offset by the increased value of money. To restore equilibrium in the goods market consumption has to rise. Over time, there is capital decumulation with lower real asset prices, decreasing investment and consump-

tion until there is a switch in the resaleability constraint.

The model can also be used to analyze policy measures of the central bank against a liquidity shock, modeled as a fall in the resaleability of the financial contract. How should a central bank react to a liquidity shock that impairs the ability of entrepreneurs to resell their financial claims? Kiyotaki argued that a traditional open market operation did not help as it would only change the composition of broad money. What the central bank needed to do instead, was to purchase the financial asset which had partial resaleability and a high liquidity premium.

The discussant of the paper was *Guido Lorenzoni*, MIT and Federal Reserve Bank of Chicago. In his discussion, he summarized the model within a simplified dynamic structure and concentrated on the role of the liquidity parameter. He pointed out that the role of *expected* liquidity changes rather than that of current changes in the liquidity parameter were crucial to explain the feedback effects between asset prices and investment. Lorenzoni acknowledged the potentially important role of this model to understand "unorthodox" monetary interventions such as the Term Security Lending Facility, recently introduced by the Federal Reserve and the Bank of England.

Boom and Bust Cycles and the Role of Frictions in Allocation of Capital between Sectors

The second paper in the first session was presented by *Guido Lorenzoni*, MIT and Federal Reserve Bank of Chicago. It had the title *Inefficient Credit Booms* and dealt with policy questions related to boom and bust cycles. Is there any precise notion that justifies the claim that there is too much ex ante borrowing or lending in a boom? What are the market incentives to leave spare borrowing capacity and why or when are these incentives not aligned with the social optimum?

To address these questions, Lorenzoni developed a model in which an entrepreneurial and a consumer sector interact over time under financial frictions inhibiting the transfer of resources between different economic sectors over time. Entrepreneurs have access to projects but not enough funds to realize these projects. As a result, they have to borrow from consumers who have resources but no access to projects. Aggregate shocks affect the future return on the entrepreneurs' projects. Due to limited access to outside finance, entrepreneurs have to sell assets to cover losses if they are hit by a negative shock. The counterpart to this liquidation of assets is a sector that can use these assets not as productively as entrepreneurs. While the debt contracts used by entrepreneurs can individually be written in a state contingent way, they are unable to take into account the general equilibrium effects of assets sales which result from their collective, individually rational behavior. A planner, who could take into account the effects of collective behavior but is subject to the same institutional setup of available financial contracts and frictions, would be able to achieve ex ante an allocation of resources between sectors that achieves a strict Pareto improvement.

In the light of this analysis, Lorenzoni concluded that there was indeed a case for the claim that there was excessive borrowing and as a result excessive volatility of asset prices and investment in boom and bust cycles. These phenomena occur because the sectors in the economy with financial frictions cannot coordinate on an ex ante collec-

tively optimal inter-sectoral allocation of funds.

The discussant *John Moore*, University of Edinburgh, concentrated on extracting the underlying logic of Lorenzoni's result about Pareto improving ex ante resource allocations between sectors. Moore showed that the basic logic of the argument can be told in a stripped down version of the model in which the essential elements that play a role are differentials between sectors in the productive use of capital combined with the inability to ex ante commit to resource transfers in the future that would bring capital to its most efficient use. Moore showed that the planner who is subject to the same frictions as the economic agents in the model can, however, achieve such transfers indirectly by controlling the equilibrium price effects of capital liquidations after a shock. Why are frictions that inhibit efficient reallocations of capital after shocks so prevalent, and why do inefficient liquidation spirals seem to play such a prominent role in real world crises? These were the questions which were recurrently raised during the workshop.

On the Importance of Diverse Portfolios for Financial Stability

Collective liquidation of portfolios stayed on the agenda also in the last paper presented in the morning session: *The Risk of Joint Liquidation: Diversity instead of Diversification* by *Wolf Wagner*, Universiteit van Tilburg. In his paper, Wagner studies a model where investors solve a portfolio allocation problem between risky assets anticipating that in the future they might be in a situation where they collectively have to fire sale their assets in an illiquid market. This anticipation of fire sales can ex ante make it optimal for investors to forego diversification benefits in order to avoid forced asset selling into an illiquid market ex post. Wagner discussed two implications of his analysis: one for regulation and the other one for asset pricing. Viewed from the perspective of his model, an efficient allocation of portfolios in the economy under the risk of potential forced liquidations or fire sales does require that not every investor individually holds a fully diversified portfolio. The market outcome may entail both under- and overdiversification compared to an efficient allocation. The asset pricing implications are that assets held by many investors simultaneously should be traded at a discount, reflecting the effect of potential future joint liquidations in an illiquid market.

