ASSESSING SYSTEMIC RISK IN BANKING SYSTEMS

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Economists have tended to think of systemic risk in terms of financial institutions such as banks, and only infrequently in terms of financial markets. With the growth of disintermediation, in which companies can access capital-market funding without going through banks or other intermediary institutions, greater focus should be devoted to financial markets and the relationship between markets and institutions. In such a system(ic) perspective banking authorities has to implement a new framework for banking system risk assessment. Conceptually, it is possible to take this perspective by carrying out a systematic analysis of the impact of a set of market and macroeconomic risk factors on banks in combination with a network model of mutual credit relations. Following the lead of many European countries (including U.K., Austria) it becomes necessarily Romanian banking authorities to develop systemic risk surveillance.

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1.Systemic Risk: the Term Meaning

Scholars historically have tended to think of systemic risk primarily in terms of financial institutions such as banks. The European Central Bank and other monetary agencies have likewise expressed concern about systemic risk and its potential systemic effects, dramatically illustrated by *the recent subprime mortgage crisis* and its impact on the mortgage-backed securities and commercial paper markets. Governments also have been concerned about the potential for systemic failure stemming from hedge-fund collapses, originally raised by the collapse of Long-Term Capital Management in 1998 and more recently prompted by the unregulated spread of hedge funds as a favored investment tool. Financial leaders also are calling for increased focus on systemic risk that extends past the traditional, bank-oriented approach.

There are, nonetheless, some confusions about what types of risk are truly "systemic" - the term meaning "of or pertaining to a system" - and what types of systemic risk should be regulated. There is not even agreement on whether systemic risk should be defined by reference to market losses or just market participant losses. Although, a common factor in the various definitions of systemic risk is that *a trigger event*, such as an economic shock or institutional failure, *causes a chain of bad economic consequences* (sometimes referred to as successive and cumulative losses). These could include *financial institution and/or market failures*. *Less dramatically*, these consequences might include *significant losses to financial institutions* or *substantial financial-market price volatility*. In either case, the consequences *impact financial institutions, markets, or both*.

Banks and other financial institutions are important sources of capital. Therefore, their failure, especially in large numbers, can deprive society of capital and increase its cost. Increases in the cost of capital, or decreases in its availability, are the most serious direct consequences of a systemic failure. The classic example of systemic risk in this context is a „bank run," in which the inability of a bank to satisfy withdrawal-demands causes its failure, in turn causing other banks or their creditors to fail. The chain of subsequent failures can occur because banks are closely intertwined financially. They lend to and borrow from each other, hold deposit balances with each other, and make payments through the interbank clearing system (whereby banks with equity and deposit accounts exceeding their liabilities can offer these excess funds to other banks who wish to increase loans to their customers). Although *a chain of bank failures* remains an important symbol of systemic risk, the ongoing trend towards disintermediation - or enabling companies to access the ultimate source of funds, the capital markets, without going through banks or other financial intermediaries - is making these failures less critical than in the past. Companies today are able to obtain most of their financing through the capital markets without the use of intermediaries. As a result, capital markets themselves are increasingly central to any examination of systemic risk. Systemic disturbances can erupt outside the international banking system and spread through capital-market linkages, rather than merely through banking relationships.

Under modern finance theory, investors and other market participants can protect themselves from risk by diversifying their investments. To the extent risk is negatively correlated, or uncorrelated, with market risk, the randomly distributed risks of a diversified investment portfolio "would tend to cancel out, producing a riskless portfolio." To the extent systemic risk affects markets, however, it is positively correlated with the markets and cannot be diversified away. The near-failure of Long-Term Capital Management ("LTCM") helps to illustrate the potential for this type of systemic risk. To avoid loses for hundreds of millions of dollars and raising the cost of capital, the Federal Reserve proactively stepped in to broker a settlement of LTCM's debts. There are overall similarities, however, between *bank systemic risk* and the kind of *systemic risk represented by LTCM*. In both, market shocks triggered institutional failures which in turn led, or could have led, to a chain of institutional and market failures. Both also were transmitted through linkages in a chain of relationships: in bank systemic risk, the linkages are interbank borrowings and the interbank clearing system for payments; in LTCM, the linkages arose from its derivatives-based hedging strategy with other institutions, which, in turn, had linkages with yet other institutions and markets.

Institutional systemic risk and market systemic risk therefore should not be viewed each in isolation. Institutions and markets can be involved in both. Another way to think about systemic risk is that its focus is sometimes on critical financial intermediaries, like banks, that are pivotal to the funding of companies, and other times its focus is on markets and/or institutions, such as hedge funds, that are either not financial intermediaries or at least not critical financial intermediaries. This integrated perspective is useful because a chain of failures of critical financial intermediaries, by definition, would significantly affect the availability and cost of capital. Synthesizing these factors, a working definition of systemic risk could be: the risk that (a) an economic shock such as market or institutional failure triggers (through a panic or otherwise) either the failure of a chain of markets or institutions or a chain of significant losses to financial institutions, (b) resulting in increases in the cost of capital or decreases in its availability, often evidenced by substantial financial-market price volatility.