The discussant, *Alexander Stomper*, IAS Vienna and MIT, organized his remarks around a set of questions related to Wagner's model. He first asked for the reasons as to why investors in the model were forced into liquidation when the portfolio value dropped below the debt level. He pointed out that there were other ways to model liquidity needs. He also discussed the assumption that investors' objective was reasonably well modeled by assuming that their goal was to minimize expected liquidation costs. Under limited liability, this would, for instance, not be an obvious goal of investors since the liquidation costs would be borne by creditors. More generally, Stomper asked for a more thorough discussion about the relations between equilibrium and the institutional structure of portfolio choice. Finally, he questioned the separation between liquidity provision and portfolio management suggested in the paper.

Why Private Liquidity Co-insurance is not Viable in a Crisis

Viral Acharya, London Business School, presented a paper co-authored with *Denis Gromb*, London Business School, and *Tanju Yorulmazer*, Federal Reserve Bank of New York, with the title *Imperfect Competition in the Interbank Market for Liquidity as a Rationale for Central Banking*. He developed a theory motivated by a rich set of historical cases that showed why private co-insurance arrangements between banks for managing crises situations may not be viable and why public provision of liquidity can improve liquidity transfers in such critical circumstances. The theory is built on the observation that crises can create market power for some institutions in the interbank market. These institutions can then use this market power to their advantage. This leads to the breakdown of private co-insurance arrangements. He presented ample historical and modern evidence for the problem that in a crisis banks with surplus liquidity use their market power to force banks in liquidity needs to inefficient asset sales.

The model is formulated within the structure of a liquidity model based on Holmstrøm and Tirole. One of two banks owns a portfolio of risky assets, e.g. loans to the corporate sector. The payoff to the loan portfolio depends on a random event and an unobservable monitoring effort where the bank has a benefit from poor monitoring. After the monitoring stage, a random refinancing need arises and the second bank is in the position to provide excess liquidity. The bank with liquidity needs can decide whether to borrow or whether to sell assets. Since assets are specific, borrowing is more efficient than asset sales, but the transfer of ownership is better than managing a portfolio of assets with poor monitoring effort. The equilibrium of the model, which is derived as the solution to a bargaining game in the interbank market, has the property that there is a market power threshold for the liquidity surplus bank that makes it individually optimal for all banks with market power above this threshold to force inefficient asset sales. This inefficiency is increasing with the market power of the liquidity provider. There is an inefficient allocation of liquidity in equilibrium. A central bank can alleviate the inefficiency by improving the outside option of the liquidity needing bank, even if it does not lend in equilibrium. In order to improve on the market allocation, the central bank must be prepared to lend against collateral outsiders would not lend against and it must have some comparative advantage in the efficiency of monitoring lenders. Therefore, it is an advantage to combine supervision with the liquidity provision role of the central bank. If a central bank has sufficient informational advantages and loss bearing capacity, it can implement the first best liquidity allocation and prevent inefficient fire sales of assets.

The discussant *Falko Fecht*, Deutsche Bundesbank, was critical about the assumption that the bargaining between the banks involved forced fire sales and suggested to model the bargaining only over the mark-up on an interbank loan and let the liquidity needing bank simultaneously decide to sell assets at a competitive rate. Fecht also pointed out that the typical instruments of the lender of last resort were standing facilities such as marginal lending facilities, which are all collateralized loans. Such loans were not very well described by the framework of the model. In Fecht's view, the authors' argument rather corresponded to a situation of

emergency liquidity assistance; but for these kinds of lendings it was hard to see how this could alter the outside option of the liquidity needing bank, since terms and conditions of such lending arrangements were not known in advance. Finally, he raised an issue concerning the market power of the liquidity providing bank. He suggested that there was evidence that the existence of a lender of last resort created incentives for banks to underinvest in liquidity. The market power of the liquidity providing bank increased the return to liquidity holding and thus might counteract these incentives.

Why is Leverage of Financial Institutions Procyclical?

Tobias Adrian, Federal Reserve Bank New York, presented a paper co-authored with *Hyun Song Shin,* Princeton University, titled *Procyclical Leverage.* The paper seeks a contract theoretical explanation for the empirical fact that large investment banks seem to manage the capital structure of their balance sheets in such a way that there is a positive one-to-one relation between balance-sheet growth and leverage. This implies a capital structure theory that is in contrast to a world where the size of the balance sheet (the selection of projects) is separated from the financing decision. The data seem to suggest a situation where equity grows at an exogenous rate, while total assets and leverage move up simultaneously when perceived risk is low and take the opposite move when perceived risk is high. This collective behavior fuels boom and bust cycles because it implies that banks react to increases in asset prices by buying more assets and to decreases in prices by selling assets, thus counteracting the usual intuition about the stabilizing role of prices as an adjustment mechanism to balance excess supply and demand. Procyclical leverage therefore implies that banks have an increasing demand curve and a decreasing supply curve for risky assets.

The aim of the paper is to offer an explanation for this kind of collective behavior based on contract theory of capital structure. In this theory the agent is a financial intermediary financed by issuing a standard debt contract. The principal is a creditor to the bank. The incentive problem arises because the agent can choose to invest in two different projects A and B. A has a lower expected return and is more risky than B. Since the debt financing makes the agent's claim a call option on the underlying assets, he has an incentive to choose riskier low return investment when the strike price of the option (the level of debt) is sufficiently high. An optimal contract has to ensure that creditors are willing to provide finance, but that at the same time the agent has an incentive to invest into good projects. It turns out that an optimal contract between a principal and an agent in this way collectively leads to procyclical leverage.

The discussant *Helmut Elsinger*, OeNB, pointed out technical difficulties in the model and gave examples which suggested that it might be difficult to guarantee that the contracting problem will be well defined and well behaved. He saw the difficulties mainly in the assumptions needed to establish procyclical leverage. He pointed out that the assumption that the creditor uses a standard debt contract might be considered as problematic as within the context of the model better sharing rules could be offered to the lenders. Finally, he pressed the authors to give a more thorough explanation as to why this particular capital structure theory applied to banks but not to the behavior

of other industries and why banks did not adjust equity.

Sophisticated Risk Management at the Level of Individual Institutions and its Aggregate Consequences

Hans Gersbach, ETH Zurich, gave a paper co-authored with *Jan Wenzelburger*, Keele University, on the macroeconomic consequences of banking regulation titled *Sophistication in Risk Management, Bank Equity and Stability*. Gersbach presented a macroeconomic model where some issues related to the new Basel II framework for capital regulation can be brought into perspective and analyzed within a coherent macroeconomic model. In particular, the following questions were addressed: While a more sophisticated risk assessment for individual obligors is clearly an improvement for an individual bank under given macroeconomic conditions, is this also true at the system level? Will Basel II affect lending and make it difficult for small and medium-sized enterprises to get loans? How will interest rates and bank capital be affected?

In the model consumers provide an exogenous supply of deposits at a given deposit rate. Since aggregate deposits cannot fund all investments, there is a need for equity financing, too. Entrepreneurs have access to risky projects which are subject to macroeconomic shocks and have an idiosyncratic quality level affecting their production output. The quality level is their private information. Instead of investing into a risky project, entrepreneurs may invest into an outside option earning the same rate as bank deposits or into bank equity which has a similar rate in equilibrium. Banks in the economy compete by setting a lending rate. If risk assessment is simple, banks can only set one rate for all entrepreneurs. In a sophisticated system, rates can be made more "risk sensitive" and may depend on the obligor's risk. For a given lending rate, there is a critical quality level so that entrepreneurs with a higher level will invest into the risky projects and entrepreneurs with a lower level will invest into the outside option. When entrepreneurs face a realization of a shock that makes it impossible to honor their debts, they default and the bank gets the project return. Otherwise the bank gets the loan repaid with interest.

In equilibrium, the lending rate must be such that bank equity earns the return of the outside option. In a simple system this condition must hold in aggregate, in a sophisticated system this condition must hold loan by loan. From this model Gersbach derived a series of results which can be grouped into three broad categories: results on the level of project financing in the economy, results on financial stability, and results on the default rate of loans. On the project finance issue, the central result is that more projects are financed with a simple system. High-quality borrowers subsidize low-quality borrowers. Financial stability issues are discussed by comparing the level of bank equity in a simple and in a sophisticated system. The central results in this respect are that a simple system has more bank equity on average and – more importantly – in times of bad macroeconomic shocks than a sophisticated system. Finally, on the issue of default rates, Gersbach tried to characterize conditions under which a simple system can exhibit a lower default rate than a sophisticated one.