This definition must be clarified in two ways. First, systemic risk should be distinguished from downturns that are caused by normal market swings. Although these downturns are sometimes conflated with systemic risk, they are more appropriately labeled systematic risk, meaning risk that cannot be diversified away and therefore affects most, if not all, market participants. As regulators call for management of systemic risk, it is important not to constrain market freedom in ways that deter systematic risk, which facilitates market equilibrium and curbs excessive interest rates or periods of inflation. Second, systemic risk is an economic, not a political, definition. It should not be used uncritically as an ex post political label for any large financial failure or downturn.

2.Integrated Models for Systemic Risk Surveillance and Stress Testing of Banking Systems

The primary mandate of central banks is to achieve and maintain price stability. Safeguarding and maintaining financial stability has always been regarded as a necessary prerequisite for this task. Institutionally, this combination of tasks was until very recently achieved by putting the central bank in charge of the oversight of individual financial institutions. More countries, from EU, have transferred responsibility for the oversight of individual financial institutions to some newly established financial supervisory authorities, while the central banks kept the mandate to safeguard and maintain systemic financial stability. These institutional changes have forced central banks to develop integrated models – such as *Systemic Risk Monitor* (SRM) - for maintaining systemic financial stability without having ultimate responsibility for the oversight of individual financial institutions and off-site banking supervision. The technical purposes of a systemic risk monitor could be to assess systemic risk in the banking system at a quarterly frequency and also to perform regular stress testing exercises. The basic idea of a systemic risk model is to combine standard techniques from modern quantitative market and credit risk management with a network model of the banking system. In contrast to standard risk management models, systemic risk model makes the step from the individual institution perspective to the system level. This step is the major challenge to be met by any systemic risk model. Only at the system level the two major reasons for simultaneous problems become visible: correlated exposures and financial interlinkages. The risk of simultaneous difficulties of institutions and the financial losses incurred in such events is the key focus of systemic financial stability analysis. Conceptually, it is possible to take this perspective by carrying out a systematic analysis of the impact of a set of market and macroeconomic risk factors on banks in combination with a network model of mutual credit relations. Whereas the modeling of noninterbank market and credit losses is rooted in standard quantitative risk management techniques, the combination with an interbank network model to arrive at total gains and losses in the banking system in a monitoring systemic risk model is new. Both the generalizations of standard individual risk management techniques and the simultaneous consideration of portfolio values across the system for given risk factor changes as well as the resolution of bilateral claims via a network clearing model focus on the main issues for an institution in charge of monitoring systemic financial stability: the probability of joint problems of institutions and their financial consequences. The system perspective un-covers exposures to aggregate risk that remains invisible for banking supervision that relies on the assessment of single institutions only. There are distinguishing problems caused directly by a macroeconomic shock from those triggered by problems of other banks in the interbank market.

2.1.An overview of the general ideas used by systemic risk model

The basic structure of the systemic risk preventing model can be described showing the individual model components as well as their interrelation: *market risk losses*, *noninterbank credit risk losses* and *interbank network model*.

Systemic Risk Surveillance model may describe a National Banking System at the end of each quarter as a system of portfolios. Each portfolio in the system belongs to one bank. It typically consists of collections of securities (stocks and bonds across domestic and foreign markets reflecting the market risk losses), a collection of corporate loans and loans to households (reflecting the noninterbank credit risk losses) as well as interbank positions (reflecting the interbank network model). The value of each portfolio is observed from the data at the end of each quarter. The future portfolio values one quarter later are random variables. Thus the difference between the portfolios values at the observation date and the portfolio values a quarter from the observation date (i.e. the gains and losses in the banking system), is subject to uncertainty. It is *the distribution* of these *gains* and *losses* that makes the subject. The usual risk management practices consist of imagining of future portfolio values as a function of time as well as of *risk factors*. Risk factors are market prices that determine portfolio values (stock market indices, interest rates and foreign ex-change rates), as well as macroeconomic variables that have an impact on the quality of loan portfolios. All individual modeling steps as well as the practical challenges that arise in systemic risk surveillance have to do with the details of *how describing* the *functional relation between risk factor changes and portfolio losses.* In systemic risk surveillance a *multivariate risk factor change distribution* is estimated every quarter based on *past observations* of *market price changes* and *changes of macroeconomic variables* that have an impact on problem event probabilities. The modeling strategy treats *the marginal risk factor distributions* and the *dependency structure* separately. Together, the marginal distributions and fitting a grouped t-copula to the data characterize the multivariate risk factor change distribution. Each drawing of risk factor changes from the multivariate distribution characterizes a scenario. Scenarios could be then translated into profits and losses at the system level in two steps. In a first step each scenario should be analyzed with respect to its impact on the value of market and noninterbank credit positions. In a second step, these positions should be combined with the network model. Thus the network model combines all financial positions and bank capital in an overall system of bank net values. The net-work model does this by applying a clearing procedure that provides the final system of bank net values for each scenario. Simulating many scenarios, we get a distribution of problem events and gains and losses that allows us to make probability assignments for problem events over a three-month horizon. The *market risk losses* and the *losses from noninterbank credit risk* are generated by two sub models that ***translate scenarios of risk factor changes*** *into the respective* ***scenario losses***: a market and a credit risk model. Systemic risk surveillance has to use ***a credit risk model*** to calculate losses from loan portfolios and it has to be carefully adapted to explicitly take into account the dependency of default rates on the state of the macro economy. The default probability of a loan in a particular industry sector depends on a set of macroeconomic variables according to a function the parameters of which are statistically estimated from historical data. Given a realization of macroeconomic variables and the implied probability of default for different industry sectors, a loan loss distribution can be derived for each bank for each value of macroeconomic risk factor changes. Loan losses are then calculated by independent draws from these loan loss distributions.

The Credit Risk Models

The last decade credit risk modelling has been evolving faster than ever and many commercially available models have appeared on the market. This phenomenon could be explained mainly by the two following reasons. The first reason is the Basel II Capital Accord. The three pillars of the recently reinforced Basel Capital Accord, are, (1) minimum capital requirements, (2) supervisory review of an institution's capital adequacy and internal assessment process, and (3) market discipline through disclosure of banking practices. In particular, with the Basel Capital Accord of 1998, banks around the world have been allowed to assess regulatory capital issues related to credit risk using internal models. The second reason is the development of the securitization of bond portfolios that has brought to light the need for quantitative estimation of credit risks. In the following sections we are going to present the most well known approaches to credit risk measurement.

Traditional methods try to estimate the probability of default (denoted PD), rather than the potential losses in the event of default (denoted LGD = the loss given default). Furthermore, these models typically specify "failure" to be bankruptcy filing, default, or liquidation, thereby ignoring consideration of the downgrades and upgrades in credit quality that are measured in mark to market models. The three broad categories of traditional models used to *estimate the probability of default* are: (1) Expert systems, including artificial neural networks; (2) Rating systems; (3) Credit scoring models.

Modern methodologies of credit risk measurement can be divided in two alternative approaches with respect to their relationship with *the asset pricing literature* of academic finance and to accomplish the estimation of default probabilities: the options-theoretic structural approach and a reduced form approach utilizing intensity-based models to estimate stochastic hazard rates. The *structural approach* models the economic process of default (calculating the firm's Distance to Default, KMV Expected Default Frequency – EDF – scores, KMV EDF scores for private firms); whereas *reduced form models* decompose risky debt prices in order to estimate the random intensity process underlying default.

Exposure models estimate credit exposure conditional on a default event (are complements to all of the above models). They are statements about how much is at risk in a given facility, not the probability of default for these facilities. Exposure models also include estimations of the recovery rate, which vary by collateral type, seniority, and industry.

Portfolio`s are also complements to above models. Given probabilities of default and the exposure for each transaction in a portfolio, a summing up is required. Due to correlations and the asymmetry of debt returns (as opposed to equity returns) it has to use the correlations of these exposures and then calculate extreme of the portfolio valuation (the 99.9% adverse value of the portfolio). Examples include *Credit-Metrics*, *Credit-Risk+*, and rating agency standards for evaluating diversification in CDOs (collateralized debt obligations).

Hybrid models (Moody's model) combine two credit risk modelling approaches: (a) a structural model based on Merton's options-theoretic view of firms, and (b) a statistical model (a statistical reduced form model using a non-linear regression approach) determined through empirical analysis of historical data. The key inputs to this hybrid model are: (a) agency rating when available, (b) modified version of the Merton model (expressed as *a distance to default*), (c) company financial statement information, (d) additional equity market information; and (e) macroeconomic variables that represent snapshots of the state of the economy or of specific industries which are used for preprocessing model inputs. KMV, EDF RiskCalc v3.1 is a powerful default prediction technology available for assessing middle market credit risk. Over the past decade, Moody's KMV has refined its techniques for gauging credit quality in the middle market. The EDF RiskCalc v3.1 model outperforms all other models examined by substantial margins, both in terms of predictive power and in terms of the accuracy of the probabilities that are produced by the models.

2.2.Using Systemic Risk Surveillance for Stress Testing

One advantage of a quantitative model is that it allows the consideration of hypothetical situations. In the context of *systemic risk assessment*, one kind of thought experiment is of particular importance. Usually it is of interest to know how the risk measures for the banking system will behave when there are extreme risk factor changes. Such thought experiments are known as stress tests. Systemic risk monitor provides a coherent framework to consistently conduct such stress testing exercises. In a stress test, one or more risk factors of interest are constrained to take extreme values, like a certain drop in GDP (gross domestic product) or a hike in interest rates. Since a complete model of the multivariate risk factor distribution is defined then can be performed a model simulation under the constraint that certain risk factors are at their stressed values. The risk measures of the model can then be studied relative to the baseline simulation based on the unconditional risk factor change distribution calibrated to historical data. The main advantage of this approach is its consistency with the dependency structures of the risk factors and therefore its consistency with the quantitative framework.

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