The discussant of this paper was *Ronel Elul*, Federal Reserve Bank of Philadelphia. Elul pointed out that the cross subsidization idea – good projects subsidize bad projects – would have more appeal if it also led to higher aver-

age consumption. Yet, in the model aggregate consumption in a simple system is lower on average as the additionally financed projects are actually projects with a negative net present value. Since these projects should not be financed anyway for efficiency reasons, Elul suggested considering a setup where the sophisticated system leads to actual underinvestment. Regarding the stability results, he made clear that it was an issue whether bank equity was indeed the appropriate measure of financial stability. But given one accepts this measure, he liked particularly the result that a simple system provided more equity for bad macro shocks. If a bad shock hits the economy, low-quality entrepreneurs default both under a sophisticated and under a simple system. In a sophisticated system, equity compensates for default by charging a higher interest rate for bad borrowers but this premium is only realized in good times. In the simple system, bank equity holders are compensated for low-quality project defaults by the good quality entrepreneurs, who repay their loans also in bad times. Elul found the results on default rates not too convincing since the conditions used to characterize lower default rates in a simple system were all described in terms of endogenous parameters.

Ambiguous Information and Illiquidity

The last presentation of the workshop was given by *Jan Werner*, University of Minnesota, based on a joint paper with *Han Ozoylev*, University of Oxford, titled *Liquidity and Asset Prices in Rational Expectations Equilibrium with Ambiguous Information*. The authors study information transmission in asset markets by explicitly modeling the concept of ambiguous information. The framework in which this issue is discussed goes back to a model by Vives where a market with risk-averse informed investors, risk-neutral competitive arbitrageurs, and a noisy supply of the risky asset is analyzed in a standard decision theoretic framework with unambiguous information. The authors find that under ambiguous information the sensitivity of asset prices to information and signals and to changes in asset supply increases, markets are less liquid, and there is excess volatility of asset prices. Ambiguity is formally modeled by assuming that arbitrageurs in the market consider in their decision not only one prior probability distribution over future asset prices but multiple prior distributions. It is assumed that in taking their decisions arbitrageurs are ambiguity averse and hence always give particular weight to the worst case. Illiquidity occurs at a range of prices at which arbitrageurs will not trade.

In his discussion, *Jürgen Eichberger*, Universität Heidelberg, first showed how the ambiguity model was related to the case with no ambiguity and discussed in depth some of the concepts related to the formal modeling of ambiguous information. He asked whether ambiguity aversion of arbitrageurs was a good parable for explaining illiquidity in financial markets. His interpretation of the stark contrast of a stop in trading under ambiguity and limitless arbitrage with no ambiguity was that it could be seen as an insight about the role of risk neutral arbitrageurs in financial markets. At the conceptual level of the model, Eichberger pointed out a certain tension between extreme sophistication in extracting information from observed prices and yet an extreme naive approach to the set of prior probability distributions, where arbitrageurs never learn the actual underlying probability distribution.

Some Common Threads

The papers covered many different aspects and details of the economics of financial stability and showed an impressive variety of different threads current research into financial stability is working on. But is there also a common thread in all these different papers? An issue raised in several papers and discussions was the fact that financial markets seem to show some frictions that made it difficult to apply standard arguments from the analysis of competitive markets. In an asset price bust, why is it apparently so difficult to take advantage of the opportunity of buying assets at lower prices and why can capital "waiting on the sidelines" not be quickly and easily mobilized to step in? Why do we so frequently see liquidation spirals and collective selling of assets exactly when prices are falling? What some of the papers showed was that by taking these frictions seriously, there was room for policy intervention. What also became clear was that standard regulation often failed to distinguish sufficiently clearly between individual institutions and the system as a whole. Individual institution thinking does not necessarily lead to correct conclusions for the aggregate. There seems to be much room and indeed a need for a stronger macroeconomic perspective on policy issues regarding the regulation of financial markets. Finally, the workshop showed very clearly that the economics of financial stability was a very active and exciting field of economic research where there was much to be gained by fostering the interaction between research at universities and central banks, by rethinking some old issues with the new tools of advanced modern economic theory, and by combining and interweaving the traditionally separated fields of monetary analysis and financial stability